KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

Estd : 1984

REGULATIONS, CURRICULUM & SYLLABI – 2022

**(CHOICE BASED CREDIT SYSTEM AND
OUTCOME BASED EDUCATION)**

(For the students admitted during 2022 - 2023 and onwards)

BACHELOR OF ENGINEERING DEGREE
IN
AUTOMOBILE ENGINEERING

DEPARTMENT OF AUTOMOBILE ENGINEERING

KONGU
Assuring the Best

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KONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 060
(Autonomous)

INSTITUTE VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Sciences, Technology, Engineering and Management for the Nation and beyond.

INSTITUTE MISSION

We are committed to value based Education, Research and Consultancy in Engineering and Management and to bring out technically competent, ethically strong and quality professionals to keep our Nation ahead in the competitive knowledge intensive world.

QUALITY POLICY

We are committed to

- Provide value based quality education for the development of students as competent and responsible citizens.
- Contribute to the nation and beyond through research and development
- Continuously improve our services

DEPARTMENT OF AUTOMOBILE ENGINEERING

VISION

To be a centre of excellence for development and dissemination of knowledge in Automobile Engineering for the Nation and beyond.

MISSION

Department of Automobile Engineering is committed to:

MS1: Establish an academic center to develop quality automotive engineers through professional teaching learning process.

MS2: Develop research interest among the graduates through state of the art facilities.

MS3: Promote innovation and industrial consultancy to meet the societal needs.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of Automobile Engineering will

PEO1: Pursue successful career in the domain of design, analysis, testing and diagnostics that meets the needs of global industries

PEO2: Habituate continuous learning to carry out research and development activities for solving real time multi-disciplinary problems

PEO3: Demonstrate entrepreneurial skills and contribute to the society as an ethical and responsible citizen

MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

MS\PEO	PEO1	PEO2	PEO3
MS1	3	3	2
MS2	3	3	2
MS3	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

PROGRAM OUTCOMES (POs)	
Graduates of Automobile Engineering will**:**	
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)	
Graduates of Automobile Engineering will**:**	
PSO1	Analyze the functioning of automotive engine, transmission, chassis and other mechanical Systems
PSO2	Examine the electrical and electronic systems related to various automotive applications

MAPPING OF PEOs WITH POs AND PSOs

PEO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
PEO1	3	3	3	3	3	3	3	2	2	3	2	3	3	3
PEO2	3	3	3	3	3	3	3	2	2	3	2	2	3	3
PEO3	2	2	2	2	3	3	3	3	3	3	3	2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638060

(Autonomous)

REGULATIONS 2022

CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION

BACHELOR OF ENGINEERING (BE) / BACHELOR OF TECHNOLOGY (BTech) DEGREE PROGRAMMES

These regulations are applicable to all candidates admitted into BE/BTech Degree programmes from the academic year 2022 – 2023 onwards.

1. DEFINITIONS AND NOMENCLATURE

In these Regulations, unless otherwise specified:

i. "University" means ANNA UNIVERSITY, Chennai.

ii. "College" means KONGU ENGINEERING COLLEGE.

iii. "Programme" means Bachelor of Engineering (BE) / Bachelor of Technology (BTech) Degree programme

iv. "Branch" means specialization or discipline of BE/BTech Degree programme, like Civil Engineering, Information Technology, etc.

v. "Course" means a Theory / Theory cum Practical / Practical course that is normally studied in a semester like Mathematics, Physics etc.

vi. "Credit" means a numerical value allocated to each course to describe the candidate's workload required per week.

vii. "Grade" means the letter grade assigned to each course based on the marks range specified.

viii. "Grade point" means a numerical value (0 to 10) allocated based on the grade assigned to each course.

ix. "Principal" means Chairman, Academic Council of the College.

x. "Controller of Examinations (COE)" means authorized person who is responsible for all examination related activities of the College.

xi. "Head of the Department (HOD)" means Head of the Department concerned.

2. PROGRAMMES AND BRANCHES OF STUDY

The following programmes and branches of study approved by Anna University, Chennai and All India Council for Technical Education, New Delhi are offered by the College.

Programme	Branch
BE	Civil Engineering
	Mechanical Engineering
	Electronics and Communication Engineering
	Computer Science and Engineering
	Electrical and Electronics Engineering
	Electronics and Instrumentation Engineering
	Mechatronics Engineering
	Automobile Engineering
	Computer Science and Design
BTech	Chemical Engineering
	Information Technology
	Food Technology
	Artificial Intelligence and Data Science
	Artificial Intelligence and Machine Learning

3. ADMISSION REQUIREMENTS

3.1 First Semester Admission

The candidates seeking admission to the first semester of the eight semester BE / BTech Degree Programme:

Should have passed the Higher Secondary Examination (10 + 2) in the academic stream with Mathematics, Physics and Chemistry as three of the four subjects of study under Part-III subjects of the study conducted by the Government of Tamil Nadu or any examination of any other University or authority accepted by the Anna University, Chennai as equivalent thereto.

(OR)

Should have passed the Higher Secondary Examination of Vocational stream (Vocational groups in Engineering / Technology) as prescribed by the Government of Tamil Nadu.

They should also satisfy other eligibility conditions as prescribed by the Anna University, Chennai and Directorate of Technical Education, Chennai from time to time.

3.2 Lateral Entry Admission

The candidates who hold a Diploma in Engineering / Technology awarded by the State Board of Technical Education, Tamilnadu or its equivalent are eligible to apply for Lateral entry admission to the third semester of BE / BTech.

(OR)

The candidates who hold a BSc degree in Science(10+2+3 stream) with mathematics as one of the subjects at the BSc level from a recognised University are eligible to apply for Lateral entry admission to the third semester of BE / BTech. Such candidates shall undergo two additional Engineering course(s) in the third and fourth semesters as prescribed by the College.

They should also satisfy other eligibility conditions prescribed by the Anna University, Chennai and Directorate of Technical Education, Chennai from time to time.

4. STRUCTURE OF PROGRAMMES

4.1 Categorisation of Courses

The BE / BTech programme shall have a curriculum with syllabi comprising of theory, theory cum practical, practical courses in each semester, professional skills training/industrial training, project work, internship, etc that have been approved by the respective Board of Studies and Academic Council of the College. All the programmes have well defined Programme Outcomes (PO), Programme Specific Outcomes (PSO) and Programme Educational Objectives (PEOs) as per Outcome Based Education (OBE). The content of each course is designed based on the Course Outcomes (CO). The courses shall be categorized as follows:

i. Humanities and Social Sciences (HS) including Management Courses, English Communication Skills, Universal Human Values and Yoga & Values for Holistic Development.
ii. Basic Science (BS) Courses
iii. Engineering Science (ES) Courses
iv. Professional Core (PC) Courses
v. Professional Elective (PE) Courses
vi. Open Elective (OE) Courses
vii. Employability Enhancement Courses (EC) like Project work, Professional Skills/Industrial Training, Comprehensive Test & Viva, Entrepreneurships/Start ups and Internship / In-plant Training in Industry or elsewhere
viii. Audit Courses (AC)
ix. Mandatory Courses (MC) like Student Induction Program and Environmental Science.
x. Honours Degree Courses (HC)

4.2 Credit Assignment and Honours Degree

4.2.1. Credit Assignment

Each course is assigned certain number of credits as follows:

Contact period per week	Credits
1 Lecture / Tutorial Period	1
2 Practical Periods	1
2 Project Work Periods	1
40 Training / Internship Periods	1

The minimum number of credits to complete the BE/BTech programme is 168.

4.2.2 Honours Degree

If a candidate earns 18 to 20 additional credits in an emerging area, then he/she can be awarded with Honours degree mentioning that emerging area as his/her specialization. The respective board of studies shall recommend the specializations for honours degree and appropriate additional courses to be studied by the candidate which shall get approval from Academic Council of the institution. A candidate shall have not less than 7.5 CGPA and no history of arrears to opt for the honours degree and has to maintain the same during the entire programme.

Various specializations for various branches recommended by the respective boards of studies are given below:

SNo	Specializations for Honours degree in emerging areas	To be offered as Honours, Only for the following branches mentioned against the specialization
1.	Construction Technology	BE – Civil Engineering
2.	Smart Cities	BE – Civil Engineering
3.	Smart Manufacturing *	BE – Mechanical Engineering
4.	Computational Product Design *	BE – Mechanical Engineering
5.	Intelligent Autonomous Systems *	BE – Mechatronics Engineering
6.	E-Mobility *	BE – Automobile Engineering
7.	Artificial Intelligence and Machine Learning	BE – Electronics and Communication Engineering
8.	System on Chip Design *	BE – Electronics and Communication Engineering
9.	Electric Vehicles	BE – Electrical and Electronics Engineering
10.	Microgrid Technologies	BE – Electrical and Electronics Engineering
11.	Intelligent Sensors Technology *	BE – Electronics and Instrumentation Engineering
12.	Smart Industrial Automation *	BE – Electronics and Instrumentation Engineering
13.	Data Science	BE – Computer Science and Engineering
14.	Cyber Security	BE – Computer Science and Engineering
15.	Data Science	BTech – Information Technology
16.	Cyber Security	BTech – Information Technology
17.	Petroleum and Petrochemical Engineering *	BTech – Chemical Engineering
18.	Waste Technology *	BTech – Chemical Engineering
19.	Food Processing and Management *	BTech – Food Technology
20.	Virtual and Augumented Reality	BE- Computer Science and Design
21.	Data Science	BE- Computer Science and Design
22.	Internet of Things (IoT)	BTech – Artificial Intelligence and Data Science
23.	Blockchain	BTech – Artificial Intelligence and Data Science

24.	Internet of Things (IoT)	BTech – Artificial Intelligence and Machine Learning
25.	Blockchain	BTech – Artificial Intelligence and Machine Learning

*Title by KEC

The courses specified under Honours degree in the emerging area may include theory, theory cum practical, practical, project work, etc. under the particular specialization. A candidate can choose and study these specified courses from fourth semester onwards and he/she shall successfully complete the courses within the stipulated time vide clause 5. Total number of credits earned in each semester may vary from candidate to candidate based on the courses chosen. The registration, assessment & evaluation pattern and classification of grades of these courses shall be the same as that of the courses in the regular curriculum of the programme of the candidate vide clause 6, clause 7 and clause 15 respectively. A candidate can earn Honours degree in only one specialization during the entire duration of the programme.

4.3 Employability Enhancement Courses

A candidate shall be offered with the employability enhancement courses like project work, internship, professional skills training/industrial training, comprehensive test & viva, and entrepreneurships/start ups during the programme to gain/exhibit the knowledge/skills.

4.3.1 Professional Skills Training/ Indsutrial Training/Entrepreneurships/Start Ups/ Inplant Training

A candidate may be offered with appropriate training courses imparting programming skills, communication skills, problem solving skills, aptitude skills etc. It is offered in two phases as phase I in fourth semester and phase II in fifth semester including vacation periods and each phase can carry two credits.

(OR)

A candidate may be allowed to go for training at research organizations or industries for a required number of hours in fifth semester vacation period. Such candidate can earn two credits for this training course in place of Professional Skills Training course II in fifth semester. He/She shall attend Professional Skills Training Phase I in fourth semester and can earn two credits.

(OR)

A candidate may be allowed to set up a start up and working part-time for the start ups by applying his/her innovations and can become a student entrepreneur during BE/BTech programme. Candidates can set up their start up from fifth semester onwards either inside or outside of the college. Such student entrepreneurs may earn 2 credits in place of Professional Skills Training II. The area in which the candidate wants to initiate a start up may be interdisciplinary or multidisciplinary. The progress of the startup shall be evaluated by a panel of members constituted by the Principal through periodic reviews.

4.3.2 Comprehensive Test and Viva

The overall knowledge of the candidate in various courses he/she studied shall be evaluated by (i) conducting comprehensive tests with multiple choice questions generally with pattern similar to GATE and/or (ii) viva-voce examination conducted by a panel of experts assigned by the Head of the department. The members can examine the knowledge of the candidate by asking questions from various domains and the marks will be assigned based on their answers. This course shall carry two credits.

4.3.3 Full Time Project through Internships

The curriculum enables a candidate to go for full time project through internship during a part of seventh semester and/or entire final semester and can earn credits vide clause 7.6 and clause 7.11.

A candidate is permitted to go for full time projects through internship in seventh semester with the following condition: The candidate shall complete a part of the seventh semester courses with a total credit of about 50% of the total credits of seventh semester including Project Work-II Phase-I in the first two months from the commencement of the seventh semester under fast track mode. The balance credits required to complete the seventh semester shall be earned by the candidate through either approved One/Two Credit Courses /Online courses / Self Study Courses or Add/Drop courses as per clause 4.4 and clause 4.5 respectively.

A candidate is permitted to go for full time projects through internship during eighth semester. Such candidate shall earn the minimum number of credits required to complete eighth semester other than project through either approved One / Two Credit Courses /Online courses / Self Study Courses or Add/Drop courses as per clause 4.4 and clause 4.5 respectively.

Assessment procedure is to be followed as specified in the guidelines approved by the Academic Council.

4.3.4 A student shall go for in-plant training for duration of two weeks during the entire programme. It is mandatory for all the students.

4.4 One / Two Credit Courses / Online Courses / Self Study Courses

The candidates may optionally undergo One / Two Credit Courses / Online Courses / Self Study Courses as elective courses.

4.4.1 **One / Two Credit Courses:** One / Two credit courses shall be offered by the college with the prior approval from respective Board of Studies. A candidate can earn a maximum of six credits through one / two credit courses during the entire duration of the programme.

4.4.2 **Online Courses:** Candidates may be permitted to earn credits for online courses, offered by NPTEL / SWAYAM / a University / Other Agencies, approved by respective Board of Studies.

4.4.3 **Self Study Courses:** The Department may offer an elective course as a self study course. The syllabus of the course shall be approved by the respective Board of Studies. However, mode of assessment for a self study course will be the same as that used for other courses. The candidates shall study such courses on their own under the guidance of member of the faculty following due approval procedure. Self study course is limited to one per semester.

4.4.4 The elective courses in the final year may be exempted if a candidate earns the required credits vide clause 4.4.1, 4.4.2 and 4.4.3 by registering the required number of courses in advance.

4.4.5 A candidate can earn a maximum of 30 credits through all one / two credit courses, online courses and self study courses.

4.5 Flexibility to Add or Drop Courses

4.5.1 A candidate has to earn the total number of credits specified in the curriculum of the respective programme of study in order to be eligible to obtain the degree. However, if the candidate wishes, then the candidate is permitted to earn more than the total number of credits prescribed in the curriculum of the candidate's programme.

4.5.2 From the first to seventh semesters the candidates have the option of registering for additional elective/Honours courses or dropping of already registered additional elective/Honours courses within two weeks from the start of the semester. Add / Drop is only an option given to the candidates.

4.6 Maximum number of credits the candidate can enroll in a particular semester cannot exceed 30 credits.

4.7 The blend of different courses shall be so designed that the candidate at the end of the programme would have been trained not only in his / her relevant professional field but also would have developed to become a socially conscious human being.

4.8 The medium of instruction, examinations and project report shall be English.

5. DURATION OF THE PROGRAMME

5.1 A candidate is normally expected to complete the BE / BTech Degree programme in 8 consecutive semesters/4 Years (6 semesters/3 Years for lateral entry candidate), but in any case not more than 14 semesters/7 Years (12 semesters/6 Years for lateral entry candidate).

5.2 Each semester shall consist of a minimum of 90 working days including continuous assessment test period. The Head of the Department shall ensure that every teacher imparts instruction as per the number of periods specified in the syllabus for the course being taught.

5.3 The total duration for completion of the programme reckoned from the commencement of the first semester to which the candidate was admitted shall not exceed the maximum duration specified in clause 5.1 irrespective of the period of break of study (vide clause 11) or prevention (vide clause 9) in order that the candidate may be eligible for the award of the degree (vide clause 16). Extension beyond the prescribed period shall not be permitted.

6. COURSE REGISTRATION FOR THE EXAMINATION

6.1 Registration for the end semester examination is mandatory for courses in the current semester as well as for the arrear courses failing which the candidate will not be permitted to move on to the higher semester. This will not be applicable for the courses which do not have an end semester examination.

6.2 The candidates who need to reappear for the courses which have only continuous assessment shall enroll for the same in the subsequent semester, when offered next, and repeat the course. In this case, the candidate shall attend the classes, satisfy the attendance requirements (vide clause 8) and earn continuous assessment marks. This will be considered as an attempt for the purpose of classification.

6.3 If a candidate is prevented from writing end semester examination of a course due to lack of attendance, the candidate has to attend the classes, when offered next, and fulfill the attendance requirements as per clause 8 and earn continuous assessment marks. If the course, in which the candidate has a lack of attendance, is an elective, the candidate may register for the same or any other elective course in the subsequent semesters and that will be considered as an attempt for the purpose of classification.

6.4 A candidate shall register for the chosen courses as well as arrear courses (if any vide clause 6.2 and 6.3) from the list of courses specified under Honours degree.

7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS

7.1 The BE/BTech programmes consist of Theory Courses, Theory cum Practical courses, Practical courses, Comprehensive Test and Viva, Project Work, Industrial Training /Professional Skills Training, Internship/In-plant Training and Entrepreneurships/ Start ups. Performance in each course of study shall be evaluated based on (i) Continuous Assessments (CA) throughout the semester and (ii) End Semester Examination (ESE) at the end of the semester except for the courses which are evaluated based on continuous assessment only. Each course shall be evaluated for a maximum of 100 marks as shown below:

Sl. No.	Category of Course	Continuous Assessment Marks	End Semester Examination Marks
1.	Theory	40	60
2.	Theory cum Practical (The distribution of marks shall be decided based on the credit weightage assigned to theory and practical components.)	50	50
3.	Practical	60	40
4.	Professional Skills Training / Comprehensive Test & Viva / Entrepreneurships / Start ups / Project Work I / Mandatory Course/Industrial Training/ Universal Human Values / Yoga and Values for Holistic Development	100	---
5.	Project Work II Phase I / Project Work II Phase II / Internships	50	50
6.	One / Two credit Course	The distribution of marks shall be decided based on the credit weightage assigned	---
7.	All other Courses		

7.2 Examiners for setting end semester examination question papers for theory courses, theory cum practical courses and practical courses and evaluating end semester examination answer scripts, project works, internships and entrepreneurships/start ups shall be appointed by the Controller of Examinations after obtaining approval from the Principal.

7.3 Theory Courses

For all theory courses out of 100 marks, the continuous assessment shall be 40 marks and the end semester examination shall be for 60 marks. However, the end semester examinations shall be conducted for 100 marks and the marks obtained shall be reduced to 60. The continuous assessment tests shall be conducted as per the schedule laid down in the academic schedule. The total of the continuous assessment marks and the end semester examination marks shall be rounded off to the nearest integer.

7.3.1 The assessment pattern for awarding continuous assessment marks shall be as follows:

Sl. No.	Type	Max. Marks	Remarks
1.	Test - I	20	Average of best 2 tests (20 marks)
	Test - II	20	
	Test - III	20	
2.	Tutorial: (Tutorial/Problem Solving (or) Simulation (or) Simulation & Mini Project (or) Mini Project (or) Case Studies (or) Any other relevant to the course)	15	Type of assessment is to be chosen based on the nature of the course and to be approved by Principal
3.	Others: Assignment / Paper Presentation in Conference / Seminar / Comprehension / Activity based learning / Class notes	05	To be assessed by the Course Teacher based on any one type.
	Total	40	Rounded off to the one decimal place

However, the assessment pattern for awarding the continuous assessment marks may be changed based on the nature of the course and is to be approved by the Principal.

7.3.2 A reassessment test or tutorial covering the respective test or tutorial portions may be conducted for those candidates who were absent with valid reasons (Sports or any other reason approved by the Principal).

7.3.3 The end semester examination for theory courses shall be for a duration of three hours and shall be conducted between November and January during odd semesters and between April and June during even semesters of every year.

7.4 Theory cum Practical Courses

For courses involving theory and practical components, the evaluation pattern as per the clause 7.1 shall be followed. Depending on the nature of the course, the end semester examination shall be conducted for theory and the practical components. The apportionment of continuous assessment and end semester examination marks shall be decided based on the credit weightage assigned to theory and practical components approved by Principal.

7.5 Practical Courses

For all practical courses out of 100 marks, the continuous assessment shall be for 60 marks and the end semester examination shall be for 40 marks. Every exercise / experiment shall be evaluated based on the candidate's performance during the practical class and the candidates' records shall be maintained.

7.5.1 The assessment pattern for awarding continuous assessment marks for each course shall be decided by the course coordinator based on rubrics of that particular course, and shall be based on rubrics for each experiment.

7.5.2 The end semester examination shall be conducted for a maximum of 100 marks for duration of 3 hours and reduced to 40 marks. The appointment of examiners and the schedule shall be decided by chairman of Board of Study of the relevant board.

7.6 Project Work II Phase I / Project Work II Phase II

7.6.1 Project work shall be assigned to a single candidate or to a group of candidates not exceeding 4 candidates in a group. The project work is mandatory for all the candidates.

7.6.2 The Head of the Department shall constitute review committee for project work. There shall be two assessments by the review committee during the semester. The candidate shall make presentation on the progress made by him/her before the committee.

7.6.3 The continuous assessment and end semester examination marks for Project Work II Phase I /Project Work II Phase II and the Viva-Voce Examination shall be distributed as below.

Continuous Assessment (Max. 50 Marks)						End Semester Examination (Max. 50 Marks)			
Zeroth Review		Review I (Max.. 20 Marks)		Review II (Max. 30 Marks)		Report Evaluation (Max. 20 Marks)	Viva - Voce (Max. 30 Marks)		
Rv. Com	Super visor	Review Committee (excluding supervisor)	Super visor	Review Committee (excluding supervisor)	Super visor	Ext. Exr.	Super visor	Exr.1	Exr.2
0	0	10	10	15	15	20	10	10	10

7.6.4 The Project Report prepared according to approved guidelines and duly signed by the Supervisor shall be submitted to Head of the Department. The candidate(s) must submit the project report within the specified date as per the academic schedule of the semester. If the project report is not submitted within the specified date then the candidate is deemed to have failed in the Project Work and redo it in the subsequent semester.

7.6.5 If a candidate fails to secure 50% of the continuous assessment marks in the project work, he / she shall not be permitted to submit the report for that particular semester and shall have to redo it in the subsequent semester and satisfy attendance requirements.

7.6.6 The end semester examination of the project work shall be evaluated based on the project report submitted by the candidate in the respective semester and viva-voce examination by a committee consisting of two examiners and supervisor of the project work.

7.6.7 If a candidate fails to secure 50 % of the end semester examination marks in the project work, he / she shall be required to resubmit the project report within 30 days from the date of declaration of the results and a fresh viva-voce examination shall be conducted as per clause 7.6.6.

7.6.8 A copy of the approved project report after the successful completion of viva-voce examination shall be kept in the department library.

7.7 Project Work I / Industrial Training

The evaluation method shall be same as that of the Project Work II as per clause 7.6 excluding 7.6.3, 7.6.5, 7.6.6 and 7.6.7. The marks distribution is given below.

Continuous Assessment (Max. 100 Marks)								
Zeroth Review		Review I (Max.. 20 Marks)		Review II (Max.. 30 Marks)		Review III (Max. 50 Marks)		
						Report Evaluation (Max. 20 Marks)	Viva - Voce (Max. 30 Marks)	
Review Committee	Supervisor	Review Committee (excluding supervisor)	Supervisor	Review Committee (excluding supervisor)	Supervisor	Review Committee	Supervisor	Review Committee
0	0	10	10	15	15	20	10	20

If a candidate fails to secure 50 % of the continuous assessment marks in this course, he / she shall be required to resubmit the project report within 30 days from the date of declaration of the results and a fresh viva-voce examination shall be conducted.

7.8 Professional Skills Training

Phase I training shall be conducted for minimum of 80 hours in 3rd semester vacation and during 4th semester. Phase II training shall be conducted for minimum of 80 hours in 4th semester vacation and during 5th semester. The evaluation procedure shall be approved by the board of the offering department and Principal.

7.9 Comprehensive Test and Viva

A candidate can earn 2 credits by successfully completing this course. The evaluation procedures shall be approved by the Principal.

7.10 Entrepreneurships/ Start ups

A start up/business model may be started by a candidate individually or by a group of maximum of three candidates during the programme vide clause 4.3.1. The head of the department concerned shall assign a faculty member as a mentor for each start up.

A review committee shall be formed by the Principal for reviewing the progress of the Start ups / Business models, innovativeness, etc. The review committee can recommend the appropriate grades for academic performance for the candidate(s) involved in the start ups. This course shall carry a maximum of two credits in fifth semester and shall be evaluated through continuous assessments for a maximum of 100 marks vide clause 7.1. A report about the start ups is to be submitted to the review committee for evaluation for each start up and the marks will be given to Controller of Examinations after getting approval from Principal.

7.11 In-Plant Training

Each candidate shall go for In-Plant training for a duration of minimum of two weeks during the entire programme of study and submit a brief report about the training undergone and a certificate issued from the organization concerned.

7.12 One / Twe Credit Courses

For all one/ two credit courses out of 100 marks, the continuous assessment shall be 50 marks and the model examination shall be for 50 marks. Minimum of two continuous assessments tests shall be conducted during the one / two credit course duration by the offering department concerned. Model examination shall be conducted at the end of the course.

7.13 Online Course

The Board of Studies will provide methodology for the evaluation of the online courses. The Board can decide whether to evaluate the online courses through continuous assessment and end semester examination or through end semester examination only. In case of credits earned through online mode from NPTEL / SWAYAM / a University / Other Agencies approved by Chairman, Academic Council, the credits may be transferred and grades shall be assigned accordingly.

7.14 Self Study Course

The member of faculty approved by the Head of the Department shall be responsible for periodic monitoring and evaluation of the course. The course shall be evaluated through continuous assessment and end semester examination. The evaluation methodology shall be the same as that of a theory course.

7.15 Audit Course

A candidate may be permitted to register for specific course not listed in his/her programme curriculum and without undergoing the rigors of getting a 'good' grade, as an Audit course, subject to the following conditions.

The candidate can register only one Audit course in a semester starting from second semester subject to a maximum of two courses during the entire programme of study. Such courses shall be indicated as 'Audit' during the time of registration itself. Only courses currently offered for credit to the candidates of other branches can be audited.

A course appearing in the curriculum of a candidate cannot be considered as an audit course. However, if a candidate has already met the Professional Elective and Open Elective credit requirements as stipulated in the curriculum, then, a Professional Elective or an Open Elective course listed in the curriculum and not taken by the candidate for credit can be considered as an audit course.

Candidates registering for an audit course shall meet all the assessment and examination requirements (vide clause 7.3) applicable for a credit candidate of that course. Only if the candidate obtains a performance grade, the course will be listed in the semester Grade Sheet and in the Consolidated Grade Sheet along with the grade SC (Successfully Completed). Performance grade will not be shown for the audit course.

Since an audit course has no grade points assigned, it will not be counted for the purpose of GPA and CGPA calculations.

7.16 Mandatory Courses

A candidate joined in first semester shall attend and complete a mandatory course namely Student Induction Program of duration three weeks at the beginning of first semester. The candidates studying in second year shall attend and complete another one mandatory course namely Environmental Science. No credits shall be given for mandatory courses and shall be evaluated through continuous assessment tests only vide clause 7.1 for a maximum of 100 marks each. Upon the successful completion, these courses will be listed in the semester grade sheet and in the consolidated grade sheet with the grade “SC” (Successfully Completed). Since no grade points are assigned, these courses will not be counted for the purpose of GPA and CGPA calculations.

7.17 Universal Human Values (UHV) and Yoga and Values for Holistic Development (YVHD)

Courses YVHD shall be offered to all first year candidates of all BE/ BTech programmes to impart knowledge on yoga and human values. Course UHV shall be offered to all the second year BE/ BTech students. These courses shall carry a maximum of 100 marks each and shall be evaluated through continuous assessment tests only vide clause 7.1. The candidate(s) can earn 2 credits for UHV and 1 credit for YVHD by successfully completing these courses. Two continuous assessment tests will be conducted and the average marks will be taken for the calculation of grades.

8. REQUIREMENTS FOR COMPLETION OF A SEMESTER

8.1 A candidate who has fulfilled the following conditions shall be deemed to have satisfied the requirements for completion of a semester and permitted to appear for the examinations of that semester.

8.1.1 Ideally, every candidate is expected to attend all classes and secure 100 % attendance. However, a candidate shall secure not less than 80 % (after rounding off to the nearest integer) of the overall attendance taking into account the total number of working days in a semester.

8.1.2 A candidate who could not satisfy the attendance requirements as per clause 8.1.1 due to medical reasons (hospitalization / accident / specific illness) but has secured not less than 70 % in the current semester may be permitted to appear for the current semester examinations with the approval of the Principal on payment of a condonation fee as may be fixed by the authorities from time to time. The medical certificate needs to be submitted along with the leave application. A candidate can avail this provision only twice during the entire duration of the degree programme.

A candidate who could not satisfy the attendance requirements as per clause 8.1.1 due to his/her entrepreneurships/ start ups activities, but has secured not less than 60 % in the current semester can be permitted to appear for the current semester examinations with the recommendation of review committee and approval from the Principal.

8.1.3 In addition to clause 8.1.1 or 8.1.2, a candidate shall secure not less than 60 % attendance in each course.

8.1.4 A candidate shall be deemed to have completed the requirements of study of any semester only if he/she has satisfied the attendance requirements (vide clause 8.1.1 to 8.1.3) and has registered for examination by paying the prescribed fee.

8.1.5 Candidate's progress is satisfactory.

8.1.6 Candidate's conduct is satisfactory and he/she was not involved in any indisciplined activities in the current semester.

8.2. The candidates who do not complete the semester as per clauses from 8.1.1 to 8.1.6 except 8.1.3 shall not be permitted to appear for the examinations at the end of the semester and not be permitted to go to the next semester. They have to repeat the incomplete semester in next academic year.

8.3 The candidates who satisfy the clause 8.1.1 or 8.1.2 but do not complete the course as per clause 8.1.3 shall not be permitted to appear for the end semester examination of that course alone. They have to repeat the incomplete course in the subsequent semester when it is offered next.

9. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION

9.1 A candidate shall normally be permitted to appear for end semester examination of the current semester if he/she has satisfied the semester completion requirements as per clause 8, and has registered for examination in all courses of that semester. Registration is mandatory for current semester examinations as well as for arrear examinations failing which the candidate shall not be permitted to move on to the higher semester.

9.2 When a candidate is deputed for a National / International Sports event during End Semester examination period, supplementary examination shall be conducted for such a candidate on return after participating in the event within a reasonable period of time. Such appearance shall be considered as first appearance.

9.3 A candidate who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of letter grades / marks.

10. PROVISION FOR WITHDRAWAL FROM EXAMINATIONS

10.1 A candidate may, for valid reasons, be granted permission to withdraw from appearing for the examination in any regular course or all regular courses registered in a particular semester. Application for withdrawal is permitted only once during the entire duration of the degree programme.

10.2 The withdrawal application shall be valid only if the candidate is otherwise eligible to write the examination (vide clause 9) and has applied to the Principal for permission prior to the last examination of that semester after duly recommended by the Head of the Department.

10.3 The withdrawal shall not be considered as an appearance for deciding the eligibility of a candidate for First Class with Distinction/First Class.

10.4 If a candidate withdraws a course or courses from writing end semester examinations, he/she shall register the same in the subsequent semester and write the end semester examinations. A final semester candidate who has withdrawn shall be permitted to appear for supplementary examination to be conducted within reasonable time as per clause 14.

10.5 The final semester candidate who has withdrawn from appearing for project viva-voce for genuine reasons shall be permitted to appear for supplementary viva-voce examination within reasonable time with proper application to Controller of Examinations and on payment of prescribed fee.

11. PROVISION FOR BREAK OF STUDY

11.1 A candidate is normally permitted to avail the authorised break of study under valid reasons (such as accident or hospitalization due to prolonged ill health or any other valid reasons) and to rejoin the programme in a later semester. He/She shall apply in advance to the Principal, through the Head of the Department, stating the reasons therefore, in any case, not later than the last date for registering for that semester examination. A candidate is permitted to avail the authorised break of study only once during the entire period of study for a maximum period of one year. However, in extraordinary situation the candidate may apply for additional break of study not exceeding another one year by paying prescribed fee for the break of study.

11.2 The candidates permitted to rejoin the programme after break of study / prevention due to lack of attendance shall be governed by the rules and regulations in force at the time of rejoining.

11.3 The candidates rejoining in new Regulations shall apply to the Principal in the prescribed format through Head of the Department at the beginning of the readmitted semester itself for prescribing additional/equivalent courses, if any, from any semester of the regulations in-force, so as to bridge the curriculum in-force and the old curriculum.

11.4 The total period of completion of the programme reckoned from the commencement of the semester to which the candidate was admitted shall not exceed the maximum period specified in clause 5 irrespective of the period of break of study in order to qualify for the award of the degree.

11.5 If any candidate is prevented for want of required attendance, the period of prevention shall not be considered as authorized break of study.

11.6 If a candidate has not reported to the college for a period of two consecutive semesters without any intimation, the name of the candidate shall be deleted permanently from the college enrollment. Such candidates are not entitled to seek readmission under any circumstances.

12. PASSING REQUIREMENTS

12.1 A candidate who secures not less than 50 % of total marks (continuous assessment and end semester examination put together) prescribed for the course with a minimum of 45 % of the marks prescribed for the end semester examination in all category of courses vide clause 7.1 except for the courses which are evaluated based on continuous assessment only shall be declared to have successfully passed the course in the examination.

12.2 A candidate who secures not less than 50 % in continuous assessment marks prescribed for the courses which are evaluated based on continuous assessment only shall be declared to have successfully passed the course. If a candidate secures less than 50% in the continuous assessment marks, he / she shall have to re-enroll for the same in the subsequent semester and satisfy the attendance requirements.

12.3 For a candidate who does not satisfy the clause 12.1, the continuous assessment marks secured by the candidate in the first attempt shall be retained and considered valid for subsequent attempts. However, from the fourth attempt onwards the marks scored in the end semester examinations alone shall be considered, in which case the candidate shall secure minimum 50 % marks in the end semester examinations to satisfy the passing requirements.

13. REVALUATION OF ANSWER SCRIPTS

A candidate shall apply for a photocopy of his / her semester examination answer script within a reasonable time from the declaration of results, on payment of a prescribed fee by submitting the proper application to the Controller of Examinations. The answer script shall be pursued and justified jointly by a faculty member who has handled the course and the course coordinator and recommended for revaluation. Based on the recommendation, the candidate can register for revaluation through proper application to the Controller of Examinations. The Controller of Examinations will arrange for revaluation and the results will be intimated to the candidate concerned. Revaluation is permitted only for Theory courses and Theory cum Practical courses where end semester examination is involved.

14. SUPPLEMENTARY EXAMINATION

If a candidate fails to clear all courses in the final semester after the announcement of final end semester examination results, he/she shall be allowed to take up supplementary examinations to be conducted within a reasonable time for the courses of final semester alone, so that he/she gets a chance to complete the programme.

15. AWARD OF LETTER GRADES:

For all the passed candidates, the relative grading principle is applied to assign the letter grades.

Marks / Examination Status	Letter Grade	Grade Point
Based on the relative grading	O (Outstanding)	10
	A+ (Excellent)	9
	A (Very Good)	8
	B+ (Good)	7
	B (Average)	6
	C (Satisfactory)	5
Less than 50	U (Reappearance)	0
Successfully Completed	SC	0
Withdrawal	W	-
Absent	AB	-
Shortage of Attendance in a	SA	-

course		

The Grade Point Average (GPA) is calculated using the formula:

$$\text{GPA} = \frac{\sum[(\text{course credits}) \times (\text{grade points})] \text{ for all courses in the specific semester}}{\sum(\text{course credits}) \text{ for all courses in the specific semester}}$$

The Cumulative Grade Point Average (CGPA) is calculated from first semester (third semester for lateral entry candidates) to final semester using the formula

$$\text{CGPA} = \frac{\sum[(\text{course credits}) \times (\text{grade points})] \text{ for all courses in all the semesters so far}}{\sum(\text{course credits}) \text{ for all courses in all the semesters so far}}$$

The GPA and CGPA are computed only for the candidates with a pass in all the courses.

The GPA and CGPA indicate the academic performance of a candidate at the end of a semester and at the end of successive semesters respectively.

A grade sheet for each semester shall be issued containing Grade obtained in each course, GPA and CGPA.

A duplicate copy, if required can be obtained on payment of a prescribed fee and satisfying other procedure requirements.

Withholding of Grades: The grades of a candidate may be withheld if he/she has not cleared his/her dues or if there is a disciplinary case pending against him/her or for any other reason.

16. ELIGIBILITY FOR THE AWARD OF DEGREE

A candidate shall be declared to be eligible for the award of the BE / BTech Degree provided the candidate has

i. Successfully completed all the courses under the different categories, as specified in the regulations.
ii. Successfully gained the required number of total credits as specified in the curriculum corresponding to the candidate’s programme within the stipulated time (vide clause 5).
iii. Successfully passed any additional courses prescribed by the respective Board of Studies whenever readmitted under regulations other than R-2022 (vide clause 11.3)
iv. No disciplinary action pending against him / her.

17. CLASSIFICATION OF THE DEGREE AWARDED

17.1 First Class with Distinction:

17.1.1. A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 8.50

(OR)

17.1.2 A candidate who joins from other institutions on transfer or a candidate who gets readmitted and has to move from one regulations to another regulations and who qualifies for the award of the degree (vide clause 16) and satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Submission of equivalent course list approved by the respective Board of studies.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 9.00

17.2 First Class:

A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have passed the examination in First class:

- Should have passed the examination in all the courses of all eight semesters (six semesters for lateral entry candidates) within ten consecutive semesters (eight consecutive semesters for lateral entry candidates) excluding authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from the examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 6.50

17.3 Second Class:

All other candidates (not covered in clauses 17.1 and 17.2) who qualify for the award of the degree (vide clause 16) shall be declared to have passed the examination in Second Class.

17.4 A candidate who is absent for end semester examination in a course / project work after having registered for the same shall be considered to have appeared for that examination for the purpose of classification.

17.5 Honors Degree:

A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have earned the BE/BTech degree with Honours (vide clause 16 and clause 4.2.2):

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 7.50

18. MALPRACTICES IN TESTS AND EXAMINATIONS

If a candidate indulges in malpractice in any of the tests or end semester examinations, he/she shall be liable for punitive action as per the examination rules prescribed by the college from time to time.

19. AMENDMENTS

Notwithstanding anything contained in this manual, the Kongu Engineering College through the Academic council of the College, reserves the right to modify/amend without notice, the Regulations, Curricula, Syllabi, Scheme of Examinations, procedures, requirements, and rules pertaining to its BE / BTech programme.

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CURRICULUM BREAKDOWN STRUCTURE – R2022										
Summary of Credit Distribution										
Category	**Semester**								**Total number of credits**	**Curriculum Content (% of total number of credits of the program)**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
HS									**15**	**8.92**
BS									**20**	**11.9**
ES									**24**	**14.28**
PC									**58**	**34.52**
PE					**3**	**3**	**9**	**3**	**18**	**10.71**
OE					**4**	**4**	**3**	**3**	**14**	**8.33**
EC				**2**	**2**	**6**	**5**	**4**	**19**	**11.30**
MC									**0**	**0**
Semester wise Total	**23**	**24**	**22**	**22**	**24**	**23**	**20**	**10**	**168**	**100.00**

Category	**Abbreviation**
Lecture hours per week	**L**
Tutorial hours per week	**T**
Practical, Project work, Internship, Professional Skill Training, Industrial Training hours per week	**P**
Credits	**C**

CATEGORISATION OF COURSES

HUMANITIES AND SOCIAL SCIENCE INCLUDING MANAGEMENT (HS)

S. No.	Course Code	Course Name	L	T	P	C	Sem
1.	22EGT11	Communication Skills I	3	0	0	3	I
2.	22VEC11	Yoga and Values for Holistic Development	--	--	--	1	I
3.	22EGT21	Communication Skills II	3	0	0	3	II
4.	22TAM01	Heritage of Tamils	1	0	0	1	II
5.	22TAM02	Tamils and Technology	1	0	0	1	III
6.	22EGL31	Communication Skills Development Laboratory	0	0	2	1	III
7.	22GET31	Universal Human Values	2	0	0	2	VI

8.	22GCT71	Engineering Economics and Management	3	0	0	3	VII
						15	

BASIC SCIENCE (BS)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22MAC11	Matrices and Ordinary Differential Equations	3	1	2	4	I
2.	22PHT14	Physics for Automobile Engineering	3	0	0	3	I
3.	22PHL11	Physics Laboratory for Automobile Engineering	0	0	2	1	I
4.	22MAC22	Multivariable Calculus and Partial Differential Equations	3	1	2	4	II
5.	22CYT26	Chemistry for Automobile Engineering	3	0	0	3	II
6.	22CYL22	Chemistry Laboratory for Mechanical Systems	0	0	2	1	II
7.	22MAT41	Numerical Methods for Engineers	3	1	0	4	III
Total Credits to be earned						**20**	

ENGINEERING SCIENCE (ES)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22CSC11	Problem Solving and Programming in C	3	0	2	4	I
2.	22MET11	Engineering Drawing	3	0	0	3	I
3.	22MEL11	Engineering Practices Laboratory	0	0	2	1	I
4.	22CSC21	Fundamentals of Data Structures	3	0	2	4	II
5.	22AUT21	Automotive Engines	3	0	0	3	II
6.	22AUL21	Automotive Engines Laboratory	0	0	2	1	II
7.	22ITC32	Introduction To Python	3	0	2	4	IV
Total Credits to be earned						**20**	

PROFESSIONAL CORE (PC)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream**
1.	22AUT11	Statics and Dynamics	3	0	0	3	I	DSN
2.	22AUC21	Manufacturing Technology	3	0	2	4	II	MFG
3.	22AUC31	Basics of Electrical and Electronics Circuits	3	0	2	4	III	EE
4.	22AUT31	Mechanics of Deformable Bodies	3	1	0	4	III	DSN
5.	22AUT32	Thermodynamics and Thermal Science	3	1	0	4	III	TF
6.	22AUT33	Hydraulics and Pneumatics	3	0	0	3	III	DSN
7.	22AUT34	Automotive Fuels and Lubricants	3	0	0	3	III	TF
8.	22AUL31	Automotive Fuels and Lubricants Laboratory	0	0	2	1	III	TF
9.	22AUL32	Hydraulics and Pneumatics Laboratory	0	0	2	1	III	DSN
10.	22AUC41	Automotive Electrical Systems and Drives	3	1	0	4	IV	DSN
11.	22AUT42	Vehicle Components Design - I	3	0	0	3	IV	AUTO
12.	22AUT43	Automatic Transmission and Control System	3	0	0	3	IV	AUTO
13.	22AUL41	Computer Aided Design Laboratory	0	0	2	1	IV	DSN
14.	22AUL42	Automotive Chassis Components Laboratory	0	0	2	1	IV	AUTO
15.	22AUC51	Vehicle Dynamics	3	0	2	4	V	AUTO
16.	22AUT51	Automotive Sensors and Controllers	3	0	0	3	V	EE
17.	22AUT52	Mechanics of Machines	3	0	0	3	V	DSN
18.	22AUT53	Vehicle Components Design - II	3	0	0	3	V	AUTO
19.	22AUL51	Automotive Sensors and Controllers Laboratory	0	0	2	1	V	EE
20.	22AUL52	Computer Aided Analysis Laboratory	0	0	2	1	V	DSN
21.	22AUT61	Automotive Embedded Systems	3	0	0	3	VI	EE
22.	22AUT62	Modelling of Hybrid and Electric Vehicles	3	0	0	3	VI	AUTO
23.	22AUL61	Automotive Embedded Systems Laboratory	0	0	2	1	VI	EE
24.	22AUL62	Vehicle Maintenance Laboratory	0	0	2	1	VI	AUTO
Total Credits to be earned						**62**		

PROFESSIONAL ELECTIVES (PEs)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Domain/ Stream**
Semester – V							
Elective – I							
1.	22AUE01	Two and Three wheeler Technology	3	0	0	3	AUTO
2.	22AUE02	Diesel and Electric Locomotives	3	0	0	3	AUTO
3.	22AUE03	Computer Integrated Manufacturing	3	0	0	3	MFG
4.	22AUE04	Automotive Control System	3	0	0	3	AUTO
5.	22AUE05	Machine Design	3	0	0	3	DSN
6.	22AUE06	Principles of Farm Machineries	3	0	0	3	DSN
Semester – VI							
Elective – II							
7.	22AUE07	Finite Element Method	3	0	0	3	DSN
8.	22AUE08	In-Vehicle Networking	3	0	0	3	EE
9.	22AUE09	Vehicle Body Engineering	3	0	0	3	AUTO
10.	22AUE10	Operations Research	3	0	0	3	MFG
11.	22AUE11	Vehicle Maintenance	3	0	0	3	AUTO
12.	22AUE12	Composite Materials	3	0	0	3	MFG
Semester – VII							
Elective – III							
13.	22AUE13	CNC and Metrology	3	0	0	3	MFG
14.	22AUE14	Computational Fluid Dynamics	3	0	0	3	TF
15.	22AUE15	Machine Vision And Image Processing	3	0	0	3	AUTO
16.	22AUE16	Automotive Pollution Control	3	0	0	3	AUTO
17.	22AUE17	Total Quality Management	3	0	0	3	MFG
18.	22AUE18	Automotive Noise, Vibration and Harshness	3	0	0	3	AUTO
Elective – IV							
19.	22GEE01	Fundamentals of Research	3	0	0	3	GE
20.	22AUE19	Automotive HVAC	3	0	0	3	TF
21.	22AUE20	Autonomous Vehicle Technology	3	0	0	3	EE
22.	22AUE21	Value Engineering	3	0	0	3	MFG

23.	22AUE22	Design of Engine Components	3	0	0	3	DSN
24.	22AUE23	Mobile Robotics	3	0	0	3	EE
Elective – V							
25.	22AUE24	Automotive Vehicle Safety	3	0	0	3	AUTO
26.	22AUE25	Non Destructive Evaluation Techniques	3	0	0	3	MFG
27.	22AUE26	Quality Assurance and Reliability	3	0	0	3	MFG
28.	22AUE27	Advanced Materials for Green Vehicles	3	0	0	3	MFG
29.	22AUE28	Automotive Testing	3	0	0	3	AUTO
30.	22AUE29	Alternate Energy Sources for Automobiles	3	0	0	3	TF
Semester – VIII							
Elective – VI							
31.	22AUE30	Road Transport Management	3	0	0	3	AUTO
32.	22AUE31	Advanced Theory of IC Engines	3	0	0	3	TF
33.	22AUE32	Automotive Product Life Cycle Management	3	0	0	3	DSN
34.	22AUE33	Process Planning and Cost Estimation	3	0	0	3	MFG
35.	22AUE34	Lean Methods for Automobile Engineers	3	0	0	3	MFG
36.	22AUE35	Automotive Styling and Modeling	3	0	0	3	AUTO
37.	22AUE36	Non-Traditional Machining Processes	3	0	0	3	MFG
Total Credits to be earned						**18**	

***** Domain/Stream Abbreviations: AUTO - Automobile, DSN - Design, EE – Electrical and Electronics, TF – Thermal and Fluid, MFG-Manufacturing, GE – General Engineering

EMPLOYABILITY ENHANCEMENT COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22GCL41/ 22GCI41	Professional Skills Training I / Industrial Training I	--	--	--	2	IV
2.	22GCL51/ 22GCI51	Professional Skills Training II / Industrial Training II	--	--	--	2	V
3.	22AUP61	Project Work I	0	0	4	4	VI
4.	22GEP61	Comprehensive Test and Viva	--	--	--	2	VI
5.	22AUP71	Project Work II Phase I	0	0	8	5	VII
6.	22AUP81	Project Work II Phase II	0	0	14	4	VIII
Total Credits to be earned						**19**	

MANDATORY COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22MNT11	Student Induction Program	--	--	--	0	I
2.	22MNT31	Environmental Science	2	0	0	0	III
Total Credits to be earned						**00**	

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22AUX01	Automotive Engineering	3	0	2	4	IV
2.	22AUO01	Automotive Electronics	3	1	0	4	V
3.	22AUO02	Vehicle Maintenance	3	1	0	4	VI
4.	22AUO03	Public Transport Management	3	0	0	3	VIII
5.	22AUO04	Autonomous Vehicles	3	0	0	3	VIII

OPEN ELECTIVE COURSES OFFERED BY OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**OFFERED BY**
		SEMESTER V					
1.	22CEX01	Remote Sensing and its Applications	3	0	2	4	CIVIL
2.	22MEX01	Renewable Energy Sources	3	0	2	4	MECH
3.	22MTO01	Design of Mechatronics Systems	3	1	0	4	MTS
4.	22MTX01	Data Acquisition and Virtual Instrumentation	3	0	2	4	MTS
5.	22MTX02	Factory Automation	3	0	2	4	MTS
6.	22AUX01	Automotive Engineering	3	0	2	4	AUTO
7.	22ECX01	Basics of Electronics in Automation Appliances	3	0	2	4	ECE
8.	22ECX02	Image Processing	3	0	2	4	ECE
9.	22EEO01	Solar and Wind Energy Systems	3	1	0	4	EEE
10.	22EEO02	Electrical Wiring and Lighting	3	1	0	4	EEE
11.	22EEO03	Programmable Logic Controller and SCADA	3	1	0	4	EEE

12.	22EEO04	Analog and Digital Electronics	3	1	0	4	EEE
13.	22EEO05	Power Electronics and Drives	3	1	0	4	EEE
14.	22EEO06	Sensors and Actuators	3	1	0	4	EEE
15.	22EIO01	Measurements and Instrumentation	3	1	0	4	EIE
16.	22EIO02	Biomedical Instrumentation and Applications	3	1	0	4	EIE
17.	22EIO03	Industrial Automation	3	1	0	4	EIE
18.	22CSX01	Fundamentals of Databases	3	0	2	4	CSE
19.	22CSX02	Data science for Engineers	3	0	2	4	CSE
20.	22CSX03	Enterprise Application Development Using Java	3	0	2	4	CSE
21.	22CSO01	Computational science for Engineers	3	1	0	4	CSE
22.	22CSO02	Formal Languages and Automata Theory	3	1	0	4	CSE
23.	22ITO01	Artificial Intelligence	3	1	0	4	IT
24.	22ITX01	Next Generation Databases	3	0	2	4	IT
25.	22GEX02	NCC Studies (Air Wing) - 1	3	0	2	4	IT
26.	22CDO01	Fundamentals of User Experience Design	3	1	0	4	CSD
27.	22ADO01	Data Warehousing and Data Mining	3	1	0	4	AIDS
28.	22ALO01	Business Intelligence	3	1	0	4	AIML
29.	22CHO01	Industrial Enzymology	3	1	0	4	CHEM
30.	22CHO02	Waste to Energy Conversion	3	1	0	4	CHEM
31.	22CHO03	Applied Nanotechnology	3	1	0	4	CHEM
32.	22FTX01	Baking Technology	3	0	2	4	FT
33.	22FTO01	Food Processing Technology	3	1	0	4	FT
34.	22MAO01	Mathematical Foundations for Machine Learning	3	1	0	4	MATHS
35.	22MAO02	Numerical Computing	3	1	0	4	MATHS
36.	22MAO03	Stochastic Processes and Queuing Theory	3	1	0	4	MATHS
37.	22MAO04	Statistics for Engineers	3	1	0	4	MATHS
38.	22PHO01	Thin Film Technology	3	1	0	4	PHYSICS
39.	22PHO02	High Energy Storage Devices	3	1	0	4	PHYSICS
40.	22PHO03	Structural and Optical Characterization of Materials	3	1	0	4	PHYSICS

41.	22CYO01	Instrumental Methods of Analysis	3	1	0	4	CHEMISTRY
42.	22CYO02	Chemistry Concepts for Competitive Examinations	3	1	0	4	CHEMISTRY
43.	22CYO03	Organic Chemistry for Industry	3	1	0	4	CHEMISTRY
		SEMESTER VI					
44.	22CEO01	Disaster Management	3	1	0	4	CIVIL
45.	22MEX02	Design of Experiments	3	0	2	4	MECH
46.	22MTO02	Robotics	3	1	0	4	MTS
47.	22MTO03	3D Printing and Design	3	1	0	4	MTS
48.	22AUO01	Automotive Electronics	3	1	0	4	ECE
49.	22ECX03	PCB Design and Fabrication	3	0	2	4	ECE
50.	22EEO07	Energy Conservation and Management	3	1	0	4	EEE
51.	22EEO08	Microprocessors and Microcontrollers Interfacing	3	1	0	4	EEE
52.	22EEO09	Electrical Safety	3	1	0	4	EEE
53.	22EEO10	VLSI System Design	3	1	0	4	EEE
54.	22EEO11	Automation for Industrial Applications	3	1	0	4	EEE
55.	22EIO04	PLC Programming with High Level Languages	3	1	0	4	EIE
56.	22EIO05	Virtual Instrumentation	3	1	0	4	EIE
57.	22CSX04	Foundations of Machine Learning	3	0	2	4	CSE
58.	22CSX05	Web Engineering	3	0	2	4	CSE
59.	22ITX02	Advanced Java Programming	3	0	2	4	IT
60.	22ITO02	Internet of Things	3	1	0	4	IT
61.	22ITO03	Fundamentals of Software Development	3	1	0	4	IT
62.	22ITO04	Mobile Application Development	3	1	0	4	IT
63.	22CDX01	Fundamentals of User Interactive Design	3	0	2	4	CSD
64.	22ADX01	Data Visualization	3	0	2	4	AIDS
65.	22ALX01	Data Exploration and Visualization Techniques	3	0	2	4	AIML
66.	22CHO04	Air Pollution Monitoring and Control	3	1	0	4	CHEM
67.	22CHO05	Paints and Coatings	3	1	0	4	CHEM
68.	22CHO06	Powder Technology	3	1	0	4	CHEM
	22FTX02	Processing of milk and milk products	3	0	2	4	FT

	22FTX03	Processing of Fruits and Vegetables	3	0	2	4	FT
69.	22MAO05	Graph Theory and its Applications	3	1	0	4	MATHS
70.	22MAX01	Data Analytics using R Programming	3	0	2	4	MATHS
71.	22MAO06	Operations Research	3	1	0	4	MATHS
72.	22MAO07	Number Theory and Cryptography	3	1	0	4	MATHS
73.	22PHO04	Synthesis, Characterization and Biological Applications of Nanomaterials	3	1	0	4	PHYSICS
74.	22PHO05	Techniques of Crystal Growth	3	1	0	4	PHYSICS
75.	22CYO04	Corrosion Science and Engineering	3	1	0	4	CHEMISTRY
76.	22CYO05	Chemistry of Cosmetics in Daily Life	3	1	0	4	CHEMISTRY
77.	22CYO06	Nanocomposite Materials	3	1	0	4	CHEMISTRY
		SEMESTER VII					
78.	22CEO02	Introduction to Smart Cities	3	0	0	3	CIVIL
79.	22CEO03	Environmental Health and Safety	3	0	0	3	CIVIL
80.	22MEO01	Fundamentals of Ergonomics	3	0	0	3	MECH
81.	22MEO02	Principles of Management and Industrial Psychology	3	0	0	3	MECH
82.	22MEO03	Waste Heat Recovery System and Storage	3	0	0	3	MECH
83.	22MTO04	Drone System Technology	3	0	0	3	MTS
84.	22AUO02	Vehicle Maintenance	3	0	0	3	AUTO
85.	22ECO01	Wearable Devices	3	0	0	3	ECE
86.	22ECX04	Electronic Hardware and Troubleshooting	2	0	2	3	ECE
87.	22EEO12	Electric Vehicle	3	0	0	3	EEE
88.	22EEO13	E-Waste Management	3	0	0	3	EEE
89.	22EEO14	Embedded System Design	3	0	0	3	EEE
90.	22EEO15	Energy Storage Systems and Controllers	3	0	0	3	EEE
91.	22EEO16	AI Techniques for Engineering Applications	3	0	0	3	EEE
92.	22EIO06	Introduction to Distributed Control Systems	3	0	0	3	EIE
93.	22EIO07	Instrumentation in Aircraft Navigation and Control	3	0	0	3	EIE
94.	22EIO08	Industry 4.0 with Industrial IoT	3	0	0	3	EIE
95.	22EIO09	Industrial Data Communication	3	0	0	3	EIE

96.	22EIO10	Wireless Instrumentation	3	0	0	3	EIE
97.	22EIO11	Instrumentation Techniques in Agriculture	3	0	0	3	EIE
98.	22CSO03	Nature Inspired optimization techniques	3	0	0	3	CSE
99.	22ITO05	Fundamentals of Cloud Computing	3	0	0	3	IT
100.	22CDO02	Introduction to Mobile Game Design	3	0	0	3	CSD
101.	22CDO03	Introduction to Graphics Design	3	0	0	3	CSD
102.	22ADO02	Neural Networks and Deep Learning	3	0	0	3	AIDS
103.	22ALO02	Industrial Machine Learning	3	0	0	3	AIML
104.	22CHO07	Hydrogen Energy	3	0	0	3	CHEM
105.	22CHO08	Rubber Technology	3	0	0	3	CHEM
106.	22FTO02	Principles of Food safety	3	0	0	3	FT
107.	22FTO03	Fundamentals of Food Packaging and Storage	3	0	0	3	FT
108.	22MAO08	Non-Linear Optimization	3	0	0	3	MATHS
109.	22MAO09	Optimization for Engineers	3	0	0	3	MATHS
110.	22CYO07	Waste and Hazardous Waste Management	3	0	0	3	CHEMISTRY
111.	22CYO08	Chemistry in Every day Life	3	0	0	3	CHEMISTRY
		SEMESTER VIII					
112.	22CEO04	Infrastructure Planning and Management	3	0	0	3	CIVIL
113.	22CEO05	Environmental Laws and Policy	3	0	0	3	CIVIL
114.	22MEO04	Safety Measures for Engineers	3	0	0	3	MECH
115.	22MEO05	Energy Conservation in Thermal Equipments	3	0	0	3	MECH
116.	22MEO06	Climate Change and New Energy Technology	3	0	0	3	MECH
117.	22MTO05	Micro and Nano Electromechanical Systems	3	0	0	3	MTS
118.	22AUO03	Public Transport Management	3	0	0	3	ECE
119.	22AUO04	Autonomous Vehicles	3	0	0	3	ECE
120.	22ECO02	Optical Engineering	3	0	0	3	EEE
121.	22EEO17	Smart Grid Technologies	3	0	0	3	EEE
122.	22EEO18	Biomass Energy Systems	3	0	0	3	EEE
123.	22EIO12	Environmental Sensors	3	0	0	3	EIE
124.	22EIO13	Pollution Control and Management	3	0	0	3	EIE

125.	22CSO04	Machine Translation	3	0	0	3	CSE
126.	22CSO05	Fundamentals of Blockchain	3	0	0	3	CSE
127.	22ITO06	Introduction to Ethical Hacking	3	0	0	3	IT
128.	22ITO07	Business Continuity Planning	3	0	0	3	IT
129.	22CDX02	Virtual Reality and Augmented Reality	3	0	0	3	CSD
130.	22ADO03	Business Analytics	3	0	0	3	AIDS
131.	22ALO03	Machine Learning for Smart Cities	3	0	0	3	AIML
132.	22CHO09	Industrial Accident Prevention and Management	3	0	0	3	CHEM
133.	22CHO10	Electrochemical Engineering	3	0	0	3	CHEM
134.	22CHO11	Smart and Functional Materials	3	0	0	3	CHEM
135.	22FTO04	Food Ingredients	3	0	0	3	FT
136.	22FTO05	Food and Nutrition	3	0	0	3	FT
137.	22CYO09	Chemistry of Nutrition for Women Health	3	0	0	3	CHEMISTRY

GENERAL OPEN ELECTIVE
(Common to All BE/BTech branches)

SNo	Course Code	**Course Title**	L	T	P	C	Offering Department	Semester
1.	22GEO01	German Language Level 1	4	0	0	4	ECE	ALL
2.	22GEO02	Japanese Language Level 1	4	0	0	4	ECE	ALL
3.	22GEO03	Design Thinking for Engineers	3	1	0	4	CSE	5
4.	22GEO04	Innovation and Business Model Development	3	1	0	4	MTS	6
5.	22GEO05	German Language Level 2	4	0	0	4	ECE	ALL
6.	22GEO06	German Language Level 3	3	0	0	3	ECE	ALL
7.	22GEO07	German Language Level 4	3	0	0	3	ECE	ALL
8.	22GEO08	Japanese Language Level 2	4	0	0	4	ECE	ALL
9.	22GEO09	Japanese Language Level 3	3	0	0	3	ECE	ALL
10.	22GEO10	Japanese Language Level 4	3	0	0	3	ECE	ALL
11.	22GEO11	French Language Level 1	4	0	0	4	ECE	ALL
12.	22GEO12	French Language Level 2	4	0	0	4	ECE	ALL
13.	22GEO13	French Language Level 3	3	0	0	3	ECE	ALL
14.	22GEO14	Spanish Language Level 1	4	0	0	4	ECE	ALL
15.	22GEO15	Spanish Language Level 2	4	0	0	4	ECE	ALL
16.	22GEO16	Spanish Language Level 3	3	0	0	3	ECE	ALL
17.	22GEO17	Entrepreneurship Development	3	0	0	3	MTS	7
18.	22GEX01	NCC Studies (Army Wing) - I	3	0	2	4	EEE	5 / 6
19.	22GEX02	NCC Studies (Air Wing) - 1	3	0	2	4	IT	5 / 6
20.	22MBO01	Cost Accounting for Engineers	3	1	0	4	MBA	5
21.	22MBO02	Economic Analysis for Decision Making	3	1	0	4	MBA	6
22.	22MBO03	Marketing Analytics	3	1	0	4	MBA	7

KEC R2022: SCHEDULING OF COURSES – BE (Automobile Engineering) Total Credits: 168

Sem	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	Course11	CH
I	22EGT11 Communicati on Skills – I (3-0-0-3)	22MAC11 Matrices and Ordinary Differential Equations (3-1*-2*-4)	22PHT14 Physics for Automobile Engineering (3-0-0-3)	22AUT11 Statics and Dynamics (3-0-0-3)	22CSC11 Problem Solving and Programming in C (3-0-2-4)	22MET11 Engineering Drawing (2-1-0-3)	22MEL11 Engineering Practices Laboratory (0-0-2-1)	22PHL11 Physics Laboratory for Automobile Engineering (0-0-2-1)	22VEC11 Yoga and Values for Holistic Development (0-0-0-1)	22MNT11 Student Induction Program (0-0-0-0)		23
II	22EGT21 Communicati on Skills – II (3-0-0-3)	22MAC22 Multivariable Calculus and Partial Differential Equations (3-1*-2*-4)	22CYT26 Chemistry for Automobile Engineering (3-0-0-3)	22AUC21 Manufacturing Technology (3-0-2-4)	22CSC21 Fundamentals of Data Structures (3-0-2-4)	22AUT21 Automotive Engines (3-0-0-3)	22TAM01 Heritage of Tamils (1-0-0-1)	22AUL21 Automotive Engines Laboratory (0-0-2-1)	22CYL22 Chemistry Laboratory for Mechanical Systems (0-0-2-1)			24
III	22AUC31 Basics of Electrical and Electronic Circuits (3-0-2-4)	22AUT31 Mechanics of Deformable Bodies (3-1-0-4)	22AUT32 Thermodynami cs and Thermal Science (3-1-0-4)	22AUT33 Hydraulics and Pneumatics (3-0-0-3)	22AUT34 Automotive Fuels and Lubricants (3-0-0-3)	22TAM02 Tamils and Technology (1-0-0-1)	22AUL31 Automotive Fuels and Lubricants Laboratory (0-0-2-1)	22AUL32 Hydraulics and Pneumatics Laboratory (0-0-2-1)	22MNT31 Environmental Science (2-0-0-0)	22EGL31 Communication Skills Development Laboratory (0-0-2-1)		22
IV	22MAT41 Numerical Methods for Engineers (3-1-0-4)	22ITC32 Introduction to Python (3-0-2-4)	22AUC41 Automotive Electrical Systems and Drives (3-0-2-4)	22AUT42 Vehicle Components Design - I (3-0-0-3)	22AUT43 Automatic Transmission and Control System (3-0-0-3)	22AUL41 Computer Aided Design Laboratory (0-0-2-1)	22AUL42 Automotive Chassis Components Laboratory (0-0-2-1)	22GCL41/22GCI41 Professional Skills Training I / Industrial Training I (0-0-0-2)				22
V	22AUC51 Vehicle Dynamics (3-0-2-4)	22AUT51 Automotive Sensors and Controllers (3-0-0-3)	22AUT52 Mechanics of Machines (3-0-0-3)	22AUT53 Vehicle Components Design - II (3-0-0-3)	Professional Elective I (3-0-0-3)	Open Elective (3-0/1-2/0-4)	22AUL51 Automotive Sensors and Controllers Laboratory (0-0-2-1)	22AUL52 Computer Aided Analysis Laboratory (0-0-2-1)	22GCL51/22GCI51P rofessional Skills Training II / Industrial Training I (0-0-0-2)			24
VI	22AUT61 Automotive Embedded Systems (3-0-0-3)	22AUT62 Modelling of Hybrid and Electric Vehicles (3-0-0-3)	Professional Elective – II (3-0-0-3)	Open Elective – II (3-1/0-0/2-4)	22AUL61 Automotive Embedded Systems Laboratory (0-0-2-1)	22AUL62 Vehicle Maintenance Laboratory (0-0-2-1)	22AUP61 Project Work I (0-0-4-4)	22GET31 Universal Human Values (2-0-0-2)	22GEP61 Comprehensive Test and Viva (0-0-0-2)			23
VII	22GCT71 Engineering Economics and Management (3-0-0-3)	Professional Elective – III (3-0-0-3)	Professional Elective – IV (3-0-0-3)	Professional Elective – V (3-0-0-3)	Open Elective – III (3-0-0-3)	22AUP71 Project Work II Phase I (0-0-8-5)						20
VIII	Professional Elective – VI (3-0-0-3)	Open Elective – IV (3-0-0-3)	22AUP81 Project Work II Phase II (0-0-14-4)									10

MAPPING OF COURSES WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	22EGT11	Communication Skills – I						✓			✓	✓	✓	✓		
1	22MAC11	Matrices and Ordinary Differential Equations	✓	✓	✓	✓	✓									
1	22PHT14	Physics for Automobile Engineering	✓	✓	✓						✓	✓		✓	✓	✓
1	22AUT11	Statics and Dynamics	✓	✓	✓	✓								✓	✓	
1	22CSC11	Problem Solving and Programming in C	✓	✓	✓	✓	✓					✓		✓		
1	22MET11	Engineering Drawing	✓	✓	✓		✓					✓		✓	✓	✓
1	22MEL11	Engineering Practices Laboratory	✓		✓	✓	✓	✓			✓	✓		✓	✓	✓
1	22PHL11	Physics Laboratory for Automobile Engineering	✓	✓	✓	✓					✓	✓		✓	✓	✓
1	22VEC11	Yoga and Values for Holistic Development						✓		✓	✓					
1	22MNT11	Student Induction Program														
2	22EGT21	Communication Skills – II						✓			✓	✓	✓	✓		
2	22MAC22	Multivariable Calculus and Partial Differential Equations	✓	✓	✓		✓								✓	
2	22CYT26	Chemistry for Automobile Engineering	✓	✓	✓	✓									✓	✓
2	22AUC21	Manufacturing Technology	✓	✓	✓			✓	✓		✓	✓		✓	✓	
2	22CSC21	Fundamentals of Data Structures	✓	✓	✓	✓										
2	22AUT21	Automotive Engines	✓	✓				✓	✓					✓	✓	
2	22AUL21	Automotive Engines Laboratory	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	
2	22CYL22	Chemistry Laboratory for Mechanical Systems	✓	✓	✓	✓			✓						✓	✓
3	22AUC31	Basics of Electrical and Electronic Circuits	✓	✓	✓					✓	✓	✓		✓		✓
3	22AUT31	Mechanics of Deformable Bodies	✓	✓	✓	✓	✓				✓	✓		✓	✓	
3	22AUT32	Thermodynamics and Thermal Science	✓	✓	✓	✓		✓	✓					✓	✓	
3	22AUT33	Hydraulics and Pneumatics	✓	✓	✓	✓	✓							✓	✓	✓
3	22AUT34	Automotive Fuels and Lubricants	✓	✓				✓	✓					✓	✓	
3	22AUL31	Automotive Fuels and Lubricants Laboratory	✓	✓	✓	✓	✓		✓		✓	✓		✓	✓	

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
3	22AUL32	Hydraulics and Pneumatics Laboratory	✓	✓	✓		✓						✓	✓	✓	✓
3	22MNT31	Environmental Science	✓	✓	✓				✓							
3	22EGL31	Communication Skills Development Laboratory									✓	✓		✓		
4	22MAT41	Numerical Methods for Engineers	✓	✓	✓											
4	22ITC32	Introduction to Python	✓	✓	✓	✓										
4	22AUC41	Automotive Electrical Systems and Drives	✓	✓	✓					✓	✓	✓		✓	✓	✓
4	22AUT41	Vehicle Components Design – I	✓	✓	✓	✓		✓						✓	✓	
4	22AUT42	Automatic Transmission and Control System	✓	✓	✓									✓	✓	✓
4	22AUL41	Computer Aided Design Laboratory	✓	✓	✓		✓				✓	✓		✓	✓	
4	22AUL42	Automotive Chassis Components Laboratory	✓	✓		✓		✓	✓	✓	✓	✓		✓	✓	
4	22GCL41/22GCI41	Professional Skills Training I / Industrial Training I	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	
5	22AUC51	Vehicle Dynamics	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	
5	22AUT51	Automotive Sensors and Controllers	✓	✓	✓									✓	✓	✓
5	22AUT52	Mechanics of Machines	✓	✓	✓	✓								✓	✓	
5	22AUT53	Vehicle Components Design – II	✓	✓	✓	✓								✓	✓	
5	22AUL51	Automotive Sensors and Controllers Laboratory	✓	✓	✓					✓	✓	✓		✓		✓
5	22AUL52	Computer Aided Analysis Laboratory	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	
6	22AUT61	Automotive Embedded Systems	✓	✓	✓		✓							✓		✓
6	22AUT62	Modelling of Hybrid and Electric Vehicles	✓	✓	✓	✓		✓	✓					✓	✓	✓
6	22AUL61	Automotive Embedded Systems Laboratory	✓	✓	✓		✓			✓	✓	✓		✓		✓
6	22AUL62	Vehicle Maintenance Laboratory	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓	
6	22AUP61	Project Work I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	22GET31	Universal Human Values						✓		✓						
6	22GEP61	Comprehensive Test and Viva	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	22GET71	Engineering Economics and Management	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
7	22AUT71	Manufacturing of Automotive Components	✓	✓	✓										✓	
7	22AUP71	Project Work II Phase I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	22AUP81	Project Work II Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Professional Elective Courses														
5	22AUE01	Two and Three Wheeler Technology	✓	✓				✓	✓					✓	✓	✓
5	22AUE02	Diesel and Electric Locomotives	✓	✓	✓		✓	✓						✓	✓	✓
5	22AUE03	Computer Integrated Manufacturing	✓	✓	✓	✓								✓	✓	
5	22AUE04	Automotive Control System	✓	✓	✓	✓								✓	✓	✓
5	22AUE05	Machine Design	✓	✓	✓	✓			✓					✓	✓	
5	22AUE06	Principles of Farm Machineries	✓	✓				✓	✓					✓	✓	
7	22AUE07	Finite Element Method	✓	✓	✓	✓	✓							✓	✓	
7	22AUE08	In-Vehicle Networking	✓	✓										✓		✓
7	22AUE09	Vehicle Body Engineering	✓	✓			✓	✓	✓					✓	✓	
7	22AUE10	Operations Research	✓	✓	✓	✓							✓	✓	✓	
7	22AUT11	Vehicle Maintenance	✓	✓			✓		✓					✓	✓	✓
7	22AUE12	Composite Materials	✓	✓	✓	✓			✓					✓	✓	
7	22AUE13	CNC and Metrology	✓	✓	✓	✓	✓							✓	✓	
7	22AUE14	Computational Fluid Dynamics	✓	✓	✓	✓	✓							✓	✓	✓
7	22AUE15	Machine Vision And Image Processing	✓	✓	✓	✓	✓							✓		✓
7	22AUE16	Automotive Pollution Control	✓	✓	✓	✓	✓	✓	✓					✓	✓	
7	22AUE17	Total Quality Management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
7	22GEE01	Fundamentals of Research														
7	22AUE18	Automotive Noise, Vibration and Harshness	✓	✓					✓					✓	✓	
7	22AUE19	Automotive HVAC	✓	✓	✓			✓	✓					✓	✓	✓
7	22AUE20	Autonomous Vehicle Technology	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	22AUE21	Value Engineering	✓	✓	✓			✓	✓				✓	✓	✓	✓
7	22AUE22	Design of Engine Components	✓	✓	✓	✓								✓	✓	
7	22AUE23	Mobile Robotics	✓	✓	✓	✓	✓							✓	✓	✓
7	22AUE24	Automotive Vehicle Safety	✓	✓				✓	✓					✓	✓	✓
7	22AUE25	Non Destructive Evaluation Techniques	✓	✓	✓	✓									✓	
7	22AUE26	Quality Assurance and Reliability	✓	✓	✓		✓							✓	✓	
7	22AUE27	Advanced Materials for Green Vehicles	✓	✓	✓	✓		✓	✓					✓	✓	
7	22AUE28	Automotive Testing	✓	✓	✓	✓	✓	✓	✓					✓	✓	
7	22AUE29	Alternate Energy Sources for Automobiles	✓	✓	✓	✓		✓	✓					✓	✓	
8	22AUE30	Road Transport Management	✓	✓				✓	✓	✓				✓	✓	✓
8	22AUE31	Advanced Theory of IC Engines	✓	✓	✓	✓	✓	✓	✓					✓	✓	
8	22AUE32	Automotive Product Life Cycle Management	✓	✓			✓	✓	✓					✓	✓	✓
8	22AUE33	Process Planning and Cost Estimation	✓	✓	✓	✓			✓	✓				✓	✓	✓
8	22AUE34	Lean Methods for Automobile Engineers	✓	✓	✓	✓		✓	✓					✓	✓	
8	22AUE35	Automotive Styling and Modeling	✓	✓	✓	✓	✓	✓						✓	✓	
8	22AUE36	Non-Traditional Machining Processes	✓	✓					✓					✓	✓	
		General Open Elective														
5	22CEX01	Remote Sensing and its Applications	✓	✓	✓	✓		✓			✓			✓		
5	22MEX01	Renewable Energy Sources	✓		✓	✓	✓	✓	✓	✓	✓					
5	22MTO01	Design of Mechatronics Systems	✓	✓	✓	✓	✓							✓		
5	22MTX01	Data Acquisition and Virtual Instrumentation	✓	✓	✓	✓	✓							✓		
5	22MTX02	Factory Automation	✓	✓	✓	✓	✓				✓	✓		✓		
5	22AUX01	Automotive Engineering	✓	✓	✓			✓	✓		✓	✓		✓		
5	22ECX01	Basics of Electronics in Automation Appliances	✓	✓	✓	✓		✓	✓	✓			✓	✓		
5	22ECX02	Image Processing	✓	✓	✓	✓	✓				✓	✓		✓		
5	22EEO01	Solar and Wind Energy Systems	✓	✓	✓			✓	✓					✓		
5	22EEO02	Electrical Wiring and Lighting	✓	✓	✓	✓	✓							✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
5	22EEO03	Programmable Logic Controller and SCADA	✓	✓	✓	✓		✓			✓			✓		
5	22EEO04	Analog and Digital Electronics	✓	✓	✓	✓	✓							✓		
5	22EEO05	Power Electronics and Drives	✓	✓	✓	✓	✓	✓			✓					
5	22EEO06	Sensors and Actuators	✓	✓	✓			✓						✓		
5	22EIO01	Measurements and Instrumentation	✓	✓	✓	✓	✓									
5	22EIO02	Biomedical Instrumentation and Applications	✓	✓	✓	✓	✓	✓		✓						
5	22EIO03	Industrial Automation	✓	✓	✓	✓	✓									
5	22CSX01	Fundamentals of Databases	✓	✓	✓											
5	22CSX02	Data science for Engineers	✓	✓	✓	✓	✓									
5	22CSX03	Enterprise Application Development Using Java	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
5	22CSO01	Computational science for Engineers	✓	✓	✓											
5	22CSO02	Formal Languages and Automata Theory	✓	✓	✓											
5	22ITO01	Artificial Intelligence	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
5	22ITX01	Next Generation Databases	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
5	22CDO01	Fundamentals of User Experience Design	✓	✓	✓	✓	✓				✓	✓	✓			
5	22ADO01	Data Warehousing and Data Mining	✓	✓	✓											
5	22ALO01	Business Intelligence	✓	✓	✓											
5	22CHO01	Industrial Enzymology	✓	✓	✓							✓	✓	✓		
5	22CHO02	Waste to Energy Conversion	✓	✓												
5	22CHO03	Applied Nanotechnology	✓	✓	✓	✓	✓	✓	✓	✓				✓		
5	22FTX01	Baking Technology	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		
5	22FTO01	Food Processing Technology	✓	✓	✓	✓		✓				✓		✓		
5	22MAO01	Mathematical Foundations for Machine Learning	✓	✓	✓	✓	✓									
5	22MAO02	Numerical Computing	✓	✓	✓											
5	22MAO03	Stochastic Processes and Queuing Theory	✓	✓	✓											
5	22MAO04	Statistics for Engineers	✓	✓	✓											
5	22PHO01	Thin Film Technology	✓	✓	✓						✓	✓		✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
5	22PHO02	High Energy Storage Devices	✓	✓	✓						✓	✓		✓		
5	22PHO03	Structural and Optical Characterization of Materials	✓	✓	✓						✓	✓		✓		
5	22CYO01	Instrumental Methods of Analysis	✓	✓	✓	✓										
5	22CYO02	Chemistry Concepts for Competitive Examinations	✓	✓	✓											
5	22CYO03	Organic Chemistry for Industry	✓	✓	✓	✓										
5	22MBO01	Cost Accounting for Engineers										✓	✓	✓		
6	22CEO01	Disaster Management	✓	✓	✓			✓	✓					✓		
6	22MEX02	Design of Experiments	✓	✓	✓	✓	✓				✓					
6	22GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
6	22MTO02	Robotics	✓	✓	✓	✓	✓							✓		
6	22MTO03	3D Printing and Design	✓	✓			✓							✓		
6	22AUO01	Automotive Electronics	✓	✓	✓	✓								✓		
6	22ECX03	PCB Design and Fabrication	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		
6	22EEO07	Energy Conservation and Management	✓	✓	✓		✓		✓	✓	✓			✓		
6	22EEO08	Microprocessors and Microcontrollers Interfacing	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		
6	22EEO09	Electrical Safety	✓	✓	✓				✓	✓			✓	✓		
6	22EEO10	VLSI System Design	✓	✓	✓	✓	✓				✓		✓	✓		
6	22EEO11	Automation for Industrial Applications	✓	✓	✓	✓			✓		✓			✓		
6	22EIO04	PLC Programming with High Level Languages	✓	✓	✓	✓	✓									
6	22EIO05	Virtual Instrumentation	✓	✓	✓	✓	✓									
6	22CSX04	Foundations of Machine Learning	✓	✓	✓											
6	22CSX05	Web Engineering	✓	✓	✓											
6	22ITX02	Advanced Java Programming	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
6	22ITO02	Internet of Things	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
6	22ITO03	Fundamentals of Software Development	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
6	22ITO04	Mobile Application Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
6	22CDX01	Fundamentals of User Interactive Design	✓	✓	✓	✓										

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
6	22ADX01	Data Visualization	✓	✓	✓											
6	22ALX01	Data Exploration and Visualization Techniques	✓	✓	✓											
6	22CHO04	Air Pollution Monitoring and Control	✓	✓	✓			✓	✓							
6	22CHO05	Paints and Coatings	✓	✓	✓				✓							
6	22CHO06	Powder Technology	✓	✓	✓			✓	✓					✓		
6	22FTX02	Processing of milk and milk products	✓	✓	✓		✓	✓		✓	✓	✓		✓		
6	22FTX03	Processing of Fruits and Vegetables	✓	✓	✓		✓	✓		✓	✓	✓		✓		
6	22MAO05	Graph Theory and its Applications	✓	✓	✓											
6	22MAX01	Data Analytics using R Programming	✓	✓	✓	✓	✓									
6	22MAO06	Operations Research	✓	✓	✓											
6	22MAO07	Number Theory and Cryptography	✓	✓	✓		✓									
6	22PHO04	Synthesis, Characterization and Biological Applications of Nanomaterials	✓	✓	✓						✓	✓		✓		
6	22PHO05	Techniques of Crystal Growth	✓	✓	✓						✓	✓		✓		
6	22CYO04	Corrosion Science and Engineering	✓	✓	✓	✓										
6	22CYO05	Chemistry of Cosmetics in Daily Life	✓	✓	✓											
6	22CYO06	Nanocomposite Materials	✓	✓	✓	✓										
6	22MBO02	Economic Analysis for Decision Making					✓					✓	✓			
7	22CEO02	Introduction to Smart Cities	✓	✓	✓	✓	✓									
7	22CEO03	Environmental Health and Safety	✓	✓	✓			✓	✓							
7	22MEO01	Fundamentals of Ergonomics	✓	✓	✓	✓	✓	✓	✓					✓		
7	22MEO02	Principles of Management and Industrial Psychology	✓					✓				✓	✓			
7	22MEO03	Waste Heat Recovery System and Storage	✓	✓	✓	✓			✓							
7	22GEO05	Entrepreneurship Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
7	22MTO04	Drone System Technology	✓	✓	✓	✓	✓							✓		
7	22AUO02	Vehicle Maintenance	✓	✓			✓		✓					✓		
7	22ECO01	Wearable Devices	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		
7	22ECX04	Electronic Hardware and Troubleshooting	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	22EEO12	Electric Vehicle	✓	✓	✓	✓		✓	✓		✓			✓		
7	22EEO13	E-Waste Management	✓	✓	✓	✓		✓	✓					✓		
7	22EEO14	Embedded System Design	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		
7	22EEO15	Energy Storage Systems and Controllers	✓	✓	✓			✓			✓		✓	✓		
7	22EEO16	AI Techniques for Engineering Applications	✓	✓	✓	✓										
7	22EIO06	Introduction to Distributed Control Systems	✓	✓	✓	✓	✓			✓		✓				
7	22EIO07	Instrumentation in Aircraft Navigation and Control	✓	✓	✓	✓	✓									
7	22EIO08	Industry 4.0 with Industrial IoT	✓	✓	✓	✓	✓			✓						
7	22EIO09	Industrial Data Communication	✓	✓	✓	✓	✓	✓								
7	22EIO10	Wireless Instrumentation	✓	✓	✓	✓	✓		✓							
7	22EIO11	Instrumentation Techniques in Agriculture	✓	✓	✓	✓	✓									
7	22CSO03	Nature Inspired optimization techniques	✓	✓	✓											
7	22ITO05	Fundamentals of Cloud Computing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
7	22ITO06	Introduction to Ethical Hacking	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
7	22CDO02	Introduction to Mobile Game Design	✓	✓	✓	✓										
7	22CDO03	Introduction to Graphics Design	✓	✓	✓	✓										
7	22ADO02	Neural Networks and Deep Learning	✓	✓	✓	✓										
7	22ALO02	Industrial Machine Learning	✓	✓	✓											
7	22CHO07	Hydrogen Energy	✓	✓										✓		
7	22CHO08	Rubber Technology	✓	✓				✓	✓					✓		
7	22FTO02	Principles of Food safety	✓	✓	✓			✓	✓	✓		✓		✓		
7	22FTO03	Fundamentals of Food Packaging and Storage	✓	✓	✓	✓	✓	✓		✓		✓		✓		
7	22MAO08	Non-Linear Optimization	✓	✓	✓											
7	22MAO09	Optimization for Engineers	✓	✓	✓											
7	22CYO07	Waste and Hazardous Waste Management	✓	✓	✓	✓			✓							
7	22CYO08	Chemistry in Every day Life	✓	✓	✓	✓										
7	22MBO03	Marketing Analytics										✓	✓	✓		
8	22CEO04	Infrastructure Planning and Management	✓	✓	✓		✓									

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
8	22CEO05	Environmental Laws and Policy	✓	✓			✓									
8	22MEO04	Safety Measures for Engineers	✓					✓	✓	✓						
8	22MEO05	Energy Conservation in Thermal Equipments	✓		✓		✓	✓	✓					✓		
8	22MEO06	Climate Change and New Energy Technology	✓		✓			✓	✓	✓						
8	22MTO05	Micro and Nano Electromechanical Systems	✓	✓	✓	✓								✓		
8	22AUO03	Public Transport Management	✓	✓				✓	✓	✓				✓		
8	22AUO04	Autonomous Vehicles	✓	✓	✓	✓	✓	✓	✓					✓		
8	22ECO02	Optical Engineering	✓	✓	✓	✓		✓	✓	✓	✓			✓		
8	22EEO17	Smart Grid Technologies	✓	✓	✓	✓	✓			✓				✓		
8	22EEO18	Biomass Energy Systems	✓	✓	✓			✓	✓				✓	✓		
8	22EIO12	Environmental Sensors	✓	✓	✓	✓	✓		✓							
8	22EIO13	Pollution Control and Management	✓	✓	✓	✓	✓	✓		✓						
8	22CSO04	Machine Translation	✓	✓	✓											
8	22CSO05	Fundamentals of Blockchain	✓	✓	✓											
8	22ITO07	Business Continuity Planning	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
8	22CDX02	Virtual Reality and Augmented Reality	✓	✓	✓	✓										
8	22ADO03	Business Analytics	✓	✓	✓	✓										
8	22ALO03	Machine Learning for Smart Cities	✓	✓	✓	✓										
8	22CHO09	Industrial Accident Prevention and Management	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓		
8	22CHO10	Electrochemical Engineering	✓	✓	✓											
8	22CHO11	Smart and Functional Materials	✓	✓					✓	✓	✓			✓		
8	22FTO04	Food Ingredients	✓	✓	✓			✓		✓		✓		✓		
8	22FTO05	Food and Nutrition	✓	✓	✓			✓				✓		✓		
8	22CYO09	Chemistry of Nutrition for Women Health	✓	✓	✓											
		General Open Elective Courses														
ALL	22GEO01	German Language Level 1								✓	✓	✓		✓		
ALL	22GEO02	Japanese Language Level 1								✓	✓	✓		✓		
5	22GEO03	Design Thinking for Engineers	✓	✓	✓	✓										

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
6	22GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
ALL	22GEO05	German Language Level 2								✓	✓	✓		✓		
ALL	22GEO06	German Language Level 3								✓	✓	✓		✓		
ALL	22GEO07	German Language Level 4								✓	✓	✓		✓		
ALL	22GEO08	Japanese Language Level 2								✓	✓	✓		✓		
ALL	22GEO09	Japanese Language Level 3								✓	✓	✓		✓		
ALL	22GEO10	Japanese Language Level 4								✓	✓	✓		✓		
ALL	22GEO11	French Language Level 1								✓	✓	✓		✓		
ALL	22GEO12	French Language Level 2								✓	✓	✓		✓		
ALL	22GEO13	French Language Level 3								✓	✓	✓		✓		
ALL	22GEO14	Spanish Language Level 1								✓	✓	✓		✓		
ALL	22GEO15	Spanish Language Level 2								✓	✓	✓		✓		
ALL	22GEO16	Spanish Language Level 3								✓	✓	✓		✓		
7	22GEO17	Entrepreneurship Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
5 / 6	22GEX01	NCC Studies (Army Wing) - I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
5 / 6	22GEX02	NCC Studies (Air Wing) - 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
5	22MBO01	Cost Accounting for Engineers										✓	✓	✓		
6	22MBO02	Economic Analysis for Decision Making					✓					✓	✓			
7	22MBO03	Marketing Analytics										✓	✓	✓		

B.E. AUTOMOBILE ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2022-23)

SEMESTER – I									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22EGT11	Communication Skills – I	3	0	0	3	40	60	100	HS
22MAC11	Matrices and Ordinary Differential Equations	3	1*	2*	4	50	50	100	BS
22PHT14	Physics for Automobile Engineering	3	0	0	3	40	60	100	BS
22AUT11	Statics and Dynamics	3	0	0	3	40	60	100	PC
22CSC11	Problem Solving and Programming in C	3	0	2	4	100	0	100	ES
22MET11	Engineering Drawing	2	1	0	3	40	60	100	ES
Practical / Employability Enhancement									
22MEL11	Engineering Practices Laboratory	0	0	2	1	60	40	100	BS
22PHL14	Physics Laboratory for Automobile Engineering	0	0	2	1	60	40	100	ES
22VEC11	Yoga and Values for Holistic Development	--	--	--	1	100	0	100	HS
22MNT11	Student Induction Program	--	--	--	0	100	0	100	MC
Total Credits to be earned					23				

SEMESTER – II									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22EGT21	Communication Skills – II	3	0	0	3	40	60	100	HS
22MAC22	Multivariable Calculus and Partial Differential Equations	3	1*	2*	4	50	50	100	BS
22CYT26	Chemistry for Automobile Engineering	3	0	0	3	40	60	100	BS
22AUC21	Manufacturing Technology	3	0	2	4	50	50	100	ES
22CSC21	Fundamentals of Data Structures	3	0	2	4	50	50	100	ES
22AUT21	Automotive Engines	3	0	0	3	40	60	100	PC
22TAM01	Heritage of Tamils	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22AUL21	Automotive Engines Laboratory	0	0	2	1	60	40	100	PC
22CYL22	Chemistry Laboratory for Mechanical Systems	0	0	2	1	60	40	100	BS
Total Credits to be earned					24				

*Alternate weeks

B.E. - AUTOMOBILE ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2022-23)

SEMESTER – III									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22AUC31	Basics of Electrical and Electronic Circuits	3	0	2	4	50	50	100	PC
22AUT31	Mechanics of Deformable Bodies	3	1	0	4	40	60	100	PC
22AUT32	Thermodynamics and Thermal Science	3	1	0	4	40	60	100	PC
22AUT33	Hydraulics and Pneumatics	3	0	0	3	40	60	100	PC
22AUT34	Automotive Fuels and Lubricants	3	0	0	3	40	60	100	PC
22TAM02	Tamils and Technology	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22AUL31	Automotive Fuels and Lubricants Laboratory	0	0	2	1	60	40	100	PC
22AUL32	Hydraulics and Pneumatics Laboratory	0	0	2	1	60	40	100	PC
22MNT31	Environmental Science	2	0	0	0	100	0	100	MC
22EGL31	Communication Skills Development Laboratory	0	0	2	1	60	40	100	HS
Total Credits to be earned					22				

SEMESTER – IV									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22MAT41	Numerical Methods for Engineers	3	1	0	4	40	60	100	BS
22ITC32	Introduction to Python	3	0	2	4	100	0	100	ES
22AUC41	Automotive Electrical Systems and Drives	3	0	2	4	50	50	100	PC
22AUT41	Vehicle Components Design – I	3	0	0	3	40	60	100	PC
22AUT42	Automatic Transmission and Control System	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
22AUL41	Computer Aided Design Laboratory	0	0	2	1	60	40	100	PC
22AUL42	Automotive Chassis Components Laboratory	0	0	2	1	60	40	100	PC
22GCL41/ 22GCI41	Professional Skills Training I / Industrial Training I *	--	--	--	2	100	0	100	EC
Total Credits to be earned					22				

* 80 Hours of training

B.E. AUTOMOBILE ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2022-23)

SEMESTER – V									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22AUC51	Vehicle Dynamics	3	0	2	4	50	50	100	PC
22AUT51	Automotive Sensors and Controllers	3	0	0	3	40	60	100	PC
22AUT52	Mechanics of Machines	3	0	0	3	40	60	100	PC
22AUT53	Vehicle Components Design – II	3	0	0	3	40	60	100	PC
	Professional Elective – I	3	0	0	3	40	60	100	PE
	Open Elective – I	3	0/1	2/0	4	40/50	60/50	100	OE
Practical / Employability Enhancement									
22AUL51	Automotive Sensors and Controllers Laboratory	0	0	2	1	60	40	100	PC
22AUL52	Computer Aided Analysis Laboratory	0	0	2	1	60	40	100	PC
22GCL51/ 22GCI51	Professional Skills Training II / Industrial Training I *	--	--	--	2	100	0	100	EC
Total Credits to be earned					24				

*80 hours of training

SEMESTER – VI									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22AUT61	Automotive Embedded Systems	3	0	0	3	40	60	100	PC
22AUT62	Modelling of Hybrid and Electric Vehicles	3	0	0	3	40	60	100	PC
	Professional Elective – II	3	0	0	3	40	60	100	PE
	Open Elective – II	3	1/0	0/2	4	40/50	60/50	100	OE
Practical / Employability Enhancement									
22AUL61	Automotive Embedded Systems Laboratory	0	0	2	1	60	40	100	PC
22AUL62	Vehicle Maintenance Laboratory	0	0	2	1	60	40	100	PC
22AUP61	Project Work I	0	0	8	4	50	50	100	EC
22GET31	Universal Human Values	2	0	0	2	100	0	100	HS
22GEP61	Comprehensive Test and Viva	--	--	--	2	100	0	100	EC
Total Credits to be earned					23				

B.E. AUTOMOBILE ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2022-23)

SEMESTER – VII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22GCT71	Engineering Economics and Management	3	0	0	3	40	60	100	HS
	Professional Elective – III	3	0	0	3	40	60	100	PE
	Professional Elective – IV	3	0	0	3	40	60	100	PE
	Professional Elective – V	3	0	0	3	40	60	100	PE
	Open Elective – III	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22AUP71	Project Work II Phase I	0	0	10	5	50	50	100	EC
Total Credits to be earned					20				

SEMESTER – VIII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
	Professional Elective – VI	3	0	0	3	40	60	100	PE
	Open Elective – IV	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22AUP81	Project Work II Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					10				

Total Credits : 168

LIST OF PROFESSIONAL ELECTIVES (PEs) (2022-23 Batch)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Domain/ Stream**
Semester – V							
Elective – I							
1.	22AUE01	Two and Three wheeler Technology	3	0	0	3	AUTO
2.	22AUE02	Diesel and Electric Locomotives	3	0	0	3	AUTO
3.	22AUE03	Computer Integrated Manufacturing	3	0	0	3	MFG
4.	22AUE04	Automotive Control System	3	0	0	3	EE
5.	22AUE05	Machine Design	3	0	0	3	DSN
6.	22AUE06	Principles of Farm Machineries	3	0	0	3	DSN
Semester – VI							
Elective – II							
7.	22AUE07	Finite Element Method	3	0	0	3	DSN
8.	22AUE08	In-Vehicle Networking	3	0	0	3	EE
9.	22AUE09	Vehicle Body Engineering	3	0	0	3	AUTO
10.	22AUE10	Operations Research	3	0	0	3	MFG
11.	22AUE11	Vehicle Maintenance	3	0	0	3	AUTO
12.	22AUE12	Composite Materials	3	0	0	3	MFG
	Semester – VII						
Elective – III							
13.	22AUE13	CNC and Metrology	3	0	0	3	MFG
14.	22AUE14	Computational Fluid Dynamics	3	0	0	3	TF
15.	22AUE15	Machine Vision And Image Processing	3	0	0	3	AUTO
16.	22AUE16	Automotive Pollution Control	3	0	0	3	AUTO
17.	22AUE17	Value Engineering	3	0	0	3	MFG
18.	22AUE18	Automotive Noise, Vibration and Harshness	3	0	0	3	AUTO
Elective – IV							
19.	22GEE01	Fundamentals of Research	3	0	0	3	GE
20.	22AUE19	Automotive HVAC	3	0	0	3	TF

21.	22AUE20	Autonomous Vehicle Technology	3	0	0	3	EE
22.	22GEE02	Total Quality Management	3	0	0	3	MFG
23.	22AUE22	Design of Engine Components	3	0	0	3	DSN
24.	22AUE23	Mobile Robotics	3	0	0	3	EE
Elective – V							
25.	22AUE24	Automotive Vehicle Safety	3	0	0	3	AUTO
26.	22AUE25	Non Destructive Evaluation Techniques	3	0	0	3	MFG
27.	22AUE26	Quality Assurance and Reliability	3	0	0	3	MFG
28.	22AUE27	Advanced Materials for Green Vehicles	3	0	0	3	MFG
29.	22AUE28	Automotive Testing	3	0	0	3	AUTO
30.	22AUE29	Alternate Energy Sources for Automobiles	3	0	0	3	TF
Semester – VIII							
Elective – VI							
31.	22AUE30	Road Transport Management	3	0	0	3	AUTO
32.	22AUE31	Advanced Theory of IC Engines	3	0	0	3	TF
33.	22AUE32	Automotive Product Life Cycle Management	3	0	0	3	DSN
34.	22AUE33	Process Planning and Cost Estimation	3	0	0	3	MFG
35.	22AUE34	Lean Methods for Automobile Engineers	3	0	0	3	MFG
36.	22AUE35	Automotive Styling and Modeling	3	0	0	3	AUTO
37.	22AUE36	Non-Traditional Machining Processes	3	0	0	3	MFG
Total Credits to be earned						**18**	

* Domain/Stream Abbreviations: AUTO - Automobile, DSN - Design, EE – Electrical and Electronics, TF – Thermal and Fluid, MFG-Manufacturing, GE – General Engineering

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SEMESTER – I									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22EGT11	Communication Skills – I	3	0	0	3	40	60	100	HS
22MAC11	Matrices and Ordinary Differential Equations	3	1*	2*	4	50	50	100	BS
22PHT14	Physics for Automobile Engineering	3	0	0	3	40	60	100	BS
22CSC11	Problem Solving and Programming in C	3	0	2	4	100	0	100	ES
22MET11	Engineering Drawing	2	1	0	3	40	60	100	ES
Practical / Employability Enhancement									
22PHL14	Physics Laboratory for Automobile Engineering	0	0	2	1	60	40	100	BS
22GCL12	Foundation Laboratory - Electrical, IoT, Web	0	0	6	3	100	0	100	ES
22VEC11	Yoga and Values for Holistic Development	--	--	--	1	100	0	100	HS
22TAM01	Heritage of Tamils	1	0	0	1	100	0	100	HS
22MNT11	Student Induction Program	--	--	--	0	100	0	100	MC
Total Credits to be earned					23				

SEMESTER – II									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22EGT21	Communication Skills – II	3	0	0	3	40	60	100	HS
22MAC22	Multivariable Calculus and Partial Differential Equations	3	1*	2*	4	50	50	100	BS
22CYT26	Chemistry for Automobile Engineering	3	0	0	3	40	60	100	BS
22CSC21	Fundamentals of Data Structures	3	0	2	4	50	50	100	ES
22AUT11	Statics and Dynamics	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
22CYL22	Chemistry Laboratory for Mechanical Systems	0	0	2	1	60	40	100	BS
22GCL11	Foundation Laboratory - Manufacturing, Design and Robotics	0	0	6	3	100	0	100	ES
22TAM02	Tamils and Technology	1	0	0	1	100	0	100	HS
Total Credits to be earned					22				

*Alternate weeks

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SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22AUC31	Basics of Electrical and Electronic Circuits	3	0	2	4	50	50	100	PC
22AUC32	Hydraulics and Pneumatics	3	0	2	4	50	50	100	PC
22AUT32	Thermodynamics and Thermal Science	3	1	0	4	40	60	100	PC
22AUT21	Automotive Engines	3	0	0	3	40	60	100	PC
22AUT34	Automotive Fuels and Lubricants	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
22AUL21	Automotive Engines Laboratory	0	0	2	1	60	40	100	PC
22AUL31	Automotive Fuels and Lubricants Laboratory	0	0	2	1	60	40	100	PC
22MNT31	Environmental Science	2	0	0	0	100	0	100	MC
22EGL31	Communication Skills Development Laboratory	0	0	2	1	60	40	100	HS
Total Credits to be earned					21				

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22MAT41	Numerical Methods for Engineers	3	1	0	4	40	60	100	BS
22ITC32	Introduction To Python	3	0	2	4	100	0	100	ES
22AUC41	Automotive Electrical Systems and Drives	3	0	2	4	50	50	100	PC
22AUT31	Mechanics of Deformable Bodies	3	0	0	3	40	60	100	PC
22AUT41	Vehicle Components Design – I	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
22AUL41	Computer Aided Design Laboratory	0	0	2	1	60	40	100	PC
22AUL42	Automotive Chassis Components Laboratory	0	0	2	1	60	40	100	PC
22GCL41/ 22GCI41	Professional Skills Training I / Industrial Training I *	--	--	--	2	100	0	100	HS
Total Credits to be earned					22				

* 80 Hours of training

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(For the students admitted from the academic year 2023-24)

SEMESTER – V									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22AUC51	Vehicle Dynamics	3	0	2	4	50	50	100	PC
22AUT51	Automotive Sensors and Controllers	3	0	0	3	40	60	100	PC
22AUT53	Vehicle Components Design – II	3	0	0	3	40	60	100	PC
22AUT54	Theory of Machines	3	1	0	4	40	60	100	PC
	Professional Elective – I	3	0	0	3	40	60	100	PE
	Open Elective – I	3	0/1	2/0	4	40/50	60/50	100	OE
Practical / Employability Enhancement									
22AUL51	Automotive Sensors and Controllers Laboratory	0	0	2	1	60	40	100	PC
22AUL52	Computer Aided Analysis Laboratory	0	0	2	1	60	40	100	PC
22GCL51/ 22GCI51	Professional Skills Training II / Industrial Training I *	--	--	--	2	100	0	100	EC
Total Credits to be earned					25				

*80 hours of training

SEMESTER – VI									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22AUT61	Automotive Embedded Systems	3	0	0	3	40	60	100	PC
22AUT62	Modelling of Hybrid and Electric Vehicles	3	0	0	3	40	60	100	PC
	Professional Elective – II	3	0	0	3	40	60	100	PE
	Open Elective – II	3	1/0	0/2	4	40/50	60/50	100	OE
Practical / Employability Enhancement									
22AUL61	Automotive Embedded Systems Laboratory	0	0	2	1	60	40	100	PC
22AUL62	Vehicle Maintenance Laboratory	0	0	2	1	60	40	100	PC
22AUP62	Project Work I	0	0	10	5	50	50	100	EC
22GET31	Universal Human Values	2	0	0	2	100	0	100	HS
22GEP61	Comprehensive Test and Viva	--	--	--	2	100	0	100	EC
Total Credits to be earned					24				

B.E. AUTOMOBILE ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2023-24)

SEMESTER – VII										
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22GCT71	Engineering Economics and Management	3	0	0	3	40	60	100	HS
22AUT71	Manufacturing of Automotive Components	3	0	0	3	40	60	100	PE
	Professional Elective – III	3	0	0	3	40	60	100	PE
	Professional Elective – IV	3	0	0	3	40	60	100	PE
	Open Elective – III	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22AUP72	Project Work II Phase I	0	0	12	6	50	50	100	EC
Total Credits to be earned					21				

SEMESTER – VIII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
	Professional Elective – V	3	0	0	3	40	60	100	PE
	Open Elective – IV	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22AUP81	Project Work II Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					10				

Total Credits : 168

LIST OF PROFESSIONAL ELECTIVES (PEs) (2023-24 Batch)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Domain/ Stream**
Semester – V							
Elective – I							
1.	22AUE01	Two and Three wheeler Technology	3	0	0	3	AUTO
2.	22AUE02	Diesel and Electric Locomotives	3	0	0	3	AUTO
3.	22AUE03	Computer Integrated Manufacturing	3	0	0	3	MFG
4.	22AUE04	Automotive Control System	3	0	0	3	EE
5.	22AUE05	Machine Design	3	0	0	3	DSN
6.	22AUE06	Principles of Farm Machineries	3	0	0	3	DSN
Semester – VI							
Elective – II							
7.	22AUE07	Finite Element Method	3	0	0	3	DSN
8.	22AUE08	In-Vehicle Networking	3	0	0	3	EE
9.	22AUE09	Vehicle Body Engineering	3	0	0	3	AUTO
10.	22AUE10	Operations Research	3	0	0	3	MFG
11.	22AUE11	Vehicle Maintenance	3	0	0	3	AUTO
12.	22AUE12	Composite Materials	3	0	0	3	MFG
	Semester – VII						
Elective – III							
13.	22AUE13	CNC and Metrology	3	0	0	3	MFG
14.	22AUE14	Computational Fluid Dynamics	3	0	0	3	TF
15.	22AUE15	Machine Vision And Image Processing	3	0	0	3	AUTO
16.	22AUE16	Automotive Pollution Control	3	0	0	3	AUTO
17.	22AUE17	Value Engineering	3	0	0	3	MFG
18.	22AUE18	Automotive Noise, Vibration and Harshness	3	0	0	3	AUTO
Elective – IV							
19.	22GEE01	Fundamentals of Research	3	0	0	3	GE
20.	22AUE19	Automotive HVAC	3	0	0	3	TF

21.	22AUE20	Autonomous Vehicle Technology	3	0	0	3	EE
22.	22GEE02	Total Quality Management	3	0	0	3	MFG
23.	22AUE22	Design of Engine Components	3	0	0	3	DSN
24.	22AUE23	Mobile Robotics	3	0	0	3	EE
25.	22AUE24	Automotive Vehicle Safety	3	0	0	3	AUTO
26.	22AUE25	Non Destructive Evaluation Techniques	3	0	0	3	MFG
27.	22AUE26	Quality Assurance and Reliability	3	0	0	3	MFG
28.	22AUE27	Advanced Materials for Green Vehicles	3	0	0	3	MFG
29.	22AUE28	Automotive Testing	3	0	0	3	AUTO
30.	22AUE29	Alternate Energy Sources for Automobiles	3	0	0	3	TF
Semester – VIII							
Elective – V							
31.	22AUE30	Road Transport Management	3	0	0	3	AUTO
32.	22AUE31	Advanced Theory of IC Engines	3	0	0	3	TF
33.	22AUE32	Automotive Product Life Cycle Management	3	0	0	3	DSN
34.	22AUE33	Process Planning and Cost Estimation	3	0	0	3	MFG
35.	22AUE34	Lean Methods for Automobile Engineers	3	0	0	3	MFG
36.	22AUE35	Automotive Styling and Modeling	3	0	0	3	AUTO
37.	22AUE36	Non-Traditional Machining Processes	3	0	0	3	MFG
Total Credits to be earned						**15**	

* Domain/Stream Abbreviations: AUTO - Automobile, DSN - Design, EE – Electrical and Electronics, TF – Thermal and Fluid, MFG-Manufacturing, GE – General Engineering

LIST OF OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OEs)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22AUX01	Automotive Engineering	3	0	2	4	V
2.	22AUO01	Automotive Electronics	3	1	0	4	VI
3.	22AUO02	Vehicle Maintenance	3	1	0	4	VII
4.	22AUO03	Public Transport Management	3	0	0	3	VII
5.	22AUO04	Autonomous Vehicles	3	0	0	3	VIII

22EGT11 - COMMUNICATION SKILLS I

(Common to All Engineering and Technology Branches)

Programme & Branch	All B.E./B.Tech. Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**I**	**HS**	**3**	**0**	**0**	**3**

Preamble	This course is designed to impart required levels of Communication Skills and Proficiency in English language necessary for different professional contexts.	
Unit – I	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Parts of speech - Tenses - Types of sentences**:** Assertive, Imperative, Interrogative & Exclamatory **–** Affirmative & Negative - Gerunds & Infinitives **- Vocabulary:** Affixes **-** Synonyms & Antonyms **- Listening:** Types of listening **-** Barriers to listening **-** Listening to short talks **-** TV shows **- Speaking:** Verbal & Non-verbal communication **-** Pair conversation **-** Role play **- Reading:** Types of Reading **–** Intensive: scanning, word by word, survey **- Writing:** Dialogue writing, Informal Letters **-** Paragraph writing		
Unit – II	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Voices **-** Impersonal passives **- Vocabulary:** Homonyms, Homophones & Homographs **- Listening:** Importance of listening **-** Listening to announcements & radio broadcasts **- Speaking:** Persuasive & Impromptu talks **-** Narrating a story **- Reading:** Reading comprehension **-** Articles from Newspapers/Magazines **-** Cloze exercises **- Writing:** Essay writing, Jumbled sentences		
Unit – III	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Prepositions **- Vocabulary:** Compound Nouns **- Listening:** Listening to TED Talks, Commentaries **- Speaking:** Self Introduction **- Reading:** Extensive: speed, skimming **-** Identifying lexical & contextual meanings **- Writing:** Instructions & Warnings **-** Formal letters: Seeking permission for Industrial visits & Inviting guests		
Unit – IV	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Articles & Determiners **- Vocabulary:** Technical Vocabulary **-** Analogy **-** Unscrambling words **-** Logical reasoning **- Listening:** Listening to conversations - **Speaking:** Tongue twisters **-** Skill Sharing **-** Note-taking **- Reading:** Note making **-** Paraphrasing & Summarizing **- Writing:** Recommendations & Suggestions **-** Business letters: Enquiry, Calling for quotations & placing orders		
Unit – V	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Cause and effect expressions **- Vocabulary:** Abbreviations & acronyms, Definitions **Listening:** Listening to eminent personalities **- Speaking:** Commonly mispronounced words **-** Welcome address, Chief guest address & Vote of thanks **- Reading -** IELTS type passages **- Writing:** Preparing transcript for a speech **-** Interpreting news articles & advertisements		
		Total:45

TEXT BOOK:

1.	Sanjay Kumar & Pushp Lata, “Communication Skills”, 2^{nd} Edition, Oxford University Press, New Delhi, 2018.

REFERENCES:

1.	Ashraf Rizvi, "Effective Technical Communication", 2^{nd} Edition, McGraw-Hill India, 2017.
2.	S. P. Dhanavel, "English and Communication Skills for Students of Science and Engineering", Orient BlackSwan Publishers, Hyderabad, 2009.
3.	Jack C. Richards and Chuck Sandy, “Passages” Student’s Book 1, 3^{rd} Edition, Cambridge University Press, New York, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	use language effectively by acquiring vocabulary and syntax in context	Applying (K3)
CO2	listen and comprehend different spoken discourses from a variety of situations	Applying (K3)
CO3	speak confidently in different professional contexts and with peers	Creating (K6)
CO4	comprehend different genres of texts by adopting various reading strategies	Understanding (K2)
CO5	write legibly and flawlessly at varied professional contexts proficiently with appropriate choice of words and structures	Creating (K6)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2			1	3	1	1
CO2									2	3		1
CO3									2	3		2
CO4						1				3	1	1
CO5										3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		37	30			33	100
CAT2		30	30			40	100
CAT3		33	34			33	
ESE		17	63			20	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MAC11 - MATRICES AND ORDINARY DIFFERENTIAL EQUATIONS							
(Common to all Engineering and Technology branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**1***	**2***	**4**

Preamble	To provide the skills to the students for solving different real time problems by applying matrices and ordinary differential equations.	
Unit – I	**Matrices:**	**9**
Introduction **–** Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors (without proof) – Cayley – Hamilton theorem (Statement and applications only) - Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Nature of Quadratic forms - Reduction of quadratic form to canonical form by orthogonal transformation – Applications of Eigen values and Eigen vectors: Stretching of an elastic membrane.		
Unit – II	**Ordinary Differential Equations:**	**9**
Introduction – Solutions of First order differential equations: Exact differential equations – Leibnitz's Linear Equation – Bernoulli's equation –Clairaut's equation - Applications: Law of natural growth and decay.		
Unit – III	**Ordinary Differential Equations of Higher Order:**	**9**
Linear differential equations of second and higher order with constant coefficients - Particular Integrals for the types: e^{ax} – cosax / sinax – x^n – $e^{ax}x^n$, e^{ax} sinbx and e^{ax} cosbx – x^n sinax and x^n cosax – Differential Equations with variable coefficients: Euler-Cauchy's equation – Legendre's equation.		
Unit – IV	**Applications of Ordinary Differential Equations:**	**9**
Method of variation of parameters – Simultaneous first order linear equations with constant coefficients – Applications of differential equations: Simple harmonic motion – Electric circuits (Differential equations and associated conditions need to be given).		
Unit – V	**Laplace Transform:**	**9**
Laplace Transform: Conditions for existence – Transform of elementary functions – Basic properties – Derivatives and integrals of transforms –Transforms of derivatives and integrals – Transform of unit step function – Transform of periodic functions. Inverse Laplace transform: Inverse Laplace transform of elementary functions – Partial fraction method – Convolution theorem (Statement only) – Applications: Solution of linear ODE of second order with constant coefficients.		

LIST OF EXPERIMENTS / EXERCISES:	
1.	Introduction to MATLAB
2.	Computation of eigen values and eigen vectors
3.	Plotting and visualizing single variable functions
4.	Solving first and second order ordinary differential equations
5.	Solution of Simultaneous first order ODEs
6.	Solving second order ODE by variation of parameters
7.	Determining Laplace and inverse Laplace transform of basic functions
8.	Solution of Second order ODE by employing Laplace transforms
	Lecture:45, Tutorials and Practical:15, Total:60

TEXT BOOK:	
1.	Ramana B V, "Higher Engineering Mathematics", 1st Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2018.

REFERENCES/ MANUAL / SOFTWARE:

1.	Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.
2.	Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi.
3.	Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics - I", 2nd Edition, Pearson India Education, New Delhi, 2018.
4.	Grewal B.S., "Higher Engineering Mathematics" 44thEdition, Khanna Publishers, New Delhi, 2018.
5.	MATLAB – Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	solve engineering problems which needs matrix computations.	Applying (K3)
CO2	identify the appropriate method for solving first order ordinary differential equations.	Applying (K3)
CO3	solve higher order linear differential equations with constant and variable coefficients.	Applying (K3)
CO4	apply the concept of ordinary differential equations for modeling and finding solutions to engineering problems.	Applying (K3)
CO5	apply Laplace Transform to find solutions of Linear Ordinary Differential Equations	Applying (K3)
CO6	understand the basics of MATLAB, solve ordinary differential equations and compute Laplace transforms using MATLAB.	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2											
CO2	3	3	2											
CO3	3	3	2											
CO4	3	3	2											
CO5	3	3	3											
CO6					3									

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	70	-	-	-	100
CAT2	10	20	70	-	-	-	100
CAT3	10	20	70	-	-	-	100
ESE	10	20	70	-	-	-	100

* ±3% may be varied (CAT 1,2,3 - 50 marks & ESE – 100 marks)

***Alternate week**

22PHT14 - PHYSICS FOR AUTOMOBILE ENGINEERING								
Programme & Branch	**BE-Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**0**	**0**	**3**

Preamble	This course aims to impart the knowledge on crystal structure, phase diagram, conductors and semiconductors and also select materials characterization techniques. It also describes the applications of aforementioned topics in Automobile Engineering and provides motivation towards innovations.	
Unit – I	**Crystal Physics:**	**9**
Introduction – Classification of solids – Space lattice – Crystal structure – Unit cell – Bravais lattice – Single and polycrystalline materials – Lattice planes – Miller indices – Indices of crystal direction – Interplanar spacing in cubic system – Hexagonal close packed crystal structure and c/a ratio – Symmetry – Symmetry elements – Crystal imperfections: line, surface and volume imperfections.		
Unit – II	**Phase Diagram:**	**9**
Introduction – Phase rule – Phase equilibrium – Phase Diagram – Type of phase diagrams: Unary phase diagram and Binary phase diagram – Iron-Carbon phase diagram – Time-temperature-transformation diagrams (TTT) – Lever rule – Analyses of actual composition and relative amounts of phases present – Invariant reactions – Cu -Ni phase diagram.		
Unit – III	**Conducting Materials:**	**9**
Conductors – Classical free electron theory of metals – Electrical conductivity – Thermal conductivity – Wiedemann-Franz law – Lorentz number – Draw backs of classical free electron theory – Quantum free electron theory – Quantum statistics: Fermi distribution function and Effect of temperature on Fermi function – Density of energy states – Carrier concentration in metals.		
Unit – IV	**Semiconducting Materials:**	**9**
Intrinsic semiconductor: Intrinsic carrier concentration, Fermi level in an intrinsic semiconductor, Variation of intrinsic conductivity with temperature and determination of band gap – Extrinsic semiconductors: Carrier concentration in N-type and P-type semiconductors – Hall effect: Theory and experimental determination of Hall coefficient and Applications – Solar Cell.		
Unit – V	**Materials Characterization:**	**9**
Importance of materials characterization – X-ray diffraction analysis – Scanning electron microscopes: principle, construction and working – Transmission electron microscope: principle, construction and working (qualitative) – Fourier transform infrared spectroscopy – Raman spectroscopy.		
		Total:45

TEXT BOOK:

1.	Hitendra K. Malik and A.K. Singh, "Engineering Physics", 2nd Edition McGraw-Hill Education , New Delhi, 2018
2.	Avadhanulu M.N., Kshirsagar P.G. and Arun Murthy T.V.S., "A Textbook of Engineering Physics", 11th Edition, S. Chand & Company Pvt. Ltd., New Delhi, 2019.

REFERENCES:

1.	Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai and Sons, New Delhi, 2009.
2.	Sam Zhang, Lin Li and Ashok Kumar, "Materials Characterization Techniques", 1st Edition, CRC Press, Boca Raton, 2008.
3.	Tamilarasan K. and Prabu K., "Materials Science", 1st Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain seven crystal systems, interplanar spacing in cubic lattice, c/a ratio of HCP crystal structure, symmetry elements, reciprocal lattice and the types of crystal imperfections and their impacts.	Applying (K3)
CO2	apply phase rules to realize the concepts of unary and binary phase diagrams and also time-temperature-transformation diagrams.	Applying (K3)
CO3	apply the concepts of classical and quantum free electron theory of metals to compute the electrical and thermal conductivity of metals and to comprehend the effect of temperature on Fermi function and to compute the expressions for density of states and carrier concentration in metals.	Applying (K3)
CO4	use the concept of density of states to compute the carrier concentration, electrical conductivity and band gap of intrinsic semiconductors and to compute the carrier concentration of extrinsic semiconductors, and also to explain the phenomenon related to Hall Effect and the working of solar cell.	Applying (K3)
CO5	apply the concepts of X-ray diffraction, SEM, TEM, FTIR and Raman effect to analyze the properties of materials using the aforementioned appropriate characterization techniques.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2						2	2		2	2	2
CO2	3	2	2						2	2		2	2	1
CO3	3	2	2						2	2		2	1	3
CO4	3	2	2						2	2		2		3
CO5	3	2	2						2	2		2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	10	50	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUT11 – STATICS AND DYNAMICS							
Programme & Branch	**B.E – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1/2**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge to represent engineering system as a force system and solve the system for equilibrium under static and dynamic conditions	
Unit – I	**Statics of Particles:**	**9**
Introduction and laws of mechanics - System of forces - Principle of transmissibility - parallelogram and triangular law of forces - Resultant of forces in plane and space - Equilibrium of a particle in plane and space. Applications - Lifting a load by crane, towing a vehicle and resultant force acting on various automotive components.		
Unit – II	**Statics of Rigid Bodies:**	**9**
Moment and couple - Vectorial representation of moment and couple – Varignon's theorem - Types of supports and their reactions - Resultant moment and couple in plane and space - Equilibrium of rigid bodies in plane and space. Applications - Moment about hinges in doors and bonnet - Moment about fixed joint in foot rest - Location of door locks - Overturning of crane while lifting large loads - Better position to hold a spanner - Best position to mount hydraulic cylinder on a tipper.		
Unit – III	**Friction:**	**9**
Introduction and laws of dry friction - Coefficient of friction - Angle of friction and repose - Sliding friction - Ladder friction - Wedge friction - Belt friction - Wheel friction and rolling resistance. Applications - Coefficient of friction required to move a vehicle - Horizontal force required to overcome rolling resistance of a vehicle - Maximum load a vehicle can pull - Tension in V belt - Braking torque in disc and drum brakes.		
Unit – IV	**Properties of Surfaces and Solids:**	**9**
First moment of area and centroid of sections - Moment of inertia of plane areas - Parallel axis theorem and perpendicular axis theorem - Polar moment of inertia and product of inertia - Principal moments of inertia of plane areas. Applications - Location of CG in a vehicle - Area moment of Inertia of chassis frame.		
Unit – V	**Dynamics of Particles and Rigid Body:**	**9**
Equations of motion - Rectilinear motion of particles - Curvilinear motion - Projectile motion. Principle of work and energy of particles and rigid body - Impulse - Momentum equations of particles and rigid body - Impact of elastic bodies. Applications - Linear and angular velocity of a vehicle, acceleration and deceleration of a vehicle, force transmitted due to vehicle impact and force exerted by driver on seat belt.		
		Total:45

TEXT BOOK:

1.	P Beer Ferdinand , Jr Russel Johnston , David F. Mazure, Philip J. Cornwell & Sanjeev Sanghi., "Vector Mechanics for Engineers: Statics and Dynamics", 11th Edition, McGraw Hill Education, New Delhi, 2017.

REFERENCES:

1.	N.H Dubey , "Engineering Mechanics: Statics and Dynamics", 1st Edition, McGraw Hill Education, New Delhi, 2016.
2.	R.C. Hibbeler, "Engineering Mechanics", 14th Edition, Pearson Education, United Kingdom, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	represent the forces in vector components (both 2D and 3D) and apply equilibrium conditions to find the unknown force in automotive systems.	Applying (K3)
CO2	calculate the moment produced by various force systems and solve rigid body problems by applying equilibrium conditions for designing automotive systems.	Applying (K3)
CO3	apply the laws of dry friction to calculate frictional force and torque in various automotive systems to analyze a vehicle.	Applying (K3)
CO4	calculate the centroid and area moment of inertia for designing automotive chassis frame.	Applying (K3)
CO5	analyze the motion of particles and rigid bodies using various principles.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**3**	**2**	**2**								**2**	**3**	
CO2	**3**	**3**	**2**	**2**								**2**	**3**	
CO3	**3**	**3**	**2**	**2**								**2**	**3**	
CO4	**3**	**3**	**2**	**2**								**2**	**3**	
CO5	**3**	**3**	**2**	**2**								**2**	**3**	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	15	70				100
CAT2	15	15	70				100
CAT3	15	15	55	15			100
ESE	10	10	60	20			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CSC11 - PROBLEM SOLVING AND PROGRAMMING IN C								
(Common to All Engineering and Technology branches except CSE, IT, CSD, AIDS & AIML)								
Programme & Branch	**All BE/BTech Engineering & Technology branches , except CSE, IT, CSD, AIDS & AIML**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**0**	**2**	**4**

Preamble	The course aims to provide exposure to problem-solving through programming. It introduces all the fundamental concepts of C Programming. This course provides adequate knowledge to solve problems using C	
Unit – I	**Introduction to C and Operators:**	**9**
The structure of a C program – Compiling and executing C program – C Tokens – Character set in C – Keywords – identifiers- Basic data Types – Variables – constants – Input / Output statements – Operators		
Unit – II	**Control Statements and Arrays:**	**9**
Decision-making and looping statements, Arrays: Declaring, initializing and accessing arrays – operations on arrays – Two-dimensional arrays and their operations.		
Unit – III	**Functions:**	**9**
Functions: Introduction- Using functions, function declaration and definition – function call – return statement – passing parameters to functions: basic data types and arrays – storage classes – recursive functions		
Unit – IV	**Strings and Pointers:**	**9**
Strings: Introduction – operations on strings: finding length, concatenation, comparing and copying – string and character manipulation functions, Arrays of strings. Pointers : declaring pointer variables – pointer expression and arithmetic, pointers and 1D arrays, pointers and strings		
Unit – V	**User-defined Data Types and File Handling:**	**9**
User-defined data types: Structure: Introduction – nested structures– arrays of structure – structure and functions -unions – enumerated data type. File Handling : Introduction - opening and closing files – reading and writing data to files -Manipulating file position indicator : fseek(), ftell() and rewind()		

LIST OF EXPERIMENTS / EXERCISES:

1.	Programs for demonstrating the use of different types of format Specifiers
2.	Programs for demonstrating the use of different types of operators like arithmetic, logical, relational, and ternary operators
3.	Programs for demonstrating the use of using decision making statements
4.	Programs for demonstrating the use of repetitive structures
5.	Programs for demonstrating one-dimensional arrays
6.	Programs for demonstrating two-dimensional arrays
7.	Programs to demonstrate modular programming concepts using functions
8.	Programs to demonstrate recursive functions.
9.	Programs to demonstrate strings (Using built-in and user-definedfunctions)
10.	Programs to illustrate the use of pointers
11.	Programs to illustrate the use of structures and unions
12.	Programs to implement file Handling

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Reema Thareja, “Programming in C ”, 2nd Edition, Oxford University Press, New Delhi, 2018.

REFERENCES/ MANUAL / SOFTWARE:	
1.	Yashavant Kanetkar, "Let us C", 16th Edition, BPB Publications, 2018.
2.	Sumitabha Das, "Computer Fundamentals and C Programming", 1st Edition, McGraw Hill, 2018.
3.	Balagurusamy E., "Programming in ANSI C", 7th Edition, McGraw Hill Education, 2017.
4.	Behrouz A. Forouzan & Richard F.Gilberg, "Computer Science A Structured Programming Approach Using C", 3rd Edition, Cengage,2017.
5.	https://www.cprogramming.com/tutorial/c-tutorial.html

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	develop simple programs using input/output statements and operators	Applying (K3), Precision (S3)
CO2	identify the appropriate looping and control statements in C and develop applications using these statements	Applying (K3), Precision (S3)
CO3	develop simple C programs using the concepts of arrays and modular programming	Applying (K3), Precision (S3)
CO4	apply the concepts of pointers and develop C programs using strings and pointers	Applying (K3), Precision (S3)
CO5	make use of user-defined data types and file concepts to solve given problems	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1				1	1		1		
CO2	3	2	2	2	1				1	1		1		
CO3	3	2	2	2	1				1	1		1		
CO4	3	2	2	2	1				1	1		1		
CO5	3	2	2	2	1				1	1		1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	10	30	60				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MET11 - ENGINEERING DRAWING							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**ES**	**2**	**1**	**0**	**3**

Preamble	To impart knowledge on orthographic, isometric projections, sectional views and development of surfaces by solving different application oriented problems.	
Unit – I	**General Principles of Orthographic Projection:**	**6+3**
Importance of Graphics in Engineering Applications - Use of Drafting Instruments - BIS Conventions and Specifications - Size, Layout and Folding of Drawing Sheets - Lettering and Dimensioning - Projections of Points, Lines and Planes - General Principles of Orthographic Projection - First Angle Projection - Layout of Views - Projection of Points Located in all Quadrant and Straight Lines Located in the First Quadrant - Determination of True Lengths and True Inclinations and Location of Traces - Projection of Polygonal Surface and Circular Lamina Inclined to both Reference Planes.		
Unit – II	**Projections of Solid:**	**6+3**
Projections of Simple Solids Like Prisms, Pyramids, Cylinder and Cone when the Axis is inclined to One Reference Plane by Change of Position Method.		
Unit – III	**Sectioning of Solids:**	**6+3**
Sectioning of Solids - Prisms, Pyramids, Cylinder and Cone in Simple Vertical Position by Cutting Planes inclined to One Reference Plane and Perpendicular to the other - Obtaining True Shape of Section.		
Unit – IV	**Development of Surfaces:**	**6+3**
Development of Lateral Surfaces of Simple Solids Like Prisms, Pyramids, Cylinders and Cones -Development of Simple Truncated Solids Involving Prisms, Pyramids, Cylinders and Cones.		
Unit – V	**Isometric Projection and Introduction to AutoCAD:**	**6+3**
Principles of Isometric Projection - Isometric Scale - Isometric Projections of Simple and Truncated Solids Like Prisms, Pyramids, Cylinders and Cones - Conversion of Isometric Projection into Orthographic Projection - Introduction to AutoCAD.		
		Lecture: 30, Tutorial:15, Total:45

TEXT BOOK:

1.	Natarajan.K.V. “A Textbook of Engineering Graphics”,35th Edition, Dhanalakshmi Publishers, Chennai, 2022,

REFERENCES:

1.	Venugopal K. and Prabhu Raja V., “Engineering Graphics”, 16th Edition, New Age International Publishers, Chennai, 2022.
2.	Basant Agrawal, Agrawal C.M., “Engineering Drawing”, 3rd Edition, McGraw Hill Education, 2019.
3.	Parthasarathy N.S., Vela Murali. “Engineering Drawing”, 1st Edition, Oxford University Press, 2015.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	interpret international standards of drawings and sketch the projections of points, lines and planes	Applying (K3)
CO2	draw the projections of 3D primitive objects like prisms, pyramids, cylinders and cones	Applying (K3)
CO3	construct the various sectional views of solids like prisms, pyramids, cylinders and cones	Applying (K3)
CO4	develop the lateral surfaces of simple and truncated solids	Applying (K3)
CO5	sketch the isometric projections of simple and truncated solids and convert isometric drawing into orthographic projection	Applying (K3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2			2					3		2		
CO2	3	2	1		2					3		2		
CO3	3	2	1		2					3		2		
CO4	3	2	1		2					3		2		
CO5	3	2	1		2					3		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	6	9	85				100
CAT2	6	9	85				100
CAT3	6	9	85				100
ESE	10	10	80				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MEL11 - ENGINEERING PRACTICES LABORATORY							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1/ 2**	**ES**	**0**	**0**	**2**	**1**

Preamble	This course is designed to provide a hands-on experience in basic of mechanical and electrical engineering practices.

LIST OF EXPERIMENTS / EXERCISES:

	PART A – MECHANICAL ENGINEERING
1.	Prepare a Square / Rectangular / V-Shape Projection with its Counterpart for Mating and Perform the Drilling, Tapping, and Assembling Tasks from the given Square / Rectangular MS Plates using Modern Power Tools.
2.	Prepare T / L / Lap Joint from given Wooden Work Piece and Make a Box / Tray out of Plywood using Modern Power Tools.
3.	Perform the Thread Formation on a GI/PVC Pipe and Prepare a Water Line from the Overhead Tank that is Leak-Proof.
4.	Make a Butt / Lap / Tee Joint of MS Plate using Arc Welding Process and Welding Simulator.
5.	**Activity:** Prepare an Innovative Model with the Knowledge from Fitting / Carpentry / Plumbing / Welding Involving Modern Power Tools.
	PART B – ELECTRICAL AND ELECTRONICS ENGINEERING
6.	Wiring circuit for fluorescent lamp and Stair case wiring
7.	Wiring Circuit of Incandescent lamp using Impulse Relay
8.	Measurement of Earth Resistance
9.	Soldering of Simple Circuits and trouble shooting
10.	Implementation of half wave and full wave Rectifier using diodes
	Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Engineering Practices Laboratory Manual.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	plan the sequence of operations for effective completion of the planned models / innovative articles	Creating (K6) Manipulation (S2)
CO2	identify and use appropriate modern power tools and complete the exercises/models accurately	Applying (K3) Manipulation (S2)
CO3	perform house wiring and realize the importance of earthing	Applying (K3), Manipulation (S2)
CO4	soldering with simple electronics circuits	Applying (K3), Manipulation (S2)
CO5	trouble shoot the electrical and electronic circuits	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3	1	3	1			3	3		3		
CO2	3		3	1	3				3	3		3		
CO3	3		3	2	1				2	2		3	3	2
CO4	3		2	1	1				2	3		3	3	2

CO5	3		3	2	1				2	2		3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

22PHL14 - PHYSICS LABORATORY FOR AUTOMOBILE ENGINEERING

Programme & Branch	**BE - Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**0**	**0**	**2**	**1**

Preamble	This course aims to impart hands on training in the determination of parameters such as thickness of a thin film, specific resistance, thermal conductivity, Fermi energy, band gap, Hall coefficient, rigidity modulus, velocity of ultrasonic waves, compressibility of a liquid, Young's modulus, frequency of alternating current and knowledge on the working of UJT, and also to impart skills on writing coding / developing project / product related to societal requirement.

LIST OF EXPERIMENTS / EXERCISES:

1.	Determination of the thickness of a thin film by air-wedge arrangement.
2.	Determination of the specific resistance of a metallic wire using Carey-Foster's bridge.
3.	Determination of the thermal conductivity of a bad conductor using Lee's disc.
4.	Determination of the Fermi energy level of copper using Wheatstone's bridge / Determination of the band gap of a semiconducting material using post-office box.
5.	Determination of the Hall coefficient of a material using Hall effect arrangement / Observation of the I-V characteristics of a uni junction transistor.
6.	Determination of the rigidity modulus of a metallic wire using torsional pendulum.
7.	Determination of the velocity of ultrasonic wave in a given liquid and the compressibility of the liquid using ultrasonic interferometer.
8.	Determination of the Young's modulus of the material of the given beam by uniform bending method.
9.	Determination of the frequency of alternating current using electrically vibrating tuning fork (Melde's apparatus).
10.	Writing coding for any one of the above experiments / developing a project / a product.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Physics Laboratory Manual / Record, Department of Physics, 1st Edition, 2020.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	determine the thickness of a thin film, the specific resistance of a metallic wire and the thermal conductivity of a bad conductor.	Applying (K3), Precision (S3)
CO2	determine the Fermi energy of a conductor or the band gap of a semiconductor, the Hall coefficient of a material or the I-V characteristics of a UJT.	Applying (K3), Precision (S3)
CO3	determine the rigidity modulus of a metallic wire, the Young's modulus of a material, the velocity of ultrasound in liquid, the frequency of alternating current and develop a coding / project / product.	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3					2	2		2	3	3
CO2	3	2	2	3					2	2		2		3
CO3	3	2	2	3					2	2		2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22VEC11 - YOGA AND VALUES FOR HOLISTIC DEVELOPMENT							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech. Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**HS**	**1**	**0**	**1**	**1**

Preamble	Yoga or yogasanas are considered as art and science of healthy living by our ancient gurus. It is method to bring harmony of body and mind for general wellbeing. Yoga is considered as one of the greatest gifts to the world by Indians for healthy living. Students in particular are benefitted by learning yoga.	
Unit – I	**Introduction:**	**2**
The Origins of Yoga – Definitions - Concepts - Aims and objectives of Yoga – Yoga is a Science and Art – Rules and Regulations of Asanas – Classifications of Yogasanas – Patanjali's Ashtanga Yoga – Pranayama – Mudras & Bandhas - Shatkarma (Cleansing Practice) - Streams of Yoga – Modern Trends in yoga.		
Unit – II	**Yoga and Mind:**	**2**
The Nature of Mind - Five Elements and the Mind - Meditation and the Mind - Functions of the Mind - Role of Yoga in Psychological problems: Mood Disorders, Major Depressive Disorder, Cyclothymic Disorder.		
Unit – III	**Yoga and Values, Diet:**	**2**
Human Values – Social Values – Role of Yoga in Personality Integration - Concepts of Natural Diet - Naturopathy Diet – Eliminative Diet – Soothing Diet – Constructive Diet.		
Unit – IV	**Asanas:**	**2**
Prayer - Starting & Closing - Preparatory practices – Loosening Practices – Meaning, Definitions and Objectives of Asanas - Principles of Practicing Asanas. Asanas: Standing – Sitting – Prone – Supine – Suryanamaskar.		
Unit – V	**Pranayama and Meditation:**	**2**
Breathing Practices for awareness - Definitions and Objectives of Pranayama - Principles of Practicing Pranayama. Pranayama: Nadi Shuddhi - Kapalabathi – Sitali – Sitkari – Bhranari – Ujjayi – Relaxation Techniques – Meditation.		
		Lecture: 10, Practical: 10, Total:20

TEXT BOOK:

1.	Swami satyananda saraswathi, "Asana pranayama mudra bandha", Bihar school of yoga, 4th Edition, 1969.
2.	Swami mukthi Bodhanandha, "Hatha yoga pradipika", Bihar school of yoga, 4th Edition, 1985.

REFERENCES:

1.	B.K.S. Iyenkar, "Yoga the path of holistic health", DK Limited, 2nd Edition, 1969.
2.	Selvarasu, "Kriya cleansing in yoga", Aruvi yoga, 3rd Edition, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	realize the importance of yoga in physical health.	Applying (K3)
CO2	realize the importance of yoga in mental health.	Applying (K3)
CO3	realize the role of yoga in personality development and diet.	Applying (K3)
CO4	do the loosening practices, Asanas and realize its benefits.	Applying (K3)
CO5	do the practice of Pranayama, meditation and realize its benefits	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						3		2	1			
CO2						3		2				
CO3						3		3				
CO4						3		2	3			
CO5						3		3				

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	-	-	-	-	-	-
CAT2	-	-	-	-	-	-	-
CAT3	20	30	50	-	-	-	100
ESE	-	-	-	-	-	-	-

* ±3% may be varied (CAT3 – 100 marks)

22EGT21 - COMMUNICATION SKILLS II								
(Common to All Engineering and Technology Branches)								
Programme & Branch	**All B.E./B.Tech. Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Communication Skills I**	**2**	**HS**	**3**	**0**	**0**	**3**

Preamble	This course is designed to equip students with the necessary skills to listen, read, write and speak so as to develop their linguistic and communicative competencies.	
Unit – I	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Sentence Patterns **-** Simple, Compound & Complex sentences **- Vocabulary:** Portmanteau words **-** One word substitution **- Listening:** Speeches from company CEOs **-** TV debates **Speaking:** Just-a-minute talk **-** Group discussion **- Reading:** Reading for Gist **- Writing:** Job application letter with resume **–** Transcoding		
Unit – II	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Concord **- Vocabulary:** Phrasal verbs **-** Idioms & Phrases - **Listening:** Listening to celebrity talks - **Speaking:** Talking about celebrities - Practicing Pronunciation through web tools - **Reading:** Company correspondence, technical texts/working principles of a machine - **Writing:** Description: Person, Place**,** Process, Product and Picture		
Unit – III	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Discourse markers **-** Transitional words and phrases **- Vocabulary:** Commonly confused words **- Listening:** Listening to guest lectures **- Speaking:** Technical & Non-technical presentations **-** Workshop presentations **- Reading:** Reputed company profiles, Business Plans **- Writing:** a dream job/company **-** Letter to the Editor **–** Biography & Autobiography **-** Checklist		
Unit – IV	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Degrees of Comparison **-** Punctuations **–** Fragments & run-ons **- Vocabulary:** British & American **-** Spelling & words **- Listening:** Listening to global accents **-** listening to motivational speeches **-** S**peaking:** Narrating personal milestones **-** Sports commentaries **-** Movie Enactment **- Reading:** Narrative passages **- Writing:** E mail **-** Agenda & Minutes of Meeting **-** Special & Technical reports		
Unit – V	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Purpose and Function **-** If clause **-** Error detection **- Vocabulary:** Coding & Decoding **-** Alphabet test **- Listening:** Listening to sample HR Interviews **- Speaking:** Introduction to phonetics - Stress, rhythm & Intonation **–** Guided & unguided speeches/conversations **-** Giving feedback **–** Debate **- Reading:** Key Note speeches **-** Newspaper reports **-** short technical texts from journals **Writing:** Circulars **-** Critical Appreciation of a non-detailed text **-** Technical proposals		
		Total:45

TEXT BOOK:	
1.	Sanjay Kumar & Pushp Lata, “Communication Skills”, 2nd Edition, Oxford University Press, New Delhi, 2018.
REFERENCES:	
1.	Meenakshi Raman and Sangeeta Sharma. “Technical Communication- Principles and Practice”. 4th Edition, Oxford University Press, New Delhi, 2022.
2.	Murphy Raymond, "English Grammar in Use", 5th Edition, Cambridge University Press, New York, 2019.
3.	Jack C. Richards and Chuck Sandy, “Passages” Student’s Book 2, 3rd Edition, Cambridge University Press, New York, 2014.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	use functional grammar for improving communication skills	Applying (K3)
CO2	listen and comprehend different accents and infer implied meanings	Applying (K3)
CO3	speak clearly, initiate and sustain a discussion and negotiate using appropriate communicative strategies	Creating (K6)
CO4	read different genres of texts, infer implied meanings and critically analyze and evaluate them	Understanding (K2)
CO5	produce different types of narrative, descriptive expository texts and understand creative, critical, analytical and evaluative writing	Creating (K6)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2			1	3	1	1
CO2									2	3		1
CO3									2	3		2
CO4						1				3	1	1
CO5										3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		37	30			33	100
CAT2		7	50			43	100
CAT3		17	50			33	100
ESE		15	45			40	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MAC22 - MULTIVARIABLE CALCULUS AND PARTIAL DIFFERENTIAL EQUATIONS							
(Common to Automobile and Chemical branches)							
Programme & Branch	**B.E - Automobile & BTech – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**BS**	**3**	**1***	**2***	**4**

Preamble	To impart the knowledge of partial derivatives, evaluation of real integrals, vector calculus to the students and solving the partial differential equations related to engineering.	
Unit – I	**Functions of Several Variables:**	**9**
Functions of two or more variables – Partial derivatives – Total differential – Taylor's series for functions of two variables – Applications: Maxima and minima – Constrained maxima and minima – Lagrange's multiplier method.		
Unit – II	**Multiple Integrals:**	**9**
Double integration in cartesian coordinates – Change of order of integration – Application: Area between two curves – Triple integration in cartesian coordinates – Volume as triple integrals.		
Unit – III	**Vector Calculus:**	**9**
Directional derivative – Gradient of a scalar point function – Divergence of a vector point function – Curl of a vector – Solenoidal and Irrotational vectors – Vector Integration: Introduction – Green's, Stoke's and Gauss divergence theorems (without proof) – Verification of the above theorems and evaluation of integrals using them.		
Unit – IV	**Partial Differential Equations:**	**9**
Introduction – Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Lagrange's linear equation – Solution of homogeneous linear partial differential equations of higher order with constant coefficients.		
Unit – V	**Applications of Partial Differential Equations:**	**9**
Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two dimensional heat equation (excluding insulated edges).		

LIST OF EXPERIMENTS / EXERCISES:

1.	Finding ordinary and partial derivatives.
2.	Computing extreme values of function of two variables.
3.	Evaluating double and triple integrals.
4.	Finding the area between two curves.
5.	Computing gradient, divergence and curl of point functions.
6.	Solving second order partial differential equations.
7.	Solving One dimensional wave equation.
8.	Solving Two dimensional heat equation.

Lecture:45, Tutorials and Practical:15, Total:60

TEXT BOOK:

1.	Ramana B V, "Higher Engineering Mathematics", 1st Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2018.

REFERENCES/ MANUAL / SOFTWARE:

1.	Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.
2.	Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi

3.	Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., " Engineering Mathematics – I ", 2^{nd} Edition, Pearson India Education, New Delhi, 2018.
4.	Grewal B.S, “Higher Engineering Mathematics" 44thEdition, Khanna Publishers, New Delhi, 2018.
5.	MATLAB – Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	compute the total derivatives and extreme values of multivariable functions.	Applying (K3)
CO2	evaluate multiple integrals and apply them to compute the area and volume of the regions.	Understanding (K2)
CO3	apply the concepts of derivatives and line integrals of vector functions in engineering problems.	Applying (K3)
CO4	formulate and solve higher order partial differential equations.	Applying (K3)
CO5	apply Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.	Applying (K3)
CO6	demonstrate MATLAB programming to understand the concepts of functions of two variables, vector operators, multiple integrals and solve Partial differential equations.	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2											
CO2	3	3	2											
CO3	3	3												
CO4	3	2	1											
CO5	3	3	3											
CO6					3									

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60	-	-	-	100
CAT2	10	30	60	-	-	-	100
CAT3	10	30	60	-	-	-	100
ESE	5	30	65	-	-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

***Alternate Week**

22CYT26 – CHEMISTRY FOR AUTOMOBILE ENGINEERING

Programme & Branch	**B.E & Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**BS**	**3**	**0**	**0**	**3**

Preamble	This course aims to emphasize the engineering students to realize the importance of electrochemistry, cells & batteries, fuel cells, fuels & combustion and the need for corrosion & its control methods.

Unit – I | ELECTROCHEMISTRY | 9

Introduction - cells - types - representation of galvanic cell – electrode potential – Nernst equation (derivation of cell EMF) – calculation of cell EMF from single electrode potential – reference electrodes: construction, working and applications of standard hydrogen electrode, standard calomel electrode, glass electrode – EMF series and its applications - potentiometric titrations (redox) – conductometric titrations – mixture of weak and strong acid vs strong base.

Unit – II | CELLS AND BATTERIES | 9

Introduction - materials used, specification of cells and batteries - types of electrolytes used in cells and batteries - types of batteries - discharging and charging of battery - characteristics of battery - battery rating - various tests on battery - purpose of series/ parallel connection of batteries – primary battery: silver button cell - secondary battery: Lead-acid, Ni-Cd battery - modern battery: lithium ion - advantages of Li-ion battery as an electrochemical energy system for electric vehicles - recycling of Lithium-ion batteries by direct cycling method - brief introduction of Na- ion battery, Ni-Metal hydride - maintenance of batteries - choice of batteries for electric vehicle applications.

Unit – III | FUELS AND COMBUSTION | 9

Introduction – classification of fuels - characteristics of a good fuel - combustion - calorific values – gross and net calorific values - theoretical calculation of calorific value by Dulong‘s formula - flue gas analysis by Orsat‘s method - solid fuels - coal and its varieties – proximate analysis – significance – metallurgical coke - Otto-Hoffman byproduct method - liquid fuel - refining of petroleum – manufacture of synthetic petrol - hydrogenation of coal - bergius process - knocking: spark ignition engine - octane number, compression ignition engine - cetane number - power alcohol and biodiesel - gaseous fuel - water gas - introduction of Bharat Stage Emission Standard (BSES) system.

Unit – IV | HYDROGEN FUEL AND FUEL CELLS | 9

Hydrogen fuel: Introduction - Hydrogen - technology for hydrogen generation (Photo electrocatalytic and photo catalytic water splitting), Biological hydrogen - Hydrogen utilization - Hydrogen storage - Compressed gas in pressure vessels, Hydrogen absorbing materials, Liquid storage, Underground storage - applications in hydrogen fuel cells.
Fuel Cell: Introduction - Role of fuel, oxidant, electrolyte with example - Importance and classification of fuel cells - description, principle, components and applications of fuel cells: alkaline fuel cell, proton exchange membrane fuel cell, direct methanol fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell - chemical concepts of air bags in automobiles.

Unit – V | CORROSION AND ITS CONTROL METHODS | 9

Corrosion: Introduction - chemical corrosion – Pilling-Bedworth rule - electrochemical corrosion and it's types – galvanic corrosion – differential aeration corrosion with examples - galvanic series - factors influencing rate of corrosion – measurement of corrosion (wt. loss method only).
Control methods – sacrificial anodic protection method - corrosion inhibitors - protective coatings - pretreatment of metal surface – metallic coating: electroplating, electroless plating and hot dipping (tinning and galvanizing) methods – non-metallic coating: anodizing - organic coating: paints, constituents and functions - ceramic coatings.

Total:45

TEXT BOOK:

1. Wiley Editorial Board, "Wiley Engineering Chemistry", 2nd Edition, Wiley India Pvt. Ltd, New Delhi, Reprint 2019.

REFERENCES:

1. Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K., Kowshalya V.N., "Chemistry for Civil Engineering", Pearson Education, New Delhi, Revised Edition 2019.
2. Dara .S.S, "A Text book of Engineering Chemistry", S. Chand and company Ltd., 2021.
3. Sunita Rattan, " A Text book of Engineering Chemistry", S.K. Kataria & Sons Publishers, First edition, 2018, Reprint-2022.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the principles of electrochemistry for various applications	Applying (K3)
CO2	employ the concepts of cells, batteries and its applications in automobiles.	Applying (K3)
CO3	apply the concepts of fuels and combustion for engineering applications	Applying (K3)
CO4	use the concepts of hydrogen fuel, fuel cells and its applications in automobiles.	Applying (K3)
CO5	make use of corrosion control methods to solve corrosion related issues.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1									2	2
CO2	3	2	1	1									2	2
CO3	3	2	1	1									2	2
CO4	3	2	1	1									2	2
CO5	3	2	1	1									2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUC21 - MANUFACTURING TECHNOLOGY							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PC**	**3**	**0**	**2**	**4**

Preamble	This course provides an overview of a wide variety of manufacturing processes like foundry technology, metal forming, metal removal, metal joining and metal finishing process to fabricate various machine element parts	
Unit – I	**Foundry Technology:**	**9**
Introduction to Molding and Casting - Molding sand: types, properties - preparation of green sand molding - Pattern making: Pattern materials, types and allowances - Core making: types of core, core materials, making of cores - Casting methods: Die casting, Centrifugal Castings, Investment Casting and Shell mold Casting - Defects in casting.		
Unit – II	**Metal Forming Processes:**	**9**
Introduction to forming process. Rolling: Rolling mills, Rolling operations - Extrusion: Forward and Backward extrusion - Production of seamless tubing and pipes - Cold and Hydrostatic Extrusion – Drawing: hot and Cold drawing - Deep drawing - Tube and wire drawing - Sheet metal operations - and forging.		
Unit – III	**Metal Removal Processes:**	**9**
Lathe: types, main parts and operations - single point cutting tool nomenclature - Drilling Machine: Types, operations, types of drills - twist drill nomenclature - reaming and tapping - Milling Machine: Types, operations - Types of milling cutters - Shaper and Planer: types, main parts, operations.		
Unit – IV	**Metal Joining Processes:**	**9**
Classification of Welding Process - Fusion Welding Processes: Arc Welding - Gas Tungsten Arc welding - Gas Metal Arc Welding - Electron Beam Welding - Laser Beam Welding - Solid State Welding: Cold Welding - Ultrasonic Welding - Friction Welding - Resistance Welding - Explosive Welding - Gas welding: Oxy – Acetylene welding process - Weld defects. Brazing and soldering: Concepts and applications.		
Unit – V	**Metal Finishing Processes:**	**9**
Grinding Machine: Methods of grinding - Types of grinding machines - Grinding wheel and its selection – Lapping – Honing - super finishing - Broaching Machine: pull type and push type broachers - Broaching methods and operations - Types of broaching machines.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Lathe operations: Step turning, Taper turning and Knurling
2.	Lathe operation: Thread Cutting
3.	Lathe operation: Eccentric turning
4.	Milling machine operation: Contour / Key way milling
5.	Milling machine operation: Spur gear milling
6.	Shaper / planner machine operation: Key way / Dove tail shape Cutting
7.	Drilling machine operations: Drilling, Reaming and Tapping
8.	Grinding machine operations: Surface grinding and Cylindrical grinding
9.	Preparation of mould for sand casting using single piece / split patterns
10.	Practice a butt / lap joint using the given metal strips by Arc / Gas welding

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1. Kalpakjian S. & Schmid R., "Manufacturing Engineering and Technology", 7th Edition, Pearson Education, India, 2013.

REFERENCES/ MANUAL / SOFTWARE:	
1.	Kaushish J.P., "Manufacturing Processes", 2nd Edition, PHI Learning Pvt. Ltd., 2013.
2.	Rao P.N., "Manufacturing Technology, Volume I & II", 3rd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the various foundry techniques like pattern making, molding, casting, melting furnaces and inspection.	Understanding (K2), Precision (S3)
CO2	infer various forming processes involving bulk forming and sheet metal operations.	Understanding (K2), Precision (S3)
CO3	demonstrate the metal removal processes according to the material and geometrical design.	Applying (K3), Precision (S3)
CO4	discuss the metal joining processes based on the properties of the base metal.	Understanding (K2), Precision (S3)
CO5	describe the various metal finishing processes for surface finishing operations.	Understanding (K2), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1				2	1		2	2		2	3	
CO2	3	1				2	1		2	2		2	3	
CO3	3	1	1			3	1		2	2		2	3	
CO4	3	1				2	1		2	2		2	3	
CO5	3	1				2	1		2	2		2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	60	20				100
CAT3	20	80					100
ESE	20	60	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CSC21 – FUNDAMENTALS OF DATA STRUCTURES

(Common to Civil, Mechanical, Automobile, Chemical Branches)

Programme & Branch	**BE - Civil, Mechanical, Automobile & BTech – Chemical Engineering Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Programming in C**	**2**	**PC**	**3**	**0**	**2**	**4**

Preamble	This course is indented to introduce the concept of elementary data structures and notion of algorithms to novice learner from cross disciplines in Engineering and Technology.	
Unit – I	**List:**	**9**
Data Structures - Abstract Data Types (ADT) - List ADT and Array Implementation - Linked List- Singly Linked List- Insertion - Deletion - Copying Singly Linked List - Doubly Linked List- Insertion -Deletion.		
Unit – II	**Stack and Queues:**	**9**
Stack ADT – Array and Linked List implementation of Stacks - Application: Balancing Parenthesis – Infix to Postfix - Postfix Expression Evaluation - Queue ADT – Array and Linked List implementation of Queues – Applications		
Unit – III	**Trees:**	**9**
Trees- Preliminaries – Binary Trees –Binary Tree Traversals - The Search Tree ADT – Binary Search Trees– Operations : Find – FindMin – FindMax – Insertion – Deletion- Expression Tree		
Unit – IV	**Graphs:**	**9**
Graphs – Definitions – Graph Traversals: Breadth First Search – Depth First Search - Shortest-Path Algorithms: Unweighted Shortest Paths – Dijkstra's Algorithm – Minimum Spanning Tree – Prim's Algorithm- Kruskal's Algorithm		
Unit – V	**Sorting and Hashing:**	**9**
Sorting - Preliminaries – Insertion Sort – Quicksort – Merge sort – Hashing – General Idea – Hash Function – Separate Chaining – Open Addressing		

LIST OF EXPERIMENTS / EXERCISES:

1.	Implementation of C programs using pointers
2.	Implementation of singly linked list and its operations
3.	Implementation of doubly linked list and its operations
4.	Implementation of Stack and its operations
5.	Implementation of Queue and its operations
6.	Implementation of Stack and Queue using Singly Linked List
7.	Evaluate the Post-fix Expression using Stack ADT
8.	Implementation of Binary Search Tree traversals
9.	Implementation of Insertion sort and Quick sort
10.	Implementation of hash function

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Weiss M. A., "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education Asia, New Delhi, 2016.

REFERENCES/ MANUAL / SOFTWARE:

1.	Horowitz Sahni, Andreson Freed, "Fundamentals of Data Structures in C", 2nd Edition, Universities Press, Hyderabad, 2011.

2.	Langsam Y.M., Augenstein J. and Tenenbaum A. M., “Data Structures using C and C++”, 2nd Edition, Pearson Education, 2015.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply List ADT for solving the given problems	Applying (K3)
CO2	make use of arrays and linked lists to create Stack and Queue ADTs.	Applying (K3)
CO3	utilize Tree ADT to develop simple application	Applying (K3)
CO4	make use of Graph ADT for standard problems	Applying (K3)
CO5	illustrate the use of standard sorting and Hashing Techniques	Applying (K3)

Mapping of COs with POs and PSOs

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO 7**	**PO 8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	60	30				100
CAT2	5	35	60				100
CAT3	5	35	60				100
ESE	5	35	60				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUT21 – AUTOMOTIVE ENGINES							
Programme & Branch	**B.E – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on IC engines and its subsystems for understanding their role in automobiles	
Unit – I	**Engine Fundamentals:**	**9**
Classification of Engines; IC. Engines - Types - Working of two stroke and four stroke IC engines – Port and valve timing diagram - Firing order. Basic Principles of Air Standard cycle - Otto Cycle - Diesel Cycle – Dual Cycle.		
Unit – II	**Fuel Supply system and ignition system**	**9**
SI Engine: Air - Fuel ratio, Simple Carburettor – Injection systems – Single point and Multipoint fuel injection - Gasoline Direct Injection. Ignition System - Battery Ignition System - Magneto Ignition System - Electronic Ignition Systems. **CI Engine:** Jerk type fuel injection pump - Distributor type fuel injection pump. Common rail direct injection system – Fuel injector – Types.		
Unit – III	**Combustion In SI Engines**	**9**
Combustion process - Stages of combustion, Flame propagation - Flame velocity and area of flame front - Rate of pressure rise - Cycle to cycle variation, Abnormal combustion - Effect of engine operating and design variables on combustion, Combustion chambers – Types, factors controlling combustion chamber design. Emission Formation in SI engine.		
Unit – IV	**Combustion in CI Engines**	**9**
Importance of air motion – Swirl, squish and tumble – Swirl ratio. Fuel air mixing – Stages of combustion – Delay period – Factors affecting delay period, Knock in CI engines – methods of controlling diesel knock. CI engine combustion chambers – Combustion chamber design objectives – open and divided. Induction swirl, turbulent combustion chambers. – Air cell chamber – M Combustion chamber. Emission Formation in CI engine.		
Unit – V	**Engine Subsystem**	**9**
Types of cooling systems and its working, Properties of coolants. Crankcase ventilation. Engine lubrication - Types of lubricating systems and its working - Properties of lubricants – Engine oil ratings. Supercharging and Turbocharging – types - working – controlling methods.		
		Lecture :45, Total:45

TEXT BOOK:

1.	Ganesan V , “Internal combustion engines”, 4th edition, Tata McGraw Hill Education, 2017. Units-I,II,III,IV,V

REFERENCES:

1.	John. B, Heywood, “Internal Combustion Engine Fundamentals”, 2nd edition, McGraw Hill Publishing Co., New York, 2017
2.	Rajput R. K, “A textbook of Internal Combustion Engines - 2nd edition, Laxmi Publications (P) Ltd, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the construction and working of IC engine and its cycle	Understanding (K2)
CO2	explain the various fuel system, injection system and ignition system used in SI and CI engines	Understanding (K2)
CO3	elaborate the combustion process in SI Engine for understanding the performance and emission characteristics	Understanding (K2)
CO4	discuss the combustion process in CI Engine for understanding the performance and emission characteristics	Understanding (K2)
CO5	summarize the working of lubrication, cooling, Turbocharging and supercharging systems	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				2	1					3	3	
CO2	3	2				2	1					3	3	**2**
CO3	3	2				2	1					3	3	
CO4	3	2				2	1					3	3	
CO5	3	2				2	1					3	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22TAM01 - தமிழர் மரபு								
(Common to All Engineering and Technology Branches)								
Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**	
Prerequisites	**Nil**	**1 / 2**	**HS**	**1**	**0**	**0**	**1**	

Preamble	தமிழர்களின் மொழி, இலக்கியம், ஓவியங்கள், சிற்பக்கலைகள், நாட்டுப்புறக் கலைகள், வீர விளையாட்டுக்கள், திணைக் கோட்பாடுகள், இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பைப் பற்றிய அறிவை வழங்குவதே இந்த பாடத்தின் நோக்கமாகும்.	
அலகு – I	**மொழி மற்றும் இலக்கியம்**	**3**
இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.		
அலகு – II	**மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**	**3**
நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.		
அலகு – III	**நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுக்கள்**	**3**
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.		
அலகு – IV	**தமிழர்களின் திணைக் கோட்பாடுகள்**	**3**
தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு- சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும் கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.		
அலகு – V	**இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு**	**3**
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறபகுதிகளில் தமிழ் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.		
		Total: 15

TEXT BOOK:

1.	ஆ. பூபாலன், தமிழர் மரபு, VRB Publishers Pvt Ltd, 2022.

REFERENCES:

1.	தமிழக வரலாறு- மக்களும் பண்பாடும்- கே கே பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2.	கணினித்தமிழ் - முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3.	கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்.(தொல்லியல் துறை வெளியீடு)
4.	பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)

COURSE OUTCOMES: படிப்பை முடித்தவுடன், மாணவர்கள்		**BT Mapped (Highest Level)**
CO1	தமிழ் மொழி மற்றும் இலக்கியத்தில் மதிப்புமிக்க கருத்துக்களை விளக்க முடியும்.	Understanding (K2)
CO2	தமிழர்களின் சிற்பம் மற்றும் அவர்களின் ஓவியங்கள் பற்றி விளக்க முடியும்.	Understanding (K2)
CO3	தமிழர்களின் நாட்டுப்புற மற்றும் தற்காப்புக் கலைகளைப் பற்றி சுருக்கமாகக் கூற முடியும்.	Understanding (K2)
CO4	தமிழர்களின் திணைக் கோட்பாடுகளைப் பற்றி விளக்க முடியும்.	Understanding (K2)
CO5	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு பற்றி விளக்க முடியும்.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		3	2	2		3		
CO2						3		3	2	2		3		
CO3						3		3	2	2		3		
CO4						3		3	2	2		3		
CO5						3		3	2	2		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	NA						

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks)

22TAM01 - HERITAGE OF TAMILS							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**HS**	**1**	**0**	**0**	**1**

Preamble	The objective of this course is to impart knowledge about Tamil language, literature, paintings, sculptures, folk arts, heroic games, doctrines, contribution of Tamils to Indian culture.	
UNIT I	**Language and Literature**	**3**
Language families in india - dravidian languages – tamil as a classical language - classical literature in tamil – secular nature of sangam literature – distributive justice in sangam literature - management principles in thirukural - tamil epics and impact of buddhism & jainism in tamil land - bakthi literature azhwars and nayanmars - forms of minor poetry - development of modern literature in tamil - contribution of bharathiyar and bharathidhasan.		
UNIT II	**Heritage - Rock Art Paintings to Modern Art – Sculpture**	**3**
Hero stone to modern sculpture - bronze icons - tribes and their handicrafts - art of temple car making - - massive terracotta sculptures, village deities, thiruvalluvar statue at kanyakumari, making of musical instruments - mridhangam, parai, veenai, yazh and nadhaswaram - role of temples in social and economic life of tamils.		
UNIT III	**Folk and Martial Arts**	**3**
Therukoothu – karagattam - villu pattu - kaniyan koothu – oyillattam - leather puppetry – silambattam – valari - tiger dance - sports and games of tamils.		
UNIT IV	**Thinai Concept of Tamils**	**3**
Flora and fauna of tamils & aham and puram concept from tholkappiyam and sangam literature - aram concept of tamils - education and literacy during sangam age - ancient cities and ports of sangam age - export and import during sangam age - overseas conquest of cholas.		
UNIT V	**Contribution of Tamils to Indian National Movement and Indian Culture**	**3**
Contribution of tamils to indian freedom struggle - the cultural influence of tamils over the other parts of india – self-respect movement - role of siddha medicine in indigenous systems of medicine – inscriptions & manuscripts – print history of tamil books.		
		Total: 15

TEXT BOOK:	
1.	S.Muthuramalingam, M.Saravanakumar, Heritage of Tamils, Yes Dee Publishing Pvt Ltd, 2023.
REFERENCES:	
1.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukarasu) (Published by : International Institute of Tamil Studies).
2.	The Contribution of Tamil of the Tamils to Indian Culture(Dr.M.Valarmathi)(Puplished by International Institute of Tamil Studies).
3.	Keeladi – 'Sangam City C ivilzation on the banks of river Vaigai; (Jointly Published by: Department of Archaeology & Tamilnadu Text Book and Educational Services Corporation, Tamilnadu).

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain valuable concepts in language and literature of tamils.	Understanding (K2)
CO2	illustrate about the tamils sculpture and their paintings.	Understanding (K2)
CO3	summarize about the tamils folk and martial arts.	Understanding (K2)
CO4	explain the thinai concept of tamils.	Understanding (K2)
CO5	explain the contribution of Tamils to the Indian National Movement and Indian culture.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		3	2	2		3		
CO2						3		3	2	2		3		
CO3						3		3	2	2		3		
CO4						3		3	2	2		3		
CO5						3		3	2	2		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	NA						

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks)

22AUL21 - AUTOMOTIVE ENGINES LABORATORY							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2/3**	**ES**	**0**	**0**	**2**	**1**

Preamble	This course provides hands on experience about dismantling cum assembling of engine and transmission components.

LIST OF EXPERIMENTS / EXERCISES:

1.	Dismantling and assembling of four stroke single cylinder IC engine
2.	Dismantling and assembling of four stroke multi cylinder IC engine
3.	Dismantling and assembling of Cooling and Lubricating system
4.	Dismantling and assembling of Turbocharger and Supercharger
5.	Valve timing diagram for four stroke diesel engine & port timing diagram for stroke petrol engine
6.	Performance test on four stroke diesel engine using eddy current dynamometer
7.	Heat balance test on four stroke diesel engines using eddy current dynamometer
8.	Performance test on four stroke diesel engine by mechanical loading
9.	Heat balance test on four stroke diesel engines by mechanical loading
10.	Emission test on Diesel and Petrol engines using exhaust gas analyzer

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	dismantle and assemble various automobile engine components.	Applying (K3), Precision (S3)
CO2	analyze performance characteristics of single cylinder CI engine.	Precision (S3), Manipulation (S2)
CO3	analyze emission characteristics of single cylinder CI engine.	Analyzing (K4), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2		1		3	1		1	3	
CO2	3	2	2	2	2	2	2		3	1		1	3	
CO3	3	2	1	1	2		1		3	1		1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22CYL22 –CHEMISTRY LABORATORY FOR MECHANICAL SYSTEMS							
(Common to MECH, MTS and AUTOMOBILE Branches)							
Programme & Branch	**B.E - MECH, MTS & Automobile**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**BS**	**0**	**0**	**2**	**1**

Preamble	This course aims to impart the basic concepts of volumetric, conductometric, complexometric, calorimetric, pH meteric, potentiometric, spectrophotometric experiments and thereby to improve the analytical capability to engineering students. It also aims to impart the knowledge on the estimation of Fe, Ni, S, Ca & Mg, DO, COD in mechanical applications.

LIST OF EXPERIMENTS / EXERCISES:	
1.	Determination of strength of an unknown solution using pH meter.
2.	Analysis and comparison of the strength of acids in the given mixture using conductivity meter.
3.	Potentiometric approach using a calomel electrode for the estimation of iron in the given sample.
4.	Spectrophotometric method for the determination of Iron in steel.
5.	Determination of molecular weight of a polymer / liquid by Ostwald viscometer.
6.	Quantitative analysis of nickel in steel by complexometric method.
7.	Estimation of sulphur present in fuel using electro-analytical techniques.
8.	Assessment of the given water sample for the suitability of drinking / industrial purpose by estimating the calcium, magnesium and total hardness by EDTA method.
9.	Determination of dissolved oxygen in the given wastewater sample.
10.	Determination of COD of the given wastewater sample.
11.	Electroplating process (Demonstration).
12.	Proximate analysis of Coal - determine moisture, volatile matter and ash content of a given sample of coal.
	Total:30

REFERENCES/ MANUAL /SOFTWARE:	
1.	Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., "Chemistry Laboratory Manual", 1st Edition, Rajaganapathy Publishers, Erode, 2022.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	estimate the hardness, DO and COD present in the given water sample.	Applying (K3), Precision (S3)
CO2	analyze the amount of Fe, Ni, conductivity and pH of the given solution.	Applying (K3), Precision (S3)
CO3	demonstrate the viscometer for the determination of Molecular weight of polymer and sulphur content in coal.	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3			3						2	2
CO2	3	2	1	3			3						2	2
CO3	3	2	1	3			2						2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22GCL11 – Foundation Laboratory - Manufacturing, Design and Robotics								
(Common to All BE/BTech branches)								
Programme& Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**ES**	**0**	**0**	**6**	**3**

Preamble	This course is designed to provide foundational knowledge on engineering with hands-on experience on developing a prototype model with the basic knowledge of Computer-aided Design, Manufacturing Processes, 3D Printing Technology, Robotics and Embedded Control.

LIST OF EXPERIMENTS / EXERCISES:

PART A – Manufacturing (30 Hours)	
1.	Selection of product, free hand sketching and detailing
2.	Construction of model using Arc/TIG/MIG/Gas/Spot welding operations
3.	Enhancing the model with sheet metal
4.	Creating the parts of the model using lathe
5.	Creating the parts of the model using milling and drilling machines
PART B – Product Design and Development (30 Hours)	
1.	Free hand sketching and detailing of the component
2.	3D part modelling of the component using CAD software
3.	Engineering Analysis of the component model
4.	Generate the component using 3D printer
5.	Value addition to the produced component using CNC milling machine, CNC laser cutting machine and CNC router
PART C – Robotics (30 Hours)	
1.	Design of electronic circuit and its debugging
2.	Interfacing of sensors, actuators and wireless communion modules with microcontroller
3.	Assembly of Tracker Robot with accessories
4.	Development of control strategies for motion control, path planning and obstacle avoidance
5.	Demonstration and testing of Robot in static environment
	Total:90

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	AutoCAD 2020 and SOLID WORKS 2018 Software

22AUC31 – BASICS OF ELECTRICAL AND ELECTRONIC CIRCUITS							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PC**	**3**	**0**	**2**	**4**

Preamble	This course deals with the basic knowledge of automotive Electricals and Electronics components

Unit – I	**DC Circuits:**	**9**

Active and passive devices - Examples –Resistor – Capacitor – Inductor – Ohm's Law – Kirchhoff's Laws - Resistors in Series and Parallel -Network Reduction -Voltage and Current Division Rule - Mesh Analysis of Simple Resistive Networks- Star and Delta Transformation

Unit – II	**AC Circuits:**	**9**

Alternating (Sinusoidal) Voltage and Current, R.M.S and Average Value, Power Factor, Form Factor and Peak Factor - AC Series Circuits -RL, RC & RLC. Introduction to three phase Systems (Qualitative only): Line and Phase Voltage/Current

Unit – III	**Semi-Conductor Devices:**	**9**

Conductors, Semiconductors and Insulators - Properties of Semiconductors - PN Junction Diode - Rectifiers and Filters - Zener Diode - LED– Photo diode - LDR- Transistors: Principle of Operation - Static Characteristics - CE Transistor as an Amplifier and Switch – Introduction Linear IC - Opamp – IC555 Timer

Unit – IV	**Boolean Algebra and Logic gates :**	**9**

Boolean Algebra - Number systems - Complements - Boolean postulates and laws - De-Morgan‟s Theorem - Minimization of Boolean expressions - Canonical forms - Logic Gates -Implementations of Logic Functions using universal Gates - Karnaugh map

Unit – V	**Combinational and Sequential circuits:**	**9**

Introduction to combinational circuits - Half adder – Full adder – Half subtractor – Full subtractor – Multiplexer/demultiplexer – Decoder – Encoder – Parity generator and checker - Magnitude comparator - Introduction to Sequential circuits – Latches – Flip-flops – Types of Flip-flops – SR, JK, D, T Flip-flops

LIST OF EXPERIMENTS / EXERCISES:

1.	Design and implementation of voltage divider circuit for automotive applications
2.	Characteristics of PN junction diode
3.	Characteristics of Zener diode
4.	Characteristics of LDR
5.	Linear Op-Amp circuits - Inverting and Non inverting Amplifiers
6.	Input and output characteristics of transistor under CE configuration
7.	Verification of Boolean theorems using digital logic gates
8.	Design and implementation of half adder and full adder using digital logic gates
9.	Design and implementation of Multiplexer and demultiplexer using digital logic gates
10.	Design and implementation of Flip-flop using digital logic gates

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Bhattacharya S.K., "Basic Electrical and Electronics Engineering", 2nd Edition, Pearson India Education Services Pvt. Ltd., India, 2017 for Units I,II,III
2.	Morris Mano M., "Digital Design", 6th Edition, Pearson Education Pvt. Ltd., New Delhi, 2018 for Units IV & V

REFERENCES:

1.	William H. HaytJr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", McGraw Hill publishers, 9thedition, New Delhi, 2020.

2.	Salivahanan S. and Arivazhagan S., "Digital Circuits and Design", 4th Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	calculate voltage and current measurements in DC circuits for automotive applications	Applying (K3), Precision (S3)
CO2	describe AC circuits in automotive applications	Applying (K3), Precision (S3)
CO3	explain the operation of semiconductor devices and their applications in automobiles	Understanding (K2), Precision (S3)
CO4	apply boolean law and karnaugh map techniques for gate level logic minimization.	Applying (K3), Precision (S3)
CO5	illustrate the operation of combinational and sequential logic circuits using the truth table	Understanding (K2), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2					1	3	2		2		3
CO2	3	2	2					1	3	2		2		3
CO3	3	2	1					1	3	2		2		3
CO4	3	2	1					1	3	2		2		3
CO5	3	2	1					1	3	2		2		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	35	50				100
CAT2	20	50	30				100
CAT3	15	35	50				100
ESE	15	35	50				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUT31 - MECHANICS OF DEFORMABLE BODIES

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	**Statics and Dynamics**	**3/4**	**PC**	**3**	**1**	**0**	**4**

Preamble	This course provides knowledge to evaluate performance of engineering structure due to various external loads by analyzing stresses, strains and deformations.	
Unit – I	**Stress, Strain and Deformation of Solids:**	**9+3**
Introduction to material properties – Stress-strain curve for ductile and brittle materials – Hooke's law – Poisson's ratio – Factor of safety. Elastic constants and their relationship. Stresses and strains due to axial force, shear force, and thermal effect. Stresses in the compound bars. Strain energy.		
Unit – II	**Analysis of Stresses in Two Dimensions:**	**9+3**
State of stresses at a point - Normal and shear stresses on inclined planes - Principal planes and stresses - Plane of maximum shear stress – Mohr's circle for biaxial stress with shear stress. Hoop and longitudinal stresses in thin cylindrical and spherical shells - Changes in dimensions and volume.		
Unit – III	**Loads and Stresses in Beams:**	**9+3**
Types of beams - Supports and Loads - Shear force and Bending Moment in beams - Cantilever, simply supported and overhanging beams - Point of contraflexure. Theory of simple bending - Bending and shear stress - Stress variation along the length and section of the beam - Section modulus.		
Unit – IV	**Deflection of Beams and Columns:**	**9+3**
Slope and Deflection of cantilever, simply supported and overhanging beams - Double integration method and Macaulay's method. Columns Types - Equivalent length – Euler's and Rankine's formulae - Slenderness ratio – Limitations of Euler's formula.		
Unit – V	**Torsion in Circular Shafts and Coiled Helical Springs:**	**9+3**
Analysis of torsion of circular solid and hollow shafts - stepped shaft - compound shaft - Shear stress distribution - angle of twist and torsional stiffness. Closed coil helical spring - stresses and deflection under axial load - Maximum shear stress in spring section including Wahl Factor.		
		Lecture: 45, Tutorial: 15, Total:60

TEXT BOOK:

1. Ferdinand P. Beer F.P and Johnston E.R., "Mechanics of Materials", 7th Edition, McGraw Hill Education, New Delhi, 2017. Units-I,II,III,IV,V

REFERENCES:

1. Hibbeler R.C., " Mechanics of Materials ", 9th Edition, Pearson Education, New Delhi, 2018.
2. S.S. Rattan., "Strength of Materials", 3rd Edition, McGraw Hill Education, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	analyze mechanical behavior of materials under simple tension or compression for varying cross sections.	Analyzing (K4)
CO2	calculate principal stresses and strains to analyze automotive components.	Analyzing (K4)
CO3	examine the theory of simple bending to design automotive chassis frame.	Analyzing (K4)
CO4	inspect beam and column strength with help of slope and deflection for various loads.	Analyzing (K4)
CO5	analyze shafts and springs based on torsional behavior.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2				1	1		2	3	
CO2	3	3	2	2	2				1	1		2	3	
CO3	3	3	2	2	2				1	1		2	3	
CO4	3	3	2	2	2				1	1		2	3	
CO5	3	3	2	2	2				1	1		2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	10	30	50			100
CAT2	10	10	30	50			100
CAT3	10	10	30	50			100
ESE	10	10	30	50			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUT32 - THERMODYNAMICS AND THERMAL SCIENCE							
Programme & Branch	**B.E. Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PC**	**3**	**1**	**0**	**4**

Preamble	This course provides the knowledge on basic concepts of thermodynamics, its laws, applications, properties of water and air, working of air compressors, vapour compression and absorption refrigeration systems, various heat transfer techniques.	
Unit – I	**First Law of Thermodynamics:**	**9+3**
Thermodynamic systems – closed, open and isolated systems. Zeroth Law of Thermodynamics, Specific heat capacities, heat transfer and work transfer directions, first law of thermodynamics, Perpetual motion Machine Types, work done in various processes, First Law applied to flow processes, Mass and Energy Balance, Steady flow energy equation (SFEE) for various applications.		
Unit – II	**Second Law of Thermodynamics:**	**9+3**
Kelvin Plank statement, Calusius Statement, Carnot cycle, Heat engine, reversed Carnot cycle – efficiency, heat engine efficiency and work done, COP of refrigerator, COP of heat pump, combined refrigerator–heat engine plant, heat pump-heat engine plant, Electrical heater-heat pump heating comparison.		
Unit – III	**Properties of Water and Air:**	**9+3**
Steam table - mollier chart, steam expansion, work done, sensible heat, latent heat, various phases of water, heat involved in phase change, solid-liquid-vapour conversion heat. Psychrometric chart, DBT, WBT, Relative Humidity, processes – cooling, heating, humidification, dehumidification, cooling-dehumidification, heating-humidification processes, cooling load calculations using psychrometric chart.		
Unit – IV	**Air Compressor, VCRS and VARS:**	**9+3**
Reciprocating Compressor, Single stage and double stage air compressor, work done, intermediate pressure, clearance volume, volumetric efficiency, Free air delivery (FAD). Vapour compression refrigeration system (VCRS), vapour absorption refrigeration systems (VARS), Comparison of VCRS and VARS, Refrigerant selection.		
Unit – V	**Heat Transfer:**	**9+3**
Modes of heat transfer, Conduction through plane wall, composite wall, cylinder, spherical systems. Extended surfaces, fin efficiency, fin effectiveness, critical thickness of insulation. Forced convection, Free convection. Radiation, black body, grey body, shape factor of perpendicular planes. Fundamentals of Heat exchanger, Types - parallel flow, counter flow, cross flow heat exchangers.		
		Lecture:45, Tutorial:15 Total:60

TEXT BOOK:

1.	Nag P.K., "Basic and Applied Thermodynamics", 2nd Edition, McGraw Hill Education, New Delhi, 2017.

REFERENCES:

1.	Rajput R.K., "Engineering Thermodynamics", 10th Edition, Laxmi Publications, New Delhi, 2018.
2.	Yunus A. Cengel, Michael A. Boles, "Thermodynamics: An Engineering Approach", 8th Edition, McGraw Hill Education, New Delhi, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply first law of thermodynamics to solve and analyze thermal systems	Applying (K3)
CO2	solve second law of thermodynamics problems on heat engine, heat pump and refrigerator	Applying (K3)
CO3	make use of air and water properties for solving various engineering applications	Applying (K3)
CO4	explain the working of air compressors, VCRS and VARS	Understand (K2)
CO5	solve heat transfer problems related to conduction, convection, radiation and heat exchangers	Applying (K3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1		1	1					2	3	
CO2	3	3	2	1		1	1					2	3	
CO3	3	3	2	1		1	1					2	3	
CO4	3	3	2	1		1	1					2	3	
CO5	3	3	2	1		1	1					2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50	-	-	-	100
CAT2	20	30	50	-	-	-	100
CAT3	20	30	50	-	-	-	100
ESE	10	20	70	-	-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUT33 - HYDRAULICS AND PNEUMATICS							
Programme & Branch	**B.E – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PC**	**3**	**0**	**0**	**3**

Preamble	To provide knowledge on hydraulic and pneumatic components for low cost automation in the automobile field.	
Unit – I	**Hydraulic Pumps:**	**9**
Review of Fluid mechanics - Basics of fluid power system - Advantages and applications of Fluid power systems. Hydraulic pumps: Pumping theory-Gear, Vane, Screw pump, Lobe and Piston pumps, Pump Performance, Characteristics and Selection - Sizing of pumps.		
Unit – II	**Hydraulic Actuators:**	**9**
Hydraulic cylinders: single acting and double acting cylinders, Special type cylinders: Rodless, tandem and Telescopic Cylinders-Calculation of cylinder force - Hydraulic Motors: Gear and vane motors.		
Unit – III	**Hydraulic Valves:**	**9**
Direction control valves: Three way valve, Four way valve, Check valve and shuttle valve – Actuation mechanisms in DCV – Pressure control valves: Pressure relief, Pressure Reducing, Counter balance, Sequencing and Unloading Valves –Flow control valves and its types –Proportional Valves –Servo valves: Mechanical type and Electro hydraulic servo valves.		
Unit – IV	**Pneumatic Components:**	**9**
Review of Gas laws and Compressor– Fluid conditioning Elements: Filter Regulator and Lubricator unit, Pneumatic silencers, After coolers, Air dryers – Air control valves – Fluid power actuators: Linear and Rotary actuators – types – Cushioning mechanism in cylinders – Sizing of Actuators.		
Unit – V	**Industrial Circuits and Maintenance:**	**9**
Construction of Hydraulic circuits - Counter balance circuit - Fail safe circuit - Regenerative circuit - Pressure intensifier circuits - Accumulator circuits. Construction of Pneumatic circuits: Cascade method - Sequence circuit. Electro-pneumatic circuit - Basics of Fluidics. Sealing devices: Types and materials – Safety aspects in Fluid Power System, Installation, Maintenance and troubleshooting of Fluid Power systems.		
		Total:45

TEXT BOOK:

1.	Anthony Esposito, "Fluid Power with Application", 7th Edition, Pearson Education Ltd, New Delhi, 2013.

REFERENCES:

1.	Srinivasan R, "Hydraulic and Pneumatic Controls", 2nd Edition, McGraw-Hill Education Pvt. Ltd. , New Delhi, 2008.
2.	Andrew Parr, " Hydraulics and Pneumatics: A Technician's and Engineer's Guide ", 3rd Edition, Butterworth-Heinemann, United Kingdom, 2011.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain the workings and selection of hydraulic pumps for industrial applications.	Understanding (K2)
CO2	exemplify the operation of hydraulic cylinders and motors.	Understanding (K2)
CO3	discuss the working of different types of hydraulic valves and their applications.	Understanding (K2)
CO4	illustrate the construction and working principles of various components in a pneumatic system.	Understanding (K2)
CO5	design the hydraulic and pneumatic circuits for various applications and their maintenance.	Applying (K3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			2							1	3	
CO2	3	3			2							1	3	
CO3	3	3			2							1	3	2
CO4	3	3			2							1	3	
CO5	3	3	2	2	2							1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	10	60	30				100
ESE	10	70	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUC32 - HYDRAULICS AND PNEUMATICS
(for 2023-2027 batch)

Programme & Branch	**B.E – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PC**	**3**	**0**	**2**	**4**

Preamble	To provide knowledge on hydraulic and pneumatic components for low cost automation in the automobile field.	
Unit – I	**Hydraulic Pumps:**	**9**
Review of Fluid mechanics - Basics of fluid power system - Advantages and applications of Fluid power systems. Hydraulic pumps: Pumping theory-Gear, Vane, Screw pump, Lobe and Piston pumps, Pump Performance, Characteristics and Selection - Sizing of pumps.		
Unit – II	**Hydraulic Actuators:**	**9**
Hydraulic cylinders: single acting and double acting cylinders, Special type cylinders: Rodless, tandem and Telescopic Cylinders-Calculation of cylinder force - Hydraulic Motors: Gear and vane motors.		
Unit – III	**Hydraulic Valves:**	**9**
Direction control valves: Three way valve, Four way valve, Check valve and shuttle valve – Actuation mechanisms in DCV – Pressure control valves: Pressure relief, Pressure Reducing, Counter balance, Sequencing and Unloading Valves –Flow control valves and its types –Proportional Valves –Servo valves: Mechanical type and Electro hydraulic servo valves.		
Unit – IV	**Pneumatic Components:**	**9**
Review of Gas laws and Compressor– Fluid conditioning Elements: Filter Regulator and Lubricator unit, Pneumatic silencers, After coolers, Air dryers – Air control valves – Fluid power actuators: Linear and Rotary actuators – types – Cushioning mechanism in cylinders – Sizing of Actuators.		
Unit – V	**Industrial Circuits and Maintenance:**	**9**
Construction of Hydraulic circuits - Counter balance circuit - Fail safe circuit - Regenerative circuit - Pressure intensifier circuits - Accumulator circuits. Construction of Pneumatic circuits: Cascade method - Sequence circuit. Electro-pneumatic circuit - Basics of Fluidics. Sealing devices: Types and materials – Safety aspects in Fluid Power System, Installation, Maintenance and troubleshooting of Fluid Power systems.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Design and testing of speed control circuits (Meter in, Meter out and Bleed off circuits)
2.	Design and testing of Electro-hydraulic circuit with pressure sequence valve
3.	Design and testing of Sequential circuit with pneumatic control (with and without time delay)
4.	Design and testing of Electro Pneumatic sequential circuit with limit switches
5.	Design and testing of Pneumatic circuits with logic controls – AND valve and OR valve
6.	Design and simulation of Sequential fluid power circuits using cascade method
7.	Design and testing of Pneumatic circuit with vacuum cup and rod less cylinder
8.	Design and testing of Hydraulic circuit with Proportional control of Pressure and Flow
9.	Design and testing of sequential circuits using cascade method
10.	Design, testing and simulation of electro pneumatic circuit with timers and counters

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Anthony Esposito, "Fluid Power with Application", 7th Edition, Pearson Education Ltd, New Delhi, 2013.

REFERENCES:

1.	Srinivasan R, "Hydraulic and Pneumatic Controls", 2nd Edition, McGraw-Hill Education Pvt. Ltd. , New Delhi, 2008.

2.	Andrew Parr, " Hydraulics and Pneumatics: A Technician's and Engineer's Guide ", 3rd Edition, Butterworth-Heinemann, United Kingdom, 2011.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain the workings and selection of hydraulic pumps for industrial applications.	Understanding (K2), Manipulation (S2)
CO2	exemplify the operation of hydraulic cylinders and motors.	Understanding (K2), Manipulation (S2)
CO3	discuss the working of different types of hydraulic valves and their applications.	Understanding (K2), Manipulation (S2)
CO4	illustrate the construction and working principles of various components in a pneumatic system.	Understanding (K2), Manipulation (S2)
CO5	design the hydraulic and pneumatic circuits for various applications and their maintenance.	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**3**			**2**							**1**	**3**	
CO2	**3**	**3**			**2**							**1**	**3**	
CO3	**3**	**3**			**2**							**1**	**3**	**2**
CO4	**3**	**3**			**2**							**1**	**3**	
CO5	**3**	**3**	**2**	**2**	**2**							**1**	**3**	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	10	60	30				100
ESE	10	70	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUT34 – AUTOMOTIVE FUELS AND LUBRICANTS								
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**3**	**PC**	**3**	**0**	**0**	**3**

Preamble	To understand the properties of fuels and lubricants for the design and operation of the I.C engines.	
Unit – I	**Manufacture of Fuels and Lubricants:**	**9**
Structure of petroleum - Refining process of fuels - Thermal cracking, catalytic cracking, polymerization, alkylation, isomerisation, & blending - Products of refining process. - Manufacture of lubricating oil base stocks - Manufacture of finished automotive lubricants.		
Unit – II	**Theory of Lubrication:**	**9**
Engine friction: Introduction - Total engine friction - Effect of engine variables on friction - Hydrodynamic lubrication- Elasto hydrodynamic lubrication - Boundary lubrication - Bearing lubrication - Functions of the lubrication system - Introduction to design of a lubricating system.		
Unit – III	**Lubricants:**	**9**
Specific requirements for automotive lubricants - Oxidation Deterioration and Degradation of lubricants - Additives and additive mechanism - Synthetic lubricants - Classification of lubricating oils - Properties of lubricating oils - Tests on lubricants. Grease - Classification, Properties & Testing.		
Unit – IV	**Properties and Testing of Fuels:**	**9**
Thermo-chemistry of fuels - Properties and testing of fuels - Relative density - Calorific value - Distillation and vapour pressure - Flash point - Spontaneous ignition temperature - Viscosity - Pour point - Flammability & ignitability - Diesel index - API gravity- Aniline point Test etc.		
Unit – V	**Combustion and Fuel Rating:**	**9**
SI Engine: Flame propagation - Mechanism of combustion - Normal combustion - Knocking - Octane rating - Fuel requirements. CI Engine: Mechanism of combustion - Diesel knocking - Cetane rating - Fuel requirements. Additives: Mechanism - Requirements of an additive - Petrol and Diesel fuel additives – Specifications of fuels.		
		Total:45

TEXT BOOK:

1.	Ganesan.V., "Internal Combustion Engineering", Tata McGraw-Hill Publishing Co., New Delhi, 2003.

REFERENCES:

1.	M.L. Mathur, R.P.Sharma "A course in internal combustion engines", Dhanpatrai publication, 2003
2.	Francis W., — Fuels and Fuel Technology: A Summarized Manual in Two Volumes, Elsevier Publications, 2016

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize the manufacturing process involved in fuels and lubricants	Understanding (K2)
CO2	explain the different mechanism involved in lubrication and different types of lubricating systems used in automobile.	Understanding (K2)
CO3	describe the properties and requirements of lubricants	Understanding (K2)
CO4	discuss the various properties of fuels used in automobile	Understanding (K2)
CO5	explain the combustion and fuel rating of conventional SI and CI fuels	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				2	2					1	3	
CO2	3	2				2	2					1	3	
CO3	3	2				2	2					1	3	
CO4	3	2				2	2					1	3	
CO5	3	2				2	2					1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	15	85					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22TAM02 – தமிழரும் தொழில்நுட்பமும்							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2 / 3**	**HS**	**1**	**0**	**0**	**1**

முன்னுரை	தமிழ் கலாச்சாரத்தோடு ஒன்றிய தொழில் நுட்பங்களை பற்றிப் எடுத்துரைத்தல்	
அலகு – I	**நெசவு மற்றும் பானை தொழில்நுட்பம்**	**3**
சங்க காலத்தில் நெசவு தொழில் – பானைத் தொழில்நுட்பம் கருப்பு சிவப்பு பாண்டங்கள் – பாண்டகளில் கீறல் குறியீடுகள்		
அலகு – II	**வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்**	**3**
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப்பொருட்களில் வடிவமைப்பு – சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச்சிற்பங்களும், கோவில்களும் – சோழர் காலத்து பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரிகட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னை இந்தோ-சாரோசெனிக் கட்டிடக் கலை.		
அலகு – III	**உற்பத்தித் தொழில்நுட்பம்**	**3**
கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச்சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள் – கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.		
அலகு – IV	**வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம்**	**3**
அணை, ஏரி, குளங்கள், மதகு – சோழர்கால குமிழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மை சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.		
அலகு – V	**அறிவியல் தமிழ் மற்றும் கணினித்தமிழ்**	**3**
அறிவியல் தமிழின் வளர்ச்சி – கணினிதத்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் சொற்குவைத் திட்டம்.		
		Total:15

TEXT BOOK:

1.	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே கே பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியில் பணிகள் கழகம்), உலகத் தமிழாராய்ச்சி நிறுவனம், சென்னை, 2002
2.	கணினித்தமிழ் முனைவர் இல. சுந்தரம், விகடன் பிரசுரம், 2016

REFERENCES:

1.	கீழடி-வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்.(தொல்லியல் துறை வெளியீடு)
2.	பொருநை-ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
3.	Social Life of Tamils (Dr.K.K.Pillay) A joint Publication of TNTB & ESC and RMRL – (in print)

4.	Social Life of the Tamils – The Classical Period (Dr.S.Sigaravelu) (Published by: International Institute of Tamil Studies).
5.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukarasu) (Published by : International Institute of Tamil Studies)
6.	The Contribution of the Tamil to Indian Culture (Dr.M.Valarmathi) (Puplished by International Institute of Tamil Studies).
7.	Keeladi – 'Sangam City Civilzation on the banks of river Vaigai; (Jointly Published by: Department of Archaeology & Tamilnadu Text Book and Educational Services Corporation, Tamilnadu)
8.	Studies in the History of India with Special Reference to Tamilnadu (Dr.K.K.Pillay) (Published by: The Author)
9.	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamilnadu Textbook and Educational Services Corporation, Tamilnadu)
10.	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

COURSE OUTCOMES: படிப்பை முடித்தவுடன், மாணவர்கள்		BT Mapped (Highest Level)
CO1	தமிழ் கலாச்சாரம் மற்றும் தமிழ் சமூகத்தினுடைய நெசவு மற்றும் பானை தொழில்நுட்பம் பற்றி விளக்க முடியும்.	Understanding (K2)
CO2	தமிழர்களின் வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்ப ஆற்றல் பற்றி விளக்க முடியும்.	Understanding (K2)
CO3	தமிழர்களின் உற்பத்தித் தொழில்நுட்பம் பற்றி சுருக்கமாகக் கூற முடியும்.	Understanding (K2)
CO4	தமிழர்களின் வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் பற்றி விளக்க முடியும்.	Understanding (K2)
CO5	தமிழர்களின் அறிவியல் தமிழ் மற்றும் கணினித்தமிழ் பற்றி விளக்க முடியும்.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		3	2	2		3		
CO2						3		3	2	2		3		
CO3						3		3	2	2		3		
CO4						3		3	2	2		3		
CO5						3		3	2	2		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	NA						

*** ±3% may be varied (CAT 1,2,3 – 50 marks)**

22TAM02 - TAMILS AND TECHNOLOGY

(Common to All Engineering and Technology Branches)

Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2 / 3**	**HS**	**1**	**0**	**0**	**1**

Preamble	This course aims to impart the essential knowledge on the tamil culture and related technology	
UNIT – I	**WEAVING AND CERAMIC TECHNOLOGY**	**3**
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.		
UNIT – II	**DESIGN AND CONSTRUCTION TECHNOLOGY**	**3**
Designing and Structural construction House & Designs in household materials during Sangam Age – Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram – Sculptures and Temples of Mamallapuram – Great Temples of Cholas and other worship places – Temples of Nayaka Period – Type study (Madurai Meenakshi Temple) – Thirumalai Nayakar Mahal – Chetti Nadu Houses, Indo – Saracenic architecture at Madras during British Period.		
UNIT – III	**MANUFACTURING TECHNOLOGY**	**3**
Art of Ship Building – Metallurgical studies – Iron industry – Iron smelting, steel – Copper and gold – Coins as source of history – Minting of Coins – Beads making – industries Stone beads – Glass beads –Terracotta beads –Shell beads/ bone beats – Archeological evidences – Gem stone types described in Silappathikaram.		
UNIT – IV	**AGRICULTURE AND IRRIGATION TECHNOLOGY**	**3**
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry – Wells designed for cattle use – Agriculture and Agro Processing – Knowledge of Sea – Fisheries – Pearl – Conche diving – Ancient Knowledge of Ocean – Knowledge Specific Society.		
UNIT – V	**SCIENTIFIC TAMIL & TAMIL COMPUTING**	**3**
Development of Scientific Tamil – Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.		
		Total:15

TEXT BOOK:

1.	Social Life of Tamils (Dr.K.K.Pillay) A joint Publication of TNTB & ESC and RMRL – (in print)
2.	Social Life of the Tamils – The Classical Period (Dr.S.Sigaravelu) (Published by: International Institute of Tamil Studies).

REFERENCES:

1.	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே கே பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியில் பணிகள் கழகம்), உலகத் தமிழாராய்ச்சி நிறுவனம், சென்னை, 2002
2.	கணினித்தமிழ் முனைவர் இல. சுந்தரம், விகடன் பிரசுரம், 2016
3.	கீழடி வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்.(தொல்லியல் துறை வெளியீடு)
4.	பொருநை ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு
5.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukarasu) (Published by : International Institute of Tamil Studies)
6.	The Contribution of the Tamils to Indian Culture (Dr.M.Valarmathi)(Puplished by International Institute of Tamil Studies).
7.	Keeladi – 'Sangam City Civilzation on the banks of river Vaigai; (Jointly Published by: Department of Archaeology & Tamilnadu Text Book and Educational Services Corporation, Tamilnadu)
8.	Studies in the History of India with Special Reference to Tamilnadu (dr.K.K.Pillay) (Published by : The Author)
9.	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamilnadu Textbook and Educational Services Corporation, Tamilnadu)
10.	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain weaving and ceramic technology in tamil culture and tamil society.	Understanding (K2)
CO2	Illustrate about the design and construction technology.	Understanding (K2)
CO3	summarize about the manufacturing technology.	Understanding (K2)
CO4	explain the agriculture and irrigation technology.	Understanding (K2)
CO5	explain the significance of tamil in scientific and computing.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		3	2	2		3		
CO2						3		3	2	2		3		
CO3						3		3	2	2		3		
CO4						3		3	2	2		3		
CO5						3		3	2	2		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	NA						

*** ±3% may be varied (CAT 1,2,3 – 50 marks)**

22AUL31 – AUTOMOTIVE FUELS AND LUBRICANTS LABORATORY							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Engines**	**3**	**PC**	**0**	**0**	**2**	**1**

Preamble	**This course provides hands on experience for testing fuels and lubricants to find various properties**

LIST OF EXPERIMENTS / EXERCISES:	
1.	Study of International and National standards for fuels and lubricants
2.	Study of Octane number and Cetane number of fuels
3.	Determine calorific value of gaseous fuel
4.	Determine calorific value of liquid fuel
5.	Identify flash and fire points of petrol and diesel
6.	Determine viscosity for the given fuel and lubricant
7.	Identify drop point of grease
8.	Conduct mechanical penetration test of grease
9.	Measure vapour pressure for gasoline fuel
10.	Measure carbon residue for liquid fuel
11.	Conduct corrosion test for liquid fuel and lubricant
12.	Identify cloud and pour point for liquid fuel and lubricant
	Total:30

REFERENCES/ MANUAL /SOFTWARE:	
1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	determine the properties of fuels and lubricants.	Applying (K3), Manipulation (S2)
CO2	identify the flow properties of fuels and lubricants.	Applying (K3), Manipulation (S2)
CO3	analyze the quality of fuels and lubricants.	Applying (K3), Manipulation (S2)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	3		1		3	3		2	3	
CO2	3	2	1	1	2		1		3	3		2	3	
CO3	3	2	1	1	2		1		3	3		2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22AUL32 - HYDRAULICS AND PNEUMATICS LABORATORY							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fluid Mechanics and Thermodynamics**	**3**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course provides knowledge and skill to generate, control and transmission of power using pressurized fluids.

LIST OF EXPERIMENTS / EXERCISES:

1.	Design and testing of speed control circuits (Meter in, Meter out and Bleed off circuits)
2.	Design and testing of Electro-hydraulic circuit with pressure sequence valve
3.	Design and testing of Sequential circuit with pneumatic control (with and without time delay)
4.	Design and testing of Electro Pneumatic sequential circuit with limit switches
5.	Design and testing of Pneumatic circuits with logic controls – AND valve and OR valve
6.	Design and simulation of Sequential fluid power circuits using cascade method
7.	Design and testing of Pneumatic circuit with vacuum cup and rod less cylinder
8.	Design and testing of Hydraulic circuit with Proportional control of Pressure and Flow
9.	Design and testing of sequential circuits using cascade method
10.	Design, testing and simulation of electro pneumatic circuit with timers and counters
11.	Profile Tracking of an Electrohydraulic Servo System
12.	Position control of an Electro pneumatic Servo System

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	identify the fluid power components and their symbols as used in industry.	Applying (K3), Manipulation (S2)
CO2	design, construct and test fluid power circuits with pneumatic, electrical, PLC and logic control for low cost automation.	Applying (K3), Manipulation (S2)
CO3	develop and simulate fluid power circuits using simulation software for industrial applications.	Applying (K3), Manipulation (S2)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2		1						2	2	2	2
CO2	2	3	3		3						2	2	3	3
CO3	2	2	3		3						2	2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22MNT31 - ENVIRONMENTAL SCIENCE							
(Common to All BE/BTech branches)							
Programme & Branch	**All B.E/B.Tech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3 / 6**	**MC**	**2**	**0**	**0**	**0**

Preamble	This course provides an approach to understand the various natural resources, ecosystem, bio-diversity, pollution control & monitoring methods for sustainable life and also to provide knowledge and to create awareness for engineering students on biological sciences.	
Unit – I	**Environmental Studies and Natural Resources**	**5**
Introduction to Environmental Science – uses, over-exploitation and conservation of forest, water, mineral, food, energy and land resources–case studies		
Unit – II	**Ecosystem and Biodiversity**	**5**
Ecosystems: concept and components of an ecosystem -structural and functional features – Functional attributes (Food chain and Food web only). Biodiversity: Introduction – Classification – Bio geographical classification of India- Values of biodiversity – Threats and Conservation of biodiversity - case studies.		
Unit – III	**Environmental Pollution**	**5**
Environmental Pollution: Definition – causes, effects and control measures of: (a) Air pollution - Climate change, global warming, acid rain, ozone layer depletion (b)Water pollution (c) Soil pollution - Role of an individual in prevention of pollution - case studies.		
Unit – IV	**Environmental Monitoring**	**5**
Sustainability -three pillars of sustainability- factors affecting environmental sustainability-approaches for sustainable development - Introduction to EIA - objectives of EIA - environment protection act – air (prevention and control of pollution) act – water (prevention and control of pollution) act.		
Unit – V	**Introduction to Biological Science**	**5**
Functions of Carbohydrates, lipids, proteins and nucleic acids - Cells and its organelles - plasma membrane, mitochondria and nucleus- Heredity and DNA - organization of DNA in cells - Genes and chromosomes- Cell division -Types of cell division- mitosis & meiosis - Cell cycle and molecules that control cell cycle.		
		Total:25

TEXT BOOK:

1.	Anubha Kaushik, and Kaushik C.P., “Environmental Science and Engineering”, 6th Multicolour Edition, New Age International Pvt. Ltd., New Delhi, 2018, for Unit-I, II, III, IV.
2.	Rastogi.SC, “Cells and Molecular Biology”, 2nd Edition, reprint, New Age International (P) Limited Publishers, New Delhi, 2008, for Unit-V.

REFERENCES:

1.	Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K., Kowshalya V.N., “Environmental Science”, Pearson Education, New Delhi, Revised Edition 2019.
2.	Mukhtar Ahmad, “Text book of modern biochemistry", Volume I & II, Oxford & IBH Publishing Co. Pvt. LTD, Delhi, 1995.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	illustrate the various natural resources and role of individual for its conservation	Understanding (K2)
CO2	elaborate the features of ecosystem and biodiversity to find the need for conservation.	Understanding (K2)
CO3	manipulate the sources, effects and control methods of various environmental pollution.	Applying (K3)
CO4	make use of the knowledge of EIA and environmental legislation laws towards sustainability.	Applying (K3)
CO5	explain the functions of carbohydrates, lipids, proteins, nucleic acids, Cells and its organelles	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1					3							
CO2	2	1					3							
CO3	3	2	1				3							
CO4	3	2	1				3							
CO5	3	1												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	NA						
ESE	NA						

* ±3% may be varied (CAT 1, 2 – 50 marks)

22EGL31 - COMMUNICATION SKILLS DEVELOPMENT LABORATORY							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3 / 4**	**HS**	**0**	**0**	**2**	**1**

Preamble	This course is designed to impart necessary skills to listen, speak, read and write in order to obtain better professional communication skills.

LIST OF EXPERIMENTS / EXERCISES:

1.	Self Introduction & Mock Interview
2.	Job Application letter with Resume
3.	Presentation: A Technical topic / Project report & a Case study
4.	Situational Dialogues / Telephonic Conversations
5.	Group Discussion
6.	Reading Aloud
7.	Listening Comprehension
8.	Writing Company Profiles
9.	Preparing reviews of a book/product/movie
10.	Pronunciation Test

Total: 30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	Orell Digital Language Lab Software

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped** **(Highest Level)**
CO1	enhance effective listening and reading skills	Understanding (K2), Imitation (S1)
CO2	acquire professional skills required for workplace/higher education	Applying (K3), Naturalization (S5)
CO3	use English language skills effectively in various situations	Applying (K3), Articulation (S4)

Mapping of COs with POs and PSOs

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1									2	3		3
CO2									2	2		2
CO3									2	2		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

22MAT41- NUMERICAL METHODS FOR ENGINEERS							
(Common to Civil, Mechanical, Mechatronics, Automobile and Food Technology Branches)							
Programme & Branch	**BE - Civil, Mechanical, Mechatronics, Automobile and BTech - Food Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**BS**	**3**	**1**	**0**	**4**

Preamble	To impart knowledge in interpolation, numerical differentiation and integration. Also develop skills to apply numerical algorithms to identify roots of algebraic and transcendental equations and solve linear system of equations, ordinary and partial differential equations.	
Unit – I	**Solution to Algebraic and Transcendental Equations:**	**9+3**
Iteration method – Method of false position – Newton-Raphson method – Solution of linear system of equations – Direct methods: Gauss elimination method and Gauss – Jordan method – Iterative methods: Gauss Jacobi and Gauss – Seidel methods.		
Unit – II	**Interpolation:**	**9+3**
Interpolation with equal intervals: Newton's forward and backward difference formulae – Central difference interpolation formulae: Gauss forward and backward interpolation formulae – Interpolation with unequal intervals: Lagrange's interpolation formula – Newton's divided difference formula.		
Unit – III	**Numerical Differentiation and Integration:**	**9+3**
Differentiation using Newton's forward, backward and divided difference formulae – Numerical integration: Trapezoidal rule – Simpsons 1/3rd rule – Simpsons 3/8th rule – Double integrals using Trapezoidal and Simpson's rules.		
Unit – IV	**Numerical Solution of First order Ordinary Differential Equations:**	**9+3**
Single step methods: Taylor series method – Euler method – Modified Euler method – Fourth order Runge-Kutta method – Multi step methods: Milne's predictor corrector method – Adam's Bashforth method.		
Unit – V	**Solutions of Boundary Value Problems in PDE:**	**9+3**
Solution of one dimensional heat equation – Bender –Schmidt recurrence relation – Crank – Nicolson method – One dimensional wave equation – Solution of two dimensional Laplace equations – Solution of Poisson equation.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Veerarajan T, Ramachandran T., "Numerical Methods", 1st Edition, McGraw Hill Education, Chennai, 2019.

REFERENCES:

1.	Sankara Rao. K., "Numerical Methods for Scientists and Engineers", 3rd Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2007.
2.	Steven C. Chapra, Raymond P. Canale., "Numerical Methods for Engineers", 7th Edition, McGraw-Hill Education, 2014.
3.	Sastry, S.S, "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning Pvt. Ltd, 2015.
4.	Ramana B V, "Higher Engineering Mathematics", 1st Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply various numerical techniques to solve algebraic and transcendental equations.	Applying (K3)
CO2	perform interpolation on given data using standard numerical techniques.	Applying (K3)
CO3	understand the concepts of numerical differentiation and integration	Applying (K3)
CO4	compute the solution of first order ordinary differential equations by numerical techniques..	Applying (K3)
CO5	apply various numerical techniques for solving partial differential equations.	Applying (K3)

Mapping of Cos with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	2	2											
CO3	3	3	2											
CO4	3	2	1											
CO5	3	3	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	10	80	-	-	-	100
CAT2	10	10	80	-	-	-	100
CAT3	10	10	80	-	-	-	100
ESE	10	10	80	-	-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22ITC32 - INTRODUCTION TO PYTHON							
(Common to Civil, Mechanical, Chemical & Automobile Engineering branches)							
Programme & Branch	**BE- Civil, Mechanical, Automobile & BTech – Chemical Engineering branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Problem Solving and Programming in C**	**3/4**	**ES**	**3**	**0**	**2**	**4**

Preamble	This course deals with core python programming. It gives a comprehensive introduction to problem solving using python constructs and libraries.	
Unit – I	**Introduction:**	**9**
Problem solving strategies – program design tools – Types of errors – Testing and Debugging- Basics: Literals – variables and identifiers – data types – input operation – comments – reserved words – indentation – Operators and Expressions – Decision Control Statements: Introduction – conditional statement – iterative statements – Nested Loops – break, continue and pass statements – else in loops.		
Unit – II	**Lists, Tuples and Dictionary:**	**9**
Lists: Access, update, nested, cloning, operations, methods , comprehensions, looping – Tuple: Create, utility, access, update, delete, operations, assignments, returning multiple values, nested tuples, index and count method – Dictionary: Create, access, add and modify, delete, sort, looping, nested, built-in methods – list vs tuple vs dictionary.		
Unit – III	**Strings and Regular Expressions:**	**9**
Strings: Concatenation , append, multiply on strings – Immutable – formatting operator – Built-in string methods and functions – slice operation – functions – operators – comparing – iterating – string module – Regular Expressions – match, search, sub, findall and finditer functions – flag options.		
Unit – IV	**Functions and Modules:**	**9**
Functions: Introduction – definition – call – variable scope and lifetime – return statement – function arguments – lambda function – documentation strings – programming practices recursive function- Modules: Modules – packages – standard library methods – function redefinition.		
Unit – V	**Object Orientation:**	**9**
Class and Objects: Class and objects – class methods and self – constructor – class and object variables – destructor – public and private data member. NumPy : NumPy Arrays – Computation on NumPy Arrays. Matplotlib : Line plots – Scatter Plots		

LIST OF EXPERIMENTS / EXERCISES:

1.	Programs using conditional and looping statements
2.	Implementation of list and tuple operations
3.	Implementation of dictionary operations
4.	Perform various string operations
5.	Use regular expressions for validating inputs
6.	Demonstration of different types of functions and parameter passing
7.	Develop programs using classes and objects
8.	Perform computation on Numpy arrays
9.	Draw different types of plots using Matplotlib

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Reema Thareja., “Python Programming using problem solving approach”, 3rd impression, Oxford University Press., New Delhi, 2017.

REFERENCES/ MANUAL / SOFTWARE:

1.	Nageswara Rao, “Core Python Programming”, 2nd Edition, DreamTech Press, New Delhi, 2018.

2.	Jake Vander Plas, " Python Data Science Handbook Essential Tools for Working with Data", O'Reilly Publishers, 1st Edition, 2016.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	use basic Python constructs to build simple programs	Applying (K3), Precision (S3)
CO2	apply list, tuple, and dictionary to handle a variety of data.	Applying (K3), Precision (S3)
CO3	apply strings and regular expressions for searching and retrieval	Applying (K3), Precision (S3)
CO4	solve the problems using functions and modules.	Applying (K3), Precision (S3)
CO5	apply object-oriented concepts and perform basic data science operations using Python	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	15	75				100
CAT2	10	15	75				100
CAT3	10	15	75				100
ESE	10	15	75				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUC41- AUTOMOTIVE ELECTRICAL SYSTEMS AND DRIVES

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Basics of Electrical and Electronic Circuits	4	PC	3	0	2	4

Preamble	This course provides knowledge on automobile wiring, charging and starting systems with various control strategies.	
Unit – I	**Electrical Wiring and Components:**	**9**
Introduction – Electrical wiring, terminals and switching devices. Output Devices: Relays – Relay logic diagram – Contactors – OLR – DOL Starter – MCB – Fuses – Timer – Counter -Vehicle interior and exterior lighting systems - horn circuit - wiper circuit - power window circuit and central locking circuit.		
Unit – II	**Charging and Starting System:**	**9**
Requirements of charging system – Charging system principles – Alternators and charging circuits. Starting system circuits – starter motor- types – Integrated starter- Speed and Torque characteristics of motor – drive mechanisms – capacity requirements – servicing and troubleshooting.		
Unit – III	**Ignition System:**	**9**
Magneto coil ignition system - Battery coil ignition system – Electronic – Programmed - Distributor less ignition systems - Spark advance and retard mechanisms - Types of spark plugs – Fuel injection system.		
Unit – IV	**Power Electronic Devices:**	**9**
Concept of Power Electronics – Power electronic systems – Power Semiconductor Devices – Principle of operation – Steady state and switching characteristics of Power diodes - Power BJT - Power MOSFET - IGBT – Steady state and switching characteristics of SCR – DIAC – TRIAC – GTO.		
Unit – V	**Electric Motor Drives:**	**9**
Introduction - DC to DC converters – Boost converter and Buck converter - Single phase and three phase DC to AC convertors - AC induction motor and control - BLDC motor and control - Plug in battery charger design. Stepper Motor and Control - Servo Motor and control - Permanent Magnet Synchronous Motor and control and Switched Reluctance Motors and control.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Design and development of lighting circuits
2.	Design and development of horn circuit and tuning
3.	Design and implementation of wiper motor circuit
4.	Hardware implementation of power window circuit
5.	Design and implementation of central locking circuit
6.	Performance test on batteries
7.	Speed control of DC motor
8.	Speed control of Induction motor
9.	Speed control of BLDC motor
10.	Speed control of Self Reluctance motor

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Tom Denton, "Automobile Electrical and Electronic Systems", 5th Edition, Routledge, United Kingdom, 2017 for Unit I,II,III
2.	Rashid M.H., "Power Electronics: Circuits Devices and Applications", 4th Edition, Pearson Education, New Delhi, 2017 for Unit IV,V

REFERENCES/ MANUAL / SOFTWARE:

1.	Wei Liu, "Introduction to Hybrid Vehicle System Modeling and Control", 1st Edition, Wiley, New Delhi, 2015.
2.	Robert Bosch GmbH, “Automotive Electrics/Automotive Electronics", 4th Edition, Wiley–Blackwell, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	design and implement electrical circuits for automotive applications	Applying (K3), Precision (S3)
CO2	illustrate the circuit diagram for the starting and charging systems with the characteristics of the starter motor and alternator.	Understanding (K2), Precision (S3)
CO3	explain the various ignition systems with advance and retard mechanisms.	Understanding (K2), Precision (S3)
CO4	describe various power electronic devices with their characteristics and functions.	Understanding (K2), Precision (S3)
CO5	demonstrate different types of electric motors with different control strategies.	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1					1	3	2		2	1	3
CO2	3	3	1					1	3	2		2	1	3
CO3	3	3	1					1	3	2		2	1	3
CO4	3	3	1					1	3	2		2	1	3
CO5	3	3	1					1	3	2		2	1	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	80					100
CAT3	20	50	30				100
ESE	10	55	35				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUT41 – VEHICLE COMPONENTS DESIGN - I							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	22AUT11 - Statics and Dynamics	**4**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on construction, working and design of chassis and its sub systems.	
Unit – I	**Chassis and Frames:**	**9**
Classification of vehicles. Frame construction – conventional - integral and semi integral type - material - load acting - selection of cross section. Chassis construction - Types of chassis layout based on powertrain location.		
Unit – II	**Suspension System:**	**9**
Sprung and unsprung weight – Functions of suspension system – Types of suspension springs – Leaf spring suspension system - Torsion bar. Shock absorbers - Mono tube - twin tube - Independent suspension system – Types. Air suspension system. Hydrolastic suspension system.		
Unit – III	**Design of Vehicle Frame and Suspension:**	**9**
Moments and stresses on frame members – Design of frame for commercial vehicles – Design of leaf springs – Design of coil spring – Design of torsion bar.		
Unit – IV	**Front axle and Steering system:**	**9**
Front axle and stub axle – Types. Importance of wheel alignment and wheel balancing. Steering geometry - Ackerman steering Mechanism. Understeer and oversteer – Factors affecting understeer and oversteer. Steering gearboxes – Types – Hydraulic power steering.		
Unit – V	**Design of front axle and Steering system:**	**9**
Bearing load on the front axle – Moments and stresses at different sections of front axle – Design of front axle beam. Turning Circle Radius– Ackermann linkage Geometry – Analytical Solution – Steering Gear box – Determination of Gear Ratio.		
		Total:45

TEXT BOOK:

1.	Dr. Kirpal Singh, "Automobile Engineering Volume 1 ", 14th Edition, Standard Publishers Distributors, New Delhi, 2020. Units-I,II,IV
2.	Giri N.K., "Automobile Mechanics", 8th Edition, Khanna Publications, New Delhi, 2020. Units-III,V

REFERENCES:

1.	James D Halderman, “Automotive Chassis Systems", 8th Edition, Pearson Publication, 2020
2.	Khurmi R.S. & Gupta J.K., "A Text Book of Machine Design", 34th Edition, Eurasia Publishing House Pvt. Ltd., New Delhi, 2005

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	summarize the construction and selection of cross section for chassis frame.	Understanding (K2)
CO2	explain the construction and working of suspension systems and their types.	Understanding (K2)
CO3	design of chassis frame and suspension springs of an automobile.	Applying (K3)
CO4	Illustrate construction and working of front axle and steering system.	Understanding (K2)
CO5	design front axle and steering system of an automobile.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				1						2	3	
CO2	3	2				1						2	3	
CO3	3	3	3	2		1						2	3	
CO4	3	2				1						2	3	
CO5	3	3	3	2		1						2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	20	60				100
CAT3	20	40	40				100
ESE	10	60	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUT42 - AUTOMATIC TRANSMISSION AND CONTROL SYSTEM							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge about the concepts of control systems and automatic transmissions for automobiles
Unit – I	**Mathematical Modeling of Systems** **9**
	Open loop and closed loop systems - System poles and zeros – order of the systems - Transfer function: Mechanical systems, Electrical systems and Electro mechanical systems - Block diagram reduction techniques - Signal flow graphs – Problems.
Unit – II	**System Response and Stability Analysis** **9**
	First order system - Response for step, ramp and impulse signals. Second order system - Time domain specifications - Root-locus plots - Frequency domain specifications - Bode plot – System stability - Proportional control - Integral control - Derivative control - PI and PID control actions - Tuning rules
Unit – III	**Hydrodynamic and Hydrostatic Transmissions** **9**
	Fluid Coupling-Principle and constructional details. Torque capacity - Performance characteristics - Torque Converter -Principle, constructional and performance characteristics. Multistage torque converters and Polyphase torque converters. Hydrostatic drives - Various types of hydrostatic systems and their applications – Principles of hydrostatic drive system - Advantages and limitations - Construction and working of typical Janny hydrostatic drive.
Unit – IV	**CVT and DCT Transmissions** **9**
	Continuously Variable Transmission (CVT) – Layouts and key components – Types and operations of a typical CVT – Belt structure and pulleys - CVT control system design and operation control - VBS based control system – Servo mechanism control system. Dual Clutch Transmissions (DCT) - Layouts, components and applications - Dry Dual Clutch Transmissions - Wet Dual Clutch Transmissions.
Unit – V	**EV and HEV Transmissions** **9**
	EV Transmissions: Single-speed EV transmission - Multiple ratio EV transmissions: Automatic gearbox based two-speed transmission and Planet gear based two-speed transmission. HEV transmissions: Architectures of hybrid electric drivetrains - Series hybrid electric drive - Parallel hybrid electric drivetrains - Torque-coupling and Speed-coupling of hybrid electric drive trains.
	Total: 45

TEXT BOOK:

1.	Salivahanan, S., R. Rengaraj, and G. R. Venkatakrishnan. Control systems engineering. Pearson, 2015. Units-I,II
2.	Yi Zhang and Chris Mi, “Automotive Power Transmission Systems ", 1st Edition, John Wiley & Sons, 2018. Units-III,IV,V

REFERENCES/ MANUAL / SOFTWARE:

1.	Mehrdad Ehsani, Uimin Gao and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles – Fundamentals, Theory and Design", 3rd Edition, CRC Press, New Delhi, 2018.
2.	Ogata K, "Modern Control Engineering", 5th Edition, Pearson Education India, New Delhi, 2015.
3.	Dr. Kirpal Singh, "Automobile Engineering Volume 1 & 2", 13th Edition, Standard Publishers Distributors, New Delhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the mathematical models for linear time-invariant systems of different sub systems in automobile engineering	Applying (K3)
CO2	determine the system response and stability for linear automotive systems	Applying (K3)
CO3	outline the various hydrodynamic and hydrostatic drives for automobiles.	Understanding (K2)
CO4	discuss the system, types, control of CVT and DCT transmission systems.	Understanding (K2)
CO5	describe the construction and operating principles of EV and HEV transmissions.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2									2	2	2
CO2	3	3	2									2	2	2
CO3	3	2	2									2	3	
CO4	3	2	2									2	3	
CO5	3	2	2									2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	70	20				100
CAT3	20	80					100
ESE	10	55	35				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUL41 - COMPUTER AIDED DESIGN LABORATORY

Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Drawing**	**4**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course provides hands on experience to design and model various automotive components by using CAD package.

LIST OF EXPERIMENTS / EXERCISES:

1.	Study the two dimensional (2D) drafting tools in CAD packages
2.	Explore the three dimensional (3D) drafting tools in CAD packages
3.	Apply 2D and 3D drafting tools to model automobile components like Cylinder block, Piston and Connecting rod.
4.	Conversion of 3D solid model of Connecting rod cum Piston assembly to 2D drawing - different views, sections, isometric view and drafting
5.	Design vehicle chassis frame using CAD tools
6.	Develop 3D Part modeling of Flange coupling and Knuckle joint
7.	Design simple gear trains using CAD tools
8.	Model disc brake assembly using CAD tools
9.	Develop 3D Part modeling of automotive Leaf spring
10.	Develop the independent suspension system using CAD Tools
11.	Model Auto car body using CAD tools
12.	Simulate the Automotive mechanism by using CAD tools

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	K.R. Gopala Krishna, "Machine Drawing", 6th Edition, Subhash Publication, New Delhi, 2017.
2.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	sketch 2D drawing by using different sketching tools in CAD packages.	Applying (K3), Precision (S3)
CO2	apply principles associated with CAD and common drafting techniques in designing 3D model of automotive components.	Applying (K3), Precision (S3)
CO3	simulate automotive mechanism in a CAD package and fabricate CAD model by using 3D printer.	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1		3				1	3		2	3	
CO2	3	2	1		3				1	3		2	3	
CO3	3	2	1		3				1	3		2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22AUL42- AUTOMOTIVE CHASSIS COMPONENTS LABORATORY							
Programme & Branch	**B.E & AUTOMOBILE ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course provides practice on dismantle, assemble and performance of automotive chassis components.

LIST OF EXPERIMENTS / EXERCISES:

1.	Measurement of Light and Heavy Commercial Vehicle Chassis Frame
2.	Calculation of gear ratios and steering angles for various steering system
3.	Dismantling and Assembling of Transfer case
4.	Dismantling and Assembling of Gear box and calculate the various gear ratios
5.	Dismantling and Assembling of Differential Unit
6.	Dismantling and Assembling of Constant Velocity Joint
7.	Dismantling and Assembling of Rear Axle
8.	Dismantling and Assembling of Disc and Drum Brake system
9.	Dismantling and Assembling of Suspension System
10.	Performance test on Coil Spring and Shock Absorber
11.	Performance test of a Two Wheeler using Chassis Dynamometer
12.	Two Wheeler Chain test using Chain test Rig
	Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Dismantle and assemble various transmission elements in a vehicle.	Applying (K3), Manipulation(S2)
CO2	Dismantle and assemble steering systems, suspension systems and braking systems in an automobile.	Applying (K3), Precision (S3)
CO3	Determine the performance test on coil spring, shock absorber and Two wheeler chassis	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		1		2	1	2	3	3		2	3	
CO2	3	2		1		2	1	2	3	3		2	3	
CO3	3	3		2		2	1	2	3	3		2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

22GCL41 - PROFESSIONAL SKILLS TRAINING - I							
(Common to All BE/ BTech Engineering and Technology branches)							
Programme & Branch	**All BE/ BTech Engineering and Technology branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	EC	0	0	80	2

Preamble	This subject is to enhance the employability skills and to develop career competency	
Unit – I	**Soft Skills – I :**	**20**
Soft skills and its importance: Pleasure and pains of transition from an academic environment to work environment-Need for change- Fear, stress and competition in the professional world-Importance of positive attitude- Self motivation and continuous knowledge upgradation-Self-confidence. Professional grooming and practices: Basics of corporate culture-Key pillars of business etiquette- Basics of etiquette-Introductions and greetings-Rules of the handshake, earning respect, business manners-Telephone etiquette- Body Language.		
Unit – II	**Quantitative Aptitude and Logical Reasoning – I:**	**30**
Problem solving level I: Number System-LCM &HCF-Divisibility test-Surds and indices-Logarithms- Ratio-proportions and variation-Partnership-Time speed and distance-Data interpretation-data representation. Logical reasoning: Family tree-Deductions-Logical connectives-Binary logic Linear arrangements- Circular and complex arrangement		
Unit – III	**Written Communication & Verbal Aptitude**	**30**
Writing Skills: Writing strategies and formats Importance of Résumés Writing a Cover letter -Responding to Job Advertisements Professional e-mail Writing Responding to e-mails and business letters Technical Report writing Interpretation of Technical Data (Transcoding) Writing One-page Essays. Verbal Aptitude Synonyms Antonyms Homonyms One word substitution Idioms and Phrases Paired words Analogies Spelling test Cloze test using suitable verb forms using appropriate articles and prepositions; Spotting Errors Sentence Correction and Formation Grammar Based questions (Transformation : Active-Passive & Direct-Indirect); Rearranging Jumbled Sentences & Jumbled paragraphs, Identifying Facts, Inferences and Judgements statements		
		Total:45

TEXT BOOK:

1.	Edgar Thorpe and Showick Thorpe, “Objective English for Competitive Examination”, 6th Edition, Pearson India Education Services Pvt Ltd, 2017.

REFERENCES:

1.	Stephen Bailey, “Academic Writing: A practical guide for students”, Routledge, New York, 2011.
2.	Meenakshi Raman and Sangeeta Sharma. “Technical Communication- Principles and Practice”. 4th Edition, Oxford University Press, New Delhi, 2022.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	develop the soft skills of learners to support them work efficiently in an organization as an individualand as a team	Applying (K3), Precision (S3)
CO2	solve real time problems using numerical ability and logical reasoning	Applying (K3), Precision (S3)
CO3	Apply communication skills effectively to understand and deliver information in various written discourses grammatically with accuracy	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				3	3		3		3	2		
CO2	3	2				3	3		3		3	2		
CO3		2				3	3		3	3	3	2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2		50	50				100
CAT3		50	50				100
ESE	NA						100

* ±3% may be varied (CAT 1,2,3 - 50 marks)

22AUC51 - VEHICLE DYNAMICS

Programme & Branch	**B.E. & Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Statics and Dynamics**	**5**	**PC**	**3**	**0**	**2**	**4**

Preamble	This course provides knowledge on dynamic, handling and ride performance characteristics of vehicles

Unit – I	**Acceleration Performance:**	**9**
Introduction - Fundamental approach to modeling - Vehicle fixed coordinate system - Earth fixed coordinate system - Static and Dynamic axle loads - Level roads and grades. Acceleration performance - Free body diagram of accelerating vehicle, maximum transferable tractive force, acceleration and gradeability.		
Unit – II	**Braking Performance:**	**9**
Free body diagram of decelerating vehicle, brake force distribution, maximum decelerating rates, maximum braking force, stopping distance and braking efficiency. Consequence of wheel lock up.		
Unit – III	**Tire Dynamics:**	**9**
Tire forces and moments - Tire axis system - Rolling resistance of a tire - Tire soil interaction - Conicity and ply steer. Cornering properties of tires and camber thrust. Various tire Models - Brush model, Magic formula model.		
Unit – IV	**Handling Characteristics:**	**9**
Low speed cornering and static steering - Ackerman steering geometry. Steady-state cornering - steering factors, vehicle control parameters - under steer, neutral steer, over steer, roll steer, compliance steer, ride steer and slip angle steer. Steady state handling - lateral acceleration gain, characteristic speed, yaw velocity gain and critical speed. Effect of braking on vehicle handling.		
Unit – V	**Ride Characteristics:**	**9**
Human response to vibration, Ride models - Quarter car, Half car and Full car model. Influence of suspension stiffness, suspension damping, and tire stiffness. Control law for LQR, H-infinite and skyhook damping.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Calculate static and dynamic axle loads of a vehicle
2.	Evaluate tractive force and acceleration parameters of a car
3.	Estimate braking torque of disc and drum brakes
4.	Analyze braking performance of a car
5.	Compare stiffness of car tire and truck tire for different payload
6.	Compute tire forces, offset and self-aligning torque
7.	Calculate cornering resistance of a four axled truck for various steering angles
8.	Evaluate steady state cornering characteristics of a vehicle
9.	Estimate ride comfort using quarter car model at constant velocity on a random road
10.	Analyze dynamics of a quarter car model with non-linear spring and sky hook damper crossing an obstacle

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Wong J.Y, "Theory of Ground Vehicles", 4th Edition, John Wiley & Sons, New Jersey, 2008.Units-1,2,3,4 & 5.
2.	Georg Rill, Abel Arrieta Castro, “Road Vehicle Dynamics: Fundamentals and Modeling with MATLAB”, 2nd edition, CRC Press, 2020.Units-1,2,3,4 & 5.

REFERENCES/ MANUAL / SOFTWARE:

1.	Thomas D. and Gillespie., "Fundamentals of Vehicle Dynamics", 1st Edition, SAE International, United States, 1992.
2.	Rajesh Rajamani., “Vehicle Dynamics and Control", 2nd Edition, Springer, 2014.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	solve the acceleration performance of a vehicle.	Applying (K3), Precision (S3)
CO2	examine the braking performance of a vehicle.	Applying (K3), Precision (S3)
CO3	calculate the forces generated in a tire by applying different models.	Applying (K3), Precision (S3)
CO4	determine the handling characteristics of a vehicle.	Applying (K3), Precision (S3)
CO5	model the ride models and their characteristics of a vehicle.	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3	1		1	1	2		2	3	
CO2	3	3	2	2	3	1		1	1	2		2	3	
CO3	3	3	2	2	3	1		1	1	2		2	3	
CO4	3	3	2	2	3	1		1	1	2		2	3	
CO5	3	3	2	2	3	1		1	1	2		2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	10	30	60				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUT51 - AUTOMOTIVE SENSORS AND CONTROLLERS							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Electrical Systems and Drives**	**5**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on concept and working of various sensors, transducers and microprocessor which finds the extensive application in the field of automobile.

Unit – I	**Electrical Transducers and Signal Conditioning:**	**9**
Introduction -Resistive transducers - Potentiometer, RTD, Thermistor - Thermocouple - Strain gauge - Inductive transducers – LVDT - RVDT - Capacitive transducer - Applications of electrical transducers in automobile. Signal Conditioning: Data acquisition system - Wheatstone bridge - Analog to digital conversion - Digital to analog conversion.		
Unit – II	**Sensors :**	**9**
Piezoelectric sensors - Hall effect sensor – Proximity sensors – Optical sensors - Oxygen sensor - Humidity sensor –Rain sensors- Current sensors - Image sensors - Parking sensors - Automotive radar sensors - LiDAR sensors- Ultrasonic sensors		
Unit – III	**Microprocessor 8085:**	**9**
Introduction to microprocessor and microcontroller - Organization of microcomputer - Internal architecture of 8085 microprocessor – Pin details – Registers organization - Memory interfacing – Timing diagram.		
Unit – IV	**Microprocessor programming:**	**9**
Addressing modes - Immediate addressing - Register addressing - Direct addressing - Register indirect addressing – Implied / Implicit addressing - Instruction sets - Data transfer group - Arithmetic group - Logical group - Branch group - Control group - Simple programs.		
Unit – V	**Electronic Control Unit:**	**9**
Introduction to ECU design – Electronic control of diesel injection- Combined ignition and Fuel management - Closed loop lambda control - Electronic engine management system - Electronic power steering - Antilock brake system – Traction control – Automatic transmission system- Automatic gear shift and Torque converter - Airbag system - Complete vehicle control systems.		
		Total:45

TEXT BOOK:

1.	Tom Denton, "Automobile Electrical and Electronic Systems", 5th Edition, Routledge, United Kingdom, 2017 for Units I,II,V
2.	Ramesh Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 6th Edition, Penram International Publishing Pvt Ltd., Mumbai, 2020 for Units III,IV.

REFERENCES:

1.	A.K.Babu, “Automotive Electrical and Electronics”, 2nd edition, Khanna Book Publishing, New Delhi, 2017.
2.	Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay ,Lyla B. Das, “Microprocessors and Microcontrollers”, 1st Edition, Pearson Education, New Delhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the working of electronic transducers and purpose of signal conditioning systems.	Understanding (K2)
CO2	discuss in detail about the operation of automotive sensors and its automotive applications.	Understanding (K2)
CO3	describe the architecture of 8085 microprocessor and its pin details.	Understanding (K2)
CO4	develop an arithmetic program using instruction set and addressing modes of 8085 microprocessor	Applying (K3)
CO5	explain the role of electronic control unit in automobile.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1									2		3
CO2	3	3	1									2		3
CO3	3	3	1									2		3
CO4	3	3	1									2		3
CO5	3	3	1									2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	60	20				100
ESE	10	70	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUT52 - MECHANICS OF MACHINES							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Statics and Dynamics**	**5**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on kinematics of mechanisms and the effect of balancing in different machine elements.	
Unit – I	**Basics of Mechanisms:**	**9**
Mechanism - Machine Structure - Kinematic link, pair and chain – Kutzback's equation - Gruebler's criteria - Constrained motion - Degrees of freedom – Grashof's law - Slider crank and crank rocker mechanisms - Inversions - Applications - Kinematic analysis of simple mechanisms - Velocity and acceleration - Four bar and slider crank using relative velocity method.		
Unit – II	**Design of Cam Profile:**	**9**
Types of cams and followers – Terminology. Follower motions - Uniform motion, simple harmonic motion, constant acceleration / deceleration motion and cycloidal motion. Cam profile – Roller, Flat faced and Knife edge follower - Graphical method.		
Unit – III	**Kinematics of Gear Trains:**	**9**
Introduction to gears, Classification – Gear terminologies, Gear ratio - Velocities – Simple gear train, Compound gear train, Reverted gear train and Epicyclic gear train, compound epicyclic gear train and Epicyclic gear train with bevel gear		
Unit – IV	**Balancing of Masses:**	**9**
Rotating masses – Single mass - single plane – single mass – different plane - Several mass – Single and different plane. Reciprocating masses - Primary and secondary balancing. Balancing - Single and multi-cylinder In-line engines.		
Unit – V	**Governors and Gyroscope:**	**9**
Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling Force. Gyroscopic couples – Gyroscopic effects in automobiles.		
		Total:45

TEXT BOOK:

1.	Rattan S.S., "Theory of Machines", 4th Edition, McGraw Hill Education, New Delhi, 2017.

REFERENCES:

1.	Norton R.L., "Kinematics and Dynamics of Machinery", Special Indian Edition, McGraw Hill Education , New Delhi, 2017.
2.	Shigley J.E, Pennock G.R, Uicker J.J Cornwell & Sanjeev Sanghi., "Theory of Machines and Mechanisms", 4th Edition, Oxford University Press, Oxford, 2014.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	calculate the velocity and acceleration of various links of simple mechanisms.	Applying (K3)
CO2	design cam profile for different follower motions.	Applying (K3)
CO3	evaluate the kinematics aspects of gears and gear trains.	Applying (K3)
CO4	determine the static and dynamic balancing of various mechanical systems.	Applying (K3)
CO5	examine the fluctuation of speed in governors and gyroscopic effect.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2								2	3	
CO2	3	3	2	2								2	3	
CO3	3	3	2	2								2	3	
CO4	3	3	2	2								2	3	
CO5	3	3	2	2								2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUT53 – VEHICLE COMPONENTS DESIGN – II							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**5**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on construction, working and design of chassis and its sub systems.	
Unit – I	**Clutch and Gear box:**	**9**
Types of clutches- Single plate clutch- Multiple Plate Clutch- Centrifugal clutch. Construction and operation of Sliding mesh, Constant mesh and Synchromesh gearboxes, Fluid coupling and Torque converter.		
Unit – II	**Design of Clutch and Gear box:**	**9**
Torque capacity of clutch – Design of single plate clutch, multi-plate clutch. Gear train calculations – Determination of gear ratios for three, four and five speed gearboxes.		
Unit – III	**Drive line and Rear axle:**	**9**
Universal joint- slip joint- Propeller shaft – Final drive – Differential – Types. Rear Axle - Loads acting on the rear axle - Full floating axle - three quarter floating axle - semi floating axle.		
Unit – IV	**Brakes and Tyres:**	**9**
Need for braking systems - Drum and disc actuation - Construction and working – mechanical – hydraulic – pneumatic - power assisted and servo braking system. Wheels and Rims - Types. Tyre - bias ply - radial ply - tubed and tubeless. Tread Pattern – Wet tyre – Dry tyre.		
Unit – V	**Design of Braking System:**	**9**
Calculations on stopping time and distance, weight transfer during braking – Braking efficiency – Design and analysis of rear wheel brake and all wheel brake. Braking of vehicle moved in a curved path - drum and disc brake design.		
		Total:45

TEXT BOOK:

1.	Dr. Kirpal Singh, "Automobile Engineering Volume 1 & 2", 14th Edition, Standard Publishers Distributors, New Delhi, 2017 & 2018 for Units I,III,IV
2.	Giri N.K., "Automobile Mechanics", 8th Edition, Khanna Publications, New Delhi, 2014 for Units II,V

REFERENCES:

1.	James D Halderman, “Automotive Chassis Systems", 8th Edition, Pearson Publication, 2020.
2.	Khurmi R.S. & Gupta J.K., "A Text Book of Machine Design", 34th Edition, Eurasia Publishing House Pvt. Ltd., New Delhi, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize the construction and working of various clutches and gear boxes	Understanding (K2)
CO2	design the various types of clutches and automotive gear boxes	Applying (K3)
CO3	explain the construction and working of drive line and rear axle.	Understanding (K2)
CO4	illustrate the construction and working principle of various Brakes and tyres	Understanding (K2)
CO5	design the various types of brakes for automotive application and calculate stopping distance of a vehicle	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3										2	3	
CO2	3	3	2	2								2	3	
CO3	3	3										2	3	
CO4	3	3										2	3	
CO5	3	3	2	2								2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	70	15				100
CAT2	15	70	15				100
CAT3	20	50	30				100
ESE	10	60	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUL51 - AUTOMOTIVE SENSORS AND CONTROLLERS LABORATORY

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	PC	0	0	2	1

Preamble	This course provides hands on experience to program microprocessor and interface sensors with microcontroller.

LIST OF EXPERIMENTS / EXERCISES:

1.	Measurement of temperature using Thermistor / RTD
2.	Measurement of temperature using Thermocouple
3.	Measurement of displacement using Potentiometer, LVDT and Capacitive transducer
4.	Torque/ Strain Measurement using Strain Gauge
5.	Force measurement using Load Cell
6.	Flow measurement using Orifice Meter
7.	Level measurement using Capacitive type level Gauge
8.	Speed measurement using Encoder and Opto-coupler
9.	8-bit Addition and subtraction of two numbers using 8085 microprocessor
10.	8-bit Multiplication and division using 8085 microprocessor
	Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	evaluate the characteristics of various sensors in the measurement system.	Analyzing (K4), Precision (S3)
CO2	analyze the characteristics of various transducers in the measurement system.	Analyzing (K4), Precision (S3))
CO3	develop the 8085 microprocessor program for arithmetic operations.	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1					1	3	2		1		3
CO2	3	3	1					1	3	2		1		3
CO3	3	3	1					1	3	2		1		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22AUL52 - COMPUTER AIDED ANALYSIS LABORATORY							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Computer Aided Design Laboratory**	**5**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course provides knowledge to evaluate structural and thermal performance of automobile components for various loading conditions by using finite element solver.

LIST OF EXPERIMENTS / EXERCISES:

1.	Study of different commercial FEA tools used for design and analysis
2.	Thermal analysis of cylinder liners
3.	Structural and thermal analysis of piston crown
4.	Design and analysis of connecting rod
5.	Stress analysis of crankshaft
6.	Stress analysis of cam shaft
7.	Design and analysis of chassis frames
8.	Stress analysis of leaf spring
9.	Stress analysis of coil spring
10.	Design and analysis of torsion bar
11.	Stress analysis of composite body panels
12.	Modal analysis of Aerofoil profile

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	ANSYS 2020 R1

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	analyze the structural behavior of automotive components.	Analyzing (K4), Precision (S3)
CO2	evaluate the thermal behavior of automotive components.	Analyzing (K4), Precision (S3)
CO3	validate the various FEA and FVM results based on simulation results.	Analyzing (K4), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3			1	3	2		1	3	
CO2	3	3	2	2	3			1	3	2		1	3	
CO3	3	3	2	2	3			1	3	2		1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22GCL51 - PROFESSIONAL SKILLS TRAINING - II								
(Common to All BE/ BTech Engineering and Technology branches)								
Programme & Branch	**All BE/ BTech Engineering and Technology branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**	
Prerequisites	**Nil**	**5**	**EC**	**0**	**0**	**80**	**2**	

Preamble	This subject is to enhance the employability skills and to develop career competency	
Unit – I	**Soft Skills – II :**	**20**
Group discussions: Advantages of group discussions-Structured GD- Team work: Value of team work in organizations- Definition of a team, why team-Elements of leadership, disadvantages of a team, stages of team formation- Group development activities. Facing an interview: Foundation in core subject- industry orientation / knowledge about the company- professional personality- Communication skills-Activities before Interview, upon entering interview room, during the interview and at the end Mock interviews.		
Unit – II	**Quantitative Aptitude and Logical Reasoning – II:**	**30**
Problem solving level II: Money related problems-Mixtures-Symbol base problem-Clocks and calendars-Simple-linear-quadratic and polynomial equations-Special, equations-Inequalities-Sequence and series-Set theory-Permutations and combinations-Probability-Statistics-Data sufficiency- Geometry-Trigonometry-Heights and distances-Co-ordinate geometry-Mensuration. Logical reasoning: Conditionality and grouping-Sequencing and scheduling- Selections-Networks:-Codes; Cubes-Venn diagram in logical reasoning- Quant based reasoning-Flaw detection- Puzzles-Cryptarithms.		
Unit – III	**Reading & Speaking Skills**	**30**
Reading: Reading comprehension– Effective Reading strategies – Descriptive, Inferential, & Argumentative reading passages – Identifying and locating factual information within a text – global reading/skimming for general understanding – selective comprehension / scanning for specific information – detailed comprehension / intensive reading – understanding the development of an argument – identifying the writer's attitude and opinions – Reading news articles in business magazines, newspapers – Reading notices and book reviews –Interpreting graphic data & Advertisements. Speaking: Mock Interviews –Self-Introduction – Sharing of Real Time Experience; Conversational Practices –Role Play – Short Talks / TED Talks –Extempore; Giving a Presentation on Various Topics – Technical / Non-Technical Topics – Project Review Presentation – Oratory and Effective Public Speaking; Pair Discussion – Group Discussion – The process of Group Discussion – Strategies to be adopted – Skills Assessed – Telephonic Conversations & Skills – Negotiating Skills.		
		Total:45

TEXT BOOK:

1.	Edgar Thorpe and Showick Thorpe, "Objective English for Competitive Examination", 6th Edition, Pearson India Education Services Pvt Ltd, 2017.

REFERENCES:

1.	Aruna Koneru, "Professional Speaking Skills," Oxford University Press India, New Delhi, 2015.
2.	Thorpe, Showick and Edgar Thorpe, "Winning at Interviews," 5th edition, Pearson Education, India, 2013.
3.	Rizvi, Ashraf M, "Effective Technical Communication," 2nd Edition, McGraw Hill Education India, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	develop the soft skills of learners to support them work efficiently in an organization as an individualand as a team	Applying (K3), Precision (S3)
CO2	solve real time problems using numerical ability and logical reasoning	Applying (K3), Precision (S3)
CO3	apply reading and speaking skills effectively for various academic and professional purposes	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	0	0	0	3	3	0	3	0	3	2		
CO2	3	2	0	0	0	3	3	0	3	0	3	2		
CO3		2	0	0	0	3	3	0	3	3	3	3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2		50	50				100
CAT3		50	50				100
ESE	NA						

* ±3% may be varied (CAT 1,2 & 3 – 50 marks)

22AUT54 - THEORY OF MACHINES							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Statics and Dynamics**	**5**	**PC**	**3**	**1**	**0**	**4**

Preamble	This course provides knowledge on kinematics of mechanisms and the effect of balancing in different machine elements.	
Unit – I	**Basics of Mechanisms:**	**9+3**
Mechanism - Machine Structure - Kinematic link, pair and chain – Kutzback's equation - Grueblers criteria - Constrained motion - Degrees of freedom – Grashof's law - Slider crank and crank rocker mechanisms - Inversions - Applications - Kinematic analysis of simple mechanisms - Velocity and acceleration - Four bar and slider crank using relative velocity method.		
Unit – II	**Design of Cam Profile:**	**9+3**
Types of cams and followers – Terminology. Follower motions - Uniform motion, simple harmonic motion, constant acceleration / deceleration motion and cycloidal motion. Cam profile – Roller, Flat faced and Knife edge follower - Graphical method.		
Unit – III	**Kinematics of Gear Trains:**	**9+3**
Introduction to gears, Classification – Gear terminologies, Gear ratio - Velocities – Simple gear train, Compound gear train, Reverted gear train and Epicyclic gear train, compound epicyclic gear train and Epicyclic gear train with bevel gear		
Unit – IV	**Balancing of Masses:**	**9+3**
Rotating masses – Single mass - single plane – single mass – different plane - Several mass – Single and different plane. Reciprocating masses - Primary and secondary balancing. Balancing - Single and multi-cylinder In-line engines.		
Unit – V	**Governors and Gyroscope:**	**9+3**
Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling Force. Gyroscopic couples – Gyroscopic effects in automobiles.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Rattan S.S., "Theory of Machines", 4th Edition, McGraw Hill Education, New Delhi, 2017.

REFERENCES:

1.	Norton R.L., "Kinematics and Dynamics of Machinery", Special Indian Edition, McGraw Hill Education , New Delhi, 2017.
2.	Shigley J.E, Pennock G.R, Uicker J.J Cornwell & Sanjeev Sanghi., "Theory of Machines and Mechanisms", 4th Edition, Oxford University Press, Oxford, 2014.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	calculate the velocity and acceleration of various links of simple mechanisms.	Applying (K3)
CO2	design cam profile for different follower motions.	Applying (K3)
CO3	evaluate the kinematics aspects of gears and gear trains.	Applying (K3)
CO4	determine the static and dynamic balancing of various mechanical systems.	Applying (K3)
CO5	examine the fluctuation of speed in governors and gyroscopic effect.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2								2	3	
CO2	3	3	2	2								2	3	
CO3	3	3	2	2								2	3	
CO4	3	3	2	2								2	3	
CO5	3	3	2	2								2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUT61 - AUTOMOTIVE EMBEDDED SYSTEMS							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Sensors and Controllers**	**6**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course deals with the basic architecture and peripheral interfacing of microcontroller with assembly language programming.

Unit – I	**Introduction to Embedded Systems:**	**9**
Introduction to RISC and CISC machines - 89C51 Microcontroller architecture - Pin configuration - Data and program memory mapping - Register organization - Basic concepts of I/O pins - Interfacing to external memory.		
Unit – II	**Microcontroller Programming:**	**9**
Instruction sets - Addressing modes - Assembly language programming - Addition, subtraction, multiplication and division. I/O port programming: LED - Seven segment display - Switch interfacing - Level triggering - Edge triggering - Timer and counter programming - Simple programs.		
Unit – III	**Communication with Peripherals:**	**9**
Liquid crystal display interfacing - Matrix keypad interfacing - Serial data communication - Applications - Interrupt programming - Hardware interrupt - Timer interrupt - External interrupt - Serial interrupt.		
Unit – IV	**Sensor Interfacing:**	**9**
Analog to digital converter - ADC 0804 with LM35 temperature sensor - Signal conditioning. Motor Interfacing: Relay logic - Pulse width modulation - Speed control of DC motor using PWM - Stepper motor interfacing with automotive applications.		
Unit – V	**Intelligent Automotive Systems:**	**9**
Introduction to 8-bit ATmega microcontroller - Simple programs - Serial UART interfacing - Servo motor interfacing with angle control - Ultrasonic sensor interfacing - Automotive applications.		
		Total:45

TEXT BOOK:

1.	Muhammad Ali mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C ", 2nd Edition, Pearson Education, New Jersey, 2011 for Units I,II,III,IV.
2.	Culkin, Jody, and Eric Hagan, "Make: Learn Electronics with Arduino: An Illustrated Beginner's Guide to Physical Computing", 1st Edition, Maker Media, San Francisco, 2017 for Units V.

REFERENCES:

1.	Muhammad Ali Mazidi , Rolin D. McKinlay , Janice G. Mazidi , "The 8051 Microcontroller: A Systems Approach ", 1st Edition, Pearson, 2013.
2.	Raj Kamal ,"Embedded Systems - SoC, IoT, AI and Real-Time Systems", 4th Edition McGraw Hill, 2020.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	interpret the basic concepts of the 8051 microcontroller.	Understanding (K2)
CO2	write assembly language programs for the 8051 microcontroller.	Applying (K3)
CO3	develop assembly language programs for interfacing peripheral devices with the 8051 microcontroller.	Applying (K3)
CO4	write assembly language programs for sensor interfacing with the 8051 microcontroller.	Applying (K3)
CO5	explain the role of the microcontroller in intelligent automotive systems.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1		2							2		3
CO2	3	2	1		2							2		3
CO3	3	2	1		2							2		3
CO4	3	3	1		2							2		3
CO5	3	3	1		2							2		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	60	30				100
CAT2	10	20	70				100
CAT3	10	40	50				100
ESE	10	35	55				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUT62 - MODELLING OF HYBRID AND ELECTRIC VEHICLES							
Programme & Branch	**B.E. & Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Electrical Systems and Drives**	**6**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course deals with modeling and simulation of hybrid and electric vehicles.	
Unit – I	**Electric Vehicles:**	**9**
Electric vehicles architecture and components – Configuration of electric vehicles - Performance of electric vehicles – Traction motor characteristics -Tractive effort - Transmission requirements - Vehicle performance - Energy consumption.		
Unit – II	**Hybrid Vehicles:**	**9**
Architecture of hybrid vehicles: Series hybrid, parallel hybrid and series-parallel hybrid - Components of hybrid vehicles – Power flow analysis in hybrid vehicles - Torque coupling in parallel hybrid-electric drive trains - Speed coupling in hybrid-electric drive trains – Torque and speed coupling in parallel hybrid-electric drive trains.		
Unit – III	**Energy Management :**	**9**
Introduction - Methods to determine state of charge - Estimation of battery power availability – Battery life prediction – Cell Balancing - Estimation of cell core temperature - Battery system efficiency - Plug-in charge characteristics, algorithm and impact on power distribution systems.		
Unit – IV	**Electric Vehicle Modeling:**	**9**
Modelling - Electric vehicle acceleration - Electric vehicle range - Design considerations for chassis systems - Design of ancillary systems.		
Unit – V	**Hybrid Vehicle Modeling:**	**9**
System modelling - Hybrid vehicle control: Engine control, Dumping control through electric motor, High-Voltage Bus spike control – Thermal control of battery system – HEV/EV traction control - Performance analysis.		
		Total:45

TEXT BOOK:

1.	Wei Liu., “Introduction to Hybrid Vehicle System Modeling and Control”, Wiley India Pvt Ltd, New Delhi, 2015

REFERENCES:

1.	Mehrdad Ehsani, Uimin Gao and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles – Fundamentals, Theory and Design", 3rd Edition, CRC Press, New Delhi, 2018.
2.	James Larminie and John Lowry., “Electric Vehicle Technology Explained”, 2nd Edition, Wiley India Pvt Ltd, New Delhi, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	summarize the layout and sub systems of electric vehicles.	Understanding (K2)
CO2	explain the architecture of various types of hybrid Vehicles.	Understanding (K2)
CO3	illustrate the battery charging characteristics and its management system.	Applying (K3)
CO4	model and simulate electric vehicles for various environmental conditions.	Applying (K3)
CO5	model and simulate hybrid vehicles for different operating conditions.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2			2	2					3	2	3
CO2	3	3	2			2	2					3	2	3
CO3	3	3	3	2		2	2					3	2	3
CO4	3	3	3	2		2	2					3	2	3
CO5	3	3	3	2		2	2					3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	40	40				100
CAT3	20	30	50				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUL61 - AUTOMOTIVE EMBEDDED SYSTEMS LABORATORY							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Sensors and Controllers Laboratory**	**6**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course provides hands on experience in programming and peripheral interfacing with microcontroller.

LIST OF EXPERIMENTS / EXERCISES:	
1.	Addition and subtraction using 89C51 microcontroller
2.	Multiplication and division using 89C51 microcontroller
3.	Interfacing of a switch and LED with 89C51 microcontroller
4.	Seven segment display interfacing with 89C51 microcontroller
5.	LCD interfacing with 89C51 microcontroller
6.	Relay Interfacing with 89C51 microcontroller
7.	DC Motor Interfacing with 89C51 microcontroller
8.	Stepper motor interfacing with 89C51 microcontroller
9.	Interfacing of switch and LED with Arduino board
10.	Servo motor interfacing with Arduino board
	Total:30

REFERENCES/ MANUAL /SOFTWARE:	
1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Apply 8051 instruction set and addressing modes for given Addition / Subtraction / Multiplication / Division programs	Applying (K3), Precision (S3)
CO2	Build LED, Switch, Seven segment, LCD, Relay, DC motor and Stepper motor interfaces with 8051 Microcontroller	Applying (K3), Precision (S3)
CO3	Demonstrate the working of LED, Switch and Servo motor interfaces using ATmega 8 bit Microcontroller	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1		2			1	3	2		1		3
CO2	3	2	1		2			1	3	2		1		3
CO3	3	2	1		2			1	3	2		1		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22AUL62 – VEHICLE MAINTENANCE LABORATORY							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Powertrain and Automotive Chassis**	**6**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course provide hands on experience in maintenance, servicing and performance test of automobile systems

LIST OF EXPERIMENTS / EXERCISES:

1.	Performance test of a two wheeler using chassis dynamometer
2.	Performance test on shock absorber
3.	Performance test on coil spring
4.	Performance test of two wheeler chain
5.	Testing and validation of Battery and battery charging
6.	Gasoline Engine Tuning: Ignition timing, valve gap, adjustment on carburetor and plugs
7.	Diesel Engine Tuning: Injection pressure, adjustment of injection pump and valves
8.	Compression and vacuum test in single and multi-cylinder engines
9.	Measurement of head light illumination
10.	Tire removal, edge rotation and position rotation
11.	Wheel balancing and wheel alignment of a car
12.	Fault diagnosis of hydraulic braking system
	Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Calculate various performance of two wheeler chassis components.	Applying (K3), Manipulation (S2)
CO2	Conduct various tests and tuning to improve the performance of automotive engines.	Applying (K3), Manipulation (S2)
CO3	Troubleshoot various faults in four wheeler chassis systems.	Applying (K3), Manipulation (S2)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1		3	2	1	1	3	2		1	3	
CO2	3	2	1		3	2	1	1	3	2		1	3	
CO3	3	2	1		3	2	1	1	3	2		1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22AUP61 - PROJECT WORK I							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**6**	**EC**	**0**	**0**	**8**	**4**
							Total:120

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	fulfill team roles assigned	Applying (K3)
CO2	communicate effectively	Applying (K3)
CO3	solve engineering problems involving current issues using modern tools	Applying (K3)
CO4	demonstrate the ability to apply the knowledge gained in the programme	Applying (K3)
CO5	recognize the global, economic and environmental issues associated with the project undertaken and the implications to the society	Analyzing (K4)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	2	2	3	3	3	2	3	3
CO2	3	3	3	3	3	2	2	2	3	3	3	2	3	3
CO3	3	3	3	3	3	2	2	2	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22AUP62 - PROJECT WORK I							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**6**	**EC**	**0**	**0**	**8**	**4**
							Total:120

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	fulfill team roles assigned	Applying (K3)
CO2	communicate effectively	Applying (K3)
CO3	solve engineering problems involving current issues using modern tools	Applying (K3)
CO4	demonstrate the ability to apply the knowledge gained in the programme	Applying (K3)
CO5	recognize the global, economic and environmental issues associated with the project undertaken and the implications to the society	Analyzing (K4)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	2	2	3	3	3	2	3	3
CO2	3	3	3	3	3	2	2	2	3	3	3	2	3	3
CO3	3	3	3	3	3	2	2	2	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

22GET31- UNIVERSAL HUMAN VALUES							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3/6**	**HS**	**2**	**0**	**0**	**2**

Preamble	To make the student to know what they 'really want to be' in their life and profession, understand the meaning of happiness and prosperity for a human being. Also to facilitate the students to understanding of harmony at all the levels of human living, and live accordingly	
Unit – I	**Introduction:**	**6**
Need and Basic Guidelines of Value Education – Content and Process of Value Education – Self Exploration – purpose of self-Exploration – Content and Process of Self exploration – Natural Acceptance – Realization and Understanding – Basic Human Aspirations – Continuous Happiness and Prosperity – Exploring Happiness and Prosperity – Basic Requirement for Fulfillment of Human Aspirations – Relationships – Physical Facilities – Right Understanding.		
Unit – II	**Harmony in the Self and Body:**	**6**
Human Being and Body – Understanding Myself as Co–existence of Self ('I') and Body, Needs of the Self and Body, Activities in the Self and Body, Self ('I') as the Conscious Entity, the Body as the Material Entity – Exercise – Body as an Instrument– Harmony in the Self ('I) – Understanding Myself – Harmony with Body.		
Unit – III	**Harmony in the Family and Society:**	**6**
Harmony in the Family – Justice – Feelings (Values) in Human Relationships – Relationship from Family to Society – Identification of Human Goal – Five dimensions of Human Endeavour.		
Unit – IV	**Harmony in Nature and Existence:**	**6**
Order of Nature – Interconnectedness – Understanding the Four order – Innateness – Natural Characteristic – Basic Activity – Conformance – Introduction to Space – Co–existence of units of Space – Limited and unlimited – Active and No–activity – Existence is Co–existence.		
Unit – V	**Implications of the above Holistic Understanding of Harmony on Professional Ethics:**	**6**
Values in different dimensions of Human Living – Definitiveness of Ethical Human Conduct –Implications of Value based Living – Identification of Comprehensive Human Goal – Humanistic Education – Universal Human Order – Competence and Issues in Professional Ethics.		
		Total:30

TEXT BOOK:	
1.	Gaur R.R., Sangal R., Bagaria G.P., "A Foundation Course in Human Values and Professional Ethics", 1st Edition, Excell Books Pvt. Ltd., New Delhi, 2016.
REFERENCES:	
1.	Ivan Illich, "Energy & Equity", The Trinity Press, USA, 1974.
2.	Schumacher E.F., "Small is Beautiful: a study of economics as if people mattered", Britain, 1973.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	restate the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society	Applying (K3)
CO2	distinguish between the Self and the Body, understand the meaning of Harmony in the Self, the Co–existence of Self and Body	Applying (K3)
CO3	infer the value of harmonious relationship based on trust, respect and other naturally acceptable feelings in human–human relationships and explore their role in ensuring a harmonious society	Applying (K3)
CO4	transform themselves to co-exist with nature by realising interconnectedness and four order of nature	Applying (K3)
CO5	distinguish between ethical and unethical practices, and extend ethical and moral practices for a better living	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	75					100
CAT2	25	75					100
ESE	NA						100

* ±3% may be varied (CAT 1 & 2 – 50 marks & ESE – 100 marks)

22GCT71 - ENGINEERING ECONOMICS AND MANAGEMENT							
(Common to All BE/BTech branches)							
Programme & Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**HS**	**3**	**0**	**0**	**3**

Preamble	The aim of the course is to create fundamental knowledge on management by introducing concepts like economics, national income, marketing, operations management, accounting principles etc.	
Unit – I	**Micro Economics**	**9**
Economics – Basics Concepts and Principles – Demand and Supply – Law of demand and Supply – Determinants – Market Equilibrium – Circular Flow of Economic Activities and Income.		
Unit – II	**Macro Economics, Business Ownership and Management concepts**	**9**
National Income and its Measurement Techniques. Inflation - Causes of Inflation – Controlling Inflation – Business Cycle - Forms of Business – Ownership Types. Management concepts: Taylor and Fayol’s Principles – Functions of Management - Managerial Skills - Levels of Management - Roles of Manager.		
Unit – III	**Marketing Management**	**9**
Marketing - Core Concepts of Marketing - Four P‘s of Marketing - New Product Development – Intellectual Property Rights (IPR), Product Life Cycle - Pricing Strategies and Decisions.		
Unit – IV	**Operations Management**	**9**
Operations Management - Resources - Types of Production System - Site Selection, Plant Layout, Steps in Production Planning and Control - Inventory - EOQ Determination.		
Unit – V	**Financial Management**	**9**
Accounting Principles – Financial Statements and its Uses – Depreciation - Straight Line and Diminishing Balance Method – Break Even Analysis – Capital Budgeting - Significance –Traditional and Discounted Cash Flow Methods.		
		Total:45

TEXT BOOK:

1.	Compiled by Department of Management Studies, Kongu Engineering College, "Economics and Management for Engineers", 1st Edition, McGraw Hill Education, Noida, 2013.

REFERENCES:

1.	Geetika, Piyali Ghosh and Purba Roy Choudhury, “Managerial Economics”, 3rd Edition, McGraw-Hill, New Delhi, 2018.
2.	William J. Stevenson, “Operations Management”, 14th Edition, McGraw-Hill Education, 2021.
3.	William G. Nickels, James M. McHugh, Susan M. McHugh, “Understanding Business”, 12th Edition, McGraw-Hill Education, New York, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify market equilibrium and interpret national income calculations and inflation issues	Applying (K3)
CO2	choose a suitable business ownership for their enterprise and illustrate managerial functions	Applying (K3)
CO3	infer marketing management decisions	Understanding (K2)
CO4	apply appropriate operation management concept in business situations	Applying (K3)
CO5	interpret financial and accounting statements and evaluate new proposals	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2			3		2	2	2	3	2		
CO2		1	2			2	2	2	2	2	3	2		
CO3	1	2	1			2		2	2	2	3	2		
CO4	1	2	1			2		2	2	2	3	2		
CO5	2	2				2		2	2	2	3	2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22AUT71 - MANUFACTURING OF AUTOMOTIVE COMPONENTS

Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on various material forming, removing and joining techniques employed in production of automotive components

Unit - I	**Engine Components I:**	**9**

Material selection and Manufacturing methods for Piston - Piston rings -Cylinder block - Wet and dry liners - Engine head - Thermal barrier coating of Engine head and valves.

Unit - II	**Engine Components II:**	**9**

Material selection and Manufacturing methods for Crank shaft - Connecting rod, Cam shaft, valve, Piston pin, Push rod, Rocker arm, tappets, spark plug.

Unit - III	**Transmission System:**	**9**

Material selection and Manufacturing methods for Clutch - Clutch lining - Gear Box - Gear - Propeller Shaft - Differential - Axle Shaft - Bearing - fasteners - Wheel drum - Methods of Gear manufacture - Gear hobbing and gear shaping machines - gear generation - gear finishing and shaving.

Unit - IV	**Vehicle Chassis:**	**9**

Material selection and manufacturing methods for chassis, dead axle, leaf spring, coil spring and shock absorbers - Wheel housing - Steering system, Brake shoes, wheel rim, Tyres.

Unit - V	**Recent Developments:**	**9**

Surface treatment - Plastics - Plastics in Automobile vehicles - Interior Dashboard - Processing of plastics - Hydro forming of exhaust manifold and lamp housing - Stretch forming of Auto body panels - MMC liners - Selection of materials for Auto components - Use of Robots in Body welding.

Total:45

TEXT BOOK:

1.	Serope Kalpakjian & Steven Schmid, "Manufacturing Processes for Engineering Materials", 6th Edition, Pearson Education India, New Delhi, 2016.

REFERENCES/ MANUAL / SOFTWARE:

1.	Kaushish J P, "Manufacturing Processes", 2nd Edition, PHI Learning Pvt. Ltd, 2013.
2.	Rao P N, "Manufacturing Technology, Volume I & II", 3rd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand basic principle and production methods of engine components	Understanding (K2)
CO2	understand the material selection and the production of forged engine components	Understanding (K2)
CO3	discuss the material selection and manufacturing of transmission system components	Understanding (K2)
CO4	summarize the importance and manufacturing of vehicle chassis components of automobile	Understanding (K2)
CO5	understand the recent developments in manufacturing process for automotive components	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1										2	
CO2	3	1	1										3	
CO3	3	2	2										3	
CO4	3	1	1										2	
CO5	3	1	1										2	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	40	60					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUP71 PROJECT WORK II PHASE I

Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**EC**	**0**	**0**	**10**	**5**
							Total:150

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	fulfill team roles assigned	Applying (K3)
CO2	communicate effectively	Applying (K3)
CO3	solve engineering problems involving current issues using modern tools	Applying (K3)
CO4	demonstrate the ability to apply the knowledge gained in the programme	Applying (K3)
CO5	recognize the global, economic and environmental issues associated with the project undertaken and the implications to the society	Analyzing (K4)

Mapping of Cos with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	2	2	2	2	2	3	3	3	2	3	3
CO2	3	3	3	3	3	2	2	2	3	3	3	2	3	3
CO3	3	3	3	3	3	2	2	2	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22AUP72 PROJECT WORK II PHASE I							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**EC**	**0**	**0**	**10**	**5**
							Total:150

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	fulfill team roles assigned	Applying (K3)
CO2	communicate effectively	Applying (K3)
CO3	solve engineering problems involving current issues using modern tools	Applying (K3)
CO4	demonstrate the ability to apply the knowledge gained in the programme	Applying (K3)
CO5	recognize the global, economic and environmental issues associated with the project undertaken and the implications to the society	Analyzing (K4)

Mapping of Cos with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	2	2	2	2	2	3	3	3	2	3	3
CO2	3	3	3	3	3	2	2	2	3	3	3	2	3	3
CO3	3	3	3	3	3	2	2	2	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

22AUP81 PROJECT WORK II PHASE II							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**8**	**EC**	**0**	**0**	**8**	**4**
							Total:120

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	fulfill team roles assigned	Applying (K3)
CO2	communicate effectively	Applying (K3)
CO3	solve engineering problems involving current issues using modern tools	Applying (K3)
CO4	demonstrate the ability to apply the knowledge gained in the programme	Applying (K3)
CO5	recognize the global, economic and environmental issues associated with the project undertaken and the implications to the society	Analyzing (K4)

Mapping of Cos with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	2	2	2	2	2	3	3	3	2	3	3
CO2	3	3	3	3	3	2	2	2	3	3	3	2	3	3
CO3	3	3	3	3	3	2	2	2	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22AUE01 – TWO AND THREE WHEELER TECHNOLOGY							
Programme & Branch	**BE – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Powertrain and Automotive Chassis**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on two and three-wheeler systems and its advancements.	
Unit – I	**Two-wheeler Engine systems:**	**9**
Two-wheeler Engines – Types and working principle. Fuel supply system - Carburetor – Types and its circuits - Fuel injection system – Layout, components and sensors. Lubrication system - Function, types and lubrication oils. Cooling system, Scavenging system. Starting system - Push, kick and auto-start mechanisms.		
Unit – II	**Two-wheeler Chassis systems:**	**9**
Frames for two-wheeler: Types and loads - Different drive systems for two-wheeler. Transmission system: Clutch and gearbox – Types and their operating mechanisms. CVT - Final drive. Steering: Fork assembly and Handle bar. Panel meters and controls on handle bar. Front suspension systems - Telescopic type, Rear suspension system - Shock absorber. Electrical systems: Lighting, charging circuit.		
Unit – III	**Two-wheeler Brakes and Wheels:**	**9**
Drum brakes and disc brakes: Types, construction and working. Front and rear brake linkage - Components - Brake actuation and control systems. Wheels: Spoked, alloy and disc wheels. Tyre: Type, construction details. Road holding, vehicle handling and stability characteristics.		
Unit – IV	**Two-wheeler Advanced Technologies**	**9**
Advanced two-wheeler engine technologies: Yamaha - Blue core, Honda - Eco technology (HET), Bajaj - DTS-i, Suzuki - Eco performance (SEP), Hero - i3s, Advanced tumble flow induction technology (ATFT), Advanced swirl flow induction system (ASFS) and APDV ignition system. Electric two-wheeler: Construction and drive train layout – Batteries and their types. Electric motors and its controllers: Types and circuits. Charger and charging system – Battery balancer and battery management system - Regenerating braking principles. Merits and demerits. Regulations and safety.		
Unit – V	**Three-wheeler:**	**9**
Three-wheeler: Classification, construction, layout of passenger and loading auto rickshaws. Frame and body: Types. Four stroke CNG and diesel engines – Drive train – Suspension and brake systems. Electric three-wheeler: Construction and performance details.		
		Total:45

TEXT BOOK:

1.	Andrew Livesey, "Motorcycle Engineering", 1st edition, Routledge Publishers, London, 2021.

REFERENCES:

1.	Dhruv U. Panchal, "Two and Three-Wheeler Technology", 1st edition, PHI Learning Pvt. Ltd, New Delhi, 2015.
2.	K.K. Ramalingam, "Two and Three-Wheeler Technology", 2nd edition, SciTech Publications, Chennai, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the power unit and its subsystems on a two-wheeler.	Understanding (K2)
CO2	explain the two-wheeler chassis and transmission systems.	Understanding (K2)
CO3	describe the types of brakes and wheels used in two-wheelers.	Understanding (K2)
CO4	outline the construction and working concepts of an electric two-wheeler.	Understanding (K2)
CO5	summarize the types of three-wheelers and their systems.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				1						2	3	
CO2	3	2				1						2	3	1
CO3	3	2				1						2	3	
CO4	3	3				2	3					2	3	2
CO5	3	2				1						2	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	15	85					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE02 - DIESEL AND ELECTRIC LOCOMOTIVES							
Programme & Branch	**BE – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Electrical Systems and Drives and Vehicle Dynamics**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on locomotive systems, modelling of traction, train dynamics, signaling and communications in locomotives.
Unit – I	**Introduction to Locomotives:** **9**
Types of locomotives – Wagon frames – Suspension elements – Bodies – Wheelsets and bearings – Brake systems – Coupling mechanisms – Standards and acceptance tests. Important parameters of locomotives. Power generation systems – Diesel engine and its systems – Electric power systems.	
Unit – II	**Traction System and Control:** **9**
Diesel-Electric locomotives with AC and DC traction system. Electric locomotives with AC and DC traction system. Traction generators and alternators. Traction motor operating principles. Control of traction motors – Control strategies for AC, DC, Synchronous and Induction traction motors.	
Unit – III	**Train Dynamics:** **9**
Train models – Rail load model – Rail connection model – Interaction of longitudinal and vertical train dynamics – Energy considerations – Starting the train – Stopping the train – Topography issues – Traction pinch points – Cycle time.	
Unit – IV	**Traction Control Modelling:** **9**
Adhesion control strategies and algorithms. Wheelset dynamics – Adhesion force modelling – Traction control modelling. Simplified traction control study – Locomotive and wagon parameters – Simulation scenarios – Constant speed mode and Acceleration mode simulation in MATLAB Simulink.	
Unit – V	**Signaling and Communications:** **9**
Signaling and interlocking - Speed signaling – Centralizing signal boxes – Solid-state control systems for locomotives - Brown-Boveri System – Radio communications, signaling and control – Automatic warning, control and driving systems on main line railways.	
	Total:45

TEXT BOOK:

1.	Maksym Spiryagin, Peter Wolfs, Colin Cole, Valentyn Spiryagin, Yan Quan Sun & Tim McSweeney, "Design and Simulation of Heavy Haul Locomotives and Trains", 1st Edition, CRC Press, New Delhi, 2016.

REFERENCES:

1.	Brian Solomon, "The American Diesel Locomotives", 1st Edition, Motorbooks International, United States of America, 2000.
2.	Duffy.M.C., "Electric Railways, 1880-1990", Illustrated Reprint Edition, Institution of Engineering and Technology, Kerala, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize different subsystems and power generation systems in locomotives.	Understanding (K2)
CO2	explain various traction control systems and control strategies.	Understanding (K2)
CO3	model mathematical equations using fundamental principles by considering train dynamics.	Applying (K3)
CO4	model and simulate traction control systems for various scenarios with different control strategies and algorithms.	Analyzing (K4)
CO5	outline signaling, communications and control systems in locomotives.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2			2						1	3	2
CO2	3	2	2			2						1	3	2
CO3	3	2	2			2						1	3	2
CO4	3	2	2		3	2						1	3	2
CO5	3	2	2			2						1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	10	50	40				100
CAT3	10	20	50	20			100
ESE	10	60	15	15			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE03 - COMPUTER INTEGRATED MANUFACTURING							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Technology**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course enables to understand about the manufacturing concepts, process planning, cellular manufacturing, FMS and Computer aided quality control methods.	
Unit – I	**Introduction:**	**9**
Introduction – Manufacturing Planning, Manufacturing control - Concurrent Engineering - CIM concepts – Computerized elements of CIM system –Types of production – Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems. Basic Elements of an Automated system – Levels of Automation. Lean Production and Just-In-Time Production-Kanban System - Smart Factories, Industrial revolution – history - Features of Industry 4.0.		
Unit – II	**Production Planning & Control and Computerized Process Planning:**	**9**
Process Planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and Master Production Schedule – Material Requirement Planning – Capacity Planning - Control Systems - Shop Floor Control - Inventory Control. Brief on Manufacturing Resource Planning (MRP-II) and Enterprise Resource Planning (ERP) – Supply Chain Management (SCM) – Simple Problems.		
Unit – III	**Cellular Manufacturing:**	**9**
Group Technology(GT), Part Families – Parts Classification and Coding – Simple Problems in Opitz Coding system – Production Flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method – Arranging Machines in a GT cell – Hollier Method – Simple Problems.		
Unit – IV	**Flexible Manufacturing System (FMS) and Automated Guided Vehicle System (AGVS):**	**9**
Types of Flexibility – FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance Technology – Vehicle Management & Safety. Automated Storage systems – Performance –Methods.		
Unit – V	**Computer Aided Quality Control:**	**9**
Computers in QC, Automated Inspection Methods and Principles, Contact Inspection Methods, Non-Contact Inspection Methods, Machine Vision System, Optical Inspection Method, Sensors, Co-ordinate Measuring Machine, Computer Aided Testing, Integration of CAQC with CAD/CAM.		
		Total:45

TEXT BOOK:

1.	Groover M.P., “Automation, Production System and Computer Integrated Manufacturing”, 4th Edition, Prentice-Hall of India, New Delhi, 2016.

REFERENCES:

1.	Koren, Yoram., "Computer control of Manufacturing Systems", McGraw Hill, New Delhi, 2014.
2.	Rao P.N., "CAD/CAM: Principles and Applications", 3rd Edition, McGraw Hill, New Delhi, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the implementation of CIM concepts in manufacturing industries.	Understanding (K2)
CO2	develop a process plan and material requirement plan for a product.	Applying (K3)
CO3	identify the parts by using different coding methods.	Applying (K3)
CO4	design a flexible manufacturing layout for a machine cell.	Applying (K3)
CO5	infer various computer aided quality control and inspection techniques.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1								1	3	
CO2	3	2	2	1								1	3	
CO3	3	2	2	1								1	3	
CO4	3	2	2	1								1	3	
CO5	3	2	2	1								1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	65	15				100
CAT2	20	65	15				100
CAT3	20	65	15				100
ESE	15	65	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE04 - AUTOMOTIVE CONTROL SYSTEM							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Electrical Systems and Drives**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on various systems modeling and control techniques in automobiles.

Unit - I	**Mathematical Modeling of Systems:**	**9**
Open loop and closed loop systems - Transfer function: Mechanical systems, Electrical systems and Electro mechanical systems - Block diagram reduction techniques - Signal flow graphs.		
Unit - II	**Time Response Analysis:**	**9**
System poles and zeros - First order system - Response for impulse, step and ramp signals. Step response of Second order Under damped system - Time domain specifications - Steady-state error constants - Position, velocity and acceleration error constants.		
Unit - III	**Frequency Response and Stability Analysis:**	**9**
Frequency domain specifications - Peak resonance, resonant frequency, bandwidth and cut-off rate. Routh-Hurwitz criterion of stability. Stability in the frequency domain - Gain and Phase margins: Bode plot.		
Unit - IV	**Compensators:**	**9**
Need for compensator – Types of compensation - Root Locus techniques – Design of Lag and Lead Compensators using root locus.		
Unit – V	**Automotive Control Techniques:**	**9**
Proportional control - Integral control - Derivative control - PI and PID control actions - Tuning rules: ZN tuning rule, Cohen-coon tuning rule. Applications - Fuel Control - Spark - Timing Control - Idle-speed Control - Cruise Control - Automatic transmission control - ABS control.		
		Total:45

TEXT BOOK:

1. Salivahanan, S., R. Rengaraj, and G. R. Venkatakrishnan. Control systems engineering. Pearson, 2015

REFERENCES:

1. Norman S. Nise, "Control System Engineering", 8th Edition, John Wiley & Sons, 2019.
2. Ogata K, "Modern Control Engineering", 5th Edition, Pearson Education India, New Delhi, 2015.
3. Nagrath I J & Gopal M, "Control System Engineering", 6th Edition, New Age International, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the mathematical models for linear time-invariant systems of different sub systems in automobile engineering	Applying (K3)
CO2	model a state-feedback controller using pole placement to meet transient response specification	Applying (K3)
CO3	apply the frequency domain analysis techniques to determine the system response and stability	Applying (K3)
CO4	design the compensators by using root locus techniques	Applying (K3)
CO5	apply the control methodologies for automotive applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1								1	2	3
CO2	3	3	2	1								1	2	3
CO3	3	3	2	1								1	2	3
CO4	3	3	2	1								1	2	3
CO5	3	3	2	1								1	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE05 – MACHINE DESIGN
(Use of PSG Design Data book is permitted)

Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Mechanics of Deformable Bodies**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge to design and analyze the various machine components.	
Unit - I	**Steady and Variable Stresses in Machine Members:**	**9**
Introduction to the design process – Factors influencing machine design - Selection of materials – Direct, bending and torsion equations – Calculation of principal stresses – Eccentric loading – Factor of safety - Theories of failure – Stress concentration – Design for variable loading – Soderberg, Goodman and Gerber relations.		
Unit - II	**Design of Parallel axis gears:**	**9**
Gear tooth terminology - Speed ratio and number of teeth - Force analysis - Tooth stresses - Dynamic effects - Fatigue strength - Factor of safety - Gear materials – Module and face width – Power rating calculations - Design of spur gear. Parallel axis helical gears – Pressure angle in the normal and transverse plane – Equivalent number of teeth - Forces and stresses - Design of helical gears.		
Unit - III	**Design of Fasteners and Welded Joints:**	**9**
Threaded fasteners – Design of bolted joints – Eccentric loading – Design of welded joints – Axially loaded unsymmetrical welded joints - Eccentric load in the plane of welds - Welded joint subjected to bending moment and twisting moment.		
Unit - IV	**Design of Bearings and Levers:**	**9**
Design of bearings - Preloading, design of rolling contact bearings - Cubic mean load - Design of journal bearings - McKee's equation - Calculation of bearing dimensions. Design of levers.		
Unit - V	**Design of Shafts and Couplings:**	**9**
Design - Solid and hollow shafts, keys and key ways, rigid, flexible couplings and knuckle joints. Introduction to gear and shock absorbing couplings.		
		Total:45

TEXT BOOK:

1.	Bhandari V.B., "Design of Machine Elements", 5th Edition, Tata McGraw-Hill, New Delhi, 2020.

REFERENCES:

1.	Richard G. Budynas and J. Keith Nisbett., "Shigley's Mechanical Engineering Design", 11th Edition, McGraw-Hill Education, Singapore, 2021.
2.	Merhyle Spotts, Terry Shoup and Lee Hornberger., "Design of Machine Elements, 8th Edition, Pearson India Education, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	design and specify the shape of various machine components.	Applying (K3)
CO2	design spur gear and helical gear for different application.	Applying (K3)
CO3	design various types of screw fasteners and welded joints for different applications.	Applying (K3)
CO4	design bearings for various industrial applications.	Applying (K3)
CO5	analyze and select shafts, couplings, keys and knuckle joint for different applications.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2			1					2	3	
CO2	3	3	2	2			1					2	3	
CO3	3	3	2	2			1					2	3	
CO4	3	3	2	2			1					2	3	
CO5	3	3	2	2			1					2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	15	70				100
CAT2	15	15	70				100
CAT3	15	15	55	15			100
ESE	5	10	70	15			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE06 - PRINCIPLES OF FARM MACHINERIES

Programme & Branch	**BE – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course emphasizes on selection cum management of farm, fertilizer and harvesting machineries.

Unit – I	**Farm Mechanization:**	**9**
Introduction: History of Mechanized Agriculture – Farming Operations and Related Machines – Functional Analysis of Agricultural Machines – Basic processes of agricultural machines – Process diagrams – Engine and Electrical Power for Agricultural Machines.		
Unit – II	**Precision Farming and Hitching Systems:**	**9**
Introduction – Sensors – Global Positioning System – Geographic Information System – Variable Rate Applications –Controller Area Networks – Hitching Systems – Tires and Traction – Soil Compaction – Traction Aids – Tractor Testing.		
Unit – III	**Soil Tillage and Crop Planting:**	**9**
Introduction to Soil Tillage – Tillage Methods and Equipment – Mechanics of Tillage Tools – Performance of Tillage Implements – Hitching of Tillage Implements – Methods and Equipment used for Crop Planting – Functional Processes – Evaluating Planter and Transplanter Performance.		
Unit – IV	**Fertilizer and Harvesting Applications:**	**9**
Selection - Calibration - Construction features - Different components and adjustment of Weed control - Plant protection equipment - Sprayers and dusters - Work physiology of men and women – Hay and Forage Harvesting – Grain Harvesting – Fruit, Nut, and Vegetable Harvesting.		
Unit – V	**Special Machineries:**	**9**
Introduction – Screw Conveyors – Pneumatic Conveyors – Bucket Elevators – Forage Blowers – Field Capacity and Efficiency of Farm Machineries – Draft and Power Requirements – Machinery Costs – Machinery Selection and Replacement.		
		Total:45

TEXT BOOK:

1. Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster., “Engineering Principles of Agricultural Machines”, 2nd edition, American Society of Agricultural and Biological Engineers, USA, 2006.

REFERENCES:

1. Boson E.S., "Theory, Construction and Calculation Agricultural Machines", Volume 2, Scientific Publishers, 2019.
2. Donnel Hunt, David Wilson., "Farm Power and Machinery Management", 11th Edition, Waveland Press Inc, 2015.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	illustrate the different methods of farm mechanization.	Understanding (K2)
CO2	describe precision farming and tractor testing.	Understanding (K2)
CO3	explain the various types of soil tillers and crop planting machines.	Understanding (K2)
CO4	summarize fertilizer and harvesting application equipment.	Understanding (K2)
CO5	identify the different types of special machinery for agricultural applications.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				2	2					1	3	
CO2	3	2				2	2					1	3	
CO3	3	2				2	2					1	3	
CO4	3	2				2	2					1	3	
CO5	3	2				2	2					1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	15	85					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE07 - FINITE ELEMENT METHOD							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Mechanics of Deformable Bodies**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge to apply finite element method in solving differential equations of structural and thermal systems.	
Unit - I	**Fundamentals of Finite Element Analysis:**	**9**
Introduction - Matrix approach – Coordinates. Numerical simulation - Gauss Elimination based Solvers. FEA General procedure - Basic element shapes - Discretization process - Node Numbering Scheme - Interpolation - Weighted residual method - Ritz techniques. Application of FEA.		
Unit - II	**One Dimensional Analysis:**	**9**
One Dimensional finite element modeling - Element Types - Linear Elements - Linear Element Shape Function - Finite Element Equation – Galerkin's method - Solid Mechanics - Heat transfer - pin fin and composite wall - Beam Element. Applications of Beam and Spring Problems.		
Unit - III	**Two-Dimensional Analysis:**	**9**
Introduction to 2-D Finite element modelling - Constant Strain Triangular - Finite element formulation - Shape Functions - strain displacement and stress strain relationship matrix - Plane Stress and Plane Strain - Temperature Effects. Applications of temperature effects on Piston and cylinder.		
Unit - IV	**Axisymmetric Continuum and Plane truss:**	**9**
Axisymmetric formulation - Element stiffness matrix and force vector - Body forces and temperature effects - Stress calculations - Boundary conditions – Analysis of cylinders - under internal / external pressures - Applications of plane truss. Piston head analysis - 2D axis symmetric elements.		
Unit - V	**Isoparametric Elements for Two-Dimensional Continuum:**	**9**
Natural Co-ordinate Systems - Isoparametric elements - The four node quadrilateral - Shape functions - Element stiffness matrix and force vector - Jacobin matrix - Stress calculations - Numerical integration - Gauss Quadrature.		
		Total:45

TEXT BOOK:

1.	Rao S.S, "The Finite Element Method in Engineering", 6th Edition, Butterworth–Heinemann (An imprint of Elsevier), New Delhi, 2018.

REFERENCES:

1.	Tirupathi R. Chandrupatla & Ashok D. Belegundu., "Introduction to Finite Elements in Engineering", 4th Edition, Pearson Education, India, 2015.
2.	Reddy J.N., "An Introduction to the Finite Element Method", 3rd Edition, McGraw Hill Education, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	formulate finite element equations and solve engineering problems.	Applying (K3)
CO2	analyze 1D structural and heat transfer problems for different applications.	Analyzing (K4)
CO3	analyze 2D structural problems for different applications.	Analyzing (K4)
CO4	solve axisymmetric and plane truss problems.	Applying (K3)
CO5	analyze isoparametric formulation and numerical integration.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2								2	3	
CO2	3	3	2	2	2							2	3	
CO3	3	3	2	2	2							2	3	
CO4	3	3	2	2	2							2	3	
CO5	3	3	2	2								2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	15	55	15			100
CAT2	15	15	35	35			100
CAT3	15	15	35	35			100
ESE	5	10	35	50			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE08 - IN - VEHICLE NETWORKING							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Embedded Systems**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on data communication, networking, automotive communication and diagnostic protocols.

Unit – I	**Controller Area Network:**	**9**
CAN Bus - Protocol - ISO/OSI layers –Properties of CAN - CAN 2.0A standard frame - Message Transfer - CAN bit - NRZ coding - bit stuffing - Data Frame - Errors - Error detection - The rest of the frame -CAN 2.0B – frame format - Compatibility of CAN 2.0A and CAN 2.0B.		
Unit – II	**CAN Physical Layer:**	**9**
Introduction - CAN bit - Nominal Bit Time - CAN and Signal Propagation – Network Type, Topology and Structure - Propagation Time - Estimating the value - Precise - Corollaries: Relations between the medium, bit rate and length of the network - Bit synchronization - Bit resynchronization -Network speed –Bit rate - Latency.		
Unit – III	**Time-Triggered protocols:**	**9**
Time-Triggered communication on CAN – High-Speed - X-by-Wire and redundant systems – FlexRay - Protocol handling - Communication frame - Architecture of a FlexRay node - Electronic components for FlexRay - Line driver -Bus guardian.		
Unit – IV	**Image Processing Algorithms:**	**9**
Vehicle - Wired and wireless communication - Basic concept of the LIN 2.0 protocol - Operating principle - Data link layer - Conformity of LIN - Fail-safe SBC approach - Safe-by-Wire Plus - Audio–Video Buses - I2C Bus - MOST Bus.		
Unit – V	**Wireless Communication:**	**9**
Radio-Frequency Communication – Internal - External - Control of opening parts - Passive keyless entry and passive go - Wireless Networks – GSM - Bluetooth -IEEE 802.11x – NFC.		
		Total:45

TEXT BOOK:

1.	Dominique Paret, "Multiplexed Networks for Embedded Systems: CAN, LIN, Flexray, Safe-by-Wire", 1st Edition, John Wiley & Sons Ltd, England, 2007.

REFERENCES:

1.	Ingolf Karls & Markus Mueck, "Networking Vehicles to Everything", 1st Edition, De/G Press, Germany, 2018.
2.	Kirsten Matheus & Thomas Königseder, " Automotive Ethernet ", 3rd Edition, Cambridge University Press, 2021.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	summarize the basics of in-vehicle networks and the CAN protocol.	Understanding (K2)
CO2	illustrate the CAN physical layer.	Understanding (K2)
CO3	classify the time-triggered and Flexray protocols for vehicle networking.	Understanding (K2)
CO4	explain and relate the multiplexed bus concepts for automotive networking.	Understanding (K2)
CO5	outline the importance of wireless systems in automobiles.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2										1		3
CO2	3	2										1		3
CO3	3	2										1		3
CO4	3	2										1		3
CO5	3	2										1		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	15	85					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE09 - VEHICLE BODY ENGINEERING							
Programme & Branch	**BE - Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Chassis**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on ergonomics, materials and design of vehicle bodies.	
Unit – I	**Ergonomics in Vehicle Bodies:**	**9**
Introduction - Seating dimensions - Interior ergonomics - Ergonomics system design - Seat comfort - Suspension seats - Split frame seating - Back pain reducers - Dash board instruments - Electronic displays - Commercial vehicle cabin ergonomics - Mechanical package layout - Goods vehicle layout.		
Unit – II	**Car Body Details:**	**9**
Types of Car body - Saloon, Hatchback, convertibles, Limousine, Estate Van, Racing and Sports car – Visibility regulations - Driver visibility - Improvement in visibility and tests for visibility. Driver seat design – Car body construction - Various panels in car bodies - Safety aspect of car body		
Unit – III	**Commercial Vehicle Body Details:**	**9**
Commercial vehicle bodies – Types and Construction: Light Commercial Vehicle – Medium Commercial Vehicle: Drop side , Box van and Panel van - Heavy commercial vehicle: Rigid and Articulated type. Dimensions of driver‘s seat in relation to controls – Driver’s cab design - Regulations.		
Unit – IV	**Vehicle Body Repair:**	**9**
Vehicle body construction materials – Properties - Steel sheet, timber, plastics, GRP and CRP. Body trim items - Body mechanisms. Hand tools - Power tools - Panel repair - Repairing sheet metal - Repairing plastics - Body fillers. Passenger compartment service. Corrosion: Anticorrosion methods - Painting – Process, procedure and challenges.		
Unit – V	**Design, Safety and Fatigue Aspects:**	**9**
Design of commercial vehicle structure - Chassis frame configuration - Structural properties of chassis frame - Press working - Spot welding - Adhesives and sealants. Crash tests - Forces in roll over, head on impact, plastic collapse and analysis. Vehicle structure fatigue – Vibration.		
		Total:45

TEXT BOOK:

1.	A.K. Babu.,” Vehicle Body Engineering”, 1st Edition, Khanna Publishers, 2021.

REFERENCES:

1.	John Fenton., “Handbook of Automotive Body and Systems Design”, John Wiley & Sons, 2013.
2.	Happian Smith., “Introduction to Modern Vehicle Design”, Butterworth Heinemann Publisher, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize the fundamentals of ergonomics in vehicle bodies.	Understanding (K2)
CO2	describe the different types of car bodies with constructional details.	Understanding (K2)
CO3	illustrate various commercial vehicle bodies with constructional details.	Understanding (K2)
CO4	identify the materials used in body building and body repair work.	Understanding (K2)
CO5	explain design techniques with safety and fatigue aspects in vehicle structure.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				2	1					1	3	2
CO2	3	2				2	1					1	3	
CO3	3	2				2	1					1	3	
CO4	3	2			1	2	1					1	3	
CO5	3	2			1	2	1					1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	15	85					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE10 - OPERATIONS RESEARCH							
Programme & Branch	**B.E – AUTOMOBILE ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course promotes the application of scientific methods in decision-making with respect to the production operations for the effective utilization of scarce resources.	
Unit – I	**Linear Models:**	**9**
Linear Models: Introduction - Phases of OR study – Formation of Linear Programming Problem (LPP) - Canonical form of LPP - Solutions to LPP - Graphical Solution - Simplex Algorithm - Artificial Variables Technique - Big M method - Two Phase method.		
Unit – II	**Transportation Problems, Assignment Problems and Sequencing Problems:**	**9**
Transportation problems: Mathematical formulation - Basic feasible solutions – North-West Corner (NWC) – Least Cost Method (LCM) – Vogels Approximation Method (VAM). Optimality test – Modified Distribution (MODI) technique. Assignment problems: Mathematical formulation –Hungarian Algorithm. Sequencing Problems:1 jobs n machine, n jobs 1 machine, n jobs 2 machine, n jobs 3 machine, n jobs m machine and 2 jobs n machine problems.		
Unit – III	**Network Models and Project Management:**	**9**
Network Models: Shortest route - Minimal spanning tree - Maximum flow models. Project Management: Construction of networks-activity and event-based diagrams - PERT-CPM-problems – Cost analysis and crashing of networks.		
Unit – IV	**Inventory Models:**	**9**
Inventory Models: Types of Inventories – Economic Order Quantity (EOQ) - Deterministic inventory models - Price break problems - Stochastic inventory models - Multi item deterministic models - Selective inventory control techniques.		
Unit – V	**Queuing Models and Replacement Models:**	**9**
Queuing Models: Queuing systems and structures - Notations - Parameter - Single server and multi-server models - Poisson input - exponential service - Constant rate service - Infinite population. Replacement Models: Replacement of Items due to deterioration with and without time value of Money - Individual and group replacement policy		
		Total:45

TEXT BOOK:

1.	Gupta P.K. & Hira D.S., "Operations Research", 7th Edition, S. Chand and Company Ltd, New Delhi, 2014.

REFERENCES:

1.	Taha & Hamdy A., "Operation Research: An Introduction", 10th Edition, Pearson Education, Chennai, 2017.
2.	Hiller Frederick S. & Lieberman Gerald J., "Introduction to Operations Research", 10th Edition, McGraw-Hill Science, Bengaluru, 2011.
3.	Vohra N.D., "Quantitative Techniques in Management", 5th Edition, McGraw Hill Education, Noida, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	formulate and solve linear programming problems	Applying (K3)
CO2	develop solutions to transportation, assignment and sequencing problems	Applying (K3)
CO3	construct networks and analyze optimality for various applications	Analyzing (K4)
CO4	identify inventory models and solve for optimality	Analyzing (K4)
CO5	assess queuing characteristics and compute the optimum replacement period for capital equipment and items that fail suddenly	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2							1	1	3	
CO2	3	3	2	2							1	1	3	
CO3	3	3	2	2							1	1	3	
CO4	3	3	2	2							1	1	3	
CO5	3	3	2	2							1	1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	20	30	30			100
CAT3	20	20	30	30			100
ESE	10	20	40	30			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE11 - VEHICLE MAINTENANCE							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Powertrain and Automotive Chassis**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on maintenance, servicing and reconditioning of various systems in automobile.

Unit – I	**Maintenance procedure and tools:**	**9**
Requirements of maintenance – Classification of maintenance – Service intervals – Vehicle service procedures – Workshop activities in vehicle maintenance. Vehicle insurance policy - Towing and recovering - First aid – Maintenance policy. Safety – Personnel, equipment and vehicles - Fire safety. Tools and equipment for shop hand – Tools and equipment for measuring and reconditioning works.		
Unit – II	**Engine Maintenance:**	**9**
Engine service procedure - Dismantling procedure of Engine. Inspection, Troubleshooting, reconditioning and replacing of engine parts. Maintenance of cooling system, lubrication system, fuel system, exhaust system and emission control system. Fault diagnosis using OBD tool.		
Unit – III	**Driveline Maintenance:**	**9**
Inspection, Troubleshooting, reconditioning and replacing procedure - Clutch, transmission, transaxle, propeller shaft, yoke, cross of universal joint, constant velocity joints, axle shafts, bearings, differential assembly.		
Unit – IV	**Chassis Maintenance:**	**9**
Maintenance, service and reconditioning procedure - Macpherson strut system, leaf spring system and shock absorbers - Rack and pinion, recirculating ball type, worm type, power steering systems - Brake systems - Wheels and tires - Tire rotation patterns. Review of wheel alignment parameters.		
Unit – V	**Electrical and HVAC Maintenance:**	**9**
Maintenance, service and troubleshooting procedure - Battery, starting, charging, lighting systems, air conditioning system. Refrigerant leakage detection and charging.		
		Total:45

TEXT BOOK:

1.	William H. Crouse and Donald l. Anglin, "Automotive Mechanics"., 10th Edition, McGraw Hill Education, New Delhi, 2017.

REFERENCES:

1.	Ed May & Les Simpson., "Automotive Mechanics” Volume I and II", 8th Edition, McGraw Hill Education, New Delhi, 2009.
2.	Jigar A. Doshi, Dhruv U. Panchal &Jayesh P. Maniar, "Vehicle Maintenance and Garage Practice", PHI Learning Pvt. Ltd, New Delhi, 2014.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	discuss the importance of maintenance, workshop practices, tools and safety requirements for automobiles.	Understanding (K2)
CO2	explain the maintenance procedure of engine with its sub-systems and possible reconditioning works.	Understanding (K2)
CO3	illustrate the maintenance related issues in transmission and drive line components.	Understanding (K2)
CO4	identify the service practices in the steering, brake, suspension and wheel.	Understanding (K2)
CO5	asses the maintenance cum troubleshooting aspects in electrical and air-conditioning systems.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2					2					2	3	
CO2	3	2			2		2					2	3	
CO3	3	2					2					2	3	
CO4	3	2					2					2	3	
CO5	3	2					2					2	1	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	65	15				100
ESE	15	70	15				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE12 - COMPOSITE MATERIALS							
Programme & Branch	**B.E. & Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Materials Science and Metallurgy**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides the basic concepts, manufacturing and characterization of composite materials for static and dynamic loads.

Unit – I	**Fiber, Matrix and Composite:**	**9**
Fiber – Glass, Carbon, Ceramic, Aramid, Polymer and Natural – Characterization and Surface treatment. Matrix – Polymer, Ceramic and Metal - Fillers and Additives used in composite – Characterization of composite.		
Unit – II	**Composite Manufacturing:**	**9**
Processing of Metal Matrix Composites (MMC) – Diffusion Bonding – Stir Casting – Squeeze Casting and Powder Metallurgy Technique. Hand Layup – Spray up - Bag Molding – Compression Molding – Pultrusion – Filament Winding – Resin Film Infusion - Elastic Reservoir Molding - Tube Rolling – Quality Inspection Methods.		
Unit – III	**Composite Performance and Analysis:**	**9**
Mechanical properties – Static and dynamic Analysis – Thermogravimetric Analysis - Fatigue and Impact properties – Environmental Effects – Long Term Properties - Service Life Predication - Fracture Behavior and Damage Tolerance.		
Unit – IV	**Composite Mechanics:**	**9**
Fiber Content - Density and Void Content - Rule of Mixture - Volume and Mass Fractions - Evaluation of Four Elastic Moduli Based on Strength of Materials Approach and Semi-Empirical Model - Longitudinal Young‘s Modulus - Transverse Young‘s Modulus– Major Poisson‘s Ratio-in-Plane Shear Modulus - Ultimate Strengths of a Unidirectional Lamina- Characteristics of Fiber-Reinforced Lamina–Laminates – Lamination Theory.		
Unit – V	**Design of Composites:**	**9**
Failure Predictions - Theories of Failure - Laminate Design Consideration - Design Criteria - Design Allowable - Design Guidelines - Joint Design-Bolted and Bonded Joints - Design Examples - Design of a Tension Member – Design of a Compression Member – Design of a Beam - Design of a Torsional Member - Application of Finite Element Method (FEM) for Design and Analysis of Laminated Composites.		
		Total:45

TEXT BOOK:

1.	Mallick P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", 3rd Edition, CRC Press Taylor and Francis, New York, 2007.

REFERENCES:

1.	Autar K Kaw, "Mechanics of Composite Materials", 2nd Edition, CRC Press, Taylor and Francis group, 2006.
2.	Bhagwan D. Agarwal, Lawrence J. Broutman & Chandrashekhar K., "Analysis and Performance of Fiber Composites", 4th Edition, John Wiley & Sons, New York, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the fundamentals of fibers - matrices - additives and composites.	Understanding (K2)
CO2	discuss the various manufacturing processes involved in the fabrication of composite material.	Understanding (K2)
CO3	determine the testing methods and properties of composite materials.	Applying (K3)
CO4	apply and solve problems concerning the mechanics of composite materials.	Applying (K3)
CO5	execute the design criteria for the development of fiber reinforced composites.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1				2					2	3	
CO2	3	1	1				2					2	3	
CO3	3	3	1				2					2	3	
CO4	3	3	3	2			2					2	3	
CO5	3	3	3	2			2					2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	60	20				100
CAT3	20	40	40				100
ESE	10	50	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE13 - CNC AND METROLOGY							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Processes**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides the concepts of CNC part programming and various measurement techniques	
Unit – I	**Basic Concepts of Metal Cutting and CNC Machines:**	**9**
Introduction – Mechanics of chip formation -Mechanics of oblique cutting - Cutting forces and power- Tool life – Surface finish-Machinability. CNC machines: Classification – Construction details: Structure, Configuration of CNC system – Compensations for Machine accuracy – DNC – Adaptive control CNC systems, Drives and Controls - Drive Mechanism, gearbox, Spindle Drives, Axes drives - Magnetic Levitation and Linear motors. Timing belts and pulleys, Spindle bearing – Arrangement and installation. Slide ways. Re-circulating ball screws – Backlash measurement and compensation, linear motion guide ways.		
Unit – II	**Tooling For CNC Machines:**	**9**
Interchangeable tooling system – Preset and qualified tools – coolant feed tooling system – Modular fixturing – Quick change tooling system – Automatic head changers – Tooling requirements for Turning and Machining centres – Tool holders – Tool assemblies – Tool Magazines – ATC Mechanisms – Automatic Pallet Changer-Tool management. Principles of location, clamping and work holding devices. Economics of CNC Machines and Retrofitting: Factors influencing selection of CNC Machines – Cost of operation of CNC Machines – Practical aspects of introducing CNC machines in industries – Maintenance features of CNC Machines – Preventive Maintenance, Other maintenance requirements. Retrofitting.		
Unit – III	**Part Programming of CNC Machines:**	**9**
Part Program Terminology - G and M Codes – Types of interpolation. CNC part programming – Manual part programming (Turning and Milling).		
Unit – IV	**Linear and Angular Measurements:**	**9**
Basic concepts: Legal metrology- Precision- Accuracy- Types of errors – Standards of measurement- Traceability – Interchangeability and selective assembly. Introduction to limits, fits and tolerances, Gauge design- Comparators-Angular measurement: bevel protractor - Angle gauges - Sine bar. Surface Finish and Form Measurement: Measurement of surface finish: Terminology – Geometrical irregularities – Roughness – Waviness. Surface- roughness measurement methods. Screw thread metrology: Terminology- Errors in thread, Gears Terminology- Measurement of various elements of gear.		
Unit – V	**Interferometry and LASER Metrology:**	**9**
Principle of light wave interference – Optical flats -Michelson and NPL flatness interferometer, Laser interferometer. Advances in Metrology: Coordinate Measuring Machine (CMM): Types - Constructional features - Possible causes of errors in CMM - Probing system – Performance and applications of CMM. Machine Vision System: Applications of machine vision in measurement- In process and On line measurement.		
		Total:45

TEXT BOOK:

1.	Narang J.S. & Narang V.D.S., "CNC Machines and Automation", Dhanpat Rai and Co. Pvt. Ltd, New Delhi, 2016 for Units I,II,III.
2.	Jain R.K., "Engineering Metrology", Khanna Publishers, New Delhi, 2013 for Units IV, V.

REFERENCES:

1.	HMT Limited., "Mechatronics", McGraw-Hill, New Delhi, 2001.
2.	Raghavendra N.V. & Krishnamurthy L., "Engineering Metrology and Measurements", Oxford University Press, India, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	estimate the parameters of metal cutting and comprehend the basic components, drives and controls involved in a CNC system.	Understanding (K2)
CO2	select various tooling systems and fixtures for CNC and identify maintenance features of CNC machines.	Understanding (K2)
CO3	develop part programming for various machining processes.	Applying (K3)
CO4	infer linear and angular measurements using various instruments and determine the surface roughness.	Understanding (K2)
CO5	understand the form and profile measurements using Coordinate Measuring Machine (CMM) with a machine vision system.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3										2	3	
CO2	3	3										2	3	
CO3	3	3	2	2	3							2	3	
CO4	3	3										2	3	
CO5	3	3										2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	85					100
CAT2	15	65	20				100
CAT3	15	85					100
ESE	15	70	15				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE14 - COMPUTATIONAL FLUID DYNAMICS							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Mechanics of Fluids and Hydraulic Machines**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course involves on the application of numerical methods to solve fluid flow and heat transfer problems. In addition, the course also provides an introduction into turbulence modeling which enables the application of CFD in vortices and eddies.	
Unit – I	**Governing Equations and Boundary Conditions:**	**9**
Governing Equations and Boundary Conditions: Basics of Computational Fluid Dynamics – Governing Equations – Continuity - Momentum and Energy Equations – General Transport Equation – Physical Boundary Conditions – Discretization – Mathematical Behavior of PDEs on CFD –Elliptic - Parabolic - Hyperbolic Equations.		
Unit - II	**Finite Difference Method:**	**9**
Finite Difference Method: Finite Difference Method – Taylors Series – Forward - Central - Backward Differences – Explicit Method – Implicit Method – Tridiagonal Matrix-Application of the TDMA to Two-Dimensional Problems– ADI Method –Solution Methodology for Parabolic and Elliptic Equations – Errors.		
Unit - III	**Finite Volume Method:**	**9**
Finite Volume Method: Finite Volume Formulation for Steady-State - One - Two and Three - Dimensional Diffusion Problems – Parabolic Equations – Explicit - Implicit Schemes - Unsteady Heat Conduction on Elliptic and Parabolic Equations - Steady State One-Dimensional Convection and Diffusion – Central - Upwind Differencing Schemes- Hybrid - Power-Law - QUICK Schemes – Properties of Discretization Schemes.		
Unit - IV	**Grid:**	**9**
Grid: Types – Grid Generation – Grid Transformation – Calculation of Flow Field Variable –Staggered Grid –Pressure and Velocity Correction – SIMPLE Algorithm – SIMPLER Algorithm-SIMPLEC Algorithm – PISO Algorithm.		
Unit - V	**Turbulence Models:**	**9**
Turbulence Models: Reynolds Stress Equation Model – Algebraic Stress Model - Turbulence – Effect of Turbulence on Time Averaged Navier Stokes Equation – Characteristics of Simple Turbulent Flow – Flat Plate Boundary Layer – Pipe Flow – Turbulence Models – Mixing Length Model –K-ε Models.		
		Total:45

TEXT BOOK:

1.	Versteeg H. K. & Malalasekera W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", 2nd Edition, Pearson Education Ltd, UK, 2007.

REFERENCES:

1.	Anderson John D., "Computational Fluid Dynamics: Basic with Applications", 1st Edition, Tata McGraw-Hill, India, 2012.
2.	Ghoshdastidar P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw Hill Publishing Company Ltd, India, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	recognize the governing equations and boundary conditions for fluid dynamics.	Applying (K3)
CO2	apply various finite difference method to solve the complex problems.	Applying (K3)
CO3	analyze the convection diffusion problems by the finite volume method.	Analyzing (K4)
CO4	identify the grid generation technique for the flow field variables.	Applying (K3)
CO5	recognize and summarize the various turbulence models and its characteristics	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	1	2							2	3	1
CO2	3	2	3	1	2							2	3	1
CO3	3	2	3	1	2							2	3	1
CO4	3	2	3	1	2							2	3	1
CO5	3	2	3	1	2							2	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	50				100
CAT2	10	20	35	35			100
CAT3	10	20	35	35			100
ESE	10	20	35	35			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE15 - MACHINE VISION AND IMAGE PROCESSING							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**EE**	**3**	**0**	**0**	**3**

Preamble	This course provides the practical knowledge about various components of machine vision systems and image processing techniques.	
Unit – I	**Processing of Information in the Human Visual System:**	**9**
Design and structure of eye– Adaptation to different light level– Rod and Cone Responses. Introduction to Building a Machine Vision Inspection: Specification– Part presentation– Performance requirement– Information interfaces– Installation space– Environment.		
Unit – II	**Designing a Machine Vision System:**	**9**
Camera types– Field view– Resolution: camera sensor resolution, Spatial resolution, Measurement of accuracy, Calculation of resolution, Resolution for a Line Scan Camera - Choice of camera, Frame grabber and hardware platform– Pixel rate– Lens design - digital and smart cameras		
Unit – III	**Lighting System & Camera Computer Interface:**	**9**
Demands on machine vision lighting – Light and light perception – Light sources for machine vision – Light Color and Part Color: Monochromatic light, white light, UV, IR and Polarized light – Light filters. Analog camera buses – Analog video signal - Parallel digital camera buses– Standard PC buses – Computer buses – Digital video transmission – Camera link – Driver software: Application programming interface- Features of machine vision system		
Unit – IV	**Image Processing Algorithms:**	**9**
Introduction to Digital Image Processing - Image sampling and quantization - Image enhancement: Gray Value Transformations, Radiometric Calibration, Image Smoothing– Geometric transformation– Image segmentation– Object Recognition and Image Understanding. Feature extraction: Region Features, Gray Value Features, Contour Features–Morphology–Edge extraction– Fitting. Template matching: Grey value based, Image pyramid matching. Optical Character recognition - Integration of vision sensors, Compact systems and vision controllers.		
Unit – V	**Applications and Case Studies:**	**9**
Diameter inspection of rivets– Tubing inspection – Glue check under UV Light– Completeness check of automotive control component– Multiple position and completeness- Check of small hybrid circuit– Pin type verification– Type and result data management of spark plugs– Robot guidance Diameter inspection of rivets– Tubing inspection – Glue check under UV Light– Completeness check of automotive control component– Multiple position and completeness- Check of small hybrid circuit– Pin type verification– Type and result data management of spark plugs– Robot guidance		
		Total:45

TEXT BOOK:

1.	Alexander Hornberg, "Handbook of Machine Vision", Wiley-VCH, Germany, 2006

REFERENCES:

1.	Davies E.K, "Machine Vision: Theory, Algorithms, Practicalities", 3rd Edition, Elsevier, India, 2005.
2.	Milan Sonka, "Image Processing Analysis and Machine Vision", 2007 Edition, Vikas Publishing House, India, 2007.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	interpret the fundamental concepts of the vision system	Understanding(K2)
CO2	identify the suitable components for designing the machine vision system	Understanding(K2)
CO3	explain the concept of lighting system and various computer interfaces	Understanding(K2)
CO4	infer the concept of image processing techniques	Understanding(K2)
CO5	design the machine vision system for real time manufacturing applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2							2		3
CO2	3	2	1	1	2							2		3
CO3	3	2	1	1	2							2		3
CO4	3	2	1	1	2							2		3
CO5	3	2	1	1	2							2		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	60	20				100
ESE	15	65	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE16 - AUTOMOTIVE POLLUTION CONTROL							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Engines**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on emission standards, formation, measurement and control techniques.	
Unit – I	**Introduction:**	**9**
Atmospheric pollution from automotive engines - Global warming – Green-house effect and effects of engine pollution on environment and human health. Emission Standards and Driving Cycles – Noise pollution.		
Unit – II	**Emission Formation in SI Engines:**	**9**
Formation of HC, CO and NO_X - Evaporative Emission. Effects of engine design and operating variables on emission formation.		
Unit – III	**Emission Formation in CI Engines:**	**9**
Basic of diesel combustion – Formation of HC, CO, NO_X, PM and smoke - Aldehyde emission. Effects of engine design and operating variables on emission formation.		
Unit – IV	**Emission Measurement Techniques:**	**9**
CO and CO_2 NDIR Analyzers – Flame Ionization Detector - Chemiluminescence Analyzer – Smoke meters – Constant Volume Sampler – Particulate Emission measurement and Dilution tunnel, Noise measurement – SLM, ISLM.		
Unit – V	**Emission Control Techniques:**	**9**
Engine Design modifications - Fuel modification - Evaporative emission control – EGR - Air injection - Thermal Reactors - Water Injection - Catalytic converters. Diesel oxidation catalyst - Particulate traps - De-NO_x catalysts - SCR systems – Noise pollution control measures.		
		Total:45

TEXT BOOK:

1.	Ganesan. V., "Internal Combustion Engines", 1st Edition, Tata McGraw Hill Education, Noida, India, 2013.

REFERENCES:

1.	John Heywood., "Internal Combustion Engine Fundamentals", 1st Edition, McGraw Hill Education, New Delhi, 2017.
2.	Pundir.B.P, "IC Engines Combustion and Emission", 1st Edition, Narosa Publishing House, New Delhi, 2010.
3.	

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain the various environmental pollution aspects, issues and standards.	Understanding (K2)
CO2	illustrate the formation of emission from SI Engines.	Applying (K3)
CO3	examine the emission formation from CI Engines.	Applying (K3)
CO4	explain the various measurement techniques for vehicle emission.	Understanding (K2)
CO5	Interpret the various emission control techniques for automotive engines.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	2	3					1	3	
CO2	3	2	2	1	1	2	3					1	3	
CO3	3	2	2	1	1	2	3					1	3	
CO4	3	2	2	1	1	2	3					1	3	
CO5	3	2	2	1	1	2	3					1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	15	65	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE17 - VALUE ENGINEERING							
Programme & Branch	**B.E – AUTOMOBILE ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on value engineering process and its functions within the organization.	
Unit – I	**Introduction:**	**9**
Value engineering concepts – Advantages – Applications - Problem recognition and role in productivity - Criteria for comparison - Element of choice. Level of value engineering in the organization - Size and skill of VE staff - Small plant – Value Engineering activity - Unique and quantitative evaluation of ideas.		
Unit – II	**Value Engineering Job Plan:**	**9**
Introduction - Orientation, information phase, speculation phase, analysis phase. Selection and Evaluation of value engineering Projects - Project selection, methods selection, value standards - Application of value engineering methodology.		
Unit – III	**Analysis Function:**	**9**
Anatomy of the function - Use esteem and exchange values, basic, secondary and unnecessary functions. Approach of function - Evaluation of function - Determining function - Classifying function - Evaluation of costs - Evaluation of worth - Determining worth - Evaluation of value.		
Unit – IV	**Value Engineering Techniques:**	**9**
Selecting products and operation for value engineering action, value engineering programmes, determining and evaluating function(s)assigning rupee equivalents, developing alternate means to required functions, decision making for optimum alternative, use of decision matrix, queuing theory and Monte Carlo method make or buy, measuring profits, reporting results, follow up, Use of advanced technique like Function Analysis System.		
Unit – V	**Versatility of Value Engineering:**	**9**
Value engineering operation in maintenance and repair activities, value engineering in non-hardware projects. Initiating a value engineering programme Introduction, training plan, career development for value engineering specialties. Fast diagramming: cost models, life cycle costs.		
		Total:45

TEXT BOOK:

1.	Anil Kumar Mukhopadhyaya., “Value Engineering: Concepts Techniques and applications”, 1st Edition, SAGE Publications 2010.

REFERENCES:

1.	Del L. Younker., “Value Engineering analysis and methodology”, 1st Edition, CRC Press, 2004.
2.	Richard Park., “Value Engineering: A Plan for Invention”, 1st Edition, Routledge, New York, 1999.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe value engineering concepts and their importance in an organization.	Understanding (K2)
CO2	explain the value engineering plan for a product.	Understanding (K2)
CO3	estimate product costs based on value engineering principles in terms of their values, functions and worthiness.	Understanding (K2)
CO4	summarize and select appropriate methods, standards and apply them to a value engineering project	Applying (K3))
CO5	discuss querying theory and FAST to perfect a value engineering project implementation.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1			2	2				2	1	2	2
CO2	3	2	1			2	2				2	1	2	2
CO3	3	2	1			2	2				2	1	2	2
CO4	3	2	1			2	2				2	1	2	2
CO5	3	2	1			2	2				2	1	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	45	35				100
ESE	15	70	15				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE18 - AUTOMOTIVE NOISE, VIBRATION AND HARSHNESS							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge about vehicle noise, vibration and harshness.	
Unit - I	**Introduction:**	**9**
Basics of sound propagation - Quantification of sound - Noise sources - Pass-by and stationary noise limits -Automotive NVH sources - Interior noise of vehicles - Sound quality - Ride comfort - Noise and vibration control in vehicles.		
Unit - II	**Transducers and Measurement:**	**9**
Transducers and exciters - Sound pressure - Intensity and power measurement -Sound level meters - Noise dosimeters - Analyzers and signal generators - Equipment for data acquisition and digital signal processing - Calibration of measurement microphones - Calibration of shock and vibration transducers - Metrology and traceability of vibration and shock measurements.		
Unit - III	**Noise Source Identification:**	**9**
Frequency and order domain analysis - Sound intensity and sound power mapping. Introduction to array techniques - Acoustic holography and beam forming - Standard methods for evaluating sound absorption coefficient and transmission loss - Types of sound absorbers - Prediction of transmission loss and flanking transmission - Damping materials and their applications.		
Unit - IV	**Passive Noise Treatments:**	**9**
Ducts and Mufflers - Types of mufflers - Performance parameters - Acoustics and backpressure - Reactive and absorptive silencers - Overall design considerations - Acoustic material characterization - Sound transmission - Absorption and damping - Behaviour of acoustic material with respect to sound absorption and transmission.		
Unit - V	**Interior Noise and Modal Analysis:**	**9**
Interior noise sources - Structure borne noise - Airborne noise, Refinement techniques and sound insulation - Definition of modal properties - Modal analysis theory - FEM and experimental modal analysis - Applications of modal analysis.		
		Total:45

TEXT BOOK:

1.	Xu Wang., "Vehicle Noise and Vibration Refinement", 1st Edition, Woodhead Publishing, Cambridge, United Kingdom, 2016.

REFERENCES:

1.	M.Harrison., "Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles", Society of Automotive Engineers, 2004.
2.	C.W. de Silva., "Vibration Monitoring, Testing, and Instrumentation", 1st Edition, CRC Press, United States, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain basics of noise, vibration and its limits.	Understanding (K2)
CO2	illustrate about the measurement techniques of sound and vibration.	Understanding (K2)
CO3	discuss various sound identification techniques.	Understanding (K2)
CO4	summarize various noise treatment techniques.	Understanding (K2)
CO5	predict modal analysis theory and its applications.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2					2					1	3	
CO2	3	2					2					1	3	
CO3	3	2					2					1	3	
CO4	3	2					2					1	3	
CO5	3	2					2					1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	65	15				100
ESE	15	70	15				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEE01 - FUNDAMENTALS OF RESEARCH							
(Common to All BE/BTech branches)							
Programme & Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**GE**	**3**	**0**	**0**	**3**
Preamble	This course familiarizes the fundamental concepts/techniques adopted in research, problem formulation and also disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.						
Unit – I	**Introduction to Research**						**9**
Introduction to Research: Types and Process of Research - Outcomes of Research - Sources of Research Problem - Characteristics of a Good Research Problem - Errors in Selecting a Research Problem - Importance of Keywords.							
Unit – II	**Literature Review**						**9**
Literature Review: Literature Collection - Methods - Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.							
Unit – III	**Research Methodology**						**9**
Research Methodology: Appropriate Choice of Algorithms/Methodologies/Methods – Data Collection – Primary Data Analysis – Experimental Methods and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations.							
Unit – IV	**Journals and Papers**						**9**
Journals and Papers: Journals in Science/Engineering - Indexing and Impact factor of Journals. Plagiarism and Research Ethics. Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study.							
Unit – V	**Reports and Presentations**						**9**
How to Write a Report - Language and Style - Format of Project Report - Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc - Different Reference Formats. Presentation using PPTs. Research Tools.							
							Total:45

TEXT BOOK:

1.	Walliman, Nicholas. “Research Methods: The basics”. 2nd edition, Routledge, 2017., for Units I, II, III, IV & V

REFERENCES:

1.	Mishra, S.B. and Alok, S. “Handbook of research methodology” Educreation Publishing, 2017
2.	Kumar, Ranjit. “Research Methodology: A step-by-step guide for beginners”. SAGE Publications Limited, 2019.
3.	Nayak, J.K. and Singh, P. “Fundamentals of Research Methodology Problems and Prospects”. SSDN Publishers & Distributors, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	list the various stages in research and categorize the quality of journals	Applying (K3)
CO2	formulate a research problem from published literature/journal papers	Evaluating (K5)
CO3	write, present a journal paper/ project report in proper format	Creating (K6)
CO4	select suitable journal and submit a research paper	Applying (K3)
CO5	compile a research report and the presentation	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	1	1	3	3	1	1	3	3	3
CO2	3	3	3	3	2	1	1	3	3	3	3	3	3	3
CO3	3	3	3	3	3	1	1	3	3	3	1	3	3	3
CO4	3	2	1	1	2	1	1	3	2	1	1	3	3	3
CO5	3	3	2	2	3	1	1	3	3	3	1	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		40	50	10			100
CAT2		30	50	10	10		100
CAT3		20	30	30	10	10	100
ESE		40	40	10	10		100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE19 - AUTOMOTIVE HVAC							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Thermal Engineering and Heat Transfer**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on automotive air-conditioning components, controls, fault diagnostics, servicing and repairing.	
Unit - I	**Air-conditioning Fundamentals:**	**9**
Heating and ventilation system – Basic theory of cooling – Vapour compression refrigeration – Alternative cycles – Air conditioning system – Expansion valve system – Fixed orifice valve system – Dual air conditioning.		
Unit - II	**Air Conditioning Components:**	**9**
Compressor – Types of compressor – Condenser – Types of condenser - Receiver drier and accumulator – Expansion valve and fixed orifice valve – Evaporator – Anti-frosting devices – Basic control switches.		
Unit - III	**Electrical and Electronics control**:	**9**
Electrical principles – Sensors and actuators – Testing sensors and actuators – Oscilloscope waveform sampling – Multiplex wiring systems – On Board Diagnostics.		
Unit - IV	**Diagnostics and Troubleshooting:**	**9**
Initial vehicle inspection – Temperature measurements – Pressure gauge reading – Cycle testing – Air-conditioning system leak testing – Sight glass.		
Unit - V	**Air Conditioning Service and Repair:**	**9**
Servicing precautions – Refrigerant: recovery, recycle and charging - System oil – System flushing – Odour removal – Retrofitting – Replacement and adjustment of compressor components – Fixed orifice valve remove and replace.		
		Total:45

TEXT BOOK:

1.	Steven Daly., "Automotive Air Conditioning and Climate Control Systems", 1st Edition, Butterworth-Heinemann, India, 2006.

REFERENCES:

1.	James D. Halderman., "Automotive Heating and Air Conditioning", 7th Edition, Pearson Prentice Hall, 2014.
2.	R.J. Dossat., "Principles of Refrigeration", 5th Edition, Prentice Hall, New Jersey, 2001.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	illustrate the basic principles of heating, ventilation and air-conditioning system.	Understanding (K2)
CO2	design the basic components of an air conditioning systems.	Applying (K3)
CO3	outline the electrical and electronic components present in air-conditioning system.	Understanding (K2)
CO4	demonstrate the troubleshooting procedure of air-conditioning system.	Applying (K3)
CO5	explain the air-conditioning service and repairing procedure.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1			1	2					2	3	2
CO2	3	3	1			1	2					2	3	2
CO3	3	3	1			1	2					2	3	2
CO4	3	3	1			1	2					2	3	2
CO5	3	3	1			1	2					2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	60	20				100
CAT3	20	45	35				100
ESE	15	50	35				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE20 - AUTONOMOUS VEHICLE TECHNOLOGY							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	To acquire knowledge on the concept of automated driving techniques and the contribution of artificial intelligence with case studies of an autonomous vehicle.	
Unit – I	**Safety in Automated Driving:**	**9**
Introduction to ADV - Safety - Vehicle and its occupants – External People and Property - Service and Repair - IMI TechSafe.		
Unit – II	**Advanced Driver Assistance Systems:**	**9**
Introduction to ADAS - Example systems - Adaptive Cruise Control - Obstacle Avoidance Radar - Basic Reversing Aid – Radar - Stereo Video Camera - Rear radar - Functional safety and risk.		
Unit – III	**Automated Driving Technologies:**	**9**
The road to autonomy – Perception - Lidar Operation - Sensor Positioning - Automated Driving System – Mapping - Other Technologies – Connectivity.		
Unit – IV	**Artificial Intelligence:**	**9**
History of AI - Top-down and bottom-up AI - Deep learning - End to End Machine Learning - Object Recognition Simplified Example - Social and Human Issues - Public reaction to Connected and autonomous vehicle – Insurance - Mobility.		
Unit – V	**Case Studies:**	**9**
Nvidia – Bosch - Google (Waymo) - Tesla Autopilot – Audi - Jaguar Land Rover - Toyota Guardian – FLIR - First sensor AG.		
		Total:45

TEXT BOOK:

1.	Tom Denton., "Automated Driving and Driver Assistance Systems", 1st Edition, Routledge, Taylor & Francis Group, UK, 2020.

REFERENCES:

1.	Maurer, Markus, J. Christian Gerdes, Barbara Lenz, and Hermann Winner., “Autonomous Driving: Technical, Legal and Social Aspects” Springer Nature, 2016.
2.	Coppola, Pierluigi, and Domokos Esztergár-Kiss., “Autonomous Vehicles and Future Mobility”, Elsevier, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the safety aspects of autonomous vehicles.	Understanding (K2)
CO2	describe advanced driver assistance systems for autonomous vehicles.	Understanding (K2)
CO3	illustrate automated driving technologies with sensor positioning.	Applying (K3)
CO4	apply the artificial intelligence techniques to autonomous vehicles.	Applying (K3)
CO5	analyse the specifications of autonomous vehicles from various manufacturers.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	1	2	2					3	2	3
CO2	3	3	2	1	1	2	2					3	2	3
CO3	3	3	2	1	1	2	2					3	2	3
CO4	3	3	2	1	1	2	2					3	2	3
CO5	3	3	2	1	1	2	2					3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	30	50				100
CAT3	10	20	35	35			100
ESE	10	40	35	15			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEE02 total quality management

22AUE22 - DESIGN OF ENGINE COMPONENTS (Use of PSG Design Data book is permitted)							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Mechanics of Deformable Bodies**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge to design and analyze Internal Combustion Engine components.	
Unit - I	**Cylinder and Piston:**	**9**
Material for cylinder and piston - Design considerations. Design - cylinder, piston, piston pin and piston rings. Piston failures - Lubrication of piston assembly.		
Unit - II	**Connecting Rod:**	**9**
Euler's - Rankine's formula for columns - Johnson formula. Material used - Design considerations. Determining minimum length of connecting rod. Design - Small end, shank, big end and cap bolts.		
Unit - III	**Crankshaft:**	**9**
Balancing of I.C. engines - Significance of firing order - Material used - Design of crankshaft under bending and twisting - Balancing weight calculations - Development of short and long crank arms - Front and rear-end details.		
Unit - IV	**Flywheels:**	**9**
Turning moment diagram - Mass of flywheel - Coefficient of fluctuation – Speed – Energy - Stresses on the rim - Design of hubs and arms.		
Unit - V	**Camshaft, Valve and Valve Train:**	**9**
Design - Cam, camshaft, cam profile generation, rocker arm, pushrods, tappets, inlet and exhaust valves and valve springs.		
		Total:45

TEXT BOOK:

1.	Khurmi R.S. & Gupta J.K., "A Text Book of Machine Design", 14th Edition, Eurasia Publishing House Pvt. Ltd, 2005.

REFERENCES:

1.	Giri N.K., "Automobile Mechanics", 1st Edition, Khanna Publications, New Delhi, 2014.
2.	Jain R.K., "Machine Design", 2nd Edition, Khanna Publications, New Delhi, 2005.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	design engine cylinder, piston and gudgeon pin.	Applying (K3)
CO2	calculate various forces acting on connecting rod.	Applying (K3)
CO3	design of crankshaft for multi cylinder IC engine.	Applying (K3)
CO4	design of flywheel for slow speed IC engine.	Applying (K3)
CO5	design of camshaft, valve and valve train components.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2								2	3	
CO2	3	3	2	2								2	3	
CO3	3	3	2	2								2	3	
CO4	3	3	2	2								2	3	
CO5	3	3	2	2								2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	15	70				100
CAT2	15	15	70				100
CAT3	15	15	70				100
ESE	5	10	85				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE23 – MOBILE ROBOTICS							
Programme & Branch	**B.E. & Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Mechanics of Machines, Automotive Control System**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course enables to grasp the knowledge on different kinds of mobile robots and their design, architecture, manufacture and structural disposition.	
Unit – I	**Introduction to Mobile Robots:**	**9**
Types of mobile robots: Automated Guided vehicles (AGVs)- Service robots - Cleaning robots – Social robots – Field robots – Inspection and exploration robots - Humanoid robots – Nuclear robots – Underwater robots - Autonomous surface vessels - Applications of mobile robots.		
Unit – II	**Mobile Robot Engineering:**	**9**
Mobile robot subsystems – Fundamentals of wheeled and legged mobile robot - Kinematics models of mobile robots: Kinematic models and constraints – Hilare mobile robots – Car-like mobile robots – Mobile robot maneuverability - Mobile robot workspace-Motion control.		
Unit – III	**Locomotion:**	**9**
Introduction - Legged mobile robots - Leg configurations and stability - Examples of legged robot locomotion - Wheeled mobile robots - Wheeled locomotion: Design space-Case studies.		
Unit – IV	**Perception and Localization:**	**9**
Sensors for mobile robots – Representing uncertainty - Feature extraction - Mobile robot localization - Challenge of localization: Noise and Aliasing - Map representation - Probabilistic map-based localization - Probabilistic map-based localization.		
Unit – V	**Planning and Navigation:**	**9**
Introduction- Competences for navigation- Planning and Reacting- Navigation architectures- Modularity for code reuse and sharing- Control localization- Techniques for decomposition- Case studies: Tiered robot architectures.		
		Total:45

TEXT BOOK:

1.	Roland Siegwart, Illah Reza Nourbakhsh & Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", 2nd Edition, MIT Press, United Kingdom, 2011.

REFERENCES:

1.	Farbed Fahimi, "Autonomous Robots – Modeling, Path Planning and Control", Springer, Switzerland, 2009.
2.	Alonzo Kelly, "Mobile Robotics: Mathematics, Models and Methods", Cambridge University Press, United Kingdom, 2013.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	identify various domains for robotic systems applications	Understanding (K2)
CO2	develop kinematic model of mobile robots	Applying (K3)
CO3	analyze different concepts of locomotion	Applying (K3)
CO4	select the sensory devices for localization	Understanding (K2)
CO5	apply the concepts of planning and navigation	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2							2	3	3
CO2	3	3	3	3	2							2	3	3
CO3	3	3	3	3	2							2	3	3
CO4	3	3	3	3	2							2	3	3
CO5	3	3	3	3	2							2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	15	15	70				100
CAT3	20	45	35				100
ESE	15	35	50				100

* ±3% may be varied (CAT 1 & 2 – 60 marks & ESE – 100 marks)

22AUE24 - AUTOMOTIVE VEHICLE SAFETY							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge to understand the various safety systems in automobile.	
Unit - I	**Introduction:**	**9**
Definitions - Driving Forces for Increased Vehicle Safety - Safety Legislation - Accident Data. Accident Avoidance - Human Factors, Comfort and Ergonomics, Acceleration and Braking and Information Systems.		
Unit - II	**Biomechanics and Occupant Simulation:**	**9**
Injury Tolerance Limits - External Injuries - Internal Injuries – Concussion, spinal Injuries and chest Injuries. Criteria in the Rule-Making Process - Head Protection, chest Protection, Neck Injury and performance Criteria for the Rule-Making Process. Test Devices - Body Part Test Devices, Three-Dimensional Dummies and Human and Dummy Modeling.		
Unit - III	**Vehicle Body and Simulation Tests:**	**9**
Low-Speed Impact - Quasi-Static Test Requirement - Seat and Seat-Belt Anchorage Point Tests, Roof Strength and Vehicle Side Structure. Frontal Collisions - Pole Test, frontal Car-to-Car Crash and design Requirements of Frontal Collisions. Lateral Collisions - Rear-End Collisions – Rollover.		
Unit - IV	**Occupant Protection and Interrelationships:**	**9**
Vehicle Compartment - Restraint Systems - Seat Belts - Airbags - Frontal Impacts, side Protection, additional Airbag and sensors for Restraint Systems - Child Restraints. Frontal Impacts - Unrestrained occupant, seat-belt clamping device, mechanical pretensioner, pyrotechnic pretensioner and seat-belt load limiter. Passive Restraints - Test Results for Different - Analysis for Lateral Collisions - Thorax Side Airbags - Side Head Protection Airbags - Analysis for Rear-End Collisions and Rollover Protection.		
Unit - V	**Pedestrian Protection and Computer Aid in Safety:**	**9**
European NCAP-Test - Legislation Activities - Solutions for Vehicles in Accidents. Numeric Tools - Calculation of Components, Total Vehicle Crash Computation, occupant and Restraint System Simulation and Pedestrian Simulation Tests.		
		Total:45

TEXT BOOK:

1.	Ulrich Seiffert and Lothar Wech., " Automotive Safety Handbook", 2nd Edition, SAE International, 2007.

REFERENCES:

1.	Mark Gonter and Ulrich Seiffert., "Integrated Automotive Safety Handbook", 1st Edition, SAE Publication, Warrendale, Pennsylvania, USA, 2014.
2.	George A. Peters and Barbara J. Peters., "Automotive Vehicle Safety", 1st Edition, CRC Press, London, 2019.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain the basic concepts of vehicle safety.	Understanding (K2)
CO2	illustrate about the biomechanics and occupation simulation process.	Understanding (K2)
CO3	summarize the vehicle body and simulation tests requirement.	Understanding (K2)
CO4	describe about the occupant protection and interrelationships of various parameters.	Applying (K3)
CO5	discuss the pedestrian protection and computer simulations in safety tests.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				2	2					2	3	1
CO2	3	2				2	2					2	3	1
CO3	3	2				2	2					2	3	1
CO4	3	2				2	2					2	3	1
CO5	3	2				2	2					2	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	85					100
CAT2	15	85					100
CAT3	15	50	35				100
ESE	10	60	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE25 - NON DESTRUCTIVE EVALUATION TECHNIQUES							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides an introduction to non-destructive evaluation testing, in-depth studies on different types of non-destructive testing equipment and appropriate selection of testing techniques based on nature of defect.	
Unit - I	**Introduction and Liquid Penetrant Testing:**	**9**
Introduction and Liquid Penetrant Testing: Non-Destructive Testing (NDT) and its importance - NDT vs Destructive Testing - Preparation of test materials - Visual Examination - Basic Principles - Optical aids and Applications. Liquid Penetrant - Principles - Procedure for Penetrant testing - Light sources and special lighting - Calibration - Penetrant testing methods - Post emulsification - Developers - Properties of liquid penetrant - Sensitivity - Applications and Limitations - Standards.		
Unit - II	**Magnetic Particle Testing:**	**9**
Magnetic Particle Testing: Principles - Theory of magnetism - Characteristics of magnetic field - Magnetizing techniques - Circular and longitudinal magnetization techniques - Procedures - Equipment calibration - Sensitivity - Principles and methods of demagnetization - Residual magnetism - Applications and Limitations - Standards - Case studies.		
Unit - III	**Ultrasonic Testing:**	**9**
Ultrasonic Testing: Properties of sound beam - Transducers - Inspection methods - Techniques for normal and angle beam inspection - Flaw characterization - Equipment - Methods of display - A Scan - B Scan - C Scan - Immersion testing - Calibration - Advanced Ultrasonic Testing Methods - Phased Array Ultrasonic Testing (PAUT) & Time of Fight Diffraction (TOFD) - Standards - Application - Advantages and Limitations.		
Unit - IV	**Radiography:**	**9**
Radiography: Electromagnetic radiation sources - X-ray production - Gamma ray sources - Properties - Radiation - Attenuation and Effects in film - Exposure charts - Radiographic imaging - Inspection techniques - Image Quality Indicators (IQI) - Applications and Limitations - Safety in industrial radiography -Neuron radiography - Standards - Case studies.		
Unit - V	**Eddy Current and Selection of NDT Methods:**	**9**
Eddy Current and Selection of NDT Methods: Eddy Current: Principles - Instrumentation - Techniques - Probe - Sensitivity - Advanced Test Methods - Applications & Limitations - Standards - Other Techniques - Acoustic Emission Testing - Principle - Techniques - Instrumentation - Applications and Standards - Homography Thermography - Principle - Equipments - Techniques - Applications and Standards - Leak testing methods - Detection and Standards. Selection of NDT Methods: Defects in material - Selection of NDT method and Instrumentation - Case studies.		
		Total:45

TEXT BOOK:

1.	Baldev Raj, Jayakumar T. & Thavasimuthu M., "Practical Non Destructive Testing", 3rd Edition, Narosa Publishing House, New Delhi, 2019.

REFERENCES:

1.	Hull Barry & John Vernon., "Non Destructive Testing", 3rd Edition, Macmillan, London, 2015.
2.	Hellier C., "Handbook of Non-Destructive Evaluation", 2nd Edition, McGraw-Hill Professional, New Delhi, 2012.
3.	Shull Peter J., "Non Destructive Evaluation: Theory -Techniques and Applications", Marcel Dekkar Inc., New York, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	depict the importance of non-destructive testing methods and impart knowledge on liquid penetrant and visual inspection methods.	Understanding (K2)
CO2	explain liquid penetrant and magnetic particle testing methods.	Understanding (K2)
CO3	illustrate the principle of ultrasonic testing and its modern methods.	Understanding (K2)
CO4	describe radiographic principles and test for material defects.	Understanding (K2)
CO5	discuss other non-destructive testing techniques and select an appropriate method for defect identification.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1									3	
CO2	3	2	1	1									3	
CO3	3	2	1	1									3	
CO4	3	2	1	1									3	
CO5	3	2	1	1									3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	15	85					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE26 - QUALITY ASSURANCE AND RELIABILITY							
(Use of Quality Control Chart is Permitted for ESE)							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on quality and the reliability concepts of various products.	
Unit - I	**Introduction and Process Control for Variables:**	**9**
Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality Cost-Variation in process- factors – process capability – process capability studies and simple problems – Theory of control chart- uses of control chart – Control chart for variables – X chart, R chart and S chart.		
Unit - II	**Process Control for Attributes:**	**9**
Control chart for attributes –control chart for proportion or fraction defectives – p chart and np chart – control chart for defects – C and U charts, State of control and process out of control identification in charts.		
Unit - III	**Acceptance Sampling:**	**9**
Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans.		
Unit - IV	**Life Testing - Reliability:**	**9**
Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.		
Unit - V	**Quality and Reliability:**	**9**
Reliability improvements – techniques - Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development –Product life cycles.		
		Total:45

TEXT BOOK:

1.	Douglas C. Montgomery., "Introduction to Statistical Quality Control", 8th Edition, John Wiley and Sons Inc, New York, 2019 for Units I,II,III.
2.	Singiresu S. Rao., "Reliability Engineering", 1st Edition, Pearson Education India, New Delhi, 2016 for Units IV,V.

REFERENCES:

1.	Amitava Mitra., "Fundamentals of Quality Control and Improvement", 4th Edition, Wiley, 2016.
2.	Besterfield D.H., "Quality Improvement", 9th Edition, Pearson, 2012.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	compute and manage variables with quality assurance and process charts.	Applying (K3)
CO2	utilize the process charts for attributes and out of control processes.	Applying (K3)
CO3	evaluate the acceptance sampling methods and their impacts on producer's and consumer's risk.	Applying (K3)
CO4	compute reliability data analysis and get acquainted with various reliability prediction and evolution methods.	Applying (K3)
CO5	explain the fundamentals of reliability management and risk assessment.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		2							1	3	
CO2	3	3	2		2							1	3	
CO3	3	3	2		2							1	3	
CO4	3	3	2		2							1	3	
CO5	3	3	2		2							1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	15	70				100
CAT2	15	15	70				100
CAT3	15	50	35				100
ESE	10	25	65				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE27 - ADVANCED MATERIALS FOR GREEN VEHICLES							
Programme & Branch	**B.E. & Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on green composite materials for automotive components.	
Unit – I	**Introduction:**	**9**
Composite materials - Foam cored steel composite box beams - Plastic moldings for open canopy shells - Reaction injection molding – Resin transfer molding – Sheet Molding compounds - Ultra light weight construction - Case study		
Unit – II	**Green composite materials from liquefied biomass:**	**9**
Introduction - Liquefaction technique - Foams- Polyurethane foams (PUFs) from liquefied lingo cellulosic - Phenolic foam from liquefied lignocelluloses - Molding materials - Liquefied wood as replacement in novolac - type resin - based composites - Epoxy – Type of resins from liquefied biomass.		
Unit – III	**Green Fibers:**	**9**
Introduction – Kenaf, Hemp and Flax fibers - Advantages and limitation - Mechanical properties and comparison with Glass fiber – Limitation - Binders used - Thermal resistance and chemical resistance.		
Unit – IV	**Biodegradable Polymer Matrix:**	**9**
Poly-lactic acid (PLA) – Synthesis mechanical properties - Thermal and creep properties - Compression and injection molding - Factors Influencing Processing of Green Composite - Performance of Green Composite.		
Unit – V	**Design of Green Bio-Composites:**	**9**
Basics of green composite design - Failure Prediction in a Unidirectional Lamina - Maximum Stress Theory - Maximum Strain Theory - Tsai-Wu Failure Theory - Failure Prediction in Random Fiber Laminates - Testing of Bio-Composites – Tensile and Impact.		
		Total:45

TEXT BOOK:

1.	Srikanth Pilla, Charles Lu., “Bio composites in Automotive Applications”, 2nd Edition, SAE International, 2015.

REFERENCES:

1.	Amar K. Mohanty, Manjusri Misra., “Natural Fibers, Biopolymers, and Bio composites”, 2nd Edition, CRC Taylor and Francis, 2005
2.	Georgios Koronis, Arlindo Silva., “Green Composites for Automotive Applications”, 1st Edition, Woodhead Publishing Limited, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe about various advanced composite materials for automotive industry.	Understanding (K2)
CO2	execute the making of green composite materials from liquefied biomass.	Applying (K3)
CO3	develop the manufacturing methods and characteristics of green fibers.	Applying (K3)
CO4	determine the properties, process and usage of biodegradable materials.	Applying (K3)
CO5	evaluate the mechanical properties of green bio-composite materials.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	1	1		1	2					2	3	
CO2	3	3	1	1		1	2					2	3	
CO3	3	3	1	1		1	2					2	3	
CO4	3	3	1	1		1	2					2	3	
CO5	3	3	1	1		1	2					2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	10	55	35				100
CAT3	10	55	35				100
ESE	10	40	50				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE28 - AUTOMOTIVE TESTING							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Engines and Automotive Chassis**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on various testing methods for automobile.	
Unit – I	**Wind Tunnel Test:**	**9**
Test requirements – Ground boundary simulation - Wind tunnel selection and Reynolds number capability, model requirements - Model details - Model mounting – Test procedure. Crash test – Types.		
Unit – II	**Ride Vibration and Body Test:**	**9**
Vibration measurement instrument – Accelerometer and signal conditioning, graphical presentation - Dynamic simulation sled testing, methodology, vehicle acceleration measurement and documentation - Crash test – Dolly roll over test, dolly role over fixture, photographic / video coverage, instrumentation - Vehicle roof strength test – Test procedure and test measurements - Door system crush test – Procedure and measurements.		
Unit – III	**Fuel Consumption Test:**	**9**
Test route selection - Vehicle test speeds - Cargo weights - Driver selection - Test data form - Calculations. Test on rough terrain, pot holes with laden and unladen conditions.		
Unit – IV	**Suspension and Stability for Directional Control:**	**9**
Dimensional and geometric characteristics - Centre of gravity position, moments and products of inertia. Suspension kinematic characteristics - Elastic and coulomb friction characteristics - Shock absorber characteristics.		
Unit – V	**Steering Control Test:**	**9**
Analysis of constant radius test - Constant steer angle test - Constant speed variable radius test - Constant speed variable steer angle test - Response gain test.		
		Total:45

TEXT BOOK:

1.	Crouse W.H. and Anglin D.L., “Automotive Mechanics”, Tata McGraw Hill Publishers, New Delhi, 2004 for Units I,II.
2.	Rangan, Mani and Sharma., “Instrumentation”, Tata McGraw Hill Publishers, New Delhi, 2004 for Units III,IV,V.

REFERENCES:

1.	SAE Hand book., Vol. 3, SAE Publications, 2000.
2.	Babu, A.K., “Automobile Mechanics”, Khanna Publishing House, Delhi.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the aero foil vehicle model by wind tunnel test.	Understanding (K2)
CO2	explain the testing procedure of vehicle body elements in improving the ride vibration.	Understanding (K2)
CO3	examine the fuel consumption by road rest procedure for various driving cycles.	Applying (K3)
CO4	illustrate the suspension system test procedure.	Applying (K3)
CO5	determine the steering system test procedure.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	2	2	1					1	3	
CO2	3	3	1	1	2	2	1					1	3	
CO3	3	3	1	1	2	2	1					1	3	
CO4	3	3	1	1	2	2	1					1	3	
CO5	3	3	1	1	2	2	1					1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	60	20				100
CAT3	20	40	40				100
ESE	15	50	35				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE29 - ALTERNATE ENERGY SOURCES FOR AUTOMOBILES							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Engines**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with alternate fuels for automobile engines.	
Unit – I	**Introduction:**	**9**
Energy scenario in India - Energy and Environment Overview - Importance of Alternate Energy sources - Availability of Alternate Energy Sources for SI and CI Engines - Emission standards and measuring techniques.		
Unit – II	**Biodiesel:**	**9**
Availability of vegetable oils - Non-edible oils as biodiesel - Blending, Emulsification, Preheating and transesterification - Effect of vegetable oils physical and chemical characteristics on biodiesel properties - Estimation of Physical and chemical properties - Performance, Emission and Combustion Characteristics in diesel engines.		
Unit – III	**Alcohol Fuel:**	**9**
Production methods of alcohols - Production of alcohol from biomass - Properties of alcohols as fuels - Methods of using alcohols in CI and SI engines - Blending, dual fuel operation, fumigation, surface ignition and oxygenated additives - Performance, emission and combustion characteristics in CI and SI engines.		
Unit – IV	**Gaseous Fuels:**	**9**
Production methods of Biogas, NG, CNG and LPG - Biogas Digester – Reactions - Viability - Economics - Physical and chemical properties - Modification required in SI and CI Engines - Performance and emission characteristics of Biogas, NG and LPG in SI and CI engines.		
Unit – V	**Hydrogen Fuel:**	**9**
Properties and Production of Hydrogen – Storage – Advantages and Disadvantages of Hydrogen – Hydrogen in SI and CI Engines – Hazards and Safety Systems – Combustion and emission characteristics. Fuel cell vehicles.		
		Total:45

TEXT BOOK:

1.	Richard Folkson.,“Alternative Fuels and Advanced Vehicle Technologies for Improved Environmental Performance”, Woodhead Publishing Ltd, 2014.

REFERENCES:

1.	Gerhard Knothe, Jon Van Gerpen and Jargon Krahl., "The Biodiesel Handbook”, 2nd Edition, AOCS Press Champaign, Illinois, 2015.
2.	Ganesan V., "Internal Combustion Engines", 4th Edition, McGraw Hill Education, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the need of alternate fuels for automobiles.	Understanding (K2)
CO2	infer the properties, combustion and emission characteristics of biodiesel blends.	Analyzing (K4)
CO3	evaluate the properties, combustion and emission characteristics of alcohol blends.	Analyzing (K4)
CO4	analyze the performance and emission characteristics of different gaseous fuels.	Analyzing (K4)
CO5	investigate the performance and emission characteristics of hydrogen addition.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2		1	3					2	3	
CO2	3	3	2	2		1	3					2	3	
CO3	3	3	2	2		1	3					2	3	
CO4	3	3	2	2		1	3					2	3	
CO5	3	3	2	2		1	3					2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	60	15	15			100
CAT2	10	45	30	15			100
CAT3	10	45	30	15			100
ESE	10	45	15	30			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE30 - ROAD TRANSPORT MANAGEMENT							
Programme & Branch	**B.E – AUTOMOBILE ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**PE**	**3**	**0**	**0**	**3**
Preamble	This course provides knowledge on motor vehicle act, vehicle taxation, vehicle insurance and transport operation structure.						
Unit – I	**Introduction:**						**9**
Personnel management - Objectives and functions – Psychology -Sociology and their relevance to organization. Drivers and conductors: Job description -Employment tests – Interviewing - Training procedure and psychological tests.							
Unit – II	**Motor Vehicle Act:**						**9**
Laws governing to use of motor vehicle & vehicle transport - Traffic rules and signs - Licensing of drivers & conductors - Responsibility of driver. Accidents - Causes & analysis. Rules regarding construction of motor vehicles - Registration of vehicle - State and interstate permits - Liabilities and preventive measures - Offenses and penalties - Different types of forms - Government motor vehicle administration structure.							
Unit – III	**Taxation and Insurance:**						**9**
Objectives - Structure and methods of levying taxation - Onetime tax - Tax exemption - Tax renewal and online tax payment. Insurance: Insurance types - Significance and renewal- Furnishing particulars of vehicles involved in an accident - Duty of driver in case of an accident -Hit and Run case -Surveyor and loss assessor - surveyor's report -Motor Accident Claims Tribunal -Solatium Fund.							
Unit – IV	**Transport Operation:**						**9**
Structure of passenger transport organizations - Depot layouts and requirements -Route planning - Scheduling of passenger transport vehicles - Preparation of timetable and fare structure - Methods of fare collection - Structure of goods transport organizations - Scheduling of goods transport vehicles - Management Information System (MIS) in goods transport operation - Storage & transportation of petroleum products -Operation cost, revenues and records.							
Unit – V	**Maintenance Management:**						**9**
Service advisor - Roles and Responsibilities - Job card and service record preparation - Trial run to understand customer complaints - Time and cost analysis for repair works - Precautions before carrying out repair works -Training procedure for mechanic - Inventory control in stores - Customer longue requirements - Customer feedback systems - Workshop Maintenance software.							
							Total:45

TEXT BOOK:

1.	"Motor Vehicle Act"., Govt. of India Publications.

REFERENCES:

1.	Santosh Sharma., "Productivity in Road Transport", 2nd Edition, Association of State Road Transport Undertakings, New Delhi.
2.	Patankar P G., "Road Passenger Transport in India", CIRT, Pune.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	illustrate interviewing and training procedures for drivers and conductors.	Understanding (K2)
CO2	exemplify public & vehicle issues with the help of motor vehicle act.	Understanding (K2)
CO3	identify appropriate tax and insurance policies for their own vehicle.	Applying (K3)
CO4	analyze the operation costs and revenues of transport operations.	Applying (K3)
CO5	explain the management principles involved in maintenance.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				2	2	1				2	2	1
CO2	3	2				2	2	1				2	2	1
CO3	3	2				2	2	1				2	2	1
CO4	3	2				2	2	1				2	2	1
CO5	3	2				2	2	1				2	2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	45	35				100
CAT3	20	45	35				100
ESE	15	50	35				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE31 - ADVANCED THEORY OF IC ENGINES							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Engines**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	To provide knowledge on advanced SI and CI engines with modifications for using alternate fuels.

Unit – I **Combustion Principles:** **9**

Thermodynamic concept of combustion – Combustion equations, heat of combustion, theoretical flame temperature, adiabatic flame temperature, chemical equilibrium and dissociation. Theories of combustion - Pre-flame reactions, Reaction rates, Laminar and Turbulent flame propagation in engines.

Unit – II **HCCI Combustion Engines:** **9**

Conventional Gasoline Combustion - HCCI techniques in gasoline engines. Conventional Diesel Combustion - Effects of EGR - Diesel HCCI engines - Early Injection, Multiple injections, Narrow angle direct injection (NADI) concept.

Unit – III **Alternate Fuels for HCCI Engines:** **9**

HCCI fuel ignition quality, HCCI fuel Specification and fuel factors. HCCI engines fuels – Natural gas, CNG, methane, n – butane, air mixtures and DME – Combustion characteristics and control phenomena.

Unit – IV **Low Temperature and Premixed Combustion:** **9**

Basic concept, Characteristics of combustion and exhaust emissions, modulated kinetics (MK) combustion – First and Second generation of MK combustion, emission and performance improvement. RCCI combustion and emission.

Unit – V **Alternate Fuels for RCCI Engines:** **9**

RCCI combustion fuel requirement. Alternate Fuels for RCCI Combustion – Gasoline, Methanol and iso butanol, PODE/Diesel blends and Methanol / diesel blends – Engine modifications - Combustion and Emission Characteristics.

Total:45

TEXT BOOK:

1. John B. Heywood., "Internal Combustion Engine Fundamentals", 2nd Edition, McGraw Hill Education, New Delhi, 2017.

REFERENCES:

1. Ganesan V., "Internal Combustion Engines", 4th Edition, McGraw Hill Education, New Delhi, 2017.
2. Patterson D.J. & Henein N.A., "Emissions from combustion engines and their control", Illustrated Edition, Ann Arbor Science Publishers, USA, 1972.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the importance of combustion principles with various characteristics.	Understanding (K2)
CO2	examine the Performance of the homogenous charge compression ignition combustion with various injection techniques.	Applying (K3)
CO3	Interpret the performance of the HCCI engine with alternate fuels used for novel combustion.	Applying (K3)
CO4	Determine the performance and possible outcomes of low temperature and premixed combustion technology.	Applying (K3)
CO5	illustrate the performance of RCCI engine with alternative fuels.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	2	2					1	3	
CO2	3	2	2	1	1	2	2					1	3	
CO3	3	2	2	1	1	2	2					1	3	
CO4	3	2	2	1	1	2	2					1	3	
CO5	3	2	2	1	1	2	2					1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	45	35				100
CAT3	20	45	35				100
ESE	15	35	50				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE32 - AUTOMOTIVE PRODUCT LIFE CYCLE MANAGEMENT							
Programme & Branch	**B.E – AUTOMOBILE ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on automotive product life cycle management.	
Unit – I	**Introduction:**	**9**
E-commerce - Forms of business - Extended enterprise - Concepts in PDM - Product life cycle, business objects, work flows, versions, views, product structure, change processes, work list, information flow model in product development, engineering bill of materials and manufacturing bill of materials.		
Unit – II	**Components of PLM Solutions:**	**9**
Object oriented approach in product development solutions - Phase gate process in product design - Disparate databases and connectivity - EAI technology - Cases for preparation of combined BOM and other reports. Component supplier management and sourcing.		
Unit – III	**Product Visualization:**	**9**
CAD neutral environment and visualization of products - Standard software – Visualization in several stages of lifecycle - Reviews, mark-up - Case studies.		
Unit – IV	**Role of PLM in Industries:**	**9**
Roles in Automotive sectors - Ten step approach to product life cycle management - Benefits of product life cycle management.		
Unit – V	**Details of Module:**	**9**
Details of modules in a PDM/PLM software - Basics on customization and implementation of automotive PDM/PLM software.		
		Total:45

TEXT BOOK:

1.	Stark John., "Product Lifecycle Management (Volume 1)", Springer International Publishing, 2015 for Units I,II.
2.	Stark John., "Product Lifecycle Management (Volume 2)", Springer International Publishing, 2016 for Units III,IV,V.

REFERENCES:

1.	Wang Lihui and Andrew YCN., "Collaborative Design and Planning for Digital Manufacturing", Springer-Verlag London Limited, 2009.
2.	Stark John, "Global Product: Strategy., Product Lifecycle Management and the Billion Customer Question", Springer Publisher, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain PLM in the automotive industry	Understanding (K2)
CO2	describe the components of PLM	Understanding (K2)
CO3	show product visualization using CAD	Applying (K3)
CO4	apply suitable PLM modules to new product development	Understanding (K2)
CO5	summarize the implementation of automotive PDM/PLM software	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				2	2					1	2	2
CO2	3	2				2	2					1	2	2
CO3	3	2			3	2	2					1	2	2
CO4	3	2			1	2	2					1	2	2
CO5	3	2			1	2	2					1	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	60	20				100
CAT3	20	80					100
ESE	15	65	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE33 - PROCESS PLANNING AND COST ESTIMATION							
Programme & Branch	**B.E – AUTOMOBILE ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on various production planning and cost estimation techniques.	
Unit – I	**Work Study and Ergonomics:**	**9**
Method study – Definition – Objectives-Motion economy - Principles – Tools and Techniques- Applications – Work measurements purpose – Use – Procedure – Tools and techniques - Standard time – Ergonomics – Principles – Applications.		
Unit – II	**Process Planning:**	**9**
Definition – Objective – Scope – Approaches to process planning - Process planning activities – Finished part requirements- Operating sequences - Machine selection – Material selection parameters -Set of documents for process planning - Developing manufacturing logic and knowledge - Production time calculation – Selection of cost optimal processes.		
Unit – III	**Introduction to Cost Estimation:**	**9**
Objective of cost estimation - Costing – Cost accounting - Classification of cost- Elements of cost.		
Unit – IV	**Cost Estimation:**	**9**
Types of estimates – Methods of estimates – Data requirements and sources - Collection of cost - Allowances in estimation.		
Unit – V	**Production Cost Estimation:**	**9**
Estimation of material cost - Labours cost and Over heads cost - Allocation of overheads – Estimation for different types of jobs.		
		Total:45

TEXT BOOK:

1.	Kesavan.R, Elanchezhian.C, Vijaya Ramnath.B.,"Process Planning and Cost Estimation", 2nd Edition, New Age International Publishers, 2019.

REFERENCES:

1.	Phillip. F Ostwalal and Jairo Munez., "Manufacturing Processes and systems", 9th Edition, John Wiley, 2008.
2.	Chitale. A.V. and Gupta. R.C., "Product Design and Manufacturing", 6th Edition, PHI, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate product plans or schedules to optimize production.	Applying (K3)
CO2	apply professional and ethical responsibility to reduce production time.	Applying (K3)
CO3	explain Production and Operations Management and its role in business organizations.	Understanding (K2)
CO4	use various cost estimation techniques.	Applying (K3)
CO5	predict the stocking level at the minimum rate.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1			2	1				1	2	2
CO2	3	2	1	1			2	1				1	2	2
CO3	3	2	1	1			2	1				1	2	2
CO4	3	2	2	2			2	1				1	2	2
CO5	3	2	2	2			2	1				1	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	50	35				100
CAT2	15	65	20				100
CAT3	15	50	35				100
ESE	10	40	50				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE34 - LEAN METHODS FOR AUTOMOBILE ENGINEERS							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on lean manufacturing technology.

Unit – I **Introduction:** **9**

Global competition, Customer requirements, Requirements of other stake holders, Seven forms of waste, evolution of lean manufacturing, Lean Manufacturing System (LMS), Value and waste, Symptoms of underperforming organizations, Elements of LMS.

Unit – II **Primary Tools used in LMS I:** **9**

5S concepts in organizations, 5S process – Sort, set in order, Shine, Standardize, Sustain, implementing 5S. TPM - Pillars of TPM - Conditions for TPM success - TPM implementation process, Overall Equipment Effectiveness and problems on computation of OEE.

Unit – III **Primary Tools used in LMS II:** **9**

Process Mapping and Value Stream Mapping (VSM) – Need for process maps, advantages, types and its construction, Steps in preparing VSM; Concept of work Cell and its design, Line balancing algorithms and problems.

Unit – IV **Secondary Tools used in LMS:** **9**

Cause and effect diagram, Pareto chart, Radar chart, Poke Yoke, Kanban, Automation, SMED, Standardized fixture, DFMA, JIT, Visual workplace - problems on Pareto analysis and computation of number of Kanban.

Unit – V **LMS Rules:** **9**

Stability, Management, Standardized work, Pull system, Continuous improvement. Lean Implementation: Training, selecting the projects, preparing project charter, project implementation, Project review. Implementing LMS for higher productivity: Operator, process, machinery and equipment, workplace organization, Inventory, LMS Design Process.

Total:45

TEXT BOOK:

1. Pascal Dennis., "Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System",3rd Edition, CRC Press, 2015.

REFERENCES:

1. Jeffrey Like.r., "The Toyota Way ",Tata McGraw-Hill, 2017.
2. N. Gopalakrishnan., "Simplified Lean Manufacture", PHI, 2010.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the importance of lean manufacturing and its elements.	Understanding (K2)
CO2	identify appropriate lean methods to solve the problem.	Applying (K3)
CO3	apply suitable algorithms and primary LMS tools to solve the problems.	Applying (K3)
CO4	solve the given problem using secondary LMS tools.	Applying (K3)
CO5	explain the various rules of the LMS.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1		2	1					1	3	
CO2	3	2	1	1		2	1					1	3	
CO3	3	2	1	1		2	1					1	3	
CO4	3	2	1	1		2	1					1	3	
CO5	3	2	1	1		2	1					1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	45	35				100
CAT3	20	45	35				100
ESE	10	40	50				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE35 – AUTOMOTIVE STYLING AND MODELINIG							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on style and model a vehicle based on customer requirement.

Unit – I **Vision:** **9**

Vehicle Identifying opportunity - Defining a vision & setting targets - Opportunities in portfolio - Research examples of personal - Design movements - Idea of narrative in design - Spreading the word and generating a mission statement - Brand and Design - Creating a design – Case study: Mazda Motorsports.

Unit – II **Ideate:** **9**

Vehicle packages and technical solutions based on the needs of target customer and market opportunity – Powertrain implications - Structure and a framework for vehicle architecture - Unique visual DNA vehicle - Surface language - Key directions and Identifying themes - Segmentation and competitive benchmarking.

Unit – III **Develop:** **9**

Case Study: Ford Mustang (phase 1) - Character development and processing imagery - Architectural and visual foundation - Design development in full-size - Refining proposals and final selection - Case Study: Ford Mustang (phase 2) - Creating an initial design prototype - Final theme selection – Final cut.

Unit – IV **Model:** **9**

Virtual 3D - Digital design process - Digital sketch modelling - 3D data development - Rapid validation mockups – Case study: clay modeling, Mazda Kiora concept – 3D Printing, rapid prototyping and hard modeling fabrication – Development strategies.

Unit – V **Build and Launch:** **9**

Idea selection - Engineering, processing, and testing - Market research - Early-stage vetting for designers - Client's management and key stakeholders - Pitching to prospective users - Selling new viewers on an idea - Launching a vehicle.

Total:45

TEXT BOOK:

1. Jordan Meadows., "Vehicle Design: Aesthetic Principles in Transportation Design", Taylor & Francis Group, 2018.

REFERENCES:

1. Tony Lewin, Ryan Borroff., "How to Design Cars Like a Pro", Motor Books International, 2010.
2. Alan Pipes., "Drawing for Designers", Laurence King Publishing, 2007

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	describe the innovative ideas in new concepts and styling.	Understanding (K2)
CO2	associate the suitable computer aided design tools for the communication of ideas.	Understanding (K2)
CO3	explain computer-aided styling for new product styling	Understanding (K2)
CO4	discuss the global standards for new product development.	Applying (K3)
CO5	infer customer insight and develop an innovative product.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	3	2						1	3	
CO2	3	2	1	1	3	2						1	3	
CO3	3	2	1	1	3	2						1	3	
CO4	3	2	1	1	3	2						1	3	
CO5	3	2	1	1	3	2						1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	45	35				100
ESE	10	55	35				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUE36 – NON-TRADITIONAL MACHINING PROCESSES							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Technology**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course addresses the various non-traditional machining processes in different applications.

Unit – I | **Mechanical Energy Based Processes** | **9**

Non-Traditional Machining Processes - Need - Classification - Applications, advantages and limitations. Principles, Equipment, Process Parameters in Abrasive Jet Machining, Abrasive Water Jet Machining and Ultrasonic Machining - Advantages and Limitations

Unit – II | **Electrical Energy Based Processes** | **9**

Electric Discharge Machining (EDM) - working Principle - components -Process Parameters - Surface Finish and Material Removal Rate - electrode / Tool – Power and Control Circuits-Tool Wear – Dielectric – Flushing – Wire cut EDM – Applications.

Unit – III | **Chemical and Electro Chemical Energy Based Processes** | **9**

Chemical Machining - Principle - components - Effect of Process Parameters - Applications, Advantages and Limitations. Electro-Chemical Machining - Electro-Chemical Honing - Electro-Chemical Grinding - Electro Chemical Deburring.

Unit – IV | **Thermal Energy Based Processes** | **9**

Laser Beam Machining and Drilling (LBM) - Plasma Arc Machining (PAM) and Electron Beam Machining (EBM) - Principle – Components – Beam control techniques – Applications.

Unit – V | **Nano Finishing Processes** | **9**

Principle, Components and Process Parameters - Abrasive Flow Machining – Chemo Mechanical Polishing, Magnetic Abrasive Finishing - Magnetorheological Finishing - Magneto Rheological Abrasive Flow Finishing –– Advantages and Limitations – Applications.

Total:45

TEXT BOOK:

1.	Vijay.K. Jain., “Advanced Machining Processes”, 1st Edition, Allied Publishers Pvt. Ltd., New Delhi, 2015.

REFERENCES:

1.	Pandey P.C. and Shan H.S., “Modern Machining Processes”, 1st Edition, Tata McGraw-Hill, New Delhi, 2017.
2.	Kapil Gupta, N.K.Jain and R.F.Laubscher., “Hybrid Machining Process: Perspectives on Machining and Finishing”, Springer International Publishing, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the need for mechanical energy based non-traditional machining processes in manufacturing.	Understanding (K2)
CO2	illustrate the knowledge of machining electrically conductive material through electrical energy.	Understanding (K2)
CO3	discuss the concepts of machining hard materials using chemical and electrochemical energy.	Understanding (K2)
CO4	describe thermal energy based nontraditional machining processes.	Understanding (K2)
CO5	illustrate the nano finishing processes for various applications.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2					2					1	3	
CO2	3	2					2					1	3	
CO3	3	2					2					1	3	
CO4	3	2					2					1	3	
CO5	3	2					2					1	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	15	85					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUX01 - AUTOMOTIVE ENGINEERING

(Offered by Department of Automobile Engineering)

Programme & Branch	All BE/BTech Branches except Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**5**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course provides the knowledge on working principle of automotive components and various alternative fuel resources recommended for automotive engines.

Unit – I | Engines and Exhaust systems: | 9

Engine components: Cylinder block - Cylinder head - Sump - Manifolds - Gaskets - Cylinder - Piston - Rings - Connecting rod - Piston pins - Crank shaft - Bearings - Valves - Mufflers. Simple Carburetor - Port and Valve Timing diagram - Engine cooling and Lubrication systems - MPFI and CRDI - Exhaust systems - SCR - EGR - Catalytic converter - DeNox Trap - Emission standards in India

Unit – II | Transmission Systems: | 9

Clutch - Types and Construction - Clutch operation - Electromagnetic - Mechanical - Hydraulic - Vacuum. Gear Boxes: Manual and Automatic - Simple Floor Mounted Shift Mechanism - CVT - Dual Clutch transmission - Over Drives - Transfer Box - Fluid flywheel - Torque converter - Propeller shaft - Slip Joint - Universal Joints - Differential and Rear Axle.

Unit – III | Steering, Brakes and Suspension: | 9

Wheels and Tyres - Wheel Alignment Parameters. Steering: Steering Geometry - Types of steering gear box - Davis and Ackermann steering mechanism - Power Steering - Electronic Steering - Types of Front Axle. Suspension systems: Types of suspension springs - Shock absorbers. Braking Systems: Types and Construction - Hydraulic brakes - Air brakes - Antilock Braking System.

Unit – IV | Chassis Frame, Battery and Lighting System: | 9

Chassis construction - Truck chassis - Four-wheel drive chassis - Body on frame - Semi integral and integral type - Loads acting on frame. Types of batteries - Construction, Operation and Maintenance. Electrical systems: Lighting - Wiring circuit.

Unit – V | Automotive accessories and Alternate Energy Sources: | 9

Head lights - Switches - Indicating lights. Accessories: Direction indicators - Windscreen wiper - Horn - Speedometer - Heaters - Air conditioner. Use of Natural Gas, LPG, CNG, LPG, Bio diesel, Shale gas, Liquid nitrogen, Ethanol and Hydrogen in Automobiles - Fuel Cells.

LIST OF EXPERIMENTS / EXERCISES:

1.	Dismantling and Assembling of Two stroke Petrol Engine
2.	Dismantling and Assembling of Four Stroke Petrol Engine
3.	Dismantling and Assembling of Four Stroke Diesel Engine
4.	Dismantling and Assembling of Constant Mesh Gear Box
5.	Dismantling and Assembling of Synchromesh Gear Box
6.	Dismantling and Assembling of Differential and Live Axles
7.	Dismantling and Assembling of Hydraulic and Pneumatic Braking Systems
8.	Dismantling and Assembling of Recirculating Ball and Rack & Pinion Steering Systems
9.	Fault diagnosis in Automotive Electrical Wiring Circuit
10.	Dismantling and Assembling of Horn, Wiper and Starter Motor

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1. Dr. Kirpal Singh., "Automobile Engineering Volume 1 & 2", 14th Edition, Standard Publishers Distributors, New Delhi, 2017 & 2018.

REFERENCES/ MANUAL / SOFTWARE:

1. Tom Denton., "Automobile Electrical and Electronics Systems", 4th Edition, Edward Arnold Publishers, 2013.
2. Ganesan V., "Internal Combustion Engines", 4th Edition, Tata McGraw-Hill, New Delhi, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	demonstrate the IC engine components and exhaust system by dismantling and assembling	Applying (K3), Precision (S3)
CO2	execute the various types of transmission and steering systems	Applying (K3), Precision (S3)
CO3	develop the suspension, brake and steering systems of automobile	Applying (K3), Precision (S3)
CO4	design the circuit for automotive electrical systems and illustrate the types of chassis	Applying (K3), Precision (S3)
CO5	execute the various automotive accessories and alternate fuel sources in automobiles	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2			1	1		3	2		1		
CO2	3	3	2			1	1		3	2		1		
CO3	3	2	2			1	1		3	2		1		
CO4	3	2	2			1	1		3	2		1		
CO5	3	3	2			1	1		3	2		1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	15	85					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUO01 - AUTOMOTIVE ELECTRONICS							
(Offered by Department of Automobile Engineering)							
Programme & Branch	**All BE/BTech Branches except Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	To acquire knowledge on basic automotive electrical and electronics systems for main functions in vehicles like charging, starting, ignition, fuel control and engine management	
Unit - I	**Charging and Starting systems:**	**9+3**
Introduction - Requirements of the charging system - Charging system principles – Alternators - Smart charging - Advanced Charging system technology - Alternator developments - Requirements of the starting system - Starter motors and circuits - Types of starter motor - Advanced starting system technology - Electronic starter motor control and stop-start system		
Unit - II	**Ignition systems:**	**9+3**
Ignition system fundamentals - Electronic ignition - Constant dwell systems- Constant energy systems - Hall Effect pulse generator - Inductive pulse generator - Dwell angle control (open loop) - Capacitor discharge ignition - Electronic spark advance - Distributor less ignition - Coil on plug (COP) ignition - spark plugs		
Unit - III	**Fuel control:**	**9+3**
Combustion - Engine fueling and exhaust emissions - Emissions and driving cycles - Fuel injection - Double fuel injectors - Diesel fuel injection - Electronic control of diesel injection - Rotary pump system - Common rail system - Electronic unit injection (EUI) - Diesel lambda sensor - air–fuel ratio		
Unit - IV	**Engine management:**	**9+3**
Combined ignition and fuel injection system - Exhaust emission control - Engine design - Catalytic converters - Closed loop lambda control - Engine management systems - Other aspects of engine management system.		
Unit - V	**Vehicle Safety and Comfort:**	**9+3**
Anti-lock brakes - Traction and stability control - Active suspension - Automatic transmission - Other chassis electrical systems - Advanced chassis systems technology - Comfort and safety - Seats, mirrors and sun-roofs - Central locking and electric windows - Cruise control - Airbags and belt tensioners - Advanced comfort and safety systems technology - Cruise control and system response - Radio suppression calculations		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:	
1.	Tom Denton., "Automobile Electrical and Electronic Systems", 5th Edition, Routledge, United Kingdom, 2017.
REFERENCES/ MANUAL / SOFTWARE:	
1.	William Ribbens., " Understanding Automotive Electronics an Engineering Perspective", 8th Edition, Elsevier Science,2017.
2.	Robert Bosch GmbH., "Bosch Automotive Handbook", 10th Edition , Wiley, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	design and implement the electrical circuits for charging and starting systems	Applying (K3)
CO2	describe the layout and types of ignition system used in gasoline engine	Understanding (K2)
CO3	execute the different elements of fuel injection systems in engines.	Applying (K3)
CO4	explain about the role of electronic control in engine management system	Understanding (K2)
CO5	carryout the various safety and comfort systems in vehicles	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1								1		
CO2	3	3	1	1								1		
CO3	3	3	1	1								1		
CO4	3	3	1	1								1		
CO5	3	3	1	1								1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	15	50	35				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUO02 - VEHICLE MAINTENANCE							
(Offered by Department of Automobile Engineering)							
Programme & Branch	**All BE/BTech Branches except Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course provides knowledge on maintenance and servicing of various systems in automobiles.	
Unit - I	**Maintenance procedure and tools:**	**9+3**
Maintenance need, policies – Classification of maintenance – Service intervals - Automotive service procedures – Workshop operations, vehicle insurance -Towing and recovering - Safety – Personnel, equipment and vehicles. Fire safety - First aid - Shop hand tools – Measuring instruments.		
Unit - II	**Engine Maintenance:**	**9+3**
General Engine service- Dismantling of Engine components- Engine repair - Working on the underside, front, and top of engine, Condition checking of seals, gaskets, and sealants in engine- Cooling system service, lubrication system service, Fuel system service - Electronic fuel injection and engine management service. Fault diagnosis using Scan tools, On and Off Board Diagnostics. Exhaust system - Servicing for parts of emission control systems.		
Unit - III	**Driveline Maintenance:**	**9+3**
Clutch - General checks, adjustment and service. Transmission and transaxle - Dismantling, identifying, checking and reassembling. Removing and replacing propeller shaft. Servicing of yokes, cross of universal joint and constant velocity joints. Rear axle service - Removing axle shafts, bearings. Servicing of differential assembly.		
Unit - IV	**Chassis Maintenance:**	**9+3**
Maintenance of suspension systems -Macpherson strut, coil spring, leaf spring and shock absorbers. Maintenance of steering systems- Rack and pinion steering, Recirculating ball type steering, Worm type steering and Power steering. Maintenance of Brake systems- Bleeding of brakes. Maintenance of wheel**-** Tire wear, tire rotation, Tire change, Wheel balance and Wheel alignment.		
Unit - V	**Electrical and HVAC Maintenance:**	**9+3**
Electrical: Maintenance of battery, starting, charging and lighting systems. **HVAC Maintenance**: Maintenance of A/C system parts- compressor, condenser, expansion valve and evaporator. Replacement of A/C hoses- Leak detection- AC Charging.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	William H. Crouse and Donald l. Anglin, "Automotive Mechanics"., 10th Edition, McGraw Hill Education, New Delhi, 2017.

REFERENCES:

1.	Ed May & Les Simpson., "Automotive Mechanics" Volume I and II", 8th Edition, McGraw Hill Education, New Delhi, 2009.
2.	Jigar A. Doshi, Dhruv U. Panchal &Jayesh P. Maniar, "Vehicle Maintenance and Garage Practice", PHI Learning Pvt. Ltd, New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	discuss the importance of maintenance, workshop practices, tools and safety requirements for automobiles	Understanding (K2)
CO2	explain the maintenance procedure of engine and its sub-systems	Understanding (K2)
CO3	illustrate the maintenance related issues with transmission and drive line	Understanding (K2)
CO4	identify the service practices in the steering, brake, suspension and wheel	Understanding (K2)
CO5	asses the maintenance cum troubleshooting aspects in electrical and air-conditioning systems.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2					2					2		
CO2	3	2			2		2					2		
CO3	3	2					2					2		
CO4	3	2					2					2		
CO5	3	2					2					2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	15	65	20				100
ESE	15	70	15				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUO03 - PUBLIC TRANSPORT MANAGEMENT							
(Offered by Department of Automobile Engineering)							
Programme & Branch	**All BE/BTech Branches except Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on motor vehicle act, vehicle taxation, vehicle insurance and transport operation structure	
Unit - I	**Introduction:**	**9**
Personnel management - Objectives and functions – Psychology -Sociology and their relevance to organization. Drivers and conductors: Job description -Employment tests – Interviewing - Training procedure and psychological tests.		
Unit - II	**Motor Vehicle Act:**	**9**
Short titles and definitions - Laws governing to use of motor vehicle & vehicle transport - Traffic rules and signs - Licensing of drivers & conductors - Responsibility of driver. Accidents - Causes & analysis. Rules regarding construction of motor vehicles - Registration of vehicle - State and interstate permits - Liabilities and preventive measures - Offenses and penalties - Different types of forms - Government motor vehicle administration structure.		
Unit - III	**Taxation and Insurance:**	**9**
Objectives, structure and methods of levying taxation - Onetime tax - Tax exemption - Tax renewal and online tax payment. Insurance: Insurance types - Significance and renewal- Furnishing particulars of vehicles involved in an accident - Duty of driver in case of an accident -Hit and Run case -Surveyor and loss assessor - surveyor's report -Motor Accident Claims Tribunal -Solatium Fund.		
Unit - IV	**Transport Operation:**	**9**
Structure of passenger transport organizations - Depot layouts and requirements -Route planning - Scheduling of passenger transport vehicles - Preparation of timetable and fare structure - Methods of fare collection - Structure of goods transport organizations - Scheduling of goods transport vehicles - Management Information System (MIS) in goods transport operation - Storage & transportation of petroleum products -Operation cost, revenues and records.		
Unit - V	**Maintenance Management:**	**9**
Service advisor - Roles and Responsibilities - Job card and service record preparation - Trial run to understand customer complaints - Time and cost analysis for repair works - Precautions before carrying out repair works -Training procedure for mechanic - Inventory control in stores - Customer longue requirements - Customer feedback systems - Workshop Maintenance software.		
		Total:45

TEXT BOOK:

1. "Motor Vehicle Act"., Govt. of India Publications.

REFERENCES:

1. Santosh Sharma., "Productivity in Road Transport", 2nd Edition, Association of State Road Transport Undertakings, New Delhi, NA.
2. Patankar P G., "Road Passenger Transport in India", CIRT, Pune.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	illustrate interviewing and training procedures for drivers and conductors	Understanding (K2)
CO2	exemplify public & vehicle issues with help of motor vehicle act	Understanding (K2)
CO3	identify appropriate tax and insurance policies for their own vehicle	Understanding (K2)
CO4	discuss the operation cost and revenues of transport operation	Understanding (K2)
CO5	explain the management principles involved in maintenance	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				3	3	2				3		
CO2	3	2				3	3	2				3		
CO3	3	2				3	3	2				3		
CO4	3	2				3	3	2				3		
CO5	3	2				3	3	2				3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	15	85					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUO04 - AUTONOMOUS VEHICLES							
(Offered by Department of Automobile Engineering)							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**8**	**OE**	**3**	**0**	**0**	**3**
Preamble	To acquire knowledge on the concept of automated driving techniques and the contribution of artificial intelligence with case studies of an autonomous vehicle.						
Unit – I	**Automated Driving:**						**9**
Introduction to ADV - Safety - Vehicle and its occupants – External people and property - Service and repair - IMI TechSafe.							
Unit – II	**Advanced driver assistance systems:**						**9**
Introduction to ADAS - Example Systems - Adaptive Cruise control - Obstacle Avoidance Radar - Basic reversing aid – Radar - Stereo Video Camera - Rear Radar - Functional Safety and Risk.							
Unit – III	**Automated driving technologies:**						**9**
Introduction - Road to Autonomy – Perception - Lidar Operation - Sensor Positioning - Automated Driving System – Mapping - Other technologies – Connectivity - Artificial Intelligence - Top-down and Bottom-up AI - Deep learning - End to End Machine Learning.							
Unit – IV	**Social and human issues:**						**9**
Introduction - Public reaction to CAVs – Insurance - Mobility as a Service - Global Overview - UK - European union – US - japan and china.							
Unit – V	**Case studies:**						**9**
Nvidia – Bosch - Google (Waymo) - Tesla Autopilot – Audi - Jaguar Land Rover - Toyota Guardian – FLIR - First sensor AG.							
							Total:45

TEXT BOOK:

1.	Tom Denton., "Automated Driving and Driver Assistance Systems", 1st Edition, Routledge, Taylor & Francis Group, United Kingdom, 2020.

REFERENCES:

1.	Maurer, Markus, J. Christian Gerdes, Barbara Lenz, and Hermann Winner., “Autonomous driving: technical, legal and social aspects” Springer Nature, 2016.
2.	Coppola, Pierluigi, and Domokos Esztergár-Kiss., “Autonomous Vehicles and Future Mobility”, Elsevier, 2019.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain the safety aspects of autonomous vehicles.	Understanding (K2)
CO2	describe advanced driver assistance systems for autonomous vehicles.	Understanding (K2)
CO3	illustrate automated driving technologies with sensor positioning.	Applying (K3)
CO4	apply the artificial intelligence techniques to autonomous vehicles.	Applying (K3)
CO5	analyse the specifications of autonomous vehicles from various manufacturers.	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	1	2	2					1		
CO2	3	3	2	1	1	2	2					1		
CO3	3	3	2	1	1	2	2					1		
CO4	3	3	2	1	1	2	2					1		
CO5	3	3	2	1	1	2	2					1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	45	35				100
CAT3	10	35	20	35			100
ESE	10	40	35	15			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

<table>
<tr><td colspan="9">22GEO01 - GERMAN LANGUAGE LEVEL 1</td></tr>
<tr><td colspan="9">(Offered by Department of Electronics and Communication Engineering)</td></tr>
<tr><td>Programme& Branch</td><td>All BE/BTech Engineering and Technology Branches</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td colspan="2">Credit</td></tr>
<tr><td>Prerequisites</td><td>Nil</td><td>All</td><td>OE</td><td>4</td><td>0</td><td>0</td><td colspan="2">4</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td>Preamble</td><td colspan="8">This course serves as an introduction to the German language and awareness towards German lifestyle and cultural aspects of Germany and German speaking countries. One can learn to introduce oneself and able to gain the basic day to day vocabulary. On keen learning one would be able to understand the sentence structure and be able to reciprocate to basic questions</td></tr>
<tr><td>Unit – I</td><td colspan="7">Good Day (Guten Tag)</td><td>12</td></tr>
<tr><td colspan="9">Greetings, Self-introduction and introducing others, Numbers, Alphabets, Countries and languages spoken. Grammar – W questions, Simple sentences, Verb conjugation and personal pronoun.</td></tr>
<tr><td>Unit – II</td><td colspan="7">Friends & Colleague (Freund und Kollegen):</td><td>12</td></tr>
<tr><td colspan="9">Hobbies, Profession, Week, Months, Season and Generate Profile. Grammar – Articles, Plural, Verbs – have and to be, Yes/No questions.</td></tr>
<tr><td>Unit – III</td><td colspan="7">n the City (In der Stadt):</td><td>12</td></tr>
<tr><td colspan="9">Name of places/buildings in the city, asking for directions, Understanding means of transport. Grammar – definite and indefinite articles, Negation articles and Imperative</td></tr>
<tr><td>Unit – IV</td><td colspan="7">Food and Appointment (Essen und Termin):</td><td>12</td></tr>
<tr><td colspan="9">Food, Shopping, initiate conversations to understand and do shopping. Grammar – Accusative case, Verbs with Accusative. Understanding time and reciprocating, Appointments, Asking excuse, Family. Grammar – Prepositions: am, um, von...bis, Possessive articles- mein, dein.., Modal verbs- müssen, können, wollen</td></tr>
<tr><td>Unit – V</td><td colspan="7">Socializing (Zeit mit Freunden):</td><td>12</td></tr>
<tr><td colspan="9">Planning together, Birthday, Invitation, Restaurant, looking for specific information in texts. Grammar – Separable verbs, Prepositions with Accusative case, Past tense of have and to be, Personal pronoun with Accusative.</td></tr>
<tr><td colspan="9" align="right">Total:60</td></tr>
<tr><td colspan="9">TEXT BOOK:</td></tr>
<tr><td>1.</td><td colspan="8">Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, “Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs”, Goyal Publishers, Delhi, 2015.</td></tr>
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<tr><td>1.</td><td colspan="8">https://ocw.mit.edu – Massachusetts Institute of Technology Open Courseware</td></tr>
<tr><td>2.</td><td colspan="8">https://www.dw.com/en/learn-german - Deutsche Welle, Geramany’s International Broadcaster</td></tr>
<tr><td colspan="9"></td></tr>
</table>

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand structure of language and introducing each other	Remembering (K1)
CO2	understand vocabulary on seasons and basic verbs	Understanding (K2)
CO3	ask for directions in a new place and avail transport as required	Understanding (K2)
CO4	understand food habits of German and ask for appointments.	Understanding (K2)
CO5	learn to socialize in a German speaking country	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO02 - JAPANESE LANGUAGE LEVEL 1							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	The basic level of Japanese which provides understanding of Hiragana, Katakana and 55 Kanjis also enables one to greet, introduce oneself and other person and also provides the ability to understand basic day to day conversations	
Unit – I	**Introduction to Hiragana and Katakana:**	**12**
Chart 1, Chart 2, Chart 3, Annexures 1 and 2 and basic Japanese rules along with similar sounded vocabularies for each chart.		
Unit – II	**Introduction to Nouns, various particles and usages:**	**12**
Forming simple sentences, asking questions, positioning differentiation and owning fundamentals – new particles and usages		
Unit – III	**Introduction of Verbs, time and place markers:**	**12**
Usage of action words in sentences and framing them – place and time markers usages – giving and receiving – omission of certain particles in a sentence.		
Unit – IV	**Introduction of Adjectives, Adverbs and usages:**	**12**
Describing nouns and verbs and framing them to relate day to day conversations- positive and negative ending of the same – introduction of the likes and dislikes expressions		
Unit – V	**Introduction to Counters and Kanji:**	**12**
How to use numbers-How to use quantifiers-Present form of adjectives and Nouns-Other necessary particles-How to use numbers and quantifiers – 55 kanji characters		
		Total:60

TEXT BOOK:

1.	"MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1.	Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2.	Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	read and understand typical expression in Hiragana and Katakana	Remembering (K1)
CO2	greet and introduce oneself and other	Understanding (K2)
CO3	communicate day to day conversations – basic level	Understanding (K2)
CO4	understand the Kanjis in Japanese Script	Understanding (K2)
CO5	comprehend concept of numbers, days, months, time and counters	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO03 - DESIGN THINKING FOR ENGINEERS							
(Offered by Department of Computer Science and Engineering)							
Programme & Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	Design Thinking is human-centered problem solving tool which emphasize on empathy, collaboration, co-creation and stakeholder feedback to unlock creativity and innovation, to devises feasible and viable idea/solutions.	
Unit – I	**Design Thinking and Explore:**	**9+3**
Design Thinking: Key Principles and Mindset – Five Phases, Methods and Tools of Design Thinking – User Guide – Foundation Building for Design Thinking – **Explore**: Methods & Tools – STEEP Analysis – Strategic Priorities – Activity System – Stakeholder Mapping – Opportunity Framing.		
Unit – II	**Empathize**	**9+3**
Empathize: Methods & Tools – Field Observation – Deep User Interview – Empathy Map – User Journey Map - Need Finding – User Insights - User Persona Development.		
Unit – III	**Experiment**	**9+3**
Experiment: Methods & Tools – Ideation – SCAMPER – Analogous Inspiration – Deconstruct & Reconstruct – User Experience Journey – Prototyping– Idea Refinement.		
Unit – IV	**Engage**	**9+3**
Engage: Methods & Tools – Story Telling – Art of Story Telling – Storyboarding – Co-Creation with Users – Collect Feedback from Users.		
Unit – V	**Evolve**	**9+3**
Evolve: Methods & Tools – Concept Synthesis – Strategic Requirements –Evolved Activity Systems – Activity System Integration – Viability Analysis – Innovation Tools using User Needs, CAP, 4S – Change Management - Quick Wins.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Lee Chong Hwa, "Design Thinking The Guidebook", Design Thinking Master Trainers of Bhutan, 2017. (E-Book)

REFERENCES:

1.	Jeanne Liedtka and Tim Ogilvie, "Designing for Growth: A Design Thinking Tool Kit for Managers", Columbia University Press, 2011.
2.	Jeanne Liedtka, Tim Ogilvie, and Rachel Brozenske, "The Designing for Growth FieldBook: A Step-by-Step Project Guide", Columbia University Press, 2014.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Construct design challenge and reframe the design challenge into design opportunity.	Applying (K3)
CO2	Interview the user, and know the feelings of users to foster deep user understanding and be able to uncover the deep user insights and needs.	Applying (K3)
CO3	Develop ideas and prototypes by brain storming using the ideation tools.	Applying (K3)
CO4	Organize the user walkthrough experience using ideal user experience journey.	Applying (K3)
CO5	Develop smart strategies & implementation plan that will deliver/achieve the idea/solution deduced from earlier phases.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1					3	2	1		3	1
CO2	3	3	3	1					3	2	1		3	1
CO3	3	3	3	1					3	2	1		3	1
CO4	3	3	3	1					3	2	1		3	1
CO5	3	3	3	1					3	2	1		3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Tests	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT 1	10	20	70				100
CAT 2	10	15	75				100
CAT 3	10	15	75				100
ESE	10	15	75				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO04 - INNOVATION AND BUSINESS MODEL DEVELOPMENT							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course will inspire the students to think innovation concepts and ideas for business model developments.	
Unit - I	**Innovation and Design Thinking:**	**9+3**
Innovation and Creativity– Types of innovation – challenges in innovation- steps in innovation management- 7 concerns of design. Design Thinking and Entrepreneurship – Design Thinking Stages: Empathize – Define – Ideate – Prototype – Test. Design thinking tools: Analogies – Brainstorming – Mind mapping		
Unit - II	**User Study and Contextual Enquiry:**	**9+3**
Explanatory research – primary and secondary data – classification of secondary data – sources of secondary data – qualitative research – focus groups – depth interviews – analysis of qualitative data – survey methods – observations- Process of identifying customer needs –organize needs into a hierarchy –establish relative importance of the needs- Establish target specifications		
Unit - III	**Product Design:**	**9+3**
Techniques and tools for concept generation, concept evaluation – Product architecture –Minimum Viable Product (MVP)- Product prototyping – tools and techniques– overview of processes and materials – evaluation tools and techniques for user-product interaction		
Unit - IV	**Business Model Canvas (BMC):**	**9+3**
Lean Canvas and BMC - difference and building blocks- BMC: Patterns – Design – Strategy – Process–Business model failures: Reasons and remedies		
Unit - V	**IPR and Commercialization:**	**9+3**
Need for Intellectual Property- Basic concepts - Different Types of IPs: Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design– Patent Licensing - Technology Commercialization – Innovation Marketing		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Rishikesha T.Krishnan, “8 Steps To Innovation: Going From Jugaad To Excellence”, Collins India, 2013.

REFERENCES:

1.	Peter Drucker, “Innovation and Entrepreneurship”, Routledge CRC Press, London, 2014.
2.	Eppinger, S.D. and Ulrich, K.T. “Product design and development”, 7th edition, McGraw-Hill Higher Education, 2020.
3.	Alexander Osterwalder, “Business model generation: A handbook for visionaries, game changers, and challengers”, 1st edition, John Wiley and Sons; 2010
4.	Indian Innovators Association, “Patent IPR Licensing – Technology Commercialization – Innovation Marketing: Guide Book for Researchers, Innovators”, Notion Press, Chennai, 2017

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand innovation need and design thinking phases	Understanding (K2)
CO2	identify, screen and analyse ideas for new products based on customer needs	Analysing (K4)
CO3	develop and analyse the product concepts based on the customer needs and presents the overall architecture of the product.	Analysing (K4)
CO4	predict a structured business model for MVP	Applying (K3)
CO5	practice the procedures for protection of their ideas' IPR	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1			2			2						3		
CO2	3	3	3	3	2	2	2	2	3	3	3	3		
CO3	2	2	3	3	3	3	3	3	3	3	3	3		
CO4				3	2	2	2	3	3	3	3	3		
CO5				3	2	2		3	2	3	3	3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	40	10			100
CAT2	20	30	40	10			100
CAT3	30	30	40				100
ESE	20	30	30	20			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO05 - GERMAN LANGUAGE LEVEL 2							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	German Language Level 1	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course aims to help the learner to acquire the vocabulary as per the Common European framework of German language A1 level competence. This course will help to assimilate the basic grammar structures and gain vocabulary to understand and reciprocate in daily life situations on a broader sense. A thorough learner will be able to gain a comprehensive understanding of the German grammar and confidently articulate in day today situations	
Unit – I	**Contacts(Kontakte):**	**12**
Understanding Letters, simple instructions, speaking about language learning, finding specific information in text, Acknowledging the theme and understanding conversations, Making appointments. Grammar – Preposition with Dative, Articles in Dative and Accusative possessive articles.		
Unit – II	**Accomodation(Die Wohnung):**	**12**
Understanding Accommodation advertisements, describing accommodation and directions, responding to an invitation, Expressing feelings, Colours. Grammar – Adjective with to be verb, Adjective with *sehr/zu*, Adjective with Accusative, prepositions with Dative		
Unit – III	**Are you Working?(Arbeiten Sie):**	**12**
Daily Schedule, speaking about past, understanding Job openings advertisements, Opinions, Telephonic conversations, Speaking about Jobs. Grammar – Perfect tense, Participle II – regular and irregular verbs, Conjunctions – *und, oder, aber*		
Unit – IV	**Clothes and Style(Kleidung und mode):**	**12**
Clothes, Chats on shopping clothes, reporting on past, Orienting oneself in Supermarkets, Information and research about Berlin. Grammar – Interrogative articles and Demonstrative articles, Partizip II – separable and non-separable verbs, Personal pronouns in Dative, Verbs with Dative		
Unit – V	**Health and Vacation(Gesundheit und Urlaub):**	**12**
Personal information, Human Body parts, Sports, Understanding instructions and prompts, health tips. Grammar – Imperative with *du/Ihr*, Modal verbs – sollen, müssen, nicht dürfen, dürfen. Suggestions for travel, Path, Postcards, weather, Travel reports, Problems in hotel, Tourist destinations. Grammar – Pronoun: *man*, Question words – *Wer, Wen, Was, Wem*, Adverbs – *Zuerst, dann, Später, Zum Schl*		
		Total:60

TEXT BOOK:

1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, “Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs”, Goyal Publishers, Delhi, 2015.
2.	

REFERENCES:

1.	https://ocw.mit.edu – Massachusetts Institute of Technology Open Courseware
2.	https://www.dw.com/en/learn-german - Deutsche Welle , Geramany’s International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand letters and simple texts	Remembering (K1)
CO2	assimilate vocabulary on Accommodation and invitation	Understanding (K2)
CO3	comprehend concept of time, telephonic conversation and job-related information	Understanding (K2)
CO4	understand how to do shopping in a German store	Understanding (K2)
CO5	understand body parts and how to plan personal travel	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO06-GERMAN LANGUAGE LEVEL 3							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	German Language Level 2	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides enriching information about various everyday situations in personal and professional life and enhances the vocabulary and speaking ability to respond to and also seek information in those situations. It also equips one to express opinions and negotiate appointments. With diligent learning one can capture all basic grammatical structure to answer confidently in everyday situations.	
Unit – I	**All about food (Rund Ums Essen):**	**9**
Understand information about person, Speak about food, Introduce self and others, Understand and explain a picture base story, To justify something, To speak about feelings, To express opinions, To answer questions on a text, To describe a restaurant. Grammar: Possessive Articles in Dative, Yes/No questions, Reflexive verbs, Sentence with ‘weil’		
Unit – II	**School days (Nach der Schulzeit):**	**9**
Understand School reports, Speak and write comments about schooldays, To speak about habits, Understand and provide City-Tipps, To Understand School types in Germany and speak about it. Grammar: Modal verbs in Past tense, Positional Verbs, Two-way prepositions in Dativ and Akkusativ.		
Unit – III	**Media in everyday life (Medien in Alltag):**	**9**
To speak about advantages and disadvantages of Media, formulate comparisons, Express your own opinion, Talk about Movies, Understand and Write Movie reviews. Grammar: Comparative degree, Comparative Sentences with ‘Als’ and ‘Wie’, Subordinate clause with ‘dass’, Superlative degree.		
Unit – IV	**Feelings and expressions (Gefühle):**	**9**
Express thanks and congratulations, Talk about feelings, To understand information about festivals and speak about it, To describe a city, Express joy and regrets, Understand and write Blog entries, Write appropriate heading. Grammar: Subordinate Clause with ‘Wenn’, Adjectives to be used along with definite articles.		
Unit – V	**Profession and Travel (Beruf und Reisen):**	**9**
To have a conversation at ticket counter, To talk about leisure activities, To gather information from Texts, Introduce people, Express career preferences, Ideate the dream job, To prepare and make telephone calls, To understand text about Workplace. Ask for information, Express uncertainty, Understand and give directions, Understand a newspaper article, Say your own opinion, Talk about the way to work, Describe a statistic, Understand information about a trip, Talk about travel. Grammar: Adjective to be used along with indefinite articles, Prepositions, verb – ‘werden’, Subordinate clause – indirect questions, All units will include elements for reading, writing, speaking and listening.		
		Total:45

TEXT BOOK:

1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, “Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs”, Goyal Publishers, Delhi, 2015
2.	

REFERENCES:

1.	Rosa-Maria Dallapiazza , Eduard von Jan, Till Schonherr, “Tangram 2 (German)” , Goyal Publishers, Delhi, 2011.
2.	https://www.dw.com/en/learn-german - Deutsche Welle , Geramany’s International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand German food style, restaurant and be able express oneself.	Remembering (K1)
CO2	understand German school system and discuss about habits and provide City-Tipps	Understanding (K2)
CO3	analyze and compare media in everyday life.	Understanding (K2)
CO4	express feelings, describe a city and write blog entries.	Understanding (K2)
CO5	seek and provide information in a professional setup, give directions to others and talk about travel	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO07-GERMAN LANGUAGE LEVEL 4							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**German Language Level 3**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course imparts knowledge about interacting with external world, understanding various cultural aspects, behaviour and addressing relationships in personal and professional front. It helps one to understand reports from various media and at work. Enhance learner's grammatical exposure and cover the core basic grammatical concepts which would lay the foundation to have a better hold of the language. With focused learning one should be able to read and respond to reports, write simple formal and informal letters and text messages and be able to engage in simple conversations in known situations.	
Unit – I	**Learning (Lernen):**	**9**
Understanding and describing learning problems, Understanding and giving advice, Giving reasons, Understanding reports about everyday work life, Talking about everyday working life, Understanding a radio report, Understanding and making a mini-presentation. Grammar: Conjunctions- denn,weil, Konjuntiv II: Sollte(suggestions), Genitive, Temporal prepositions – bis, über + Akkusativ,ab+dativ		
Unit – II	**Athletic (Sportlich):**	**9**
Expressing enthusiasm, hope, disappointment, Understanding and writing fan comments, Formulating follow-ups, Making suggestions and reacting, Making an appointment, Understanding a report about an excursion, Understanding difficult texts, Introducing a tourist attraction. Grammar: Conjunctions – deshalb, trotzdem, Verbs with Dativ and Akkusativ		
Unit – III	**Living Together (Zusammen Leben):**	**9**
To complain, apologize & give in, As for something, Understand experience reports, Report on the past, Talk about pets, Respond to information, Write and correct a story. Grammatik: Konjunctiv II- könnte, Subordinate clauses – als and Wenn.		
Unit – IV	**Good Entertainment (Gute Unterhaltung):**	**9**
Talk about music style, Buy concert tickets, Introduce a musician / band, Understand newspaper reports, Give more detailed information about a person, Understand information about painting, Understand description of a picture, Describe a picture. Grammatik: Interrogative Articles: Was fuer eine? , Pronouns – man/jemand/niemand and alles/etwas/nichts , Relative sentences in Nominativ		
Unit – V	**Passage of time and Culture (Zeitablauf & Kultur):**	**9**
Talk about wishes, Express wishes, Give Suggestions, Understand a conversation, Plan something together, To ask others something, Understand a text, Exchange information, Talk about proverbs, write a story. Understand information about other cultures, Discuss about behavior, Express intentions, Use the appropriate salutation, Understand tips in a text, Talk about forms of addressing others, Give more information, Discuss about clichés and write about them. All units will include elements for reading, writing, speaking and listening. Grammatik: Konjunctiv II (Wishes, Suggestions), Verbs with prepositions, W- questions with prepositions, Relative sentences in Akkusativ, Subordinate clauses with damit and Um…Zu.		
		Total:45

TEXT BOOK:

1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, "Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch", Goyal Publishers, Delhi, 2015.

REFERENCES:

1.	Rosa-Maria Dallapiazza, Eduard von Jan, Till Schonherr, "Tangram 2 (German)", Goyal Publishers, Delhi, 2011.
2.	https://www.dw.com/en/learn-german - Deutsche Welle, Geramany's International Broadcaster

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	leverage learning in Workplace, understanding reports and make presentation.	Remembering (K1)
CO2	reciprocate to different situations, make appointment and understand texts.	Understanding (K2)
CO3	handle relationships and respond appropriately to exchange information	Understanding (K2)
CO4	familiarize to various channels of entertainment	Understanding (K2)
CO5	know about various cultural aspects, usage of proverbs and cliches.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO08 - JAPANESE LANGUAGE LEVEL 2							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Japanese Language Level 1**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	The basic level of Japanese which provides understanding of Hiragana, Katakana and 110 Kanjis and provides the ability to understand basic conversations and also enables one to request other person and also understand Casual form	
Unit – I	**Introduction to groups of verbs:**	**12**
tai form-Verb groups-te form-Give and ask permission to do an action-Present continuous form-Restrict other person from doing an action-nouns-Basic Questions		
Unit – II	**Introduction to Casual Form:**	**12**
nai form-Dictionary form-ta form-Polite style and Casual style differences-Conversation in plain style-Place of usage of Polite style and Casual style		
Unit – III	**Express opinions and thoughts:**	**12**
Introduction to new particle-Express someone one’s thought-Convey the message of one person to another-Ask someone if something is right -Noun modifications		
Unit – IV	**Introduction to If clause and remaining Kanjis:**	**12**
If clause tara form-Express gratitude for an action done by other person-Hypothetical situation-Particles to use in case of Motion verbs-50 Kanjis		
Unit – V	**Introduction to giving and receiving with te form and “when, even if” usages:**	**12**
Providing to and getting from differences - Understanding of situations and framing sentences using when and even if..etc.		
		Total:60

TEXT BOOK:

1.	“MINNA NO NIHONGO–Japanese for Everyone”, 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017

REFERENCES:

1.	Margherita Pezzopane, “Try N5”, 2nd Edition, Tankobon Softcover, Japan, 2017.
2.	Sayaka Kurashina, “Japanese Word Speedmaster”, 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	differentiate groups of verbs and its forms	Remembering (K1)
CO2	understand Polite form and Casual form of Japanese	Understanding (K2)
CO3	comprehend personal communication and express greetings	Understanding (K2)
CO4	understand the Kanjis in Japanese Script and If clause	Understanding (K2)
CO5	comprehend concept of “even if”, “when” and job-related information	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO09 - JAPANESE LANGUAGE LEVEL 3							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Japanese Language Level 2**	**All**	**OE**	**3**	**0**	**0**	**3**
Preamble	The intermediate level of Japanese which provides understanding of all forms ofverbs, adverbs, conjunctions, etc. which includes 150 Kanji's and provides the ability to comprehend conversations encountered in daily life						
Unit – I	**Introduction to Potential verbs:**						**9**
Causes and Reasons-Favouring Expressions-Expressing a State-Potential Verb Sentences-Simultaneous actions-Verb Groups-te Form-Customary Actions-Nouns-Basic Questions and Kanji's.							
Unit – II	**Introduction to Transitive and Intransitive verbs:**						**9**
Consequence of verbs- Embarrassment about Facts- Consequence of Verbs with an Intentions-Affirmative Sentences- Conjunctions-Basic Questions and kanji's.							
Unit – III	**Introduction to Volitional forms:**						**9**
Expressions of Speakers Intention-Expressing Suggestion or Advice-Usage of Adverbs and Quantifiers-Basic Questions and kanji's.							
Unit – IV	**Introduction to Imperative and Prohibitive verbs:**						**9**
Commanding person- Interrogatives-Expressions of Third Person-Actions and its Occurrence - Possibilities of an Action-Changing of States Basic Questions and Kanji's.							
Unit – V	**Introduction to Conditional form and Passive verbs:**						**9**
Description of Requirement and Speaker's Judgement, HabitualActions, Directions and suggestions-Passive forms of Verbs-Basic Questions and Kanji's.							
							Total:45

TEXT BOOK:

1.	"MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1.	Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2.	Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	read and understand BasicVocabularies.	Remembering (K1)
CO2	understand Conversations used in daily life.	Understanding (K2)
CO3	comprehend personal communication and express greetings.	Understanding (K2)
CO4	understand the Kanji's in Japanese Script.	Understanding (K2)
CO5	comprehend Coherent conversations in everyday situations.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO10 -JAPANESE LANGUAGE LEVEL 4							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**JAPANESE LANGUAGE LEVEL 3**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	The intermediate level of Japanese provides understanding of expressions of verbs, its pattern, Relationships which also includes 150 Kanji's and also provides the ability to understand relationship among the people.	
Unit – I	**Introduction to Reasoning:**	**9**
Causes and Sequences-Causes and Effects-Interrogative Patterns-Adjective as a Noun -Basic Questions and Kanji's		
Unit – II	**Introduction to Exchanging of things:**	**9**
Expressions for Giving and Receiving of Things-Polite Expression of Request-Indicating a Purpose of Actions-Basic Quantifiers-Basic Questions and kanji's.		
Unit – III	**Introduction to States of an Action:**	**9**
Sentence Pattern to Indicate Appearance-Degree of Action and State-Adjectives as Adverbs- Convey information -Basic Questions and kanji's.		
Unit – IV	**Introduction to Causative Verbs:**	**9**
Causative Forms of Verbs-Asking Opportunity to do something-Hypothetical Questions-Judgement and Course of an actions-Basic Questions and Kanji's.		
Unit – V	**Introduction to Relationship in Social Status:**	**9**
Honorific expressions- Respectful expressions- Humble expressions-Polite expressions-Basic Questions and Kanji's.		
		Total:45

TEXT BOOK:

1.	"MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1.	Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2.	Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	read and Understand Relationship of a Person.	Remembering (K1)
CO2	understand Conversations Used in Everyday Activities.	Understanding (K2)
CO3	comprehend Contents at Near Natural Speed.	Understanding (K2)
CO4	understand the Kanji's in Japanese Script..	Understanding (K2)
CO5	comprehend Orally Presented Materials.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO11 - FRENCH LANGUAGE LEVEL 1								
(Offered by Department of Electronics and Communication Engineering)								
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**All**	**OE**	**4**	**0**	**0**	**4**
Preamble	This course provides a foundation of the French language as well as an understanding of the French culture and lifestyle of France and other French-speaking nations. The student will be learning how to introduce him/herself and acquire basic everyday vocabulary. By following the structured curriculum and practicing the same as per the learning process, one can comprehend the structure of sentences and respond to basic communications						
Unit – I	**Introduction**						**12**
French and French culture, alphabets, pronunciation, accents, rules, and terms for pronunciation (mas-fem), Salutations, numbers.							
Unit – II	**Daily Life**						**12**
Subject Pronoun, Francophonie's, adjectives – colors, week, months, seasons.							
Unit – III	**Articles and Verbs**						**12**
Articles - Indefinite, definite, partitive, and contracted, (examples), introductions to verbs, 1st group of verb							
Unit – IV	**In the City**						**12**
2nd group of verbs, irregular verbs (avoir, etre, faire …..) present yourself & negative sentences. (faire and Jouer verb with the expressions)							
Unit – V	**Food and Culture**						**12**
Prepositions – preposition of places (country, cities and etc), Imperative mode, invitations, culture – food (wine, cheese ….) Future (recent future)							
							Total:60

TEXT BOOK:

1.	A1 – saison

REFERENCES:

1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G, Les idees – 0 and 1

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped** **(Highest Level)**
CO1	Understand the grammatical structure of the language and introduce self to others.	Remembering (K1)
CO2	Understand basic verbs and appropriate vocabulary.	Understanding (K2)
CO3	Ask for directions and arrange for transportation, etc, as needed.	Understanding (K2)
CO4	Understand the food habits of France and ask for appointments	Understanding (K2)
CO5	Learn to socialize in French-speaking countries	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	3		3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO12 -FRENCH LANGUAGE LEVEL 2							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**All**	**OE**	**4**	**0**	**0**	**4**
Preamble	This course is designed to assist students in developing vocabulary in accordance with the Common European Framework of Reference for Languages at the A2 level. This course will aid in the integration of basic grammar structures as well as the acquisition of vocabulary necessary to comprehend and respond in everyday circumstances. The learner will be able to develop a thorough comprehension of French grammar and confidently express themselves in everyday circumstances.						
Unit – I	**French and You**						**12**
Habits, Strengths & Weakness, Recommendations, Sentiments, Motivations, about favorite films and Types of screens in the movie world, Verbs (Regulars and irregulars), Reflexive Verbs, Prepositions							
Unit – II	**Eat and Repeat**						**12**
Favorite foods, Recopies, Types of meals, Describing House and Kitchen, Presentation of the recipe, Comparatives, Possessive pronouns, Present continuous tense, Simple conditional form							
Unit – III	**Vacation**						**12**
Invitations, presentation, Greetings, Goodbyes, Activities on vacation, past experiences, Describing favorite place, Recommendations on various tours, Past perfect, Past imperfect tense							
Unit – IV	**Likes and Views**						**12**
Favorite persons & things, Giving advice, Experience, Moods, Illness, Discomforts, Symptoms, Roleplay (Doctor & Patient, Guide & Tourist, Pharmacist & Patient), Past perfect, Past indefinite, Imperative							
Unit – V	**Then and Now**						**12**
Habits, customs, circumstances of the past and present, Debates on past and present situations and feelings. Past imperfect tense, Past perfect and Present comparatives.							
							Total:60

TEXT BOOK:

1.	A2 – Saison

REFERENCES:

1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G .Les idees – 0 and 1

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Understand the French language in deep and its usage	Remembering (K1)
CO2	Preparation of their Favorite recipes, Know the Objects used in Kitchen and house.	Understanding (K2)
CO3	Converse about their vacation, their Favorite Destination	Understanding (K2)
CO4	Understand complex verbs and be able to communicate about their past experiences	Understanding (K2)
CO5	Know the difference between Past and Present and Compare them.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO13- FRENCH LANGUAGE LEVEL 3							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course gives knowledge regarding a variety of personal and professional circumstances, as well as improving vocabulary and speaking abilities to reply to and seek information in those settings. It also gives you the ability to articulate yourself and arrange appointments. With perseverance, one can master all of the essential grammatical structures needed to respond confidently in everyday circumstances. It almost gives you an idea of how Natives communicate.	
Unit – I	**Start Over**	**9**
Use of periphrases, Discuss a day in life, work, problems in the world, Predictions about the future (actions and situations), Hypothetical situations, Imperfect and future tense.		
Unit – II	**Prohibitions and More**	**9**
Prohibitions, Obligations, Habits to change, social customs, Use of the subjunctive, Describe synopsis of Movie and its relation to real life, Debate on books vs movies, usage of connectors, Object Direct and Indirect.		
Unit – III	**Let's be Creative**	**9**
Write a letter by describing the problem, talk about desires and Necessities, propose solutions, Recommendations and Suggestions, Create an Advertisement, Give Instructions, Imperative negative, Use of Object Direct, and Indirect		
Unit – IV	**Travel and Communication**	**9**
Talk about Tours, Types of tourism and communication, Send messages, petitions, Talk to people on the telephone, Roleplay (Tourists and Guide, Tourists and Travel agents), Past Pluscumperfect, All Past tenses.		
Unit – V	**Let's Talk**	**9**
Expression of Interests, Sentiments, Feelings, Sensations, Manias etc. Certain suggestions to make a better future, the use of superlatives, Exclamatory phrases, subjunctives.		
		Total:45

TEXT BOOK:

1.	B1 – Saison

REFERENCES:

1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G Les idees – 0 and 1

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Learn on Future tense.	Remembering (K1)
CO2	Understand Permissions and Prohibitions.	Understanding (K2)
CO3	Knowing about Letter writing, Creating Ads, Expressing Desires, and Instructing Others.	Understanding (K2)
CO4	Understanding rules for travel and Enhancing communications.	Understanding (K2)
CO5	Expressing the feelings and emotions using advanced grammar	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	3		3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO14 - SPANISH LANGUAGE LEVEL 1							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of Spanish Language**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course provides a foundation of the Spanish language as well as an understanding of the Spanish culture and lifestyle of Spain and other Spanish-speaking nations. The student will be learning how to introduce him/herself and acquire basic everyday vocabulary. By following the structured curriculum and practicing the same as per the learning process, one can comprehend the structure of sentences and respond to basic communications.

Unit – I	**Greetings and Good byes (Los Saludos y Despidirse):**	**12**
Greetings,Self-Introduction , Formal and Informal ways of introducing oneself and others, Alphabets& Numbers, Countries and Languages Spoken, Parts of Grammar – Noun, Personal Pronoun, Describe surroundings and its vocabulary		
Unit – II	**Vida Cotidiana (Daily Life):**	**12**
Time of the day, Days of the week, Months of the year, Seasons, Verb (To be, To Have), Adverbs, Likes and Dislikes, Personality and physical description, simple sentences		
Unit – III	**Friends and Family (Amigos y La Familia):**	**12**
Vocabulary of family, Animals, Professions, Parts of the body, Opinions on family cultures, Articles – Definite and Indefinite, Hobbies, Regular and Irregular verbs.		
Unit – IV	**In the City (En la Cuidad):**	**12**
Buildings in the city, Name of the places, asking for directions, Helping each other, Description of house and its components, Modes of Transport, Grammar - Possessive articles, prepositions		
Unit – V	**Food and Culture(La comida y cultura):**	**12**
Food (types and varieties) , shopping, ordering at a restaurant, inviting to parties, Roleplay (as diner and customer, salesman and customer…etc.) Past tense (all three tenses-Past Participle, Indefinite past and past imperfect- (to be and to have)		
		Total:60

TEXT BOOK:

1.	Chicos Chicas Libro de Alumno nivel 1, Ma Angeles Palomino , edelsa, GRUPO DIDASCALIA, S.A., plaza cuidad de salta,3-28043 MADRID(ESPANA).

REFERENCES:

1.	https://nuevadelhi.cervantes.es/en/spanish_courses/students/spanish_general_courses/spanish_courses_level_a1.htm

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the grammatical structure of the language and introduce self to others.	Remembering (K1)
CO2	understand basic verbs and appropriate vocabulary.	Understanding (K2)
CO3	ask for directions and arrange for transportation, etc, as needed.	Understanding (K2)
CO4	understand the food habits of Spain and Latin countries and ask for appointments	Understanding (K2)
CO5	learn to socialize in Spanish speaking countries	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	3		3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO15 - SPANISH LANGUAGE LEVEL 2							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of Spanish Language**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course aims to help the Learner to acquire the vocabulary as per theframework of Spanish language A2 level competence. This course will help to assimilate the basicgrammar structures and gain vocabulary to understand and reciprocate in daily life situations on a broader sense. A thorough learner will be able to gain a comprehensive understanding of the Spanish grammar and confidently articulate in day today situations.	
Unit – I	**Spanish and You (El Español y tú)**	**12**
Habits, Strengths & Weakness, Recommendations, Sentiments, Motivations, About favorite films and Types of screens in the movie world, Verbs(Regulars and irregulars), Reflexive Verbs, Prepositions		
Unit – II	**Eat and Repeat (**Comer y repetir**)**	**12**
Favorite foods, Recipies, Types of meals, Describing House and Kitchen, Presentation of recipe, Comparatives, Possessive pronouns, Present continuous tense, Simple conditional form		
Unit – III	**Its Vacation Time (**Tiempo de vacaciones)	**12**
Invitations, presentation, Greetings, Goodbyes, Activities on vacation, past experiences, Describing favorite place, Recommendations on various tours, Past perfect, Past imperfect tense, Usage of Todavia or No		
Unit – IV	**Likes and Views (**Gustasyvistas)	**12**
Favorite persons & things, Giving advices, Experience, Moods, Illness, Discomforts, Symptoms, Roleplay (Doctor & Patient, Guide & Tourist, Pharmacist & Patient), Past perfect, Past indefinite, Imperative		
Unit – V	**Then and Now(Antes y Ahora)**	**12**
Habits, customs, circumstances of the past and present, Debates on past and present situations and feelings. Past imperfect tense, Past perfect and Present comparatives.		
		Total:60

TEXT BOOK:

1.	AULA INTERNACIONAL 2 (A2) Jaime Corpas, AgusinGarmendia, Nuria Sanchez, Carmen Soriano Goyal Publishers and Distributors Pvt LTD, 86, UB Jawahar Nagar, Kamla Nagar, Delhi-110007.

REFERENCES:

1.	https://nuevadelhi.cervantes.es/en/spanish_courses/students/spanish_general_courses/spanish_courses_level_a1.htm

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the Spanish language in deep and its usage	Remembering (K1)
CO2	prepare for their Favorite recipes, Know the Objects used in Kitchen and house.	Understanding (K2)
CO3	converse about their vacation, their Favorite Destination	Understanding (K2)
CO4	understand complex verbs and be able to communicate about their past experiences	Understanding (K2)
CO5	know the difference between Past and Present and Comparing them.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	3		3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO16 - SPANISH LANGUAGE LEVEL 3							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of Spanish Language**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides enriching information about various everyday situations in personal and professional life and enhances the vocabulary and speaking ability to respond to and also seek information in those situations. It also equips one to express opinions and negotiate appointments. With diligent learning one can capture all basic grammatical structure to answer confidently in everyday situations. It almost gives a basic idea on how Natives speak.	
Unit – I	**Start Over(Volver a Empezar)**	**9**
Use of periphrases, Discuss a day in life, work, problems in the world, Predictions about future (actions and situations),Hypothetical situations, Imperfect and future tense.		
Unit – II	**Prohibitions and More(Prohibiciones y mas)**	**9**
Prohibitions, Obligations, Habits to change, social customs, Use of subjunctive, Describe synopsis of Movie and its relation to real life, Debate on books vs movies, usage of connectors, Object Direct and Indirect.		
Unit – III	**Let's be Creative (Seamoscreatives)**	**9**
Write a letter by describing the problem,talk about desires and Necessities, propose solutions, Recommendations and Suggestions, Create an Advertisement, Give Instructions, Imperative negative, Use of Object Direct and Indirect.		
Unit – IV	**Travel and Communication (Viajar y comunicar)**	**9**
Talk about Tours, Types of tourism and communication, Send messages, petitions, Talk to people on telephone, Role play(Tourists and Guide, Tourists and Travel agents), Past Pluscumperfect, All Past tenses.		
Unit – V	**Let's Talk(Hablemos)**	**9**
Expression of Interests, Sentiments, Feelings, Sensations, Manias etc. Certain suggestions to make a better future, use of superlatives, Exclamatory phrases, subjunctive.		
		Total:45

TEXT BOOK:

1.	Aula International 3 (B1) [Paperback] Jaime Corpas, Agusin Garmendia, Nuria Sanchez, Carmen Soriano Goyal Publishers and Distributors Pvt LTD, 86, UB Jawahar Nagar, Kamla Nagar, Delhi-110007.

REFERENCES:

1.	https://nuevadelhi.cervantes.es/en/spanish_courses/students/spanish_general_courses/spanish_courses_level_a1.htm

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	learn on Future tense.	Remembering (K1)
CO2	understand about Permissions and Prohibitions.	Understanding (K2)
CO3	knowing about Letter writing, Creating Ads, Expressing Desires and Instructing Others.	Understanding (K2)
CO4	understanding rules for travel and Enhance communications.	Understanding (K2)
CO5	expressing the feelings and emotions using advanced grammar	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	3		3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO17 - ENTREPRENEURSHIP DEVELOPMENT								
(Offered by Department of Mechatronics Engineering)								
Programme & Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Economics & Management**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	The purpose of this course to create entrepreneurial awareness among engineering students.	
Unit – I	**Entrepreneurship Concepts:**	**9**
Entrepreneurship & Entrepreneur- Role in Economic Development - Factors affecting Entrepreneurship- Creativity and Innovation - Entrepreneurship vs Intrapreneurship- Entrepreneurial Motivation factors – Types of Entrepreneurship & Entrepreneurs - Characteristics of Entrepreneurs - Entrepreneurship Development in India		
Unit – II	**Entrepreneurial Ventures and opportunity assessment:**	**9**
New venture creation – Bootstrapping, Minipreneurship, Start-ups, Acquiring, Franchising & Social venturing - Venture development stages - Models of market opportunity- Opportunity assessment: Critical Factors In Opportunity Assessment, Idea vs Opportunity, Evaluation process, Global opportunities for entrepreneurs.		
Unit – III	**Business Plan:**	**9**
Designing Business Model- Business Model Canvas- Objectives of a Business Plan - Business Planning Process – Structure of a Business Plan – Technical, Marketing, Financial Feasibility assessment - Competitive analysis - Common errors in Business Plan formulation - Presentation of the Business Plan: The ‘Pitch’- case studies		
Unit – IV	**Financing and accounting:**	**9**
Forms of entrepreneurial capital – Sources of Financial capital: debt financing- Commercial banks and other sources, equity financing: Initial Public offering (IPO), Private placement - Venture capitalists - Angel investors-New forms of financing: Impact investors, Micro-financing, Peer-to-Peer Lending, Crowd funding - Natural capital. Preparing Financial Budget, Break even analysis, Taxation-Direct and indirect taxes, Insolvency and Bankruptcy- Case Study		
Unit – V	**Small Business Management:**	**9**
Definition of Small Scale Industries: Strengths and Weaknesses, Sickness in Small Enterprises: Symptoms -Causes and remedies-Indian Startup Ecosystem – Institutions supporting small business enterprises, Business Incubators – Government Policy for Small Scale Enterprises - Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger, FDI and Sub-Contracting		
		Total:45

TEXT BOOK:

1.	Donald F. Kuratko,”Entrepreneurship: Theory, Process, Practice”, 11th Edition, Cengage Learning, Boston, 2020.

REFERENCES:

1.	Robert D. Hisrich, Michael P. Peters & Dean A. Shepherd, Sabyasachi Sinha "Entrepreneurship", 11th Edition, McGraw Hill, Noida, 2020.
2.	Charantimath Poornima .M, "Entrepreneurship Development and Small Business Enterprises", 3rd Edition, Pearson Education, Noida, 2018.
3.	Gordon E & Natarajan K, "Entrepreneurship Development", 6th Edition, Himalaya Publishing House, Mumbai, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the importance of entrepreneurship and demonstrate the traits of an entrepreneur	Applying (K3)
CO2	identify suitable entrepreneurial ventures and business opportunity	Applying (K3)
CO3	assess the components of business plan	Analyzing (K4)
CO4	appraise the sources of finance and interpret accounting statements	Applying (K3)
CO5	interpret the causes of sickness of small scale enterprises and its remedies	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2	2	1	1		3	2		
CO2	1	2	2	2		2	2	1	1		3	2		
CO3	2	2	2	2	2	2	2	2	2	2	3	2		
CO4	1	1	2	1		2	1	1	1	2	3	2		
CO5	1	1	2	1		2	1	1	1	2	3	2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	30	30	20			100
CAT3	30	30	40				100
ESE	10	30	40	20			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEX01 – NCC Studies (Army Wing) – I							
(Offered by Department of Electrical and Electronics Engineering)							
Programme & Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5 / 6**	**OE**	**3**	**0**	**2**	**4**
Preamble	This course is designed especially for NCC Cadets. This course will help develop character, camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working in teams, learning military subjects including weapon training.						
Unit - I	**NCC Organisation & National Integration**						**9**
NCC Organisation – History of NCC- NCC Organisation- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honours and Awards – Incentives for NCC cadets by central and state govt. National Integration- Unity in diversity- contribution of youth in nation building- national integration council- Images and Slogans on National Integration.							
Unit - II	**Basic physical Training & Drill**						**9**
Basic physical Training – various exercises for fitness(with Demonstration)-Food – Hygiene and Cleanliness. Drill- Words of commands- position and commands- sizing and forming- saluting- marching- turning on the march and wheeling- saluting on the march- side pace, pace forward and to the rear- marking time- Drill with arms- ceremonial drill- guard mounting. (WITH DEMONSTRATION)							
Unit - III	**Weapon Training**						**9**
Main Parts of a Rifle- Characteristics of 5.56mm INSAS rifle- Characteristics of .22 rifle- loading and unloading – position and holding- safety precautions – range procedure- MPI and Elevation- Group and Snap shooting- Long/Short range firing(WITH PRACTICE SESSION) - Characteristics of 7.62mm SLR- LMG- carbine machine gun.							
Unit - IV	**Social Awareness and Community Development**						**9**
Aims of Social service-Various Means and ways of social services- family planning – HIV and AIDS- Cancer its causes and preventive measures- NGO and their activities- Drug trafficking- Rural development programmes - MGNREGA-SGSY-JGSY-NSAP-PMGSY-Terrorism and counter terrorism- Corruption – female foeticide -dowry –child abuse-RTI Act- RTE Act- Protection of children from sexual offences act- civic sense and responsibility							
Unit - V	**Specialized Subject (ARMY)**						**9**
Basic structure of Armed Forces- Military History – War heroes- battles of Indo-Pak war- Param Vir Chakra- Career in the Defence forces- Service tests and interviews-Fieldcraft and Battlecraft-Basics of Map reading including practical.							
							Lecture :45, Practical:30, Total:75

TEXT BOOK:

1.	National Cadet Corps- A Concise handbook of NCC Cadets by Ramesh Publishing House, New Delhi, 2014

REFERENCES:

1.	Cadets Handbook – Common Subjects SD/SW published by DG NCC, New Delhi.
2.	Cadets Handbook- Specialized Subjects SD/SW published by DG NCC, New Delhi
3.	NCC OTA Precise published by DG NCC, New Delhi.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	display sense of patriotism, secular values and shall be transformed into motivated youth who will contribute towards nation building through national unity and social cohesion.	Applying (K3)
CO2	demonstrate Health Exercises, the sense of discipline, improve bearing, smartness, turnout, develop the quality of immediate and implicit obedience of orders..	Applying (K3)
CO3	basic knowledge of weapons and their use and handling.	Applying (K3)
CO4	understanding about social evils and shall inculcate sense of whistle blowing against such evils and ways to eradicate such evils	Applying (K3)
CO5	acquaint, expose & provide knowledge about Army/Navy/ Air force and to acquire information about expansion of Armed Forces, service subjects and important battles.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3	3	3	3	3				
CO2					3									
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	-	-	-	-	-	-
CAT2	-	-	-	-	-	-	-
CAT3	-	-	-	-	-	-	-
ESE	The examination and award of marks will be done by the Ministry of Defence, Government of India which includes all K1 to K6 knowledge levels. The maximum marks for the End Semester Examination is 500 marks. It will be converted to 100 marks.						

<table>
<tr><td colspan="8" align="center">22GEX02 - NCC STUDIES (AIR WING) – I</td></tr>
<tr><td colspan="8" align="center">(Offered by Department of Information Technology)</td></tr>
<tr><td>Programme & Branch</td><td>All BE/BTech Engineering and Technology Branches</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Prerequisites</td><td>Nil</td><td>5 / 6</td><td>OE</td><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Preamble</td><td colspan="7">This course is designed especially for NCC Cadets. This course will help develop character, camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working in teams, honing qualities such as self-discipline, self-confidence, self-reliance and dignity of labour in the cadets.</td></tr>
<tr><td>Unit–I</td><td colspan="6">NCC Organization and National Integration</td><td>9+3</td></tr>
<tr><td colspan="8">NCC Organization – History of NCC- NCC Organization- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training - NCC badges of Rank - Honors’ and Awards – Incentives for NCC cadets by central and state govt. History and Organization of IAF - Indo-Pak War-1971 - Operation Safed Sagar. National Integration - Unity in diversity - contribution of youth in nation building - national integration council - Images and Slogans on National Integration.</td></tr>
<tr><td>Unit–II</td><td colspan="6">Drill and Weapon Training</td><td>9+3</td></tr>
<tr><td colspan="8">Drill- Words of commands - position and commands - sizing and forming - saluting - marching - turning on the march and wheeling - saluting on the march - side pace, pace forward and to the rear - marking time - Drill with arms - ceremonial drill - guard mounting.(WITH DEMONSTRATION). Main Parts of a Rifle - Characteristics of .22 rifle - loading and unloading – position and holding - safety precautions – range procedure - MPI and Elevation - Group and Snap shooting - Long/Short range firing (WITH PRACTICE SESSION).</td></tr>
<tr><td>Unit–III</td><td colspan="6">Principles of Flight</td><td>9+3</td></tr>
<tr><td colspan="8">Laws of motion-Forces acting on aircraft – Bernoulli’s theorem - Stalling - Primary control surfaces – secondary control surfaces - Aircraft recognition.</td></tr>
<tr><td>Unit-IV</td><td colspan="6">Aero Engines</td><td>9+3</td></tr>
<tr><td colspan="8">Introduction of Aero engine -Types of engine - piston engine - jet engines - Turbo prop engines-Basic Flight Instruments - Modern trends.</td></tr>
<tr><td>Unit–V</td><td colspan="6">Aero Modeling</td><td>9+3</td></tr>
<tr><td colspan="8">History of aeromodeling - Materials used in Aero-modeling - Types of Aero-models – Static Models - Gliders - Controlline models - Radio Control Models - Building and Flying of Aero-models.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8" align="right">Lecture:45, Tutorial:30, Total:75</td></tr>
<tr><td colspan="8">TEXT BOOK:</td></tr>
<tr><td>1.</td><td colspan="7">“National Cadet Corps - A Concise handbook of NCC Cadets”, Ramesh Publishing House, NewDelhi, 2014.</td></tr>
<tr><td colspan="8">REFERENCES/ MANUAL / SOFTWARE:</td></tr>
<tr><td>1.</td><td colspan="7">“Cadets Handbook – Common Subjects SD/SW”, DGNCC, New Delhi.</td></tr>
<tr><td>2.</td><td colspan="7">“Cadets Handbook – Specialised Subjects SD/SW”, DGNCC, New Delhi.</td></tr>
<tr><td>3.</td><td colspan="7">“NCCOTA Precise”, DGNCC, New Delhi.</td></tr>
<tr><td colspan="8"></td></tr>
</table>

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	build sense of patriotism, secular values and shall be transformed into motivated youth who will carry out nation building through national unity and social cohesion.	Applying (K3)
CO2	demonstrate the sense of discipline with smartness and have basic knowledge of weapons and their use and handling	Applying (K3)
CO3	illustrate various forces and moments acting on aircraft	Applying (K3)
CO4	outline the concepts of aircraft engine and rocket propulsion	Applying (K3)
CO5	design, build and fly chuck gliders/model air planes and display static models.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3	3	3	3	3				
CO2					3									
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	-	-	-	-	-	-
CAT2	-	-	-	-	-	-	-
CAT3	-	-	-	-	-	-	-
ESE	The examination and award of marks will be done by the Ministry of Defence, Government of India which includes all K1 to K6 knowledge levels. The maximum marks for the End Semester Examination is 500 marks. It will be converted to 100 marks.						

22MBO01 - COST ACCOUNTING FOR ENGINEERS							
(Offered by Department of Management Studies)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To provide an In-depth study of the Cost Accounting principles and techniques for identification, analysis and classification of costs components to facilitate decision Making.	
Unit – I	**Introduction to Cost Accounting**	**9 + 3**
Introduction to Cost Accounting: Meaning - Scope, objectives and significance of Cost Accounting its relationship with financial accounting and management accounting– cost centres – cost units – Elements of cost – classification of cost – preparation of cost sheet.		
Unit – II	**Cost Ascertainment – Elements of cost**	**9 + 3**
Material Costs: Procurement of materials – Inventory management and control – scrap, spoilage, defectives and wastage **Labour Costs:** Time Keeping, Time booking and payroll – Labour turnover – principles and methods of remuneration and incentive schemes. **Overheads:** Collection, classification and apportionment and allocation of overheads.		
Unit – III	**Basic Costing Methods**	**9 + 3**
Operating Costing - Meaning - Preparation of Operating Cost Sheet - Transport Costing - Power Supply Costing - Hospital Costing.		
Unit – IV	**Advanced Costing Methods**	**9 + 3**
Features of Job Costing - Batch Costing - Preparation of Cost Sheet Under Job Costing, and Batch Costing - Process Costing - Process Loss - Normal and Abnormal Loss.		
Unit – V	**Cost Accounting Techniques**	**9 + 3**
Budget and Budgetary Control: Budgetary control as a management Tool – Installation of Budgetary control system classification of budgets – Fixed and Flexible Budgeting. **Standard Costing and Variance Analysis:** Budgetary control and standard costing – Suitability of standard costing – Standard costing as a management Tool – Cost variances – Direct material cost variances – Direct labour cost variances – Overhead variances – Sales variance.		
		Lecture: 45, Tutorial: 15, Total:60

TEXT BOOKS

1.	JawaharLal, SeemaSrivastava, Manisha Singh, " Cost Accounting, Text, Problems and Cases", 6th Edition, McGraw Hill Education, New Delhi, 2020.
2.	William Lanen, Shannon Anderson and Michael Maher, "Fundamentals of cost Accounting",7th Edition, McGraw Hill Education, New Delhi, 2020.

REFERENCES

1.	M.N.Arora and PriyankaKatyal, "Cost Accounting", 5th Edition, Vikas publishing House, New Delhi, 2023.
2.	Ravi M.Kishore, " Cost and Management Accounting", 6th Edition, Taxmann, New Delhi, 2021
3.	M.N.Arora, "Cost and Management Accounting",11th Edition, Vikas Publishing, New Delhi, 2021.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the conceptual frame work of cost accounting	Understanding (K2)
CO2	understand the basic concepts and process in determination of cost of product and services	Understanding (K2)
CO3	use the basic costing methods in different business situation	Applying (K3)
CO4	demonstrate the advanced costing methods in various decision making situation	Applying (K3)
CO5	prepare various types of budgets and determine variance in different situations.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										2	3	1		
CO2										2	3	1		
CO3										2	3	1		
CO4										2	3	1		
CO5										2	3	1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	15	35	50				100
CAT 3	15	35	50				100
ESE	25	25	50				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MBO02 Economic Analysis for Decision Making							
(Offered by Department of Management Studies)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Basic understanding of differential calculus**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	The course aims at introducing a few vital techniques required for carrying out economic analysis for making informed managerial decisions.	
Unit – I	**Economic Optimization**	**9 + 3**
Economic Optimization: Theory of firm – Business versus Economic profit – Revenue relations – Cost relations – Profit relations – Marginal versus incremental concept.		
Unit – II	**Forecasting**	**9 + 3**
Forecasting: Forecasting applications – Techniques –Naire method – Moving average – Exponential smoothing - Trend analysis – Linear Trend – Growth Trend – Sales, cost and revenue forecasting.		
Unit – III	**Production and Cost Analysis**	**9 + 3**
Production: Production function – Returns to scale and returns to factor – Total, managerial and average product – Law of diminishing returns – Optimal input usage – Production function estimation. **Cost Analysis:** Economic and Accounting costs – Time in cost analysis – Short run cost – Long run cost – cost relations – cost volume – profit analysis.		
Unit – IV	**Competitive Market Analysis**	**9 + 3**
Competitive Market Analysis: Characteristics of competitive markets – Profit maximisation – Marginal analysis in competition – competitive market supply curve – Equilibrium in competitive markets - Monopoly – Monopolistic competition.		
Unit – V	**Game theory and Competitive Strategy**	**9 + 3**
Game Theory Basics - Prisoner's Dilemma - Saddle Point - Two Person Zero Sum Game - Games without Saddle Points - Dominance Rule - Mixed Strategies.		
		Lecture: 45, Tutorial: 15, Total:60

TEXT BOOKS

1.	Mark Hirschey, “Managerial Economics”, 12th Edition, Cengage Learning, New Delhi, 2022.
2.	Geetika, PiyaliGhosh, Purba Roy Choudhury, “Managerial Economics”, 3rd Edition, McGraw Hill Education, New Delhi, 2019.

REFERENCES

1.	Gupta. G, “Managerial Economics”, 2nd Edition, McGraw Hill Education, New Delhi, 2019.
2.	Ahuja. H. L, “Principles of Microeconomics”, 22nd Edition, S. Chand Publishing, New Delhi, 2019.
3.	PanneerSelvam R, P. Sivasankaran, P. Senthilkumar., “Managerial Economics”, 1st Edition, Cengage Learning, New Delhi, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Understand revenue, cost and profit relations and apply techniques to find best course of action.	Applying (K3)
CO2	Apply appropriate forecasting techniques for estimating sales, cost and revenue.	Applying (K3)
CO3	Understand the relation between inputs and output of production system and perform cost – volume – profit analysis	Applying (K3)
CO4	Apply market equilibrium concepts in monopoly and monopolistically competitive markets.	Applying (K3)
CO5	Understand game theory and apply in different strategic decisions	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					2					1	3			
CO2					2					1	3			
CO3					2					1	3			
CO4					2					1	3			
CO5					2					1	3			

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	35	35	30				100
CAT2	15	45	40				100
CAT 3	15	35	50				100
ESE	5	40	55				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MBO03 Marketing Analytics							
(Offered by Department of Management Studies)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Basic understanding of differential calculus**	**7**	**OE**	**3**	**1**	**0**	**4**

Preamble	Marketing analytics enables marketers to measure, manage and analyze marketing performance to maximize its effectiveness and optimize return on investment (ROI). This course exposes the students with the tools to measure customer value and apply analytic tools to various marketing decisions.	
Unit – I	**Market & Marketing Analytics**	**9 + 3**
Introduction - Introduction to marketing analytics, Models & Metrics **Market Insight** - Market sizing. **Market Segmentation** –Segmentation, Targeting & Positioning		
Unit – II	**Business & Competition**	**9 + 3**
Competitive Analysis - Competitor identification, analysis, and actions **Business Strategy** –Scenarios, Decision Model, Metrics **Business Operations** - Forecasting		
Unit – III	**Product and Price**	**9 + 3**
Product and Service Analytics - Conjoint analysis and product/service metrics **Price Analytics** - Pricing techniques and assessment		
Unit – IV	**Distribution & Promotion**	**9 + 3**
Distribution Analytics –Characteristics, Channel evaluation and selection, Multichannel distribution and metrics. **Promotion Analytics** - Promotion budget estimation and allocation, Metrics		
Unit – V	**Sales**	**9 + 3**
Sales Analytics - Metrics for sales, profitability, and support		
		Lecture: 45, Tutorial: 15, Total:60

TEXT BOOKS

1.	Stephen Sorger, "Marketing Analytics: Strategic Models and Metrics", 1st Edition, Admiral Press, UK, 2016.
2.	Wayne L. Winston, "Marketing Analytics: Data-Driven Techniques with Microsoft Excel", 1st Edition, Wiley, New Delhi, 2018.

REFERENCES

1.	Tommy Blanchard, "Data Science for Marketing Analytics", 1st Edition, Packt Publishing, UK, 2019.
2.	Mike Grigsby, "Marketing Analytics", 2nd Edition, Kogan Page, UK, 2018.
3.	David A. Aaker, V. Kumar, Robert P. Leone, George S. Day., "Marketing Research", 1st Edition, Wiley, New Delhi, 2019.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Understand the importance of Analytics in Marketing, size and segment the market	Understanding (K2)
CO2	Understand the Business, competition and its related decisions.	Understanding (K2)
CO3	Identify important features of a product and suitable pricing methods.	Applying (K3)
CO4	Assess Channel performance and Promotion Metrics.	Applying (K3)
CO5	Assess sales performance.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										2	3	1		
CO2										2	3	1		
CO3										2	3	1		
CO4										2	3	1		
CO5										2	3	1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	35	65					100
CAT2	15	35	50				100
CAT 3	15	15	70				100
ESE	25	25	50				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAO01 - MATHEMATICAL FOUNDATIONS FOR MACHINE LEARNING							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To impart the basic knowledge in linear algebra, decomposition of matrices, continuous optimization, linear regression and support vector machines which provide the foundations for machine learning and deep learning.	
Unit – I	**Vector Spaces:**	**9+3**
Real Vector spaces (Definition & Problems) – Subspaces – Linear Combinations – Linear dependence and independence – Basis and dimension – Row space, Column space and Null Space.		
Unit – II	**Linear Transformations:**	**9+3**
Introduction – Rank and nullity. – Dimension theorem – Kernel and range – Change of basis – Composition and inverse transformations – Matrices of linear transformations.		
Unit – III	**Inner Product Spaces:**	**9+3**
Norms – Inner products – Length and Distance – Angle and Orthogonality – Orthonormal Basis – Gram-Schmidt Process – QR-Decomposition.		
Unit – IV	**Matrix Decomposition and Vector Calculus:**	**9+3**
Matrix Decomposition: Cholesky decomposition – Singular Value Decomposition. Vector Calculus: Differentiation of Univariate Functions – Partial Differentiation and Gradients – Gradients of Vector valued functions – Gradients of matrices – Useful Identities for Computing Gradients – Higher Order Derivatives – Linearization and Multivariate Taylor Series.		
Unit – V	**Optimization:**	**9+3**
Introduction – Classification of Optimization Problems – Constrained multivariable optimization with inequality constraints – Kuhn Tucker conditions – Lagrange's multiplier method –- Unconstrained optimization: Steepest descent method – Newton's method.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Howard Anton and Chris Rorres, "Elementary Linear Algebra", 11th Edition, John Wiley & Sons, New Delhi, 2014 for Units I,II,III.
2.	M. P. Deisenroth, A. A. Faisal, and C. S. Ong, "Mathematics for Machine Learning", 1st Edition Cambridge University Press, 2019 for Units – IV, V.

REFERENCES:

1.	David C. Lay, Steven R. Lay, Judith McDonald, "Linear Algebra and its Applications", 5th Edition, Pearson Education, New Delhi, 2016.
2.	Ethem Alpaydin, "Introduction to Machine Learning(Adaptive Computation and Machine Learning series)", 4th Edition, MIT Press,USA,2020.
3.	R. O. Duda, E. Hart, and D.G. Stork, "Pattern classification", 2nd Edition, John Wiley & Sons, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the concepts of vector spaces.	Understanding (K2)
CO2	interpret the concepts of linear transformations.	Understanding (K2)
CO3	apply the concept of inner product space and decompose the given matrix by means of orthonormal vectors.	Applying (K3)
CO4	demonstrate the knowledge of factorisation of matrices and vectors in Machine learning.	Understanding (K2)
CO5	identify suitable optimization algorithms for machine learning applications.	Applying (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	1												
CO3	3	2												
CO4	3	3	3	1										
CO5	3	2	3	3										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	65	20				100
CAT2	15	65	20				100
CAT3	15	50	60				100
ESE	10	40	50				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAO02 - NUMERICAL COMPUTING

(Offered by Department of Mathematics)

Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To impart knowledge in interpolation, numerical differentiation and integration. Also develop skills to apply numerical algorithms to identify roots of algebraic and transcendental equations, finding eigen values and solve linear system of equations, ordinary differential equations.

Unit – I	**Solution to Algebraic and Transcendental Equations and Eigen value problems:**	**9+3**

Solution to Algebraic and Transcendental Equations**:** Bisection method **-** Iteration method – Method of false position – Newton-Raphson method
Iterative method for Eigen values: Power method – Jacobi's method.

Unit – II	**Solution of Simultaneous Linear Algebraic equations:**	**9+3**

Introduction - Direct methods: Gauss elimination method – Gauss - Jordan method – LU decomposition method – Crout's method –Iterative methods: Gauss Jacobi and Gauss – Seidel methods.

Unit – III	**Interpolation:**	**9+3**

Interpolation with equal intervals: Newton's forward and backward difference formulae – Central difference interpolation formulae: Gauss forward and backward interpolation formulae – Interpolation with unequal intervals: Lagrange's interpolation formula – Newton's divided difference formula.

Unit – IV	**Numerical Differentiation and Integration:**	**9+3**

Differentiation using Newton's forward, backward and divided difference formulae – Numerical integration: Trapezoidal rule – Simpsons $1/3^{rd}$ rule – Simpsons $3/8^{th}$ rule – Double integrals using Trapezoidal and Simpson's rules.

Unit – V	**Numerical Solution of First order Ordinary Differential Equations:**	**9+3**

Single step methods**:** Taylor series method – Euler method – Modified Euler method – Fourth order Runge-Kutta method – Multi step methods: Milne's predictor corrector method – Adam's Bashforth method.

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Veerarajan T, Ramachandran T., "Numerical Methods", 1^{st} Edition, Tata McGraw Hill Publishing Company, New Delhi, 2018.

REFERENCES:

1.	Kandasamy, P., Thilakavathy, K. and Gunavathy, K., "Numerical Methods", Reprint Edition, S.Chand & Co, New Delhi, 2016.
2.	Sankara Rao. K., "Numerical Methods for Scientists and Engineers", 3^{rd} Edition, Prentice Hall of India Pvt. Ltd, , New Delhi, 2007.
3.	Steven C. Chapra, Raymond P. Canale., "Numerical Methods for Engineers", 7^{th} Edition, McGraw-Hill Education, 2014.
4.	Sastry, S.S, "Introductory Methods of Numerical Analysis", 5^{th} Edition, PHI Learning Pvt. Ltd, 2015.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply various numerical techniques to solve algebraic and transcendental equations.	Applying (K3)
CO2	solve simultaneous linear equations by numerical methods.	Applying (K3)
CO3	compute intermediate values of given evenly (or) unevenly spaced data.	Applying (K3)
CO4	apply the concepts of numerical differentiation and integration in real time applications.	Applying (K3)
CO5	identify the solution of first ordinary differential equations by numerical methods.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	2	2											
CO3	3	3	2											
CO4	3	2	1											
CO5	3	3	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	15	75				100
CAT2	10	15	75				100
CAT3	10	15	75				100
ESE	10	15	75				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAO03 - STOCHASTIC PROCESSES AND QUEUING THEORY							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To provide an in-depth knowledge in random variables, random process, correlation and promote the ability to apply suitable queuing models to real time applications.	
Unit – I	**Random Variables:**	**9+3**
Discrete and Continuous random variables – Probability Mass and Probability density functions – Mathematical expectation and Variance – Moments – Moment generating functions.		
Unit – II	**Random processes:**	**9+3**
General concepts and definitions – Classification – Stationary process – Markov chains – Transition probabilities – Poisson process.		
Unit – III	**Correlation and Spectral densities:**	**9+3**
Auto Correlation – Cross Correlation – Properties (Without Proof) – Power spectral density – Cross spectral density – Properties (Without Proof) – Wiener- Khintchine relation – Relationship between cross power spectrum and cross correlation function.		
Unit – IV	**Queuing Theory:**	**9+3**
Characteristics of a queueing system – Kendall's notation – Queuing model I (Infinite capacity single server Poisson queue model) (M/M/1) : (∞/FIFO) – Little's formulae – Queuing model II (Infinite capacity multiple server Poisson queue model (M/M/C): (∞/FIFO) – Queuing model III (Finite capacity single server Poisson queue model) (M/M/1): (N/FIFO) – Queueing model IV (Finite capacity multiple server Poisson model) (M/M/C) : (N/ FIFO).		
Unit – V	**Non-Markovian Queues and Queue Networks:**	**9+3**
Introduction to Non-Markovian queues – M/G/1 queue – Pollaczek-Khintchine formula – Series queues – Open and Closed queuing networks		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Veerarajan, T, “Probability and Statistics, Random Processes and Queuing Theory”, 1st edition, McGraw-Hill Education, Chennai, 2019.

REFERENCES:

1.	Athanasios Papoulis, S. Unnikrishna Pillai., “Probability, Random Variables and Stochastic Processes”, 4th edition, McGraw Hill, New Delhi, 2017.
2.	Allen A.O., “Probability, Statistics and Queuing Theory”, 2nd Edition, Academic Press, New Delhi, 1990.
3.	Roy D. Yates and David J. Goodman, “Probability and Stochastic Processes - A friendly Introduction for Electrical and Computer Engineers”, 3rd edition, John Wiley & Sons, 2014.
4.	John F. Shortle, James M. Thompson, Donald Gross and Carl M. Harris, “Fundamentals of Queuing Theory”, 5th edition, John Wiley and Sons, New York, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply random variables suitably in practical problems.	Applying (K3)
CO2	apply the concept of random process in communication problems.	Applying (K3)
CO3	understand the concepts and properties of Spectral Density Function and Cross Correlation function.	Understanding (K2)
CO4	use the appropriate queuing model for a given practical application.	Applying (K3)
CO5	identify the real time queue in computer networks and take decision accordingly.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	2												
CO3	3	2												
CO4	3	3	3										2	
CO5	3	3	3										3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	70				100
CAT2	10	30	60				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAO04 - STATISTICS FOR ENGINEERS								
(Offered by Department of Mathematics)								
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To impart the basic knowledge in presentation of data, descriptive statistical measures and provide skills to apply correlation, suitable non- parametric tests and control charts to control the variations in real time applications.	
Unit – I	**Organization and Presentation of Data:**	**9+3**
Introduction to Statistics – Collection of data – Classification and tabulation of data – Types of data: primary, secondary, quantitative and qualitative data – Types of Measurements: nominal, ordinal, discrete and continuous data – Presentation of data – Diagrammatic and Graphical Representation: Histogram - Frequency curve - Frequency polygon - Cumulative frequency distributions – Ogive curves – Stem and leaf chart.		
Unit – II	**Descriptive Statistics:**	**9+3**
Measures of location or central tendency: Arithmetic mean – Median – Mode – Geometric mean – Harmonic mean – Partition values: Quartiles – Deciles and percentiles – Measures of dispersion: Mean deviation – Quartile deviation – Standard deviation – Coefficient of variation – Measures of skewness – Kurtosis.		
Unit – III	**Correlation and Regression:**	**9+3**
Correlation and Regression: Scatter Diagram – Karl Pearson's Correlation Coefficient – Rank Correlation - Regression Coefficients – Fitting of Regression Lines. Multiple Correlation and Regression: Multiple and partial correlation – Method of least squares – Plane of regression – Properties of residuals – Coefficient of multiple correlation – Coefficient of partial correlation – Multiple correlation with total and partial correlations – Regression and partial correlations in terms of lower order coefficient..		
Unit – IV	**Non-parametric tests:**	**9+3**
Introduction – Sign test: One sample sign test – Sign test for paired samples – Signed rank test – Rank Sum test: Mann Whitney U test – Kruskal-Wallis test – One sample run test – Tests of randomness.		
Unit – V	**Statistical Quality Control:**	**9+3**
Introduction to Statistical quality control – Control charts – Control chart for variables: $\bar{X}$-chart – R-chart – s-chart – Charts for attributes: np-chart – p-chart – c-chart.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	S.P.Gupta, "Statistical Methods", 44th Revised Edition, Sultan Chand & Sons, New Delhi, 2011 for Units I,II, V
2.	S.C.Gupta, V.K.Kapoor, "Fundamentals of Mathematical Statistics", 12th Edition, Sultan Chand & Sons, New Delhi, 2022. for Units III, IV.

REFERENCES:

1.	Jay L. Devore., "Probability and Statistics for Engineering and the Sciences", 9th Edition, Cengage Learning, USA, 2016.
2.	G.C.Beri, "Business Statistics", 3rd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
3.	Johnson. R.A., Miller. I and Freund. J., "Probability and Statistics for Engineers", 9th Edition, Pearson Education, India, 2018.
4.	Anthony Hayter, "Probability and Statistics for Engineers and Scientists", 4th Edition, Cengage Learning, USA, 2012.
5.	J. K. Sharma, "Business Statistics", 5th Edition, Vikas Publishing House Pvt Ltd, Noida, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	demonstrate the classification of data and present the data in various forms.	Understanding (K2)
CO2	compute and interpret descriptive statistical measures using numerical and graphical techniques.	Applying (K3)
CO3	apply statistical methods like correlation, regression analysis in analysing and interpreting experimental data.	Applying (K3)
CO4	use appropriate non-parametric test to analyze experimental data.	Applying (K3)
CO5	identify suitable control charts for monitoring processes..	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	3	2												
CO3	3	3	2											
CO4	3	3	1											
CO5	3	3	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	50				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22PHO01 - THIN FILM TECHNOLOGY
(Offered by Department of Physics)

Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to impart the essential knowledge on deposition, characterization and application of thin films in various engineering fields, and also provides motivation towards innovations.	
Unit – I	**Theories and models of thin film growth:**	**9+3**
Introduction – Theories of thin film nucleation: Impingement, Adsorption and Thermal accommodation – The capillarity model – The atomistic models – Structural consequences of thin film nucleation – The four stages of film Growth – The incorporation of defects during growth.		
Unit – II	**Vacuum technology:**	**9+3**
Principle and working of vacuum pumps: Roots vacuum pump, Rotary pump, Diffusion pump, Turbo molecular pump, Cryogenic pump, Ion pump, Ti-sublimation pump – Measurement of Pressure: Bayet-Albert gauge, Pirani and Penning gauge – Cold cathode and hot cathode ionization gauges – Pressure controlling system (qualitative).		
Unit – III	**Deposition of thin films - Physical methods:**	**9+3**
Thermal evaporation – Electron beam evaporation – Pulsed laser deposition – Ion plating – DC sputtering – RF sputtering – Magnetron sputtering – Reactive sputtering – Molecular beam epitaxy - Demonstration of deposition of thin films by RF sputtering.		
Unit – IV	**Deposition of thin films – Chemical methods:**	**9+3**
Chemical vapor deposition – Sol-gel method – Chemical bath deposition – Hydro thermal methods – Electroplating deposition – Electroless deposition – Spray Pyrolysis - Spin coating.		
Unit – V	**Characterization and Applications of thin films:**	**9+3**
Characterization: X-ray diffraction, Energy dispersive X-ray analysis, Atomic probe microscopy, Scanning Tunneling Microscope, X-ray Photoemission Spectroscopy, UV-vis spectroscopy and Four probe resistivity – Applications (qualitative): Thin film solar cells, Thin film gas sensors, Thin films for information storage and Optical coatings.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Maissel L.I. and Glang R, Hand book of Thin Film Technology, Reprint, McGraw Hill Inc., New York, 1970, (Unit I – IV)
2.	Sam Zhang, Lin Li and Ashok Kumar, Materials Characterization Techniques, 1st edition, CRC Press, Boca Raton, 2008 (Unit V)

REFERENCES:

1.	Ohring M, Material Science of Thin Films, 2nd Edition, Academic Press, New Jersey, 2001
2.	Goswami A, Thin Film Fundamentals, Reprint, New Age International (P) Ltd, New Delhi, 2003
3.	Chopra K. L, Thin Film Phenomena, Illustrated, McGraw Hill Inc., New York, 1969

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	utilize the appropriate theory and models to comprehend the thin film growth process.	Applying (K3)
CO2	apply the principle of vacuum pump to explain select methods to create vacuum and to make use of the principle of vacuum gauge to explain the measurement of vacuum by select methods.	Applying (K3)
CO3	describe the deposition of thin films by select physical methods using the principle of working of respective methods.	Applying (K3)
CO4	explain the deposition of thin films by select chemical methods using the principle of working of respective methods.	Applying (K3)
CO5	make use of select characterization techniques to comprehend the properties of thin films and also to illustrate the various device applications of thin films.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2						2	2		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	2	2						2	2		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)**

22PHO02 - HIGH ENERGY STORAGE DEVICES
(Offered by Department of Physics)

Programme& Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	This course aims to impart the essential knowledge on the fundamental principles and application areas of proven technologies and materials for energy storage solutions, together with an overview of development trends in this engineering field.	
Unit – I	**Introduction to Energy Storage:**	**9+3**
An overview of energy storage systems (qualitative): Thermal energy storage, mechanical energy storage, chemical energy storage, electrical energy storage, electrochemical energy storage, electrostatic energy storage, magnetic energy storage and optical energy storage – General criteria of energy storage systems – Conventional batteries: fundamentals and applications – Grid connected and off grid energy storage systems and requirements.		
Unit – II	**Thermal storage and Mechanical Storage:**	**9+3**
Thermal storage: Thermal properties of materials, principle of operations, efficiency factors, large scale and medium scale operations – Merits and demerits of thermal storage system – Recent development in thermal storage systems. Mechanical Storage: Types of mechanical storage systems, principle of operations, emerging advances and technologies in mechanical storage systems – Flywheel.		
Unit – III	**Magnetic storage, Electro-optic, Optical and Chemical Storage:**	**9+3**
Magnetic storage: Principle of operation, emerging challenges and a review on devices and technology. Electro-optic and optical storage: Emerging devices and upcoming technologies (qualitative). Chemical storage: Power to gas – Hydrogen and Methane. Power to liquid – Bio fuels – Aluminum-Boron, silicon, and zinc.		
Unit – IV	**Electrochemical Storage:**	**9+3**
Materials, Principle of operation, positive electrode materials, negative electrode materials, electrolytes. Li-ion batteries: Principle of operation, battery components, design of electrodes, cell and battery fabrications – Building block cells – Battery modules and packs –Li-polymer batteries – Applications – Future developments: Sodium-battery, magnesium battery, aluminum battery and silicon battery.		
Unit – V	**Fuel Cells, Hydrogen storage and Super capacitors:**	**9+3**
Fuel Cells: Introduction to fuel cells, PEM (polymer electrolyte membrane), Hydrogen PEM fuel cell, direct methanol fuel cell, alkaline fuel cells and solid oxide fuel cells. Hydrogen storage systems: Solid state hydrogen storage tanks, gas phase hydrogen storage tanks, cryogenic hydrogen storage tanks and liquid phase hydrogen storage tanks. Super capacitors: Features of super capacitors, basic principle of operation, performance and technologies of super capacitors.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Robert A. Huggins, Energy Storage, Springer, 2010, (Unit I – V)
2.	Ehsani, Y. Gao, S. Gay, A. Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, CRC Press, New York, 2005 (Unit I - V)

REFERENCES:

1.	Yuping Wu, Lithium-Ion Batteries: Fundamentals and Applications (Electrochemical Energy Storage and Conversion), CRC Press, United Kingdom, 2015
2.	Trevor M. Letcher, Storing Energy: with Special Reference to Renewable Energy Sources, 2nd edition, Elsevier, 2022
3.	D. Linden and T. S. Reddy, Handbook of Batteries, 4th edition, McGraw Hill, Newyork, 2011

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	utilize the appropriate concepts and models to comprehend the basics of energy storage systems.	Applying (K3)
CO2	apply the principle of thermal and mechanical storage systems to explain the working and the recent advancements in thermal and mechanical storage systems.	Applying (K3)
CO3	ultilize the principle of operation of magnetic storage systems, electro-optic, optical and chemical storage systems to illustrate the respective process under gone in these techniques.	Applying (K3)
CO4	explain the principle of operation of electrochemical storage device and materials used and to elucidate the construction and working of various types of high energy storage batteries.	Applying (K3)
CO5	make use of various techniques to construct different types of fuel cells and to explain the advanced techniques involved in hydrogen storage systems and also to explain the principle and working of super capacitors.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2						2	2		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	2	2						2	2		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22PHO03 - STRUCTURAL AND OPTICAL CHARACTERIZATION OF MATERIALS
(Offered by Department of Physics)

Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to impart the essential knowledge on the characterization of materials using X-ray diffraction, Raman spectroscopy, UV-visible spectroscopy, Electron microscopy and Scanning tunneling microscopy and their application in various engineering fields, and also provides motivation towards innovations.	
Unit – I	**Introduction to Characterization Techniques and X-Ray Diffraction:**	**9+3**
Importance of materials characterization – Classification of characterization techniques – Crystalline materials – Reciprocal lattice – Theory of X-ray diffraction – Powder and Single crystal X-ray diffraction: Instrumentation (qualitative), XRD pattern, systematic procedure for structure determination (qualitative), crystallite size determination (Scherrer equation), strain calculation – Applications.		
Unit – II	**Electron Microscopy:**	**9+3**
Need of electron microscopy – Electron specimen interaction: Emission of secondary electrons, backscattered electrons, characteristic X-rays, transmitted electrons, specimen interaction volume – Resolution – Scanning electron microscope and transmission electron microscope: Schematic diagram and working – Different types of filaments – Field emission scanning electron microscope –Wavelength dispersive X-ray analysis – Three parameter equation for quantitative composition analysis.		
Unit – III	**Scanning Tunneling Microscopy:**	**9+3**
Introduction to quantum mechanical tunneling – Basic principles of scanning tunneling microscopy – Two modes of scanning: constant height mode and constant voltage mode – Instrumentation and working – Applications.		
Unit – IV	**Raman Spectroscopy:**	**9+3**
Introduction – Pure rotational Raman spectra – Vibrational Raman spectra – Polarization of light and Raman effect – Structure determination – Instrumentation and working – Near-Infra-Red Raman Spectroscopy – Applications.		
Unit – V	**Ultra Violet &Visible Spectroscopy:**	**9+3**
Regions of UV-Visible radiation – Colour and light absorption – Chromophore concept – Beer's and Lambert's laws – Theory of electronic transition – Frank-Condon principle – Instrumentation and working – Applications.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Cullity B. D. and Stock S. R, Elements of X-ray diffraction, 3rd Edition, Pearson Education, India, 2003 (Unit I)
2.	Banwell C. N, McCash E. M, Choudhury H. K, Fundamentals of Molecular Spectroscopy, 5th Edition, Tata McGraw-Hill Publ., New Delhi, 2013 (Unit II-V)

REFERENCES:

1.	Holt D. B. and Joy D. C, SEM micro characterization of semiconductors, 1st Edition, Academic Press, New Delhi, 1989
2.	Willard H. H., Merritt L. L., John A Dean, and Settle Jr. F. A, Instrumental methods of Analysis 7th Edition, Wadsworth Publishing Company, United States, 1988
3.	Elton N. Kaufman, Characterization of Materials (Volume1 & 2), 2nd, Wiley-Interscience, New Jersey, 2012

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply the concept of X-ray diffraction to determine the crystal structure and related structural parameters of materials.	Applying (K3)
CO2	determine the micro-structural parameters of materials and to perform surface analysis of materials using the concept of matter waves and electron microscopy.	Applying (K3)
CO3	utilize the concept and phenomenon of quantum mechanical tunneling to interpret the surface image recorded at atomic level using scanning tunneling microscopy.	Applying (K3)
CO4	make use of the concept of Raman effect and Raman spectroscopy to determine the crystal structure and related structural parameters of materials.	Applying (K3)
CO5	apply the theory of UV-Vis spectroscopy to comprehend the working of UV-Vis spectrophotometer.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2						2	2		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	2	2						2	2		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	25	35	40				100
CAT3	30	30	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22CYO01 - INSTRUMENTAL METHODS OF ANALYSIS

(Offered by Department of Chemistry)

Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	Instrumental methods of analysis aim to prepare the students to have all-encompassing knowledge of spectral methods in order to identify the molecules and reaction mechanism for the process to enhance application towards the industries.	
Unit – I	**Absorption and Emission Spectroscopy**	**9+3**
Basic concepts of Absorption and Emission Spectroscopy – representation of spectra – basic elements of practical spectroscopy – signal to noise ratio - techniques for signal to noise enhancement – resolving power – Fourier transform spectroscopy – evaluation of results – basic principles, instrumentation and applications of Atomic Absorption, Atomic Fluorescence and Atomic Emission Spectroscopy.		
Unit – II	**IR, Raman and NMR Spectroscopy**	**9+3**
Infrared Spectroscopy – correlation of IR Spectra with molecular structure, instrumentation, samplings technique and quantitative analysis. Raman Spectroscopy – Classical and Quantum theory instrumentation, Structural analysis and quantitative analysis. Nuclear Magnetic resonance Spectroscopy – basic principles – pulsed Fourier transform NMR spectrometer – Structural elucidation using NMR spectra and quantitative analysis.		
Unit – III	**Surface Studies**	**9+3**
Surface Study – X-Ray Emission Spectroscopy (XES), X- Ray Photo Electron Spectroscopy (XPS) - Auger Electron Spectroscopy (AES) - Transmission Electron Microscopy (TEM) - Scanning Electron Microscopy (SEM) - Surface Tunneling Microscopy (STEM) - Atomic Force Microscopy (AFM).		
Unit – IV	**Mass Spectroscopy**	**9+3**
Mass spectroscopy – Ionization methods in mass spectroscopy – mass analyzer – ion collection systems - correlation of molecular spectra with molecular structure - Instrumentation design and application of Fourier Transform Mass Spectroscopy (FT-MS) and Ion Microprobe Mass Analyzer (IMMA).		
Unit - V	**Thermal Analysis**	**9+3**
Thermal Analysis: principles and instrumentations and applications of Thermogravimetry (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), evolved gas detection, Thermo Mechanical Analysis and Thermometric Titration.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Chatwal. G. R., Anand, Sham K., “Instrumental Methods of Chemical Analysis” 5th Edition, Himalaya Publishing House, 2019.

REFERENCES:

1.	B.K. Sharma, Instrumental Method of Chemical Analysis, Krishna Prakashan Media (P) Ltd. 2019.
2.	Willard,H.H, Merritt,L.L, Dean,J.A, and Settle, F.A, “Instrumental methods of analysis” CBS Publishers & Distributors, 7 Ed, 2004.
3.	Kaur. H, “Instrumental Methods of Chemical Analysis”, XII Edition, Pragati prakashan, Meerat, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	illustrate the basics of spectroscopy to understand the instrumentation of various spectral techniques.	Understanding (K2)
CO2	apply the IR, Raman and NMR for quantitative analysis of the sample.	Applying (K3)
CO3	apply the various techniques for the better understanding of surface morphology.	Applying (K3)
CO4	explain the principle, instrumentation of mass spectroscopy for the analysis of organic sample.	Understanding (K2)
CO5	illustrate the thermal analysis for the identification of thermal stability of the compounds.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1												
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	1												
CO5	3	1												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO02 - CHEMISTRY CONCEPTS FOR COMPETITIVE EXAMINATIONS
(Offered by Department of Chemistry)

Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to refresh the knowledge of chemistry required for competitive examinations and equip the students with a capacity to solve the problems in chemistry while participating various competitive examinations including TNFUSRC-FORESTER (paper-II: General science-chemistry), UPSC-IAS (prelims: General science-chemistry), GATE (thermodynamics concept for chemical & mechanical engineering).	
Unit – I	**Periodic Classification of Elements**	**9+3**
Mendeleev's periodic table-Law and classification of elements- Modern periodic law-Modern periodic table and its characteristics - Periodic properties – important aspects of s, p & d block elements -Reactivity series and Uses - Alloys-Uses of Alloys- Properties of nano metals and oxides.		
Unit – II	**Chemical Equations and Bonding**	**9+3**
Chemical Equations: Types of ions and radicals- oxidation and reduction-redox reactions - balancing ionic equations. **Chemical Bonding:** Octet rule -types of chemical bond -formation of ionic and covalent bond- common properties of ionic and covalent compounds- differences between ionic and covalent compounds-Coordinate covalent bond- Coordination compounds – nomenclature and isomerism - application in analytical chemistry.		
Unit – III	**Acids, Bases, Salts and Metallurgy**	**9+3**
Acid- base theory – Bronsted- Lowry theory- conjugate acid-base- Lewis concept- HSAB- applications- pH scale- Importance of pH in everyday life-salts-classification of salts-uses of salts. **Metallurgy:** introduction-terminologies in metallurgy-differences between minerals and ores-occurrence of metals- metallurgy of aluminum, copper and iron.		
Unit – IV	**Carbon and its Compounds**	**9+3**
Introduction-compounds of carbon-modern definition of organic chemistry- bonding in carbon and its compounds-allotropy-physical nature of carbon and its compounds-chemical properties of carbon compounds-homologous series-hydrocarbons and their types-functional groups- classification of organic compounds based on functional group-ethanol-ethanoic acid.		
Unit – V	**Thermodynamics**	**9+3**
Introduction- some important terms in thermodynamics-thermodynamic system, process, properties and energy- first law of thermodynamics: mathematical expression and interpretation- applications of first law of thermodynamics-molar heat capacity-reversible isothermal expansion/compression of an ideal gas-adiabatic expansion of an ideal gas-isobaric and isochoric processes in ideal gases- second laws of thermodynamics: entropy- entropy change for isolated system (system and surroundings)- entropy change for system only (ideal gas)- entropy change for mixing of ideal gases-entropy of physical changes- entropy of chemical changes-Maxwell relations.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Steven S. Zumdahl, Susan A. Zumdahl and Donald J. DeCoste , "Chemistry", 10th Edition, Cengage Learning, 2018., for Units-I, II, III, IV.
2.	Wiley editorial board. "Wiley Engineering Chemistry". 2nd Edition, Wiley India Pvt. Ltd, New Delhi, Reprint 2019, for Units- I, II, III, V.

REFERENCES:

1.	B.R. Puri, L.R. Sharma, Principles of Inorganic Chemistry, 33rd Edition, Vishal Publishing Co., 2020.
2.	Paula Bruise, "Organic Chemistry", 8th Edition, Pearson Education, 2020.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply the basic concept of periodic classification of elements to explain the periodic properties and reactivity series of s, p & d block elements.	Applying (K3)
CO2	utilize the concepts of chemical equation and bonding to solve the problems in balancing ionic equation and differentiate ionic and covalent compounds.	Applying (K3)
CO3	apply the concept of acid, base, salts and metallurgy to explain HSAB concepts, Importance of pH in everyday life, classification of salts and metallurgy of Al, Cu & Fe.	Applying (K3)
CO4	make use of the concept of carbon and its compounds to explain bonding and classification of carbon compounds.	Applying (K3)
CO5	utilize the important terms and concepts of thermodynamics to explain the first law and second law of thermodynamics with examples.	Applying (K3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	1											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO03 – ORGANIC CHEMISTRY FOR INDUSTRY

(Offered by Department of Chemistry)

Programme & Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	Organic Chemistry for Industry aims to equip the students to have wide-range knowledge on organic chemistry in order to meet the industrial needs.	
Unit – I	**Basic aspects of Organic Chemistry**	**9+3**
Organic intermediates: carbocations, carbanions, free radicals, carbenes and nitrenes, their method of formation, stability and synthetic applications- Nucleophilic uni- and bimolecular reactions (SN1 and SN2)- Elimination reactions (E1 & E2; Hoffman & Saytzeff's rule).		
Unit – II	**Molecular Rearrangements**	**9+3**
Reactions involving electron deficient, carbon, nitrogen, oxygen centers, emphasis on synthetic utility of the rearrangements - Migration of carbon: Wagner-Meerwein, Pinacol-pinacolone, benzyl-benzilic acid rearrangement – Migration of nitrogen: Beckmann rearrangement, Hofmann, Curtius, Lossen rearrangements- Migration of oxygen: Bayer-Villiger oxidation.		
Unit – III	**Synthetic Reagents & Applications**	**9+3**
Lithium aluminium hydride- sodium borohydride- selenium-di-oxide- osmium tetroxide- phenyl isothiocyanate- N-bromosuccinamide (NBS)- lead tetraacetate - dicyclohexylcarbodiimide (DCC) – pyridinium chlorochromate (PCC) – Swern oxidation –p-toluenesulphonyl chloride – trifluoroacetic acid- lithium diisopropylamide (LDA) – 1,3- dithiane (reactive umpolung) - crown ethers-Trimethyl silyl iodide - dichlorodicyanobenzoquinone (DDQ) – Gilman reagent– phase transfer catalysts- Wilkinson's catalysts.		
Unit – IV	**Unit Operations**	**9+3**
Extraction: Liquid equilibria-extraction with reflux-extraction with agitation-counter current extraction. **Filtration:** Theory of filtration- pressure and vacuum filtration-centrifugal filtration. **Distillation:** Azeotropic and steam distillation. **Evaporation**: Types of evaporators-factors affecting evaporation. **Crystallization:** Crystallization from aqueous-non- aqueous solutions factors affecting crystallization-nucleation.		
Unit – V	**Unit Processes**	**9+3**
Nitration: Nitrating agents-aromatic nitration-kinetics and mechanism of aromatic nitration- process equipment for technical nitration-mixed acid for nitration. **Halogenation:** Kinetics of halogenations-types of halogenations-catalytic halogenations-Case study on industrial halogenation process. **Fermentation**: Aerobic and anaerobic fermentation. Production of Antibiotics: Penicillin and Streptomycin-Production of Vitamins: B2 and B12.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	P.S.Kalsi," Organic Reactions and their Mechanisms", 5^{th} Edition, New Age International publishers, 2020, for Unit-I, II, III, V.
2.	Arun Bahl, B.S.Bahl, "Advanced Organic Chemistry", 6^{th} Edition, S Chand, 2022, for Unit-IV, V.

REFERENCES:

1.	V.K.Ahluwalia, Rakesh Parashar, "Organic Reaction Mechanisms" Fourth Edition, 2011
2.	Jonathan Clayden, Nick Greeves, Stuart Warren, "Organic Chemistry", 2^{nd} Edition, Oxford University Press, 2014.
3.	Paula Yurkanis Bruice, "Organic Chemistry",8^{th} Edition, Pearson, 2020.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	illustrate the basic concept of organic intermediates to explain the SN1, SN2, E1 and E2 reactions.	Understanding (K2)
CO2	utilize the concepts of molecular rearrangement to explain reactions involving electron deficient, carbon, nitrogen, oxygen centers, emphasis on synthetic utility of the rearrangements.	Applying (K3)
CO3	select the suitable synthetic regents for various functional group conversions in organic synthesis.	Applying (K3)
CO4	make use of the concept of extraction, filtration, distillation, evaporation, crystallization for the purification of organic compounds.	Applying (K3)
CO5	apply the concept of nitration, halogenations and fermentation to explain the industrial unit process.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1												
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22MAO05 - GRAPH THEORY AND ITS APPLICATIONS							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	To develop rigorous logical thinking and analytical skills by graph theoretic concepts which helps for solving real time engineering problems in networks, computer architecture, compiling techniques, model checking, artificial intelligence, software engineering, expert systems, software/hardware correctness problem.

Unit – I	**Graphs:**	**9+3**
Introduction – Definition – Types of graphs – Degree of vertex – Walk, path and cycle – Isomorphism – Connected graph – Hamiltonian graph – Euler graph – Digraph - Shortest paths – Shortest path algorithms: Dijkstra's algorithm – Warshall's algorithm.		
Unit – II	**Trees:**	**9+3**
Introduction – Properties of trees – Pendant vertices in a tree – Distances and centers in a tree – Rooted and binary trees – Spanning tree – Construction of spanning tree: BFS algorithm – DFS algorithm - Minimum Spanning tree – Minimal spanning tree algorithms: Prim's algorithm – Kruskal's algorithm.		
Unit – III	**Graph Coloring:**	**9+3**
Vertex coloring – Chromatic number – Chromatic partitioning – Independent sets – Chromatic polynomial – Matching – Covering – Four color problem (statement only) – Simple applications.		
Unit – IV	**Matrix Representation and Applications:**	**9+3**
Matrix Representation: Incidence matrix – Circuit matrix - Cut-set matrix – Path Matrix – Adjacency matrix – Properties - The Chinese Postman Problem – Fleury's Algorithm – Travelling salesman problem.		
Unit – V	**Network Flows and Applications:**	**9+3**
Flows and cuts in networks - Max-flow Min-cut Theorem – Transport networks –Residual capacity and Residual network – Ford-Fulkerson Algorithm – Edmonds-Karp Algorithm – Maximal Flow Applications: Multiple sources and sinks – Maximum Bipartite matching.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", 1st Edition, Dover Publications, New York, 2016 for Units I, II, III.
2.	S. Saha Ray, "Graph Theory with Algorithms and Its Applications in Applied Science and Technology", 1st Edition, Springer, London, 2013 for Units IV,V.

REFERENCES:

1.	Douglas B West, "Introduction to Graph Theory", 2nd Edition, Pearson Education, New Delhi, 2002.
2.	Jonathan L. Gross and Jay Yellen, "Graph Theory and its Applications", 2nd Edition, CRC Press, New York, 2006.
3.	J.A.Bondy and U.S.R. Murty ,Graph Theory and Applications , 5th Edition, Elsevier Science Publishing Co., Inc., New York,1982.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply basic graph theoretic concepts in finding shortest path.	Applying (K3)
CO2	intrepret the concepts of tress and its types.	Applying (K3)
CO3	compute the Chromatic partition, Chromatic polynomial and Matching of a given graph.	Applying (K3)
CO4	apply the concepts of matrix representation of graph structures.	Applying (K3)
CO5	identify the maximal flow in network by means of suitable algorithms.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	1												
CO3	3	1												
CO4	3	2	2											
CO5	3	2	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAX01 - DATA ANALYTICS USING R PROGRAMMING							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**0**	**2**	**4**

Preamble	To impart the basic knowledge in R and develop skills to apply the knowledge of R programming to statistical measures, data handling, probability, testing of hypothesis and design of experiments.	
Unit – I	**Introduction to R:**	**9**
Overview of R programming – Need for R – Installing R – Environment setup with R Studio – Packages: Installing packages – Running and manipulating packages – Basic objects: Vectors – Matrix – Array – Lists – Factors – Data frames.		
Unit – II	**R Programming Structures and Functions:**	**9**
Basic expressions: Arithmetic expressions – Control Statements: if and if-else statements –– switch statement – Loops: for loop – while loop – Function: Creating a function – calling a function – Default value for function arguments – Logical functions – Math functions – Statistical functions – Apply-family functions – Getting started with strings – Formatting data and time.		
Unit – III	**Descriptive Statistics:**	**9**
Summary command – Summarizing samples – cumulative statistics – summary statistics for data frames – summary tables – Linear Modeling: Simple linear regression – Multiple regression – Curvilinear regression – Plotting linear models and curve fitting.		
Unit – IV	**Working with data:**	**9**
Reading and writing data: Text-format in a file – Excel worksheets – Native data files – built-in datasets. Visualizing data: Scatter plots – line plots – bar charts – pie charts – Cleveland dot charts –Histogram and density plots – Box-whisker plots.		
Unit – V	**Probability Distributions, Testing of hypothesis and ANOVA:**	**9**
Probability Distributions: Binomial Distribution – Poisson Distribution – Normal Distribution. Testing of Hypothesis and ANOVA: Student's t-test – Non-Parametric tests: Wilcoxon U-test – Paired t and U-tests – Correlation and covariance – Tests for association – Analysis of variance: One-way ANOVA – Two-way ANOVA.		

List of Exercises / Experiments:	
1.	Implementation of operations of data objects such as vector, list and matrix.
2.	Implementation and use of array, factors and data frames in R.
3.	Programs using decision making statements and looping structures.
4.	Programs to demonstrate programming concepts using functions (Using built-in and user-defined functions)
5.	Performing various basic statistical measures for the given data.
6.	Calculate the regression coefficient and obtain the lines of regression for the given data.
7.	Creating and reading various types of data files.
8.	Create different charts for visualization of given set of data.
9.	Computation of probability using Binomial, Poisson and Normal distributions.
10.	Perform the t-test for testing significance of mean.
11.	Perform various non-parametric tests for the given sample data.
12.	Perform One way and two way ANOVA.
	Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Kun Ren, "Learning R Programming", 1st Edition, Packt Publishing Ltd, UK, 2016 for Units I, II.
2.	Mark Gardener, "Beginning R-The Statistical Programming Language",1st Edition, John Wiley & Sons,Inc, USA, 2012 for Units III,IV, V.

REFERENCES:

1.	Seema Acharya, "Data Analytics using R", 1st Edition, McGraw Hill Education, Chennai, 2018.
2.	Norman Matloff, "The Art of R Programming", 1st Edition, No Starch Press, San Francisco, 2011.
3.	Paul Teetor, "R Cookbook", 1st Edition, O'Reilly Media, USA, 2011.

4.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the basics of fundamentals of R.	Understanding (K2) Manipulation (S2)
CO2	apply the concepts of decision, looping structures and functions in real time problems.	Applying (K3) Manipulation (S2)
CO3	apply R programming to descriptive statistics.	Applying (K3) Manipulation (S2)
CO4	apply the libraries for data manipulation and data visualization in R.	Applying (K3) Manipulation (S2)
CO5	use R studio to identify the probability and test statistical hypothesis.	Applying (K3) Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1											
CO2	3	1	1		2									
CO3	3	2	2	2	2									
CO4	3	3	2	3	2									
CO5	3	2	2	3	2									

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAO06 - OPERATIONS RESEARCH							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	To provide the skills for solving the real time engineering problems involving linear objective functions, transportation models and also impart knowledge in finding optimal solutions to problems involving limited resources, project management techniques and game theoretic concepts.	
Unit – I	**Linear Programming:**	**9+3**
Introduction to Operations research – Applications of OR – Linear Programming – Formation of Linear Programming Problem – Solution of LPP: Basic concepts – Graphical Solution – Simplex method – Artificial techniques: Big M method.		
Unit – II	**Transportation and Assignment Problems:**	**9+3**
Transportation Problem: Introduction – Mathematical formulation – Solution of transportation problem: Initial basic feasible solution: North-West Corner Rule – Vogel's Approximation Method – Optimal Solution: MODI method. Assignment Problems: Introduction – Mathematical Formulation – Hungarian Algorithm.		
Unit – III	**Game Theory:**	**9+3**
Introduction – Basic Terminology – Two-Person zero sum games – Pure strategies (Games with saddle point) – Mixed Strategies (Games without saddle points) – Rule of Dominance – Solution of Mixed Strategy games: Algebraic method – Arithmetic method – Graphical method.		
Unit – IV	**Sequencing models:**	**9+3**
Sequencing problems: Introduction – Johnson's algorithm – Processing of n jobs through two machines – Processing of n jobs through three machines – Processing of 'n' jobs through 'm' machines - Processing of two jobs through 'm' machines.		
Unit – V	**Network and Project Management:**	**9+3**
Introduction – Basic terminology **–** Rules of Network construction – Fulkerson's Rule for numbering of events – Construction of network – Critical Path Method (CPM) – Programme Evaluation and Review Technique (PERT).		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Sharma J.K, "Operations Research – Theory and Applications", 6th Edition, Trinity Press, India, New Delhi, 2017.

REFERENCES:

1.	Taha, Hamdy A., "Operation Research: An introduction", 9th edition, Pearson Education, 2010.
2.	Hiller, Frederick. S. and Lieberman, Gerald. J., "An introduction to Operations research- concepts and cases", Tata McGraw Hill (SIE) 8th edition, 2005.
3.	Ravindran, A., Phillips, D.J., and Solberg, J.J., "Operations Research- Principles and Practice", John Wiley & Sons, 2005.
4.	Kanti Swarup, P.K. Gupta, Man Mohan, "Operations Research", 15th revised Edition, S. Chand & Sons Education Publications, New Delhi, 2017.
5.	Gupta P.K. and Hira D.S., "Operations Research: An Introduction", 7th Revised Edition, S.Chand and Co. Ltd., New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	formulate and solve linear programming problems.	Applying (K3)
CO2	apply transportation and assignment algorithms in engineering problems.	Applying (K3)
CO3	use game theory concepts in practical situations.	Applying (K3)
CO4	identify the minimum processing times for sequencing problems	Applying (K3)
CO5	apply the concepts of CPM and PERT in scheduling the project networks.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAO07 - NUMBER THEORY AND CRYPTOGRAPHY							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	To provide the skills for applying various number theoretic algorithms, congruences, primality tests in cryptography and network security and impart knowledge of basic cryptographic techniques.	
Unit – I	**Divisibility Theory:**	**9+3**
Division algorithm – Base-b representations – Number patterns – Prime and composite numbers – GCD – Euclidean Algorithm – Fundamental theorem of Arithmetic – LCM.		
Unit – II	**Theory of Congruences:**	**9+3**
Basic concepts – Properties of congruences – Linear congruences – Solution of linear congruences – Fermat's Little theorem – Chinese remainder theorem.		
Unit – III	**Number Theoretic Functions:**	**9+3**
Introduction – Functions τ and σ – Mobius function – Greatest integer function – Euler's Phi function – Euler's theorem – Properties of Euler's function – Applications to Cryptography.		
Unit – IV	**Primality testing and Factorization:**	**9+3**
Primality testing: Fermat's pseudo primality test – Solvay-Strassen test – Fibonacci test – Lucas test – Integer factorization: Trial division – Pollard's Rho method – Quadratic sieve method.		
Unit – V	**Classical Cryptographic Techniques:**	**9+3**
Introduction – Substitution techniques – Transposition techniques – Encryption and decryption – Symmetric and asymmetric key cryptography – Steganography.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Thomas Koshy, "Elementary Number Theory with Applications", 2nd Edition, Academic Press, Elsevier, USA, 2007 for Units I ,II, III.
2.	William Stallings, "Cryptography and Network Security: Principles and Practice", 7th Edition, Pearson Education, New Delhi, 2019 for Units IV,V.

REFERENCES:

1.	Ivan Niven, Herbert S. Zukerman, Hugh L. Montgomery, "An Introduction to the Theory of Numbers", Reprint Edition, John Wiley & Sons, New Delhi, 2008.
2.	Bernard Menezes, "Cryptography and Network Security", Cengage Learning India, 1st Edition, New Delhi, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the concepts of divisibility and canonical decompositions.	Understanding (K2)
CO2	obtain the knowledge in theory of congruences and solution of linear congruences.	Understanding (K2)
CO3	use different number theoretic function suitably in cryptography.	Applying (K3)
CO4	apply Primality test and factorisation algorithms to network security problems.	Applying (K3)
CO5	apply the suitable cryptographic techniques to handle real time security issues.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	3	1												
CO3	3	1												
CO4	3	2	1		2									
CO5	3	2	1		2									

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22PHO04 - SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL APPLICATIONS OF NANOMATERIALS
(Offered by Department of Physics)

Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to impart the knowledge on the fundamentals of nanomaterials, synthesis of nanomaterials, analysis of nanomaterials, carbon tubes and biological applications of nanomaterials.	
Unit – I	**Introduction to nanomaterials**	**9+3**
Nanoscience and nanotechnology – Scientific revolution – Nanoscale – Nanosized effects – Surface-to-volume ratio – Quantum confinement effect – Classification of nanomaterials based on dimension – Properties of nanomaterials – Metal nanoparticles – Ceramic nanoparticles – Semiconductor nanoparticles – Polymer nanomaterials.		
Unit – II	**Synthesis of nanomaterials**	**9+3**
Physical, chemical and mechanical methods of preparation – Top down approaches and bottom up approaches – Physical Vapor Deposition method – Colloidal precipitation method – Sol-Gel method – Chemical precipitation method – Green synthesis method of nanomaterials.		
Unit – III	**Characterization of nanomaterials**	**9+3**
X-ray diffraction analysis – Grain size calculation – Lattice parameters - Cell volume – Photoluminescence analysis – Emission peak analysis – UV visible spectroscopy analysis – Bandgap estimation – HRTEM & AFM analysis (qualitative) – particle size analysis – BET (qualitative).		
Unit – IV	**Carbon nanotubes**	**9+3**
Allotropes of carbon – Diamond – Graphite – Graphene – Fullerenes – Carbon nanotubes – Properties – SWCNT – MWCNT – Structure of Carbon nanotubes – Preparation: Laser ablation method – CVD – Applications.		
Unit – V	**Biological applications**	**9+3**
Antibacterial activity – Mechanism – Antifungal activity – Microorganism – Gram positive bacteria – Gram negative bacteria – Disc diffusion method – Antioxidant activity – DPPH method – Anticancer activity – Cytotoxity – MTT method –Toxicity of nanoparticles.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1. Charles P Poole Jr., and Frank J. Ownes ,. "Introduction to Nanotechnology", John Wiley Sons, Inc., 2003.

REFERENCES:

1. C. Kittel., "Introduction to Solid State Physics", Wiley Eastern Ltd., (2005).
2. Tamilarasan K. and Prabu K., "Materials Science", 1st Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the properties of nanomaterials using concepts such as surface to volume ratio and quantum confinement and also able to classify nanomaterials.	Applying (K3)
CO2	explain the synthesis of nanomaterials using select physical and chemical methods.	Applying (K3)
CO3	explain the characterization of nanomaterials using XRD, UV-vis, HRTEM & AFM and BET.	Applying (K3)
CO4	Illustrate the preparation of CNT and their applications.	Applying (K3)
CO5	explore the biological applications of nanomaterials such as antibacterial activity, antifungal activity, antioxidant activity and anticancer activity.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2						2	2		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	2	2						2	2		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22PHO05 - TECHNIQUES OF CRYSTAL GROWTH
(Offered by Department of Physics)

Programme& Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	1	0	4

Preamble	This course aims to impart the knowledge on crystals, physics of crystal growth and crystal growth methods.	
Unit – I	**Introduction to Crystals**	**9+3**
Classification of solids – Crystalline and amorphous – Single and polycrystalline materials – Space lattice – Bravais lattice – Lattice planes – Miller indices – Indices of crystal direction – Symmetry – Symmetry elements in cubic crystal – Physical properties.		
Unit – II	**Theories of Crystal Growth**	**9+3**
Phase rule – Phase diagrams – Binary phase diagrams – Alloy and compounds – Binary system with complete solid solution and no solid solution (eutectic) – Invariant reactions – Eutectic, peritectic and peritectoid (qualitative) – Nucleation concept – Homogeneous, heterogeneous nucleation – Classical theory – Energy of formation of nucleus – Kinetic theory of nucleation (qualitative) – Atmospheric nucleation.		
Unit – III	**Melt growth**	**9+3**
Bulk crystal growth methods – Melt growth methods – Bridgman (vertical and horizontal) and Czochralski methods – Liquid encapsulated technique (LEC) for semiconductors – Vermeil growth technique for growing gem crystals – Zone melting.		
Unit – IV	**Solution growth**	**9+3**
Low temperature solution growth – High temperature solution growth – Electro crystallization – Crystal growth in gel – Growth of biological crystals – Hydrothermal technique.		
Unit – V	**Vapour growth**	**9+3**
Physical vapour transport – chemical vapour transport. Epitaxial growth techniques – Liquid phase epitaxy – Vapour phase epitaxy: chloride, hydride, metalorganic – Molecular beam epitaxy – Chemical beam epitaxy.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Introduction to Crystallography Philips, Read Books (9 June 2011), India.

REFERENCES:

1.	B. D. Cullity Addison, Elements of X-ray diffraction, Wesley Publishers, 1977.
2.	Santhana Raghavan and Dr. P. Ramasamy, Crystal growth processes and methods, KRU publications, 1999.
3.	Leonid V. Azaroff, Introduction to Solids, Tata McGraw Hill Publishing Company.
4.	C. Kittel Wiley, Introduction to Solid State Physics, Eastern University Edition.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the physical properties of crystals using the concepts of crystalline materials, amorphous material, space lattice, unit cell, Miller indices and crystal symmetry.	Applying (K3)
CO2	explain nucleation in crystal growth using the concepts of phase diagrams and formation energy.	Applying (K3)
CO3	demonstrate the growth of bulk crystals using melt growth techniques.	Applying (K3)
CO4	demonstrate the growth of crystals using solution growth techniques.	Applying (K3)
CO5	comprehend the growth of epitaxy crystal using vapour growth techniques.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2						2	2		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	2	2						2	2		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22CYO04 - CORROSION SCIENCE AND ENGINEERING

(Offered by Department of Chemistry)

Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	Corrosion science and engineering aims to equip the students to have a wide-range of knowledge on corrosion and prevention methods in order to meet the industrial needs.	
Unit – I	**Corrosion and its Units**	**9+3**
Introduction- electro chemical mechanism Vs chemical mechanism - emf series and Galvanic series – galvanic corrosion – area effect in anodic and cathodic metal coatings – prediction using emf series and galvanic series - Pilling Bedworth's ratio and it consequences (Problems) – units of corrosion rate: mdd (milligrams per square decimeter per day), mmpy (millie miles per year) and mpy (mils per year) –- importance of corrosion prevention in various industries: direct and indirect effects of determining corrosion rates - weight loss method, weight gain method and chemical analysis of solution.		
Unit – II	**Thermodynamics of Corrosion**	**9+3**
Electrode potentials, Electrical double layer, Gouy−Chapman model, Stern model, Bockris – Devanathan−Müller model - free energy and oxidation potential - criterion of corrosion (Problems) - basis of Pourbaix Diagrams - Pourbaix diagrams of water, magnesium, aluminium and Iron - limitations and applications.		
Unit – III	**Kinetics of Corrosion**	**9+3**
Electrochemical polarization – Evan's diagram – activation polarization – concentration polarization - mixed potential theory(Wagner and Traud) – application of mixed potential theory – effect of metal in acid solution – cathodic protection of iron in acid solution – effect of cathodic reaction – effect of cathodic area – passivity – Flade potential – theories of passivity - adsorption theory – oxide film theory – film sequence theory.		
Unit – IV	**Types of Corrosion**	**9+3**
Introduction - (i) Crevice - differential aeration corrosion (ii) pitting – mechanism and factors (iii) intergranular- chromium depletion theory, weld decay and knife line attack (iv) stress - SCC mechanism, corrosion fatique- Cavitation damage – fretting damage (v) stray current corrosion - causes and its control.		
Unit - V	**Prevention of Corrosion**	**9+3**
Inhibitors – types of inhibitors, chemisorption of inhibitors, effect of concentration, effect of molecular structure, vapour phase inhibitors – prevention of corrosion at the design stage and in service conditions – control of catastrophic oxidation and hydrogen disease – Langelier saturation index and its uses - corrosion prevention by surface coatings – phosphating and its uses -principles and procedures of cathodic protection: sacrificial anodes and external cathodic current impression- painting, vitreous enamels, plastic lining.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	E. McCafferty, Introduction to Corrosion Science, 2nd Edition, Springer, 2017.

REFERENCES:

1.	R. Winston, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, Revised 4th Edition, Wiley publisher, 2008.
2.	Fontanna, "Corrosion Engineering", (Materials Science and Metallurgy series), McGraw Hill international Ed., 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the mechanism, expression of rate of corrosion and importance of corrosion studies to familiarize for industrial needs.	Understanding (K2)
CO2	demonstrate the thermodynamics and kinetics of different models of corrosion with respect to the environment.	Applying (K3)
CO3	utilize the theories of corrosion to interpret with the real time applications.	Applying (K3)
CO4	organize the various types of corrosion to understand the corrosion problems.	Applying (K3)
CO5	summarize the corrosion prevention methods to avoid corrosion related issues.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	1												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO05 - CHEMISTRY OF COSMETICS IN DAILY LIFE

(Offered by Department of Chemistry)

Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to provide knowledge on chemistry of cosmetics for engineering students.

Unit - I	**Formulation of Cosmetic Product**	**9+3**

Introduction - basic sciences of cleansing – surfactant and adsorption, surfactant micelles, surfactants and cleansing, surfactants and foam (foam formation, stability, drainage, rupture and collapse and defoaming) - basics of dispersions - electrical charges associated with surfaces and barriers – basics of emulsion (stability, Ostwald ripening, prevention of creaming and sedimentation).

Unit - II	**Structuring Materials and Regulation for Cosmetics**	**9+3**

Introduction - water/hydrophilic base materials, oleaginous/hydrophobic base materials and amphiphilic substances - adding functions and effects - materials that add or improve functional value, emotional value and materials for quality control – cosmetic and personal care product safety – potential contaminants in cosmetics – regulations related to cosmetics – cosmetic regulation in india - future challenges in cosmetics material development.

Unit - III	**Polymers in Cosmetic Products**	**9+3**

Polymers in Cosmetics - polymer solubility and compatibility, polymer conformation - polymers that modify surfaces - film-forming polymers in cosmetics and personal care products - hair-conditioning polymers - polymers for the treatment of skin - polymers as controlled release matrices - dendritic polymers - polymeric antimicrobials and bacteriostats.

Unit - IV	**Natural Products and Fragrance in Cosmetics**	**9+3**

Introduction – natural products – extraction methods - encapsulation and controlled release - allergens in cosmetics – testing for allergens - aroma chemicals - fragrance creation and duplication - fragrance applications -– malodor – fragrance allergies and sensitivities.

Unit - V	**Preparation of Cosmetics**	**9+3**

Cosmetics in day to day life – characteristics, types, formulation, preparation and evaluation methods of lipstick, shampoo, powder, nail lacquer, creams, toothpaste and hair dye.

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Kazutami Sakamoto, Robert Y. Lochhead, Howard I. Maibach, Yuji Yamashita, Cosmetic Science and Technology: Theoretical Principles and Applications, Elsevier, 2017 , for Units- I, II, III, IV, V.
2.	Gaurav Kumar Sharma, Jayesh Gadiya, Meenakshi Dhanawat A text book of cosmetic formulation, 2018, for Unit-V.

REFERENCES:

1.	R.K. Nema, K.S. Rathore , B.K. Dubey, Textbook of Cosmetics, CBS Publishers and Distributors, 2017.
2.	Bruno Burlando, Elisa Bottini-Massa, LuisellaVerotta, Laura Cornara, Herbal Principles in Cosmetics: Properties and Mechanisms of Action, CRC Press, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the formulation of cosmetics products.	Understanding (K2)
CO2	identify the structuring materials and regulation involved in cosmetics development.	Applying (K3)
CO3	interpret the polymers and its role in cosmetics.	Understanding (K2)
CO4	develop knowledge about natural products and Fragrance in Cosmetics.	Applying (K3)
CO5	apply the knowledge of cosmetics to explain the characteristics, formulation, preparation and quality control of different cosmetic products used in day to day life.	Applying (K3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	2	1											
CO3	3	1												
CO4	3	2	1											
CO5	3	2	1											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO06 – NANOCOMPOSITE MATERIALS
(Offered by Department of Chemistry)

Programme& Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to equip the students to have knowledge on processing, characterization, properties, features and applications of nanocomposites.	
Unit – I	**Introduction of nanocomposites**	**9+3**
Introduction – nanocomposites – nanocomposites past and present – nomenclature – composite materials: introduction to solids - atomic and molecular solids – role of statistics in materials – primary, secondary and tertiary structure – transitions.		
Unit - II	**Properties and features of nanocomposites**	**9+3**
Properties: physics of modulus – continuum measurements – yield – fracture – rubbery elasticity and viscoelasticity – composites and nanocomposites – surface mechanical properties –diffusion and permeability – features of nanocomposites: basics of polymer nanocomposites - nano reinforcements – matrix materials – hazards of particles.		
Unit - III	**Processing of nanocomposites**	**9+3**
Viscosity: types of flow, experimental viscosity, non-newtonian flow -low-viscosity processing: solvent processing, particle behavior, in situ polymerization, post-forming, hazards of solvent processing - melt, high shear and direct processing: melting and softening, melt processes with small shears or low-shear rates flow, meltprocesses with large deformations or high-shear rates, thermo-kinetic processes.		
Unit - IV	**Characterization of nanocomposites**	**9+3**
Introduction to characterization – experiment design – sample preparation – imaging –structural characterization – scales in nanocomposites – texture – electromagnetic energy –visualization – physicochemical analysis – characterization of physical properties.		
Unit - V	**Applications of nanocomposites**	**9+3**
Nanocomposites – optical, structural applications – nanoparticulate systems with organic matrices – applications – biodegradable protein nanocomposites – applications-polypropylene nanocomposites – application as exterior automatic components – hybrid nanocomposite materials – application for corrosion protection.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Thomas E. Twardowski, “Introduction to Nanocomposite Materials – Properties, Processing, Characterization”, DesTech Publications, April 2007, for Units-I, II, III, IV.
2.	Klaus Friedrich, Stoyko Fakivov, Zhony Shang, “Polymer Composites from Nano – to Macro – scale”, Springer USA, 2005, for Units-I, II, V.

REFERENCES:

1.	Pulickel M. A, Linda S. S, Paul V.B, “Nanocomposite Science and Technology”, Wiley-VCH, 2006.
2.	Vikas Mittal, Characterization techniques for polymer nanocomposites, Wiley-VCH, 2012.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	identify the knowledge of nanocomposites and to explain its structure.	Applying (K3)
CO2	apply the knowledge on various properties and features of nanocomposites.	Applying (K3)
CO3	choose the various concepts involving in the processing of nanocomposites.	Applying (K3)
CO4	apply the acquired knowledge on characterization of nanocomposites.	Applying (K3)
CO5	organize the applications of nanocomposites in various fields.	Applying (K3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22MAO08 - NON-LINEAR OPTIMIZATION							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	The course focuses on the basic concepts, various techniques and applications of engineering optimization.	
Unit – I	**Classical Optimization Techniques:**	**9**
Introduction to Optimization – Statement of an Optimization problem – Mathematical formulation – Multi variable optimization with equality constraints – Lagrange multipliers method – Multi variable optimization with inequality constraint – Kuhn Tucker conditions.		
Unit – II	**Non-Linear Programming: One-Dimensional Minimization Method:**	**9**
Introduction – Unimodal function – Elimination Methods: Unrestricted search – Exhaustive search – Dichotomous search – Interval halving method – Fibonacci method – Golden section method – Direct root methods: Newton method – Secant method.		
Unit – III	**Non-Linear Programming: Unconstrained Optimization Techniques:**	**9**
Introduction to Unconstrained optimization – Direct Search Methods: Grid search method – Univariate method – Hookes and Jeeve's method – Powell's method.		
Unit – IV	**Unconstrained Optimization Techniques (Indirect Methods):**	**9**
Gradient of a Function – Indirect Search Methods: Steepest descent method – Fletcher-Reeves method – Newton's method – Marquardt method.		
Unit – V	**Non-Linear Programming: Constrained Optimization Techniques:**	**9**
Introduction – Characteristics of a Constrained Problem – Direct Methods: Random search method – Sequential linear programming – Indirect methods: Transformation techniques – Exterior penalty function method – Interior penalty function method.		
		Total:45

TEXT BOOK:

1.	S.S.Rao, Engineering Optimization Theory and Practice, 5th Edition, John Wiley & Sons Ltd, USA, 2020.

REFERENCES:

1.	David Luenberger and Yinyu Ye, Linear and Nonlinear Programming, 4th edition, Springer-Verlag, 2015
2.	A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, Engineering Optimization: Methods and applications, 2nd Edition, Wiley India Pvt. Ltd., 2006.
3.	Yang, Xin-She. Optimization Techniques and Applications with Examples. 1st Edition, John Wiley & Sons, United Kingdom, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	solve problems with equality and inequality constraints.	Applying (K3)
CO2	solve nonlinear programming problems of functions of single variable.	Applying (K3)
CO3	use methods of unconstrained optimization to solve non linear problems	Applying (K3)
CO4	solve nonlinear optimization problems in the presence of inequality and equality constraints.	Applying (K3)
CO5	apply several modern methods of optimization for solving engineering problems	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2											
CO2	3	2												
CO3	3	3	1											
CO4	3	3	3											
CO5	3	2	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	10	80				100
CAT2	10	10	80				100
CAT3	10	10	80				100
ESE	10	10	80				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAO09 - OPTIMIZATION FOR ENGINEERS							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	To provide the skills for solving the real time engineering problems involving linear and non-linear objective functions and also impart knowledge in finding optimal solutions to problems involving multi-level decision making and analyzing queuing models.	
Unit – I	**Linear Programming:**	**9**
Introduction to Operations research – Applications of OR – Linear Programming – Formation of Linear Programming Problem – Solution of LPP: Basic concepts – Graphical Solution – Simplex method – Artificial techniques: Big M method.		
Unit – II	**Integer Programming:**	**9**
Introduction – Types of Integer Programming Problems – Solution of Integer programming problems – Gomory's all integer cutting plane method - Gomory's Mixed-Integer Cutting Plane Method – Branch and Bound method.		
Unit – III	**Dynamic programming:**	**9**
Introduction – Characteristics – Formulation of Dynamic programming problems –Dynamic programming Algorithm – Solution of Discrete Dynamic programming problem – Solution of LPP by Dynamic programming.		
Unit – IV	**Queueing Theory:**	**9**
Characteristics of a queueing system – Kendall's notation – Queuing model I (Infinite capacity single server Poisson queue model) (M/M/1) : (∞/FIFO) – Little's formulae – Queuing model II (Infinite capacity multiple server Poisson queue model (M/M/C): (∞/FIFO) – Queuing model III (Finite capacity single server Poisson queue model) (M/M/1): (N/FIFO) – Queueing model IV (Finite capacity multiple server Poisson model) (M/M/C) : (N/ FIFO)..		
Unit – V	**Non-Linear Programming:**	**9**
Introduction – Mathematical formulation of Non-linear programing problems – Non-linear programing problem with equality constraints – Lagrange multipliers method – Non-linear programing problem with inequality constraint – Kuhn Tucker conditions.		
		Total:45

TEXT BOOK:

1.	Sharma J.K, "Operations Research – Theory and Applications", 6th Edition, Trinity Press, India, New Delhi, 2017.

REFERENCES:

1.	Taha, Hamdy A., "Operation Research: An introduction", 9th edition, Pearson Education, 2010.
2.	Hiller, Frederick. S. and Lieberman, Gerald. J., "An introduction to Operations research- concepts and cases", Tata McGraw Hill (SIE) 8th edition, 2005.
3.	Ravindran, A., Phillips, D.J., and Solberg, J.J., "Operations Research- Principles and Practice", John Wiley & Sons, 2005.
4.	Kanti Swarup, P.K. Gupta, Man Mohan, "Operations Research", 15th revised Edition, S. Chand & Sons Education Publications, New Delhi, 2017.
5.	Gupta P.K. and Hira D.S., "Operations Research: An Introduction", 7th Revised Edition, S.Chand and Co. Ltd., New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	formulate and solve linear programming problems.	Applying (K3)
CO2	solve Integer Programming problems that exist in real time applications.	Applying (K3)
CO3	demonstrate the theoretical workings of dynamic programming method to find shortest path for given network.	Applying (K3)
CO4	use the appropriate queuing model for a given practical application.	Applying (K3)
CO5	apply the concept of non-linear programming for solving the problems involving non-linear constraints and objectives.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22CYO07 - WASTE AND HAZARDOUS WASTE MANAGEMENT
(Offered by Department of Chemistry)

Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	Waste and Hazardous waste management aims to equip the students to have a wide-range of knowledge on waste management.	
Unit – I	**Solid Waste Management**	**9**
Solid wastes: definition, sources, types, composition of solid waste- Solid waste management system: collection, separation, processing and transformation of solid waste – combustion, aerobic composting, vermicomposting, pyrolysis, landfill-classification, types, methods and control of leachate in landfills - recycling of material found in municipal solid waste- recycling of paper and cardboard, recycling of plastics, recycling of glass.		
Unit – II	**Hazardous Waste Management**	**9**
Hazardous wastes: definition, nature and sources of hazardous waste, classification and characteristics of hazardous waste-chemical class of hazardous waste, generation, segregation, treatment and disposal: waste reduction, waste minimization, recycling - chemical treatment: acid base neutralization, chemical precipitation, oxidation/reduction, hydrolysis, electrolysis, chemical extraction and leaching, ion exchange, photolytic reaction- thermal treatment methods: incineration – biodegradation of hazardous waste: aerobic, anaerobic, reductive dehalogenations - land treatment and composting.		
Unit – III	**E- Waste & Biomedical Waste Management**	**9**
E-Waste Management: definition, sources, classification, collection, segregation, treatment and disposal. **Biomedical Waste Management :** Introduction-definition –components of biomedical waste-waste generation –waste identification and waste control-waste storage-labeling and color coding-handling and transportation-waste treatment and disposal- autoclave, hydroclave , microwave treatments- chemical disinfection – sanitary and secure landfill.		
Unit – IV	**Pollution From Major Industries And Management**	**9**
Introduction- sources and characteristics - waste treatment flow sheets for selected industries such as textiles, tanneries, pharmaceuticals, sugar, petroleum refinery, fertilizer and dairy industries.		
Unit – V	**Solid Waste Management and Legislation**	**9**
Solid waste management plan - solid waste (management and handling) rules - biomedical waste (management and handling) rules-plastic waste management rules - e-waste management rules - hazardous and other wastes (management and transboundary movement) rules - construction and demolition waste management rules.		
		Total: 45

TEXT BOOK:

1.	George Tchobanoglous, Hillary Theisen, Samuel a Vigil, Integrated solid waste management (Engineering principle and management issues) McGraw hill Education (India) Pvt. Ltd., 2015, for Unit-I, II, V.
2.	SC Bhatia, Handbook of Industrial pollution and control (Volume-1), CBS Publisher and Distributers, New Delhi, 2002, for Unit-II, III, IV, V.

REFERENCES:

1.	Manual on Municipal Solid Waste management, Central public Health and Environmental Engineering Organization (CPHEEO), Govt. of India, May 2000.
2.	Michael D. LaGrega, Phillip L. Buckingham, Jeffrey C. Evans, Hazardous waste management, MEDTEC, 2015.
3.	Majeti Narasimha Vara Prasad, Meththika Vithanage, Anwesha Borthakur, “Handbook of Electronic Waste Management: International Best Practices and Case Studies” 1st Edition, Butterworth-Heinemann, 2019.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply the technical points that are required to set up a solid waste management system.	Applying (K3)
CO2	explain the various disposal and treatment methods of hazardous wastes.	Understanding (K2)
CO3	organize the appropriate method for managing e-waste and biomedical waste.	Applying (K3)
CO4	identify the hazards from various industries and apply the waste management techniques for its treatment.	Applying (K3)
CO5	relate the legal legislation to solid waste management.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1			3							
CO2	2	1					3							
CO3	3	2	1	1			3							
CO4	3	2	1	1			3							
CO5	2	1					3							

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO08 - CHEMISTRY IN EVERY DAY LIFE
(Offered by Department of Chemistry)

Programme& Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course aims to prepare the students to have the knowledge on oils, fats, sugar, adulterants in food, creams, milk powder, soil, fertilizer, pesticides, insecticides, fungicides and herbicides in order to know its chemistry in our everyday activities.	
Unit – I	**Oils, Fats and Sugar**	**9**
Distinction between oils and fats – properties – classification – edible oils – vegetable oils –animal oils – manufacture of oils by solvent extraction – refining of crude vegetable oils – processing of animal fats – manufacture of cane sugar – manufacture of sucrose from beet root.		
Unit – II	**Adulterants in food**	**9**
Food Adulteration and prevention – common food adulterants – food additives – food colorants– preservatives – flavourants – food poisoning – analysis of adulterants in edible oils, coffee powder, chilli powder, turmeric powder, meat , fish, ghee and milk – harmful effects of food adulterants		
Unit – III	**Creams and Milk powder**	**9**
Creams: Composition-chemistry of creaming process- Factors influencing cream separation (Mention the factors only) - Estimation of fat in cream - Milk powder: Need for making powder-drying process- spraying, drum drying, jet drying and foam drying-principles involved in each.		
Unit – IV	**Soil and Fertilizers**	**9**
Soil analysis: Composition of soil - Organic and Inorganic constituents-Soil acidity - buffering capacity of soils -Liming of soil - Fertilizers: primary nutrients –role of Nitrogen, potassium and phosphorous on plant growth –Complex fertilizers and mixed fertilizers and its composition - Secondary nutrients – micronutrients and their functions in plants -optimal addition of Fertilizers to obtain estimated yield.		
Unit – V	**Pesticides, Insecticides, Fungicides and Herbicides**	**9**
Pesticides – Classification – general methods of application and toxicity, Safety measures when using pesticides-Insecticides: Inorganic pesticides – borates - Organic pesticides – D.D.T. and BHC-Plant derivatives: pyrethrin and Nicotine - Synthetic organic pesticides: Endrin and Aldrin (Chemical name - Structure- functions and uses)-Fungicides: Inorganic (Bordeaux mixture) and organic (dithiocarbamate) fungicides - Industrial fungicides: Creosote fractions - Herbicides: Selective and non-selective - 2, 4-dicholorophenoxyacetic acid and 2,4,5-tricholorophenoxyaceticacid (structure and function).		
		Total: 45

TEXT BOOK:

1.	Sharma B K , Industrial Chemistry, Goel publishing house, New Delhi, 2011, for Units- I, II, IV
2.	Alex V Ramani, Food Chemistry, MJP Publishers, Chennai, 2009, for Units -II, III, V.

REFERENCES:

1.	Dilip Kumar Das, Introductory Soil Science, 1st Edition, Kalyani Publishers, Reprint 2002.
2.	K. Bagavathi Sundari– “Applied Chemistry”, MJP Publishers, Chennai, 2006.
3.	Ashutosh Kar, Medicinal Chemistry, Wiley Eastern limited, New Delhi, 1993.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	outline the importance of oils, fats and sugar.	Understanding (K2)
CO2	identify the harmful effects of adulterants in food.	Applying (K3)
CO3	develop the knowledge on creams and milk powder.	Applying (K3)
CO4	interpret the nature and composition of soil and fertilizers.	Understanding (K2)
CO5	illustrate the difference of pesticides, insecticides, fungicides and herbicides.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	1												
CO5	3	1												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO09 - CHEMISTRY OF NUTRITION FOR WOMEN HEALTH
(Offered by Department of Chemistry)

Programme & Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	This course aims to provide knowledge for engineering students on components of health, fitness and also the role of nutrition for women health.	
Unit - I	**Nutrition**	**9**
Energy- functions, sources and concept of energy balance - recommended dietary allowances, dietary sources - effects of deficiency and/ or excess consumption on health of the following nutrients: carbohydrates and dietary fiber – lipids – proteins - fat soluble vitamins: A, D,E and K - water soluble vitamins: Thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin C – minerals: calcium, iron, zinc and iodine.		
Unit - II	**Women Health**	**9**
Disease pattern and reproductive health- menopause – hypothyroid- PCOD-diabetes - policies and programs for promoting maternal and child nutrition and health - concept of small family - methods of family planning - merits and demerits.		
Unit - III	**Nutrition for Nursing Mother and Infants**	**9**
Physiology and psychology of lactation, hormonal control, composition of colostrums and breast milk, nutritional requirements of a nursing mother, advantages of breast feeding, food and nutritional requirements for infants, weaning and supplementary foods for infants and immunization.		
Unit - IV	**Nutrition for Physical Fitness**	**9**
Significance of physical fitness and nutrition in the prevention and management of weight control, obesity, diabetes mellitus, CV disorders, bone health and cancer - nutrition and exercise regimes for pre and postnatal fitness - nutritional and exercise regimes for management of obesity - critical review of various dietary regimes for weight and fat reduction - prevention of weight cycling.		
Unit - V	**Role of Women in National Development**	**9**
Women in family and community: Demographic changes menarche, marriage, fertility, morbidity, mortality, life expectancy, sex ratio, aging, widowhood. Women in society: Women's role, their resources, and contribution to family, and effect of nutritional status.		
		Total: 45

TEXT BOOK:

1.	Srilakshmi, B., Nutrition Science, New Age International (P) Ltd., New Delhi, 2017, for Units- I, IV, V.
2.	Arpita Verma, Women's Health and Nutrition: Role of State and Voluntary Organizations, Rawat Publishers, 2017, for Units - II, III, IV.

REFERENCES:

1.	Shubhangini A Joshi , Nutrition and Dietetics, TataMacGraw Hill, 2010.
2.	Rujuta Diwekar, Women and The Weight Loss Tamasha, Westland ltd, 2010.
3.	Swaminathan, M., Advanced Textbook on Food and Nutrition, Vol. 1, Second Edition, Bangalore Printing and Publishing Co. Ltd., Bangalore, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of the knowledge of dietary sources in day to day life.	Applying (K3)
CO2	explain the disease pattern and policies towards women health.	Understanding (K2)
CO3	develop knowledge about nutrition during lactation and for infants.	Applying (K3)
CO4	utilize the knowledge of physical fitness and nutrition towards good health.	Applying (K3)
CO5	interpret the various role of women in society.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	1												
CO3	3	2	1											
CO4	3	2	1											
CO5	3	1												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

DEGREE & PROGRAMME : B.E & AUTOMOBILE ENGINEERING

HONOURS DEGREE TITLE: E-Mobility

The following courses are identified to earn additional 18 credits to get a Honours degree with specialization in **E-Mobility**

S.No	Course Code	Course Title	Credits	Prerequisites	Semester
1.	22AUH01	Automotive Communication Protocols	4	Nil	5
2.	22AUJ01	Power Electronics and Drives	4	Basics of Electrical and Electronic Circuits	5
3.	22AUH02	Automotive IOT Technologies	4	Nil	6
4.	22AUH03	Advanced Energy Storage Management	3	Nil	6
5.	22AUH04	Advanced Vehicle Technologies	3	Automotive Electrical Systems and Drives, Automotive Sensors and Controllers	7
		TOTAL	**18**		

22AUH01 - AUTOMOTIVE COMMUNICATION PROTOCOLS							
Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/6/7**	**HN**	**3**	**1**	**0**	**4**

Preamble	This course provides knowledge on data communication, networking, automotive communication and diagnostic protocols.	
Unit – I	**Controller Area Network:**	**9+3**
CAN Bus - protocol - ISO/OSI layers –Properties of CAN - CAN 2.0A standard frame - Message transfer - CAN bit - NRZ coding - bit stuffing - data frame - Errors - Error detection - The rest of the frame -CAN 2.0B – frame format - Compatibility of CAN 2.0A and CAN 2.0B.		
Unit – II	**CAN Physical Layer:**	**9+3**
Introduction - CAN bit - Nominal bit time - CAN and signal propagation – Network type, topology and structure - Propagation time - Estimating the value - Precise - Corollaries: relations between the medium, bit rate and length of the network - Bit synchronization - Bit resynchronization -Network speed –Bit rate - Latency.		
Unit – III	**Time-Triggered protocols:**	**9+3**
Time-triggered communication on CAN – high-speed - X-by-Wire and redundant systems – FlexRay - Protocol handling - Communication frame - Architecture of a FlexRay node - Electronic components for FlexRay - Line driver -Bus guardian.		
Unit – IV	**Multiplexed Bus Concepts:**	**9+3**
Vehicle - Wired and wireless communication - Basic concept of the LIN 2.0 protocol - Operating principle - Data link layer - Conformity of LIN - Fail-safe SBC approach - Safe-by-Wire Plus - Audio–Video Buses - I2C Bus - MOST Bus.		
Unit – V	**Wireless Communication:**	**9+3**
Radio-Frequency Communication – Internal - External - Control of opening parts - Passive keyless entry and passive go - Wireless Networks – GSM - Bluetooth -IEEE 802.11x – NFC.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Dominique Paret, "Multiplexed Networks for Embedded Systems: CAN, LIN, Flexray, Safe-by-Wire", 1st Edition, John Wiley & Sons Ltd, England, 2007. UNIT I,II,III,IV,V

REFERENCES:

1.	Ingolf Karls & Markus Mueck, "Networking Vehicles to Everything", 1st Edition, De/G Press, Germany, 2018.
2.	Kirsten Matheus & Thomas Königseder, " Automotive Ethernet ", 3rd Edition, Cambridge University Press, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize about the basics of in-vehicle networks and CAN protocol.	Understanding (K2)
CO2	illustrate about the CAN physical layer.	Understanding (K2)
CO3	classify the time-triggered and Flexray protocols for vehicle networking.	Understanding (K2)
CO4	explain and relate the multiplexed bus concepts for automotive networking.	Understanding (K2)
CO5	outline the importance of wireless systems in automobiles.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**2**	**2**	**1**								**1**		**3**
CO2	**3**	**2**	**2**	**1**								**1**		**3**
CO3	**3**	**2**	**2**	**1**								**1**		**3**
CO4	**3**	**2**	**2**	**1**								**1**		**3**
CO5	**3**	**2**	**2**	**1**								**1**		**3**

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUJ01 - POWER ELECTRONICS AND DRIVES

Programme & Branch	B.E. -Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Basics of Electrical and Electronic Circuits	5/6/7	HN	3	0	2	4

Preamble	This course discusses power processing electronic circuits apart from introducing the basics of power semiconductor devices and drives.	
Unit – I	**Power Electronics Devices:**	**9**

Concept of power electronics – Power semiconductor devices - Principle of operation – Steady state and switching characteristics of power diodes, power BJT, power MOSFET, IGBT – Firing circuit for thyristor- Steady state and switching characteristics of SCR –Two transistor model of SCR – DIAC – TRIAC – GTO.

Unit – II	**AC-DC and DC-AC Converter:**	**9**

Principle of phase controlled converter with R and RL load - Freewheeling diode- Single phase full wave converter – Single phase semi converter – Three phase semi converter – Three phase fully controlled converter – Applications of AC-DC converter. Introduction to inverter –Single phase and Three phase voltage source inverters –PWM inverters – Applications of DC-AC converter.

Unit – III	**DC - DC and AC - AC Converter:**	**9**

DC Chopper – Control strategies – Principle of operation – Step up and step down chopper – Applications of DC-DC converter – Single phase AC voltage controller – On - off control and phase control – Sequence control of AC voltage controller – Single phase: Step up and step down cycloconverters - – Applications of AC-AC converter.

Unit – IV	**DC Drives:**	**9**

DC Drives - Introduction to DC drives – Basic performance equations of DC motor – Single phase DC drives – Three phase DC drives – Chopper Drives – Two quadrant chopper drive – Four quadrant chopper drive.

Unit – V	**AC Drives:**	**9**

Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Simulation of power converters using software.

LIST OF EXPERIMENTS / EXERCISES:

1.	Steady state characteristics of SCR.
2.	Single Phase Half controlled and Fully controlled rectifiers.
3.	Three Phase fully controlled rectifiers.
4.	Step down and step up converter.
5.	Three Phase inverters – 180° and 120° mode of operation.
6.	Three Phase AC voltage controller.
7.	Simulation of DC converters (Single phase, three phase controlled converters and choppers).
8.	Simulation of AC converters (Inverter and AC voltage regulator).
9.	PWM signal generation using DSPACE.
10.	Design of converter.

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2014. UNIT I,II,III
2.	Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2012. UNIT IV, V

REFERENCES/ MANUAL / SOFTWARE:

1.	Singh M.D. & Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2013.
2.	Muhammad H. Rashid, "Power Electronics: Devices, Circuits & Applications", 4th Edition, Pearson, 2017.
3.	Laboratory Manual
4.	MATLAB Software
5.	DSPACE, PSIM software and Power quality analyzer

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the operation and switching characteristics of power solid state devices	Understanding (K2), Manipulation (S2)
CO2	describe the working principle of AC – DC and DC – AC converters	Understanding (K2), Manipulation (S2)
CO3	express the construction and working of DC – DC and AC – AC converters	Applying (K3), Precision (S3)
CO4	select a suitable power converter for a given DC drive	Understanding (K2), Manipulation (S2)
CO5	choose an appropriate power converter for a given AC drive	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1		2							2	1	1
CO2	3	2	1		2							2	3	3
CO3	3	2	1		2							2	3	3
CO4	3	2	1		2							2	2	2
CO5	3	2	1		2							2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	30	35	35				100
CAT3	30	30	40				100
ESE	20	50	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUH02 - AUTOMOTIVE IOT TECHNOLOGIES

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5/6/7	HN	3	1	0	4

Preamble	This course provides knowledge on data communication, networking, automotive communication and diagnostic protocols.	
Unit – I	**Introduction to IOT:**	**9+3**
Introduction-IoT Architecture-Application-based IoT Protocols-Infrastructure-based protocols-Data protocols-Transport protocols. Cloud Computing: Types of cloud-Business aspects of cloud-Virtualization- Key aspect of cloud computing-Mobile cloud computing- Fog Computing: Applications of Fog computing. Sensor Cloud: Applications of Sensor Cloud- Big Data.		
Unit – II	**IoT Architectures:**	**9+3**
Overview of IOT components - Various architectures of IOT and IIOT, Advantages and disadvantages, Industrial internet – Reference architecture; IIOT system components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IOT.		
Unit – III	**Sensor and Interfacing:**	**9+3**
Introduction to sensors, Transducers, Classification, Roles of sensors in IIoT, Various types of sensors, Design of sensors, sensor architecture, special requirements for IIoT sensors, Role of actuators, Types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial and Parallel, Ethernet, BACNet and M2M		
Unit – IV	**IOT Protocols and Cloud:**	**9+3**
Introduction to Industrial data transmission, Features & Components of : Fieldbus, Profibus, HART, Interbus, Bitbus, CC-link, Modbus, Batibus,DigitalSTROM, Controller area network, DeviceNet, LonWorks, ISA 100.11a, Wireless HART, LoRa & LoRaWAN, NB-IoT, IEEE 802.11AH. Clouds : Types of clouds		
Unit – V	**IOT Application in Automobiles:**	**9+3**
Fleet Management: Real-time location monitoring of the fleet - Weight/Volume tracking - Trucks' performance statistics like fuel and mileage - Tracking traffic conditions on the road - Route management - Time and Driver management - connected cars: Vehicle to vehicle - Vehicle to infrastructure - Vehicle to pedestrians - Vehicle to network - Automotive Maintenance System - Autonomous vehicle: In-vehicle Infotainment and Telematics		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Anandarup Mukherjee, Chandana Roy, Sudip Misra," Introduction to Industrial Internet of Things and Industry 4.0", 1st Edition, CRC Press,2020, for Unit I, II, III, IV.
2.	ArshdeepBahga, Vijay K. Madisetti—Internet of Things: A Hands-on Approach, 1stEdition, Universities PressHyderabad, 2015, for Unit V.

REFERENCES:

1.	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", 1st Edition, Apress, New York, 2017
2.	Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", John Wiley& sons publications, United Kingdom, 2013
3.	Olivier Hersent, David Boswarthic &, Omar Elloumi, "The Internet of Things: Key Applications and Protocols", 2nd Edition, Wiley publication, New Jersey, 2012

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	comprehend the fundamentals of IIoT and its potential, challenges	Understanding (K2)
CO2	infer the various components and architecture of IIoT	Understanding (K2)
CO3	design the sensors based IIoT architecture with interface standards	Applying (K3)
CO4	realize and choose the Protocols and Cloud platforms for different IIoT solutions	Applying (K3)
CO5	build the concepts of Design Thinking for automotive applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2							1		3
CO2	2	2	2	2	3							1		3
CO3	2	2	2	2	3							1		3
CO4	2	2	2	2	3							1		3
CO5	3	3	2	3	3							2		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	10	70	20				100
CAT3	10	60	30				100
ESE	15	65	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUH03 - ADVANCED ENERGY STORAGE MANAGEMENT

Programme & Branch	**B.E. - Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/6/7**	**HN**	**3**	**0**	**0**	**3**

Preamble	This course aims to impart the essential knowledge on the fundamental principles and application in advanced energy storage management.

Unit – I | Introduction to Energy Storage: | 9

An overview of energy storage systems: Thermal Energy Storage, Mechanical Energy Storage, Chemical Energy Storage, Electrical Energy Storage, Electrochemical Energy Storage, Electrostatic Energy Storage, Magnetic Energy Storage and Optical Energy Storage – General criteria of energy storage systems - Conventional batteries: fundamentals and applications - Grid connected and Off grid energy storage systems and requirements.

Unit – II | Thermal storage and Mechanical Storage: | 9

Thermal storage: Thermal properties of materials, Principle of operations, Efficiency factors, Large scale and Medium scale operations - Merits and demerits of thermal storage system - Recent development in thermal storage systems. Mechanical Storage: Types of mechanical storage systems, Principle of operations, Emerging advances and technologies in mechanical storage systems - Flywheel.

Unit – III | Magnetic storage, Electro-optic and Optical storage: | 9

Magnetic storage: Principle of operation, Emerging challenges and a review on devices and technology. Electro-optic and Optical storage: Principles of operation, Device fabrication, Emerging devices and Upcoming technologies.

Unit – IV | Electrochemical Storage: | 9

Materials, Principle of Operation, Positive electrode materials, negative electrode materials, electrolytes. Li-ion batteries: Principle of operation, Battery components, design of Electrodes, Cell and battery fabrications - Building block cells - Battery modules and packs - Li-polymer batteries – Applications - Future developments: Sodium-battery, Magnesium battery, Aluminum battery and Silicon battery.

Unit – V | Fuel Cells, Hydrogen storage and Super capacitors: | 9

Fuel Cells: Introduction to fuel cells, PEM (polymer electrolyte membrane), Hydrogen PEM fuel cell, Direct Methanol fuel cell, Alkaline fuel cells and Solid oxide fuel cells. Hydrogen storage systems: Solid state hydrogen storage tanks, Gas phase hydrogen storage tanks, Cryogenic hydrogen storage tanks, and Liquid phase hydrogen storage tanks. Super capacitors: Features of super capacitors, Basic principle of operation, Performance and technologies of super capacitors.

Total:45

TEXT BOOK:

1. Robert A. Huggins, Energy Storage, Springer, 2010.

REFERENCES:

1. Yuping Wu, Lithium-Ion Batteries: Fundamentals and Applications(Electrochemical Energy Storage and Conversion), CRC Press, United Kingdom, 2015
2. Trevor M. Letcher, Storing Energy: with Special Reference to Renewable Energy Sources, Elsevier, 2016
3. D. Linden and T. S. Reddy, Handbook of Batteries, McGraw Hill, Newyork, 2002

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the appropriate concepts and models to comprehend the basics of energy storage systems.	Understanding (K2)
CO2	explain the working and the recent advancements in thermal and mechanical storage systems.	Understanding (K2)
CO3	summarize the principle of operation of magnetic storage systems, electro-optic and optical storage systems to illustrate the respective device fabrication techniques	Understanding (K2)
CO4	explain the principle of operation of electrochemical storage device and materials used, and to elucidate the construction and working of various types of high energy storage batteries.	Understanding (K2)
CO5	discuss the construction and working of different types of fuel cells and to explain the advanced techniques involved in hydrogen storage systems and also to explain the principle and working of super capacitors.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1		2	3					1		
CO2	3	2	1	1		2	3					1		
CO3	3	2	1	1		2	3					1		
CO4	3	2	1	1		2	3					1		
CO5	3	2	1	1		2	3					1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22AUH04 - ADVANCED VEHICLE TECHNOLOGIES								
Programme & Branch	**B.E. - Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Automotive Electrical Systems and Drives, Automotive Sensors and Controllers	**5/6/7**	**HN**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge in advanced technological innovations in electronics, artificial intelligence and cybersecurity into the operation of automobiles, vehicle-to-vehicle communication in automotive industry

Unit – I	**Automotive E/E and Automotive Software Technology**	**9**
Mechatronic Systems in the Car - Automotive Electronics - Driver Assistance Electronics - Electronic Control Units - Entertainment/Infotainment Electronics - Sensor Technology - E/E Architectures and Topologies - Functional Safety - Automotive Software Engineering – AUTOSAR - AUTOSAR Adaptive Platform – GENIVI – Case Studies - Advanced Driver Assistance System		
Unit – II	**Connected Car on Cyber-Physical Systems**	**9**
Introduction to Cyber-Physical Systems - Internet of Things - Internet of Things Enabling Technologies - RFID and WSN Technology - Telematics, Infotainment, and the Evolution of the Connected Car - Platforms and Architectures - Connected Car Architecture and Challenges - Connected Car in the Cloud- Autonomous Vehicles		
Unit – III	**Automotive Cybersecurity**	**9**
Introduction to Cybersecurity - IT Security in Automotive Cyber-Physical Systems - Hacking and Automotive Attack Surfaces and Vulnerabilities - Intrusion Detection and Prevention - Functional Safety and Security - Car Hacking Examples – Case Studies - Vehicles Disabled Remotely via Web Application		
Unit – IV	**Carsharing and Ridesharing**	**9**
Carsharing Concept - Car2go - Use Cases and Requirement Analysis for Carsharing - Hardware/Software Modifications for Carsharing - Electric Vehicles and Carsharing - Car Hailing and Ridesharing - Safety in Ridesharing - Cyberattacks and Cybersecurity in Ridesharing		
Unit – V	**Connected Parking and Automated Valet Parking**	**9**
Parking - Connected Parking - Parking Assistance - Automated Valet Parking - Cyber Threats - Intrusion Detection and Prevention - Types of Intrusion Detection Systems - Artificial Neural Network-Based IDS - Implementation - Image Processing and Image Analysis - Implementation Using MATLAB		
		Total:45

TEXT BOOK:

1.	Dietmar P. F. Möller, Roland E. Haas, “Guide to Automotive Connectivity and Cybersecurity - Trends, Technologies, Innovations and Applications”, 1st Edition, Springer Publication, Switzerland, 2019.

REFERENCES:

1.	Rajalakshmi Krishnamurthi, Fatos Xhafa, Adarsh Kumar, Sukhpal Gill, “Autonomous and Connected Heavy Vehicle Technology”, 1st Edition, Academic Press, United Kingdom, 2022.
2.	Pierluigi Coppola, Domokos Esztergár-Kiss, “Autonomous Vehicles and Future Mobility”, 1st Edition, Elsevier, Netherland, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate an overview of mechatronic, electric, and electronic systems in the automotive domain, as well as architectures and bus system requirements.	Understanding (K2)
CO2	discuss about the key technologies that are essential for the evolution of connected cars and to overcome the challenges.	Understanding (K2)
CO3	describe about the cybersecurity as a body of technologies, processes, and practices designed to protect computers, data, networks, and programs in autonomous vehicles.	Understanding (K2)
CO4	explain the carsharing and ridesharing services as a promising approach for reducing personal car usage.	Understanding (K2)
CO5	indicate the straightforward applications of connected parking, including the main challenges and opportunities.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1		3		2			1		3	1	3
CO2	3	2	1		3		2			1		3	1	3
CO3	3	2	1		3		2			1		3	1	3
CO4	3	2	1		3		2			1		3	1	3
CO5	3	2	1		3		2			1		3	1	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)