KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

Estd : 1984

REGULATIONS, CURRICULUM & SYLLABI – 2020

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

(For the students admitted during 2020 - 2021 and onwards)

BACHELOR OF ENGINEERING DEGREE
IN
AUTOMOBILE ENGINEERING

DEPARTMENT OF AUTOMOBILE ENGINEERING

KONGU
Assuring the Best

INDEX

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 2020

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 2020 – 2021 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” means authorized person who is responsible for all examination related activities of the College.

xi. “Head of the Department” means Head of the Department concerned of the College.

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 in relevant branches of study.

(OR)

The candidates who hold a BSc degree (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 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

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 Training, Industrial Training, Comprehensive Test & Viva, Entrepreneurships/Start ups and Internship 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 169.

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 8.0 CGPA and no history of arrears during the entire programme to opt for the honours degree.

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, internship and entrepreneurships/start ups during the programme to gain/exhibit the knowledge/skills.

4.3.1 Professional Skills Training/ Industrial Training/Entrepreneurships/Start Ups

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 fifth semester and phase-II in sixth 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 sixth semester vacation period. Such candidate can earn two credits for this training course in place of Professional Skills Training Phase-II in sixth semester. He/She shall attend Professional Skills Training Phase-I in fifth 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 a maximum of 2 credits per semester for two semesters each in place of either Professional Skills Training-I / II or Industrial Training-I/ II respectively. 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 & 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 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-I Phase-II 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 Value Added 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 Value Added 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.

4.4 Value Added Courses / Online Courses / Self Study Courses

The candidates may optionally undergo Value Added Courses / Online Courses / Self Study Courses as elective courses.

4.4.1 **Value Added Courses:** Value Added courses each with One / Two credits shall be offered by the college with the prior approval from the respective Board of Studies. A candidate can earn a maximum of six credits through value added 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 value added 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 eighth 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. Total number of credits of such courses during the entire programme of study cannot exceed eight.

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), 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, Project Work, Professional Skills Training / Industrial Training, Internship 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 / Practical	50	50
2.	Theory cum Practical	The distribution of marks shall be decided based on the credit weightage assigned to theory and practical components.	
3.	Professional Skills Training / / Comprehensive Test & Viva / Entrepreneurships / Start ups / Project Work - I / Industrial Training / Mandatory Course	100	---
4.	Project Work-II Phase-I / Project Work-II Phase-II / Internships	50	50
5.	Value Added Course	The distribution of marks shall be decided based on the credit weightage assigned	---
6.	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 50 marks and the end semester examination shall be for 50 marks. However, the end semester examinations shall be conducted for 100 marks and the marks obtained shall be reduced to 50. The continuous assessment tests shall be conducted as per the schedule laid down in the academic schedule. Three tests shall be conducted for 50 marks each and reduced to 30 marks each. 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:

<table>
<tr><th>Sl. No.</th><th>Type</th><th>Max. Marks</th><th>Remarks</th></tr>
<tr><td rowspan="3">1.</td><td>Test - I</td><td>30</td><td rowspan="3">Average of best two</td></tr>
<tr><td>Test - II</td><td>30</td></tr>
<tr><td>Test - III</td><td>30</td></tr>
<tr><td>2.</td><td>Tutorial</td><td>15</td><td>Should be of Open Book/Objective Type.
Average of best 4 (or more, depending on the nature of the course, as may be approved by Principal)</td></tr>
<tr><td>3.</td><td>Assignment / Paper Presentation in Conference / Seminar / Comprehension / Activity based learning / Class notes</td><td>05</td><td>To be assessed by the Course Teacher based on any one type.</td></tr>
<tr><td colspan="2">Total</td><td>50</td><td>Rounded off to the one decimal place</td></tr>
</table>

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 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 50 marks and the end semester examination shall be for 50 marks. Every exercise / experiment shall be evaluated based on the candidate's performance during the practical class and the candidate's 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.

7.6 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 (both Phase-I and Phase-II) and the Viva-Voce Examination shall be distributed as below:

<table>
<tr><td colspan="6">Continuous Assessment
(Max. 50 Marks)</td><td colspan="4">End Semester Examination
(Max. 50 Marks)</td></tr>
<tr><td colspan="2">Zeroth Review</td><td colspan="2">Review I
(Max.. 20 Marks)</td><td colspan="2">Review II
(Max. 30 Marks)</td><td>Report Evaluation
(Max. 20 Marks)</td><td colspan="3">Viva - Voce
(Max. 30 Marks)</td></tr>
<tr><td>Rv. Com</td><td>Guide</td><td>Review Committee (excluding guide)</td><td>Guide</td><td>Review Committee (excluding guide)</td><td>Guide</td><td>Ext. Exr.</td><td>Guide</td><td>Exr.1</td><td>Exr.2</td></tr>
<tr><td>0</td><td>0</td><td>10</td><td>10</td><td>15</td><td>15</td><td>20</td><td>10</td><td>10</td><td>10</td></tr>
</table>

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 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 guide 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 Phase-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	Guide	Review Committee (excluding guide)	Guide	Review Committee (excluding guide)	Guide	Review Committee	Guide	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 4th semester vacation and during 5th semester. Phase-II training shall be conducted for minimum of 80 hours in 5th semester vacation and during 6th semester. The evaluation procedure shall be approved by 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 two credits in sixth semester respectively 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 Projects through Internships

Each candidate shall submit a brief report about the project through internship undergone and a certificate issued from the organization concerned at the time of Viva-voce examination to the review committee. The evaluation method shall be same as that of the Project Work-II as per clause 7.6.

7.12 Value Added Course

Minimum of two assessments shall be conducted during the value added course duration by the offering department concerned.

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 SF (Satisfactory). 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 Course

A candidate shall attend and complete the induction training program of duration three weeks at the beginning of the first semester. It is mandatory for all candidates who have joined in various branches of all BE/BTech programmes. No credits shall be given for such courses and shall be evaluated through continuous assessment tests only vide clause 7.1 for a maximum of 100 marks each. Since these courses have no grade points assigned, these courses will not be counted for the purpose of GPA and CGPA calculations.

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

Courses such as YVHD and UHV shall be offered to all candidates of all BE/BTech programmes. 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

Range of % of Total Marks	Letter Grade	Grade Point
91 to 100	O (Outstanding)	10
81 to 90	A+ (Excellent)	9
71 to 80	A (Very Good)	8
61 to 70	B+ (Good)	7
50 to 60	B (Average)	6
Less than 50	RA (Reappear)	0
Satisfactory	SF	0
Withdrawal	W	-
Absent	AB	-
Shortage of Attendance in a course	SA	-

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-2020 (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 and 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 7.00

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 Honours 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 8.00

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 Kongu Engineering 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										
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	**4**	**3**		**3**			**3**		**13**	**6.5 %**
BS	**11**	**11**	**4**	**4**					**30**	**17.75 %**
ES	**4**	**4 / 8**	**8**	**4 / 0**					**20**	**11.8 %**
PC	**4**	**4 / 0**	**12**	**9 / 13**	**12**	**12**	**3**		**56**	**33.15 %**
PE					**3**		**12**	**3**	**18**	**10.65 %**
OE				**4**	**4**	**3**		**3**	**14**	**8.3 %**
EC					**2**	**6**	**3**	**7**	**18**	**10.65 %**
MC									**0**	**1.2 %**
Semester wise Total	**23**	**22**	**24**	**24**	**21**	**21**	**21**	**13**	**169**	**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.	20EGT11	English Language Skills	3	0	0	3	I
2.	20VEC11	Yoga and Values for Holistic Development	1	0	1	1	I
3.	20EGT21	Advanced Communication Skills	3	0	0	3	II
4.	20EGL31	English for Workplace Communication Laboratory	0	0	2	1	IV
5.	20GET31	Universal Human Values	2	0	0	2	IV
6.	20MBT71	Economics and Management for Engineers	3	0	0	3	VII
Total Credits to be earned						**13**	

BASIC SCIENCE (BS)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	20MAC11	Matrices and Differential Equations	3	1*	2*	4	I
2.	20PHT11	Applied Physics	3	0	0	3	I
3.	20CYT11	Applied Chemistry	3	0	0	3	I
4.	20PHL11	Physical Sciences Laboratory I	0	0	2	1	I
5.	20MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	II
6.	20PHT22	Materials Science and Metallurgy	3	0	0	3	II
7.	20CYT22	Chemistry for Mechanical Systems	3	0	0	3	II
8.	20PHL23	Physical Sciences Laboratory II	0	0	2	1	II
9.	20MAT31	Probability and Partial Differential Equations	3	1	0	4	III
10.	20MAT41	Statistics and Numerical Methods	3	1	0	4	IV
Total Credits to be earned						**30**	

ENGINEERING SCIENCE (ES)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	20MEC11	Engineering Drawing	2	0	2	3	I
2.	20MEL11	Engineering Practices Laboratory	0	0	2	1	I
3.	20AUT22	Manufacturing Technology	3	0	0	3	II
4.	20AUL21	Manufacturing Technology Laboratory	0	0	2	1	II
5.	20CSC31	Programming in C	3	0	2	4	II / III
6.	20AUT34	Automotive Electrical Systems & Drives	3	0	2	4	III
7.	20CSC41	Python Programming	3	0	2	4	III / IV
Total Credits to be earned						**20**	

PROFESSIONAL CORE (PC)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream**
1.	20AUT11	Statics and Dynamics	3	1	0	4	I	DSN
2.	20AUT21	Mechanics of Fluids and Hydraulic Machines	3	1	0	4	II / IV	TF
3.	20AUT31	Mechanics of Deformable Bodies	3	0	0	3	III	DSN
4.	20AUT32	Automotive Powertrain	3	0	0	3	III	AUTO
5.	20AUT33	Thermodynamics	3	1	0	4	III	TF
6.	20AUL31	Mechanics of Deformable Bodies Laboratory	0	0	2	1	III	DSN
7.	20AUL32	Automotive Power Train Laboratory	0	0	2	1	III	AUTO
8.	20AUT41	Thermal Engineering and Heat Transfer	3	0	0	3	IV	TF
9.	20AUT42	Automotive Chassis	3	0	0	3	IV	AUTO
10.	20AUL41	Fuels and Lubricants Laboratory	0	0	2	1	IV	TF
11.	20AUL42	Automotive Chassis Components Laboratory	0	0	2	1	IV	AUTO
12.	20AUT51	Mechanics of Machines	3	1	0	4	IV	DSN
13.	20AUT52	Automotive Sensors and Controllers	3	0	0	3	V	EE
14.	20AUT53	Vehicle Dynamics	3	0	0	3	V	AUTO
15.	20AUL51	Computer Aided Design Laboratory	0	0	2	1	V	DSN
16.	20AUL52	Automotive Sensors and Controllers Laboratory	0	0	2	1	V	EE
17.	20AUL53	Vehicle Dynamics Simulation Laboratory	0	0	2	1	V	AUTO
18.	20AUT61	Machine Design	3	0	0	3	V	DSN
19.	20AUT62	Automotive Control System	3	0	0	3	VI	AUTO
20.	20AUT63	Automotive Embedded Systems	3	0	0	3	VI	EE
21.	20AUL61	Computer Aided Analysis Laboratory	0	0	2	1	VI	DSN
22.	20AUL62	Vehicle Maintenance Laboratory	0	0	2	1	VI	AUTO
23.	20AUL63	Automotive Embedded Systems Laboratory	0	0	2	1	VI	EE
24.	20AUT71	Hybrid and Electric Vehicles	3	0	0	3	VII	EE
Total Credits to be earned						**56**		

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

23.	20AUE22	Design of Engine Components	3	0	0	3	MFG
24.	20AUE23	Autonomous Vehicle Technology	3	0	0	3	EE
Elective - V							
25.	20AUE24	Automotive Safety and Ergonomics	3	0	0	3	AUTO
26.	20AUE25	Non Destructive Evaluation Techniques	3	0	0	3	MFG
27.	20AUE26	Quality Assurance and Reliability	3	0	0	3	MFG
28.	20AUE27	Advanced Materials for Green Vehicles	3	0	0	3	MFG
29.	20AUE28	Automotive Testing	3	0	0	3	AUTO
30.	20AUE29	Alternate Energy Sources for Automobiles	3	0	0	3	TF
Semester - VIII							
Elective - VI							
31.	20AUE30	Road Transport Management	3	0	0	3	AUTO
32.	20AUE31	Advanced Theory of IC Engines	3	0	0	3	TF
33.	20AUE32	Automotive Product Life Cycle Management	3	0	0	3	DSN
34.	20AUE33	Process Planning and Cost Estimation	3	0	0	3	MFG
35.	20AUE34	Lean Methods for Automobile Engineers	3	0	0	3	MFG
36.	20AUE35	Automotive Styling and Modeling	3	0	0	3	AUTO
37.	20AUE36	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.	20GEI51	Professional Skills Training I / Industrial Training I	--	--	--	2	V
2.	20GEI61	Professional Skills Training II / Industrial Training II	--	--	--	2	VI
3.	20AUP61	Project Work I	0	0	4	2	VI
4.	20GEP61	Comprehensive Test and Viva	--	--	--	2	VII
5.	20AUP71	Project Work II Phase I	0	0	6	3	VII
6.	20AUP81	Project Work II Phase II	0	0	14	7	VIII
Total Credits to be earned						**18**	

MANDATORY COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	20MNT11	Induction Training Program	--	--	--	0	I
2.	20MNT31	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.	20AUO01	Automotive Engineering	3	0	2	4	IV
2.	20AUO02	Automotive Electronics	3	0	2	4	V
3.	20AUO03	Vehicle Maintenance	3	0	0	3	VI
4.	20AUO04	Public Transport Management	3	0	0	3	VIII
5.	20AUO05	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 IV					
1.	20MAO01	Mathematical Foundations of Machine Learning	3	1	0	4	MATHS
2.	20PHO01	Thin film Technology	3	1	0	4	PHYSICS
3.	20CYO01	Corrosion Science and Engineering	3	1	0	4	CHEMISTRY
4.	20CEO01	Remote Sensing and its Applications	3	0	2	4	CIVIL
5.	20MEO01	Renewable Energy Sources	3	0	2	4	MECH
6.	20MTO01	Design of Mechatronics Systems	3	1	0	4	MTS
7.	20ECO01	PCB Design and Fabrication	3	0	2	4	ECE
8.	20ECO02	Neural Networks and Fuzzy Logic for Engineering Applications	3	0	2	4	ECE
9.	20EEO01	Electrical Wiring and Lighting	3	1	0	4	EEE
10.	20EEO02	Solar and Wind Energy Systems	3	1	0	4	EEE
11.	20EIO01	Neural Networks and Deep Learning	3	1	0	4	EIE

12.	20CSO01	Data Structures and its Applications	3	0	2	4	CSE
13.	20CSO02	Formal Languages and Automata Theory	3	1	0	4	CSE
14.	20CSO03	Computational Science for Engineers	3	1	0	4	CSE
15.	20ITO01	Python Programming	3	0	2	4	IT
16.	20ITO02	Advanced Java Programming	3	0	2	4	IT
17.	20CHO01	Polymer Technology	3	1	0	4	CHEM
18.	20CHO02	Introduction to Drugs and Pharmaceuticals Technology	3	1	0	4	CHEM
19.	20FTO01	Food Processing Technology	3	1	0	4	FT
20.	20FTO02	Baking Technology	3	0	2	4	FT
		SEMESTER V					
21.	20MAO02	Graph Theory and its Applications	3	1	0	4	MATHS
22.	20MAO03	Number Theory and Cryptography	3	1	0	4	MATHS
23.	20CYO02	Instrumental Methods of Analysis	3	1	0	4	CHEMISTRY
24.	20CEO02	Disaster Management	3	1	0	4	CIVIL
25.	20MEO02	Design of Experiments	3	0	2	4	MECH
26.	20MTO02	Factory Automation	3	0	2	4	MTS
27.	20MTO03	Data Acquisition and Virtual Instrumentation	3	0	2	4	MTS
28.	20ECO03	Principles of Quantum Computing	3	0	2	4	ECE
29.	20EEO03	Energy Conservation and Management	3	1	0	4	EEE
30.	20EIO02	Digital Image Processing and Its Applications	3	1	0	4	EIE
31.	20EIO03	Industrial Automation	3	1	0	4	EIE
32.	20CSO04	Web Engineering	3	0	2	4	CSE
33.	20CSO05	Foundations of Data Analytics	3	1	0	4	CSE
34.	20CSO06	Nature Inspired Optimization Techniques	3	1	0	4	CSE
35.	20CSO07	Introducing Data Science	3	1	0	4	CSE
36.	20ITO03	Java Programming	3	1	0	4	IT
37.	20ITO04	Next Generation Databases	3	1	0	4	IT
38.	20CHO03	Bio Energy Resources	3	1	0	4	CHEM
39.	20CHO04	Fundamentals of Nanoscience and Nanotechnology	3	1	0	4	CHEM
40.	20FTO03	Processing of Milk and Milk products	3	0	2	4	FT
41.	20FTO04	Processing of Fruits and Vegetables	3	0	2	4	FT

		SEMESTER VI					
42.	20MAO04	Advanced Linear Algebra	3	0	0	3	MATHS
43.	20MAO05	Optimization Techniques	3	0	0	3	MATHS
44.	20PHO02	Structural and Optical Characterization of Materials	3	0	0	3	PHYSICS
45.	20CYO03	Waste and Hazardous Waste Management	3	0	0	3	CHEMISTRY
46.	20CEO03	Introduction to Smart Cities	3	0	0	3	CIVIL
47.	20CEO04	Environmental Health and Safety	3	0	0	3	CIVIL
48.	20MEO03	Fundamentals of Ergonomics	3	0	0	3	MECH
49.	20MEO04	Principles of Management and Industrial Psychology	3	0	0	3	MECH
50.	20MTO04	3D Printing and Design	3	0	0	3	MTS
51.	20MTO05	Drone System Technology	3	0	0	3	MTS
52.	20ECO04	Electronic Hardware and Troubleshooting	2	0	2	3	ECE
53.	20ECO05	Principles of Communication Techniques	3	0	0	3	ECE
54.	20EEO04	Micro Grid and Smart Grid	3	0	0	3	EEE
55.	20EEO05	Electrical Safety	3	0	0	3	EEE
56.	20EIO04	Biomedical Instrumentation and Applications	3	0	0	3	EIE
57.	20EIO05	PLC Programming and its Applications	3	0	0	3	EIE
58.	20CSO08	Artificial Intelligence and its applications	3	0	0	3	CSE
59.	20ITO05	Business Continuity Planning	3	0	0	3	IT
60.	20ITO06	Mobile Application Development	3	0	0	3	IT
61.	20CHO05	Enzyme Engineering	3	0	0	3	CHEM
62.	20CHO06	Nuclear Engineering	3	0	0	3	CHEM
63.	20FTO05	Principles of Food safety	3	0	0	3	FT
64.	20FTO06	Food and Nutrition	3	0	0	3	FT
		SEMESTER VIII					
65.	20CEO05	Infrastructure Planning and Management	3	0	0	3	CIVIL
66.	20CEO06	Environmental Laws and Policy	3	0	0	3	CIVIL
67.	20MEO05	Safety Measures for Engineers	3	0	0	3	MECH
68.	20MEO06	Energy Conservation in Thermal Equipments	3	0	0	3	MECH
69.	20MTO06	Robotics	3	0	0	3	MTS

70.	20MTO07	Virtual and Augment Reality in Industry 4.0	3	0	0	3	MTS
71.	20ECO06	Bioinspired Computing Technologies	2	0	2	3	ECE
72.	20EEO06	Electric Vehicle	3	0	0	3	EEE
73.	20EIO06	Measurements and Instrumentation	3	0	0	3	EIE
74.	20EIO07	Graphical Programming using Virtual Instrumentation	3	0	0	3	EIE
75.	20CSO09	Applied Machine Learning	3	0	0	3	CSE
76.	20CSO10	Fundamentals of Blockchain	3	0	0	3	CSE
77.	20CSO11	Fundamentals of Internet of Things	3	0	0	3	CSE
78.	20ITO07	Essentials of Information Technology	3	0	0	3	IT
79.	20ITO08	Virtual and Augmented Reality Frameworks	3	0	0	3	IT
80.	20CHO07	Fertilizer Technology	3	0	0	3	CHEM
81.	20FTO07	Food Ingredients	3	0	0	3	FT
82.	20FTO08	Fundamentals of Food Packaging and Storage	3	0	0	3	FT
Total credits to be earned						**14**	

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

		GENERAL OPEN ELECTIVE	L	T	P	C	Offering Department	Semester
1.	20GEO01	German Language Level 1	4	0	0	4	ECE	IV/ V/ VI/ VIII
2.	20GEO02	Japanese Language Level 1	4	0	0	4	ECE	IV/ V/ VI/ VIII
3.	20GEO03	Design Thinking for Engineers	3	0	0	3	CSE	V
4.	20GEO04	Innovation and Business Model Development	3	0	0	3	MTS	VIII
5.	20GEO05	German Language Level 2	4	0	0	4	ECE	IV/ V/ VI/ VIII
6.	20GEO06	German Language Level 3	3	0	0	3	ECE	IV/ V/ VI/ VIII
7.	20GEO07	German Language Level 4	3	0	0	3	ECE	IV/ V/ VI/ VIII
8.	20GEO08	Japanese Language Level 2	4	0	0	4	ECE	IV/ V/ VI/ VIII
9.	20GEO09	Japanese Language Level 3	3	0	0	3	ECE	IV/ V/ VI/ VIII
10.	20GEO10	Japanese Language Level 4	3	0	0	3	ECE	IV/ V/ VI/ VIII
11.	20GEO11	NCC Studies (Army Wing) – I	3	0	2	4	EEE	V / VI
12.	20GEO12	NCC Studies (Air Wing) – I	3	0	2	4	IT	V / VI

KEC R2020: SCHEDULING OF COURSES – BE (Automobile Engineering) Total Credits: 169

Sem	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	CH
I	20EGT11 English Language Skills (3-0-0-3)	20MAC11 Matrices and Differential Equations (3-1*-2*-4)	20PHT11 Applied Physics (3-0-0-3)	20CYT11 Applied Chemistry (3-0-0-3)	20MEC11 Engineering Drawing (2-0-2-3)	20AUT11 Statics and Dynamics (3-1-0-4)	20PHL11 Physical Sciences Laboratory I (0-0-2-1)	20MEL11 Engineering Practices Laboratory (0-0-2-1)	20VEC11 Yoga and Values for Holistic Development (1-0-1-1)	20MNT11 Induction Training Program (0-0-0-0)	29
II	20EGT21 Advanced Communication Skills (3-0-0-3)	20MAC21 Multivariable Calculus and Complex Analysis (3-1*-2*-4)	20PHT22 Materials Science and Metallurgy (3-0-0-3)	20CYT22 Chemistry for Mechanical Systems (3-0-0-3)	20AUT21 / 20CSC31 Mechanics of Fluids and Hydraulic Machines / Programming in C (3-1-0-4)	20AUT22 Manufacturing Technology (3-0-0-3)	20PHL23 Physical Sciences Laboratory II (0-0-2-1)	20AUL21 Manufacturing Technology Laboratory (0-0-2-1)			26
III	20MAT31 Probability and Partial Differential Equations (3-1-0-4)	20CSC31 / 20CSC41 Programming in C / Python Programming (3-0-2-4)	20AUT31 Mechanics of Deformable Bodies (3-0-0-3)	20AUT32 Automotive Powertrain (3-0-0-3)	20AUT33 Thermodynamics (3-1-0-4)	20AUT34 Automotive Electrical Systems & Drives (3-0-2-4)	20AUL31 Mechanics of Deformable Bodies Laboratory (0-0-2-1)	20AUL32 Automotive Powertrain Laboratory (0-0-2-1)	20MNT31 Environmental Science (2-0-0-0)		30
IV	20MAT41 Statistics and Numerical Methods (3-1-0-4)	20CSC41 / 20AUT21 Python Programming /Mechanics of Fluids and Hydraulic Machines (3-0-2-4)	20AUT41 Thermal Engineering and Heat Transfer (3-1-0-4)	20AUT42 Automotive Chassis (3-0-0-3)	Open Elective I (3-1/0-0/2-4)	20AUL41 Fuels and Lubricants Laboratory (0-0-2-1)	20AUL42 Automotive Chassis Components Laboratory (0-0-2-1)	20EGL31 English for Workplace Communication Laboratory (0-0-2-1)	20GET31 Universal Human Values (2-0-0-2)		29
V	20AUT51 Mechanics of Machines (3-0-0-3)	20AUT52 Automotive Sensors and Controllers (3-0-0-3)	20AUT53 Vehicle Dynamics (3-0-0-3)	Open Elective II (3-1/0-0/2-4)	Professional Elective I (3-0-0-3)	20AUL51 Computer Aided Design Laboratory (0-0-2-1)	20AUL52 Automotive Sensors and Controllers Laboratory (0-0-2-1)	20AUL53 Vehicle Dynamics Simulation Laboratory (0-0-2-1)	20GEI51 Professional Skills Training I / Industrial Training I (0-0-0-2)		23
VI	20AUT61 Machine Design (3-0-0-3)	20AUT62 Automotive Control System (3-0-0-3)	20AUT63 Automotive Embedded Systems (3-0-0-3)	Open Elective III (3-0-0-3)	20AUL61 Computer Aided Analysis Laboratory (0-0-2-1)	20AUL62 Vehicle Maintenance Laboratory (0-0-2-1)	20AUL63 Automotive Embedded Systems Laboratory (0-0-2-1)	20GEI61 Professional Skills Training II / Industrial Training II (0-0-0-2)	20AUP61 Project Work I (0-0-4-2)	20GEP61 Comprehensive Test and Viva (0-0-0-2)	22
VII	20MBT71 Economics and Management for Engineers (3-0-0-3)	20AUT71 Hybrid and Electric Vehicles (3-0-0-3)	Professional Elective II (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)	20AUP71 Project Work II Phase I (0-0-6-3)				24
VIII	Open Elective IV (3-0-0-3)	Professional Elective VI (3-0-0-3)	20AUP81 Project Work II Phase II (0-0-14-7)								20

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	20EGT11	English Language Skills						✓			✓	✓	✓	✓		
1	20MAC11	Matrices and Differential Equations	✓	✓	✓	✓	✓									
1	20PHC11	Applied Physics	✓	✓	✓											
1	20CYC11	Applied Chemistry	✓	✓	✓	✓										
1	20MEC11	Engineering Drawing	✓	✓	✓	✓						✓	✓	✓	✓	
1	20AUT11	Statics and Dynamics	✓	✓	✓	✓								✓	✓	
1	20PHL11	Physical Sciences Laboratory I				✓										
1	20MEL11	Engineering Practices Laboratory	✓		✓	✓	✓	✓			✓	✓		✓		
1	20VEC11	Yoga and Values for Holistic Development						✓		✓	✓			✓		
1	20MNT11	Induction Training Program														
2	20EGT21	Advanced Communication Skills						✓			✓	✓	✓	✓		
2	20MAC21	Multivariable Calculus and Complex Analysis	✓	✓	✓		✓									
2	20PHT22	Materials Science and Metallurgy	✓	✓	✓											
2	20CYT22	Chemistry for Mechanical Systems	✓	✓	✓	✓										
2	20AUT21	Mechanics of Fluids and Hydraulic Machines	✓	✓	✓	✓								✓	✓	
2	20AUT22	Manufacturing Technology	✓	✓	✓	✓								✓	✓	
2	20PHL23	Physical Sciences Laboratory II			✓											
2	20AUL21	Manufacturing Technology Laboratory	✓	✓	✓	✓					✓	✓		✓	✓	
3	20MAT31	Probability and Partial Differential Equations	✓	✓	✓											
3	20CSC31	Programming in C														
3	20AUT31	Mechanics of Deformable Bodies	✓	✓	✓	✓								✓	✓	
3	20AUT32	Automotive Powertrain	✓	✓	✓	✓		✓	✓					✓	✓	✓
3	20AUT33	Thermodynamics	✓	✓	✓	✓		✓	✓					✓	✓	
3	20AUT34	Automotive Electrical Systems & Drives	✓	✓	✓	✓	✓				✓	✓		✓		✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
3	20AUL31	Mechanics of Deformable Bodies Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	
3	20AUL32	Automotive Power Train Laboratory	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	
3	20MNT31	Environmental Science														
4	20MAT41	Statistics and Numerical Methods	✓	✓	✓	✓										
4	20CSC41	Python Programming														
4	20AUT41	Thermal Engineering and Heat Transfer	✓	✓	✓	✓		✓	✓					✓	✓	
4	20AUT42	Automotive Chassis	✓	✓	✓	✓		✓						✓	✓	
4	20AUL41	Fuels and Lubricants Laboratory	✓	✓	✓	✓	✓		✓		✓	✓		✓	✓	
4	20AUL42	Automotive Chassis Components Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	
4	20EGL31	English for Workplace Communication Laboratory									✓	✓		✓		
4	20GET41	Universal Human Values						✓	✓	✓	✓	✓				
5	20AUT51	Mechanics of Machines	✓	✓	✓	✓		✓	✓					✓	✓	
5	20AUT52	Automotive Sensors and Controllers	✓	✓	✓			✓	✓					✓	✓	✓
5	20AUT53	Vehicle Dynamics	✓	✓	✓	✓		✓						✓	✓	
5	20AUL51	Computer Aided Design Laboratory	✓	✓	✓		✓				✓	✓		✓	✓	
5	20AUL52	Automotive Sensors and Controllers Laboratory	✓	✓	✓	✓	✓				✓	✓		✓		✓
5	20AUL53	Vehicle Dynamics Simulation Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	
5	20GEI51	Professional Skills Training I / Industrial Training I	✓	✓				✓	✓		✓	✓	✓	✓		
6	20AUT61	Machine Design	✓	✓	✓	✓			✓					✓	✓	
6	20AUT62	Automotive Control System	✓	✓	✓	✓								✓	✓	✓
6	20AUT63	Automotive Embedded Systems	✓	✓	✓	✓			✓					✓		✓
6	20AUL61	Computer Aided Analysis Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	
6	20AUL62	Vehicle Maintenance Laboratory	✓	✓	✓		✓	✓	✓	✓		✓		✓	✓	
6	20AUL63	Automotive Embedded Systems Laboratory	✓	✓	✓	✓	✓				✓	✓		✓		✓
6	20AUP61	Project Work I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	20GEI61	Professional Skills Training II / Industrial Training II	✓	✓				✓	✓		✓	✓	✓	✓		
6	20GEP61	Comprehensive Test and Viva	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	20MBT71	Economics and Management for Engineers	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
7	20AUT71	Hybrid and Electric Vehicles	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓
7	20AUP71	Project Work II Phase I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	20AUP81	Project Work II Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Professional Elective Courses														
5	20AUE01	Two and Three Wheeler Technology	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓
5	20AUE02	Diesel and Electric Locomotives	✓	✓	✓	✓	✓							✓	✓	✓
5	20AUE03	Computer Integrated Manufacturing	✓	✓	✓	✓								✓	✓	
5	20AUE04	Theory of Fuels and Lubricants	✓	✓	✓	✓		✓	✓					✓	✓	
5	20AUE05	Hydraulics and Pneumatics	✓	✓	✓	✓	✓							✓	✓	✓
5	20AUE06	Principles of Farm Machineries	✓	✓	✓	✓		✓	✓					✓	✓	
7	20AUT07	Finite Element Method	✓	✓	✓	✓	✓							✓	✓	
7	20AUE08	In-Vehicle Networking	✓	✓	✓	✓								✓		✓
7	20AUE09	Vehicle Body Engineering	✓	✓	✓	✓	✓	✓	✓					✓	✓	
7	20AUE10	Operations Research	✓	✓	✓	✓	✓						✓	✓	✓	
7	20AUT11	Vehicle Maintenance	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓
7	20AUE12	Composite Materials	✓	✓	✓	✓			✓					✓	✓	
7	20AUE13	CNC and Metrology	✓	✓	✓	✓	✓							✓	✓	
7	20AUE14	Computational Fluid Dynamics	✓	✓	✓	✓	✓							✓	✓	
7	20AUE15	Design of Chassis Components	✓	✓	✓	✓			✓					✓	✓	
7	20AUE16	Automotive Pollution Control	✓	✓	✓	✓		✓	✓					✓	✓	
7	20AUE17	Total Quality Management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
7	20GEE01	Fundamentals of Research	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	20AUE18	Automotive Noise, Vibration and Harshness	✓	✓	✓	✓		✓	✓					✓	✓	
7	20AUE19	Automotive HVAC	✓	✓	✓			✓	✓					✓	✓	✓
7	20AUE20	Micro Electro Mechanical Systems	✓	✓	✓	✓	✓							✓	✓	✓
7	20AUE21	Value Engineering	✓	✓	✓	✓			✓					✓	✓	
7	20AUE22	Design of Engine Components	✓	✓	✓	✓								✓	✓	

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	20AUE23	Autonomous Vehicle Technology	✓	✓	✓	✓		✓	✓					✓		✓
7	20AUE24	Automotive Safety and Ergonomics	✓	✓	✓	✓		✓	✓					✓	✓	✓
7	20AUE25	Non Destructive Evaluation Techniques	✓	✓			✓					✓		✓	✓	
7	20AUE26	Quality Assurance and Reliability	✓	✓	✓	✓			✓				✓	✓	✓	
7	20AUE27	Advanced Materials for Green Vehicles	✓	✓	✓	✓		✓	✓					✓	✓	
7	20AUE28	Automotive Testing	✓	✓	✓	✓	✓	✓	✓					✓	✓	
7	20AUE29	Alternate Energy Sources for Automobiles	✓	✓	✓	✓		✓	✓					✓	✓	
8	20AUE30	Road Transport Management	✓	✓				✓	✓	✓		✓	✓	✓	✓	
8	20AUE31	Advanced Theory of IC Engines	✓	✓	✓	✓		✓						✓	✓	
8	20AUE32	Automotive Product Life Cycle Management	✓	✓	✓	✓	✓		✓					✓	✓	
8	20AUE33	Process Planning and Cost Estimation	✓	✓	✓	✓			✓				✓	✓	✓	
8	20AUE34	Lean Methods for Automobile Engineers	✓	✓	✓	✓		✓					✓	✓	✓	
8	20AUE35	Automotive Styling and Modeling	✓	✓	✓		✓	✓			✓			✓	✓	
8	20AUE36	Non-Traditional Machining Processes	✓	✓	✓	✓								✓	✓	
		General Open Elective														
4,5,6,8	20GEO01	German Language Level 1								✓	✓	✓		✓		
4,5,6,8	20GEO02	Japanese Language Level 1								✓	✓	✓		✓		
6	20GEO03	Design Thinking for Engineers	✓	✓	✓	✓										
8	20GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4,5,6,8	20GEO05	German Language Level 2								✓	✓	✓		✓		
4,5,6,8	20GEO06	German Language Level 3								✓	✓	✓		✓		
4,5,6,8	20GEO07	German Language Level 4								✓	✓	✓		✓		
4,5,6,8	20GEO08	Japanese Language Level 2								✓	✓	✓		✓		
4,5,6,8	20GEO09	Japanese Language Level 3								✓	✓	✓		✓		
4,5,6,8	20GEO10	Japanese Language Level 4								✓	✓	✓		✓		
4,5	20GEO11	NCC Studies (Army Wing) – I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
4,5	20GEO12	NCC Studies (Air Wing) – I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				

B.E. AUTOMOBILE ENGINEERING CURRICULUM – R2020
(For the students admitted in the academic year 2020-21)

SEMESTER – I									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20EGT11	English Language Skills	3	0	0	3	50	50	100	HS
20MAC11	Matrices and Differential Equations	3	1*	2*	4	50	50	100	BS
20PHT11	Applied Physics	3	0	0	3	50	50	100	BS
20CYT11	Applied Chemistry	3	0	0	3	50	50	100	BS
20MEC11	Engineering Drawing	2	0	2	3	50	50	100	ES
20AUT11	Statics and Dynamics	3	1	0	4	50	50	100	PC
Practical / Employability Enhancement									
20PHL11	Physical Sciences Laboratory I	0	0	2	1	50	50	100	BS
20MEL11	Engineering Practices Laboratory	0	0	2	1	50	50	100	ES
20VEC11	Yoga and Values for Holistic Development	1	0	1	1	100	0	100	HS
20MNT11	Student Induction Program	--	--	--	0	100	0	100	MC
Total Credits to be earned					23				

***Alternate weeks**

SEMESTER – II									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20EGT21	Advanced Communication Skills	3	0	0	3	50	50	100	HS
20MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	50	50	100	BS
20PHT22	Materials Science and Metallurgy	3	0	0	3	50	50	100	BS
20CYT22	Chemistry for Mechanical Systems	3	0	0	3	50	50	100	BS
20AUT21	Mechanics of Fluids and Hydraulic Machines	3	1	0	4	50	50	100	PC
20AUT22	Manufacturing Technology	3	0	0	3	50	50	100	ES
Practical / Employability Enhancement									
20PHL23	Physical Sciences Laboratory II	0	0	2	1	50	50	100	BS
20AUL21	Manufacturing Technology Laboratory	0	0	2	1	50	50	100	ES
Total Credits to be earned					22				

***Alternate weeks**

B.E. AUTOMOBILE ENGINEERING CURRICULUM – R2020
(For the students admitted in the academic year 2020-21)

SEMESTER – III									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MAT31	Probability and Partial Differential Equations	3	1	0	4	50	50	100	BS
20CSC31	Programming in C	3	0	2	4	50	50	100	ES
20AUT31	Mechanics of Deformable Bodies	3	0	0	3	50	50	100	PC
20AUT32	Automotive Powertrain	3	0	0	3	50	50	100	PC
20AUT33	Thermodynamics	3	1	0	4	50	50	100	PC
20AUT34	Automotive Electrical Systems and Drives	3	0	2	4	50	50	100	ES
Practical / Employability Enhancement									
20AUL31	Mechanics of Deformable Bodies Laboratory	0	0	2	1	50	50	100	PC
20AUL32	Automotive Powertrain Laboratory	0	0	2	1	50	50	100	PC
20MNT31	Environmental Science 3/4	2	0	0	0	100	0	100	MC
Total Credits to be earned					24				

SEMESTER – IV									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MAT41	Statistics and Numerical Methods	3	1	0	4	50	50	100	BS
20CSC41	Python Programming	3	0	2	4	50	50	100	ES
20AUT41	Thermal Engineering and Heat Transfer	3	1	0	4	50	50	100	PC
20AUT42	Automotive Chassis	3	0	0	3	50	50	100	PC
	Open Elective - I	3	1/0	0/2	4	50	50	100	OE
Practical / Employability Enhancement									
20AUL41	Fuels and Lubricants Laboratory	0	0	2	1	50	50	100	PC
20AUL42	Automotive Chassis Components Laboratory	0	0	2	1	50	50	100	PC
20EGL31	English for Workplace Communication Laboratory	0	0	2	1	50	50	100	HS
20GET31	Universal Human Values	2	0	0	2	100	0	100	HS
Total Credits to be earned					24				

B.E. AUTOMOBILE ENGINEERING CURRICULUM – R2020
(For the students admitted in the academic year 2020-21)

SEMESTER – V									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20AUT51	Mechanics of Machines	3	0	0	3	50	50	100	PC
20AUT52	Automotive Sensors and Controllers	3	0	0	3	50	50	100	PC
20AUT53	Vehicle Dynamics	3	0	0	3	50	50	100	PC
	Open Elective - II	3	1/0	0/2	4	50	50	100	OE
	Professional Elective - I	3	0	0	3	50	50	100	PE
Practical / Employability Enhancement									
20AUL51	Computer Aided Design Laboratory	0	0	2	1	50	50	100	PC
20AUL52	Automotive Sensors and Controllers Laboratory	0	0	2	1	50	50	100	PC
20AUL53	Vehicle Dynamics Simulation Laboratory	0	0	2	1	50	50	100	PC
20GEL51/ 20GEI51	Professional Skills Training I / Industrial Training I	--	--	--	2	100	0	100	EC
Total Credits to be earned					21				

SEMESTER – VI									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20AUT61	Machine Design	3	0	0	3	50	50	100	PC
20AUT62	Automotive Control System	3	0	0	3	50	50	100	PC
20AUT63	Automotive Embedded Systems	3	0	0	3	50	50	100	PC
	Open Elective - III	3	0	0	3	50	50	100	OE
Practical / Employability Enhancement									
20AUL61	Computer Aided Analysis Laboratory	0	0	2	1	50	50	100	PC
20AUL62	Vehicle Maintenance Laboratory	0	0	2	1	50	50	100	PC
20AUL63	Automotive Embedded Systems Laboratory	0	0	2	1	50	50	100	PC
20AUP61	Project Work I	0	0	4	2	100	0	100	EC
20GEL61/ 20GEI61	Professional Skills Training II / Industrial Training II	--	--	--	2	100	0	100	EC
20GEP61	Comprehensive Test and Viva	--	--	--	2	100	0	100	EC
Total Credits to be earned					21				

B.E. AUTOMOBILE ENGINEERING CURRICULUM – R2020
(For the students admitted in the academic year 2020-21)

SEMESTER – VII										
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20GET71	Engineering Economics and Management	3	0	0	3	50	50	100	HS
20AUT71	Hybrid and Electric Vehicles	3	0	0	3	50	50	100	PC
	Professional Elective – II	3	0	0	3	50	50	100	PE
	Professional Elective – III	3	0	0	3	50	50	100	PE
	Professional Elective – IV	3	0	0	3	50	50	100	PE
	Professional Elective - V	3	0	0	3	50	50	100	PE
Practical / Employability Enhancement									
20AUP71	Project Work II Phase I	0	0	12	6	50	50	100	EC
Total Credits to be earned					24				

SEMESTER – VIII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
	Open Elective - IV	3	0	0	3	50	50	100	OE
	Professional Elective -VI	3	0	0	3	50	50	100	PE
Practical / Employability Enhancement									
20AUP81	Project Work II Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					10				

Total Credits : 169

B.E. AUTOMOBILE ENGINEERING CURRICULUM – R2020
(with the inclusion of Amendment No.2022.18.07)
(For the students admitted in the academic year 2021-22)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20EGT11	English Language Skills	3	0	0	3	40	60	100	HS
20MAC11	Matrices and Differential Equations	3	1*	2*	4	50	50	100	BS
20PHT11	Applied Physics	3	0	0	3	40	60	100	BS
20CYT11	Applied Chemistry	3	0	0	3	40	60	100	BS
20MEC11	Engineering Drawing	2	0	2	3	50	50	100	ES
20AUT11	Statics and Dynamics	3	1	0	4	40	60	100	PC
Practical / Employability Enhancement									
20PHL11	Physical Sciences Laboratory I	0	0	2	1	60	40	100	BS
20MEL11	Engineering Practices Laboratory	0	0	2	1	60	40	100	ES
20VEC11	Yoga and Values for Holistic Development	1	0	1	1	100	0	100	HS
20MNT11	Student Induction Program	--	--	--	0	100	0	100	MC
Total Credits to be earned					23				

***Alternate weeks**

SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20EGT21	Advanced Communication Skills	3	0	0	3	40	60	100	HS
20MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	50	50	100	BS
20PHT22	Materials Science and Metallurgy	3	0	0	3	40	60	100	BS
20CYT22	Chemistry for Mechanical Systems	3	0	0	3	40	60	100	BS
20CSC31	Programming in C	3	0	2	4	50	50	100	ES
20AUT22	Manufacturing Technology	3	0	0	3	40	60	100	ES
Practical / Employability Enhancement									
20PHL23	Physical Sciences Laboratory II	0	0	2	1	60	40	100	BS
20AUL21	Manufacturing Technology Laboratory	0	0	2	1	60	40	100	ES
Total Credits to be earned					22				

***Alternate weeks**

B.E. AUTOMOBILE ENGINEERING CURRICULUM – R2020
(For the students admitted in the academic year 2021-22)

SEMESTER – III									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MAT31	Probability and Partial Differential Equations	3	1	0	4	40	60	100	BS
20CSC33	Fundamentals of Data Structures	3	0	2	4	50	50	100	ES
20AUT31	Mechanics of Deformable Bodies	3	0	0	3	40	60	100	PC
20AUT32	Automotive Powertrain	3	0	0	3	40	60	100	PC
20AUT33	Thermodynamics	3	1	0	4	40	60	100	PC
20AUT34	Automotive Electrical Systems and Drives	3	0	2	4	50	50	100	ES
Practical / Employability Enhancement									
20AUL31	Mechanics of Deformable Bodies Laboratory	0	0	2	1	60	40	100	PC
20AUL32	Automotive Powertrain Laboratory	0	0	2	1	60	40	100	PC
20MNT31	Environmental Science	2	0	0	0	100	0	100	MC
Total Credits to be earned					24				

SEMESTER – IV									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MAT41	Statistics and Numerical Methods	3	1	0	4	40	60	100	BS
20AUT21	Mechanics of Fluids and Hydraulic Machines	3	0	2	4	50	50	100	PC
20AUT41	Thermal Engineering and Heat Transfer	3	1	0	4	40	60	100	PC
20AUT42	Automotive Chassis	3	0	0	3	40	60	100	PC
	Open Elective – I	3	1/0	0/2	4	40/50	60/50	100	OE
Practical / Employability Enhancement									
20AUL41	Fuels and Lubricants Laboratory	0	0	2	1	60	40	100	PC
20AUL42	Automotive Chassis Components Laboratory	0	0	2	1	60	40	100	PC
20EGL31	English for Workplace Communication Laboratory	0	0	2	1	60	40	100	HS
20GEL51/20GEI51	Professional Skills Training I / Industrial Training I *	--	--	--	2	100	0	100	EC
Total Credits to be earned					24				

*80 hours of training

B.E. AUTOMOBILE ENGINEERING CURRICULUM – R2020
(For the students admitted in the academic year 2021-22)

SEMESTER – V

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20AUT51	Mechanics of Machines	3	0	0	3	40	60	100	PC
20AUT52	Automotive Sensors and Controllers	3	0	0	3	40	60	100	PC
20AUT53	Vehicle Dynamics	3	0	0	3	40	60	100	PC
	Open Elective – II	3	1/0	0/2	4	40/ 50	60/ 50	100	OE
	Professional Elective – I	3	0	0	3	40	60	100	PE
Practical / Employability Enhancement									
20AUL51	Computer Aided Design Laboratory	0	0	2	1	60	40	100	PC
20AUL52	Automotive Sensors and Controllers Laboratory	0	0	2	1	60	40	100	PC
20AUL53	Vehicle Dynamics Simulation Laboratory	0	0	2	1	60	40	100	PC
20GEL61/ 20GEI61	Professional Skills Training II / Industrial Training II *	--	--	--	2	100	0	100	EC
Total Credits to be earned					21				

*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									
20AUT61	Machine Design	3	0	0	3	40	60	100	PC
20AUT62	Automotive Control System	3	0	0	3	40	60	100	PC
20AUT63	Automotive Embedded Systems	3	0	0	3	40	60	100	PC
	Open Elective – III	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
20AUL61	Computer Aided Analysis Laboratory	0	0	2	1	60	40	100	PC
20AUL62	Vehicle Maintenance Laboratory	0	0	2	1	60	40	100	PC
20AUL63	Automotive Embedded Systems Laboratory	0	0	2	1	60	40	100	PC
20AUP61	Project Work I	0	0	4	2	100	0	100	EC
20GET31	Universal Human Values	2	0	0	2	100	0	100	HS
20GEP61	Comprehensive Test and Viva	--	--	--	2	100	0	100	EC
Total Credits to be earned					21				

B.E. AUTOMOBILE ENGINEERING CURRICULUM – R2020
(For the students admitted in the academic year 2021-22)

SEMESTER – VII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20GET71	Engineering Economics and Management	3	0	0	3	40	60	100	HS
20AUT71	Hybrid and Electric Vehicles	3	0	0	3	40	60	100	PC
	Professional Elective – II	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
	Professional Elective - V	3	0	0	3	40	60	100	PE
Practical / Employability Enhancement									
20AUP71	Project Work II Phase I	0	0	12	6	50	50	100	EC
Total Credits to be earned					24				

SEMESTER – VIII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
	Open Elective - IV	3	0	0	3	40	60	100	OE
	Professional Elective -VI	3	0	0	3	40	60	100	PE
Practical / Employability Enhancement									
20AUP81	Project Work II Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					10				

Total Credits : 169

LIST OF PROFESSIONAL ELECTIVES (PEs)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Domain/ Stream**
Semester – V							
Elective – I							
1.	20AUE01	Two and Three wheeler Technology	3	0	0	3	AUTO
2.	20AUE02	Diesel and Electric Locomotives	3	0	0	3	AUTO
3.	20AUE03	Computer Integrated Manufacturing	3	0	0	3	MFG
4.	20AUE04	Theory of Fuels and Lubricants	3	0	0	3	TF
5.	20AUE05	Hydraulics and Pneumatics	3	0	0	3	DSN
6.	20AUE06	Principles of Farm Machineries	3	0	0	3	DSN
Semester - VII							
Elective – II							
7.	20AUE07	Finite Element Method	3	0	0	3	DSN
8.	20AUE08	In-Vehicle Networking	3	0	0	3	EE
9.	20AUE09	Vehicle Body Engineering	3	0	0	3	AUTO
10.	20AUE10	Operations Research	3	0	0	3	MFG
11.	20AUE11	Vehicle Maintenance	3	0	0	3	AUTO
12.	20AUE12	Composite Materials	3	0	0	3	MFG
Elective - III							
13.	20AUE13	CNC and Metrology	3	0	0	3	MFG
14.	20AUE14	Computational Fluid Dynamics	3	0	0	3	TF
15.	20AUE15	Design of Chassis Components	3	0	0	3	MFG
16.	20AUE16	Automotive Pollution Control	3	0	0	3	AUTO
17.	20AUE17	Total Quality Management	3	0	0	3	MFG
18.	20GEE01	Fundamentals of Research	3	0	0	3	GE
Elective – IV							
19.	20AUE18	Automotive Noise, Vibration and Harshness	3	0	0	3	AUTO
20.	20AUE19	Automotive HVAC	3	0	0	3	TF
21.	20AUE20	Micro Electro Mechanical Systems	3	0	0	3	EE
22.	20AUE21	Value Engineering	3	0	0	3	MFG
23.	20AUE22	Design of Engine Components	3	0	0	3	MFG
24.	20AUE23	Autonomous Vehicle Technology	3	0	0	3	EE

Elective - V							
25.	20AUE24	Automotive Safety and Ergonomics	3	0	0	3	AUTO
26.	20AUE25	Non Destructive Evaluation Techniques	3	0	0	3	MFG
27.	20AUE26	Quality Assurance and Reliability	3	0	0	3	MFG
28.	20AUE27	Advanced Materials for Green Vehicles	3	0	0	3	MFG
29.	20AUE28	Automotive Testing	3	0	0	3	AUTO
30.	20AUE29	Alternate Energy Sources for Automobiles	3	0	0	3	TF
Semester - VIII							
Elective - VI							
31.	20AUE30	Road Transport Management	3	0	0	3	AUTO
32.	20AUE31	Advanced Theory of IC Engines	3	0	0	3	TF
33.	20AUE32	Automotive Product Life Cycle Management	3	0	0	3	DSN
34.	20AUE33	Process Planning and Cost Estimation	3	0	0	3	MFG
35.	20AUE34	Lean Methods for Automobile Engineers	3	0	0	3	MFG
36.	20AUE35	Automotive Styling and Modeling	3	0	0	3	AUTO
37.	20AUE36	Non-Traditional Machining Processes	3	0	0	3	MFG
Total Credits to be earned						**18**	

LIST OF OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OEs)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	20AUO01	Automotive Engineering	3	0	2	4	IV
2.	20AUO02	Automotive Electronics	3	0	2	4	V
3.	20AUO03	Vehicle Maintenance	3	0	0	3	VI
4.	20AUO04	Public Transport Management	3	0	0	3	VIII
5.	20AUO05	Autonomous Vehicles	3	0	0	3	VIII

20EGT11 ENGLISH LANGUAGE SKILLS

(Common to all Engineering and Technology Branches)

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

Preamble	This course is designed to impart required levels of fluency in using the English Language at A2/B1 Level in the Common European Framework (CEFR).	
Unit - I	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – I**	**9**
Listening - Talking about past experiences - listening to descriptions - Speaking - Exchanging personal information - Talking about cities and transportation - Reading - Life and achievements of a famous personality - Global transport systems - Writing - Childhood experiences - Process Description – Grammar & Vocabulary – Past tense – Expressions of quantity – Indirect questions.		
Unit - II	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – II**	**9**
Listening - Information about hotels and accommodation - Recipes and food items - Speaking - Life style changes and making comparisons - Talking about food - Reading - Habit formation and changing habits - International cuisine - Writing - Personal email - emails about food and recipes – Grammar & Vocabulary – Evaluations and Comparisons with adjectives – Simple past and present perfect tenses.		
Unit - III	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – III**	**9**
Listening - Information about travel - descriptions / conversations about family life - Speaking - Vacations and Holidays - Requests, complaints and offering explanations - Reading - Tourist places and travel experiences - Group behaviour and politeness - Writing - Personal letter about travelling - Writing guidelines and checklists – Grammar & Vocabulary – Future tense – Modals – Two-part verbs.		
Unit - IV	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – IV**	**9**
Listening - Descriptions about festivals - Presentations on technology - Speaking - About technology - festivals, special events and traditions - Reading - Sports, hobbies and past time - About different cultures - Writing - Product Description - Writing web content – Grammar & Vocabulary – Infinitives and Gerunds for uses and purposes – Imperatives for giving suggestions – Relative clauses of time.		
Unit - V	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – V**	**9**
Listening - Talking about changes - Job preferences - Speaking - Comparing different periods or phases in life – Changes that happen - Skills and abilities, Personality Development - Employability Skills – Reading - Reading about life experiences - Emotions and feelings – Job preferences – Jobs and Personality – Writing - Writing about one's past, present and future – Researching job options – Choosing the right job – Grammar & Vocabulary – Time contrasts – Conditional sentences with "if clauses" – Gerunds – short responses.		

Total: 45

TEXT BOOK:

1.	Jack C. Richards, Jonathan Hull, and Susan Proctor, "Interchange - Student's Book 2", 4th Edition, Cambridge University Press, New York, 2017.

REFERENCES:

1.	Sanjay Kumar and Pushp Lata, "Communication Skills", 2nd Edition, Oxford University Press, New Delhi, 2015.
2.	Pamela Hartmann and Brenda Wegmann, "New Interactions English Language Learning and Assessment Platform (Level Intro - Level IV)", McGraw Hill India, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	use language effectively and accurately acquiring vocabulary from real-life context	Applying (K3)
CO2	listen/view and comprehend different spoken discourses / excerpts in different accents	Applying (K3)
CO3	read different genres of texts adopting various reading strategies	Analyzing (K4)
CO4	write cohesively, coherently and flawlessly avoiding grammatical errors, using a wide range of vocabulary, organizing their ideas logically on a topic	Creating (K6)
CO5	speak clearly, confidently, comprehensibly and communicate with others using appropriate communicative strategies	Creating (K6)

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	2	2		
CO2									2	3		1		
CO3						1				3	1	1		
CO4										3		1		
CO5									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		16	30	37		17	100
CAT2		17	30	37		16	100
CAT3		13	33	37		17	100
ESE		7	21	37		35	100

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

20MAC11 - MATRICES AND 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 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.		
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.		
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^nsinax and x^ncosax – 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** & **Inverse 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) – Solution of linear ODE of second order with constant coefficients.		

List of Exercises / Experiments:

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

***Alternate week**

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

TEXT BOOK:

1.	Ravish R. Singh, Mukul Bhatt "Engineering Mathematics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

REFERENCES:

1.	Kreyszig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley Sons, 2011.
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.	MATLAB 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	know the basics of MATLAB and computing eigen values and eigen vectors of real matrix by MATLAB.	Understanding (K2), Manipulation (S2)
CO7	solve ordinary differential equations with constant and variable coefficients and simultaneous first order ordinary differential equations using MATLAB.	Applying (K3), Manipulation (S2)
CO8	compute Laplace and inverse Laplace Transform of basic functions and solve Second Order ODE by using Laplace Transform with 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	1										
CO2	3	3	2	1										
CO3	3	3	2	1										
CO4	3	3	2											
CO5	3	3	2	1										
CO6					3									
CO7					3									
CO8					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)**

20PHT11 - APPLIED PHYSICS
(Common to All Engineering and Technology Branches)

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

Preamble	This course aims to impart the essential concepts of propagation of elastic waves, acoustics, ultrasonics, laser and fiber optics, quantum physics, crystal structure and crystal defects. It also describes the physical phenomena related to the aforementioned concepts and their applications in engineering and provides motivation towards innovations	
Unit - I	**Propagation of Elastic Waves:**	**9**
Oscillatory Motion: Introduction to simple harmonic motion - Damping velocity - Damping coefficient - Differential equation of simple harmonic motion - Velocity and acceleration - Restoring force - Vibration of a spring and mass system - Frequency response - Phase response - Resonance - Wave motion: Definition of a plane progressive wave - Attenuation of waves - Differential equation of a plane progressive wave - Phase velocity - Phase and phase difference - Solution of the differential equation of a plane progressive wave.		
Unit - II	**Acoustics and Ultrasonics:**	**9**
Acoustics: Introduction - Reverberation and reverberation time - Growth and decay of sound - Sabine's formula for reverberation time – Determination of sound absorption coefficient – Design of an auditorium: Factors affecting acoustics of buildings and the remedies. Ultrasonics: Introduction – Properties of ultrasonic waves – Generation of ultrasonic waves: Magnetostrictive generator and Piezoelectric generator - Determination of velocity of ultrasonics in a liquid: Acoustic grating – Industrial application: Non-destructive testing - Other applications of ultrasonic waves (qualitative).		
Unit - III	**Laser and Fiber Optics:**	**9**
Laser and Applications: Introduction – Interaction of light with matter - Three quantum process: Stimulated absorption, spontaneous emission and stimulated emission - Population inversion - Einstein's coefficients and their relations - Pumping methods - Nd:YAG laser - CO_2 laser - Holography. Fiber Optics and Applications: Introduction - Numerical aperture and acceptance angle - Classification of optical fibers based on refractive index, modes and materials - Fiber optics communication system (qualitative) - Fiber optic sensors: Temperature and displacement sensors.		
Unit - IV	**Quantum Physics:**	**9**
Introduction - Blackbody radiation - Planck's quantum hypothesis - Compton scattering (qualitative) - de Broglie's hypothesis - Properties of matter waves - Application of Heisenberg uncertainty principle - Schrodinger's time independent and time dependent wave equations - Physical significance of wave function - The free particle - Potential energy step - Infinite potential well (one - dimensional).		
Unit - V	**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 in cubic crystal - Crystal imperfections: line, surface and volume imperfections - Features of crystal imperfections (qualitative).		

Total: 45

TEXT BOOK:

1.	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.	Purnima Khare and Swarup A.,"Engineering Physics: Fundamentals and Modern Applications", 1st Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts, 2009.
2.	Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai and Sons, New Delhi, 2009.
3.	Tamilarasan K. and Prabu K., "Engineering Physics – I", 3rd Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	make use of the concepts of oscillatory and wave motion to comprehend the phenomena related to the propagation of elastic waves.	Applying (K3)
CO2	apply the concepts of growth and decay of sound energy in a hall to compute Sabine's formula to recognize the requirements of acoustically good buildings, and to describe the production of ultrasonic wave, working of acoustic grating & non-destructive testing using ultrasonic waves.	Applying (K3)
CO3	apply the concepts of stimulated emission to explain the working and the applications of laser in engineering and technology, and to apply the principle of propagation of light through optical fiber to compute acceptance angle and numerical aperture to comprehend the loss in optical fiber, fiber optic communication system and working of fiber optic sensors.	Applying (K3)
CO4	use the concepts of quantum mechanics to describe the behavior of electrons in a metal by solving Schrodinger's wave equation for particle motion in infinite potential well.	Applying (K3)
CO5	utilize the concepts of the seven crystal systems to obtain interplanar spacing in cubic lattice and c/a ratio of HCP crystal structure, and to comprehend symmetry elements, reciprocal lattice and the types of crystal imperfections and their impacts.	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	20	40	40				100
CAT2	20	35	45				100
CAT3	25	35	40				100
ESE	20	40	40				100

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

20CYT11 - APPLIED CHEMISTRY
(Common to All Engineering and Technology Branches)

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

Preamble	Applied Chemistry course explores the basic principles and advancements of chemistry in the field of engineering and technology. It aims to impart the fundamentals of chemistry towards innovations in science and technology and also for societal applications.	
Unit - I	**Water Technology:**	**9**
Introduction - sources of water - impurities in water - types of water - hardness of water- expression of hardness (simple problems) - units of hardness –estimation of hardness of water by EDTA method – determination of alkalinity - disadvantages of using hard water in Industries - boiler troubles - scale and sludge, boiler corrosion, caustic embrittlement, priming and foaming - softening of water: i) Internal treatment process - carbonate and calgon conditioning ii) External treatment method -demineralization process iii) Treatment of water for municipal water supply (Removal of suspended particles and disinfection methods, Break-point of chlorination).		
Unit - II	**Electrochemistry:**	**9**
Introduction – electrochemical cells - applications of electrochemical series - reference electrode - standard calomel electrode - ion selective electrode - glass electrode - concentration cells - electrode and electrolyte concentration cells (simple problems) - applications- potentiometric titrations - acid-base, redox, precipitation titrations - advantages- conductometric titrations - strong acid vs strong base, weak acid vs strong base, mixture of weak and strong acid vs strong base- advantages of conductometric titrations.		
Unit - III	**Corrosion and its Control:**	**9**
Introduction – causes and effects of corrosion - types of corrosion - chemical corrosion – Pilling Bed-worth rule - electrochemical corrosion –types - galvanic corrosion, concentration cell corrosion – other types of corrosion -stress, intergranular and microbiological corrosion- galvanic series - factors influencing rate of corrosion – corrosion control methods - design and material selection, anodic protection, corrosion inhibitors, protective coatings - i) metallic coatings : hot dipping (tinning and galvanizing) ii) non-metallic coating : anodizing iii) organic coating : paints – constituents and their functions.		
Unit - IV	**Fuels and Combustion:**	**9**
Introduction – classification of fuels - characteristics of a good fuel - combustion - calorific values – gross and net calorific values - Dulong's formula (simple problems) - Flue gas analysis by Orsat's method - ignition temperature - spontaneous ignition temperature - explosive range - solid fuels - coal and its varieties – proximate and ultimate analysis – significance – metallurgical coke - Otto-Hoffman byproduct method - liquid fuel - refining of petroleum – manufacture of synthetic petrol - hydrogenation of coal - Bergius process - knocking - octane number – cetane number - gaseous fuel - water gas.		
Unit - V	**Polymers:**	**9**
Introduction – terminology - classification - polymerization - types of polymerization (definition only)- polymerisation techniques- bulk, solution, suspension and emulsion polymerisation - plastics- difference between thermoplastics and thermosetting plastics - compounding of plastics- plastic moulding methods - compression, injection, extrusion and blow moulding methods - industrial polymers: preparation, properties and applications of PVC, PAN, polyurethane, polyesters –biodegradable polymers-classification and applications.		

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., "Applied Chemistry", 6th Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2019.
2. Payal B. Joshi, Shashank Deep, "Engineering Chemistry", Oxford University Press, New Delhi, 2019.
3. Palanna O., "Engineering Chemistry", 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 the suitable water softening methods to avoid boiler troubles.	Applying (K3)
CO2	apply the principle of electrochemistry for various applications.	Applying (K3)
CO3	make use of corrosion control methods to solve corrosion related problems.	Applying (K3)
CO4	illustrate the quality of fuels from its characteristics.	Understanding (K2)
CO5	explain the types of polymers, plastics and fabrication methods.	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										
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)**

20MEC11 – ENGINEERING DRAWING

(Common to Civil, Mechanical, Mechatronics, Automobile Engineering, Chemical & Food Technology Branches)

Programme & Branch	BE(Civil, Mech, MTS, Auto) &BTech(Chem, FT)	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	ES	2	0	2	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:**	**9**
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:**	**9**
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:**	**9**
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:**	**9**
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:**	**9**
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, Practical:30, Total:60

TEXT BOOK:

1.	Venugopal K. and Prabhu Raja V., “Engineering Graphics”, 15th Edition, New Age International Pvt. Ltd., New Delhi, 2018.

REFERENCES:

1.	Basant Agrawal, Agrawal C.M., “Engineering Drawing”, 2nd Edition, McGraw Hill Education, 2019.
2.	Gopalakrishnana K.R. “Engineering Drawing”, Volume. I & II, Subhas Publications, Bengaluru, 2014.
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.	Understanding (K2)
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 in to 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								3	2	2	2	
CO2	3	2	1	1						3	2	3	2	
CO3	3	2	1	1						3	2	3	2	
CO4	3	2	1	1						3	2	3	2	
CO5	3	2	1	1						3	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	25	35	40				100

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

20AUT11 - STATICS AND DYNAMICS

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1	PC	3	1	0	4

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+3**
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+3**
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+3**
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+3**
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+3**
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.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Beer Ferdinand P, Russel Johnston Jr, 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. Dubey N.H., "Engineering Mechanics: Statics and Dynamics", 1st Edition, McGraw Hill Education, New Delhi, 2016.
2. Hibbeler R.C., "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								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	10	20	70				100
CAT2	10	20	70				100
CAT3	10	10	65	15			100
ESE	10	10	65	15			100

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

20PHL11 – PHYSICAL SCIENCES LABORATORY I

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech Branches	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 the physical parameters such as Young's modulus, rigidity modulus, frequency of vibration, velocity of ultrasonic waves, compressibility of water, wavelength of laser, acceptance angle and the numerical aperture of an optical fiber, and to develop the skills in handling different basic instruments and also aims to impart the basic concepts of volumetric, conductometric and pH meter experiments and thereby, to improve the analytical capability.

List of Exercises / Experiments:

1.	Determination of the Young's modulus of the material of a given beam using uniform bending method.
2.	Determination of the rigidity modulus of the material of a given wire using torsional pendulum.
3.	Determination of frequency of electrically vibrating rod by forming standing waves using Melde's apparatus.
4.	Determination of the velocity of ultrasonic waves in a liquid and the compressibility of a liquid using ultrasonic interferometer.
5.	Determination of (i) the wavelength of a semiconductor laser and (ii) the acceptance angle and the numerical aperture of a given optical fiber.
6.	Estimation of total, temporary and permanent hardness of water by EDTA method.
7.	Estimation of $Ca^{2+}$and Mg^{2+}hardness separately by EDTA method.
8.	Estimation of alkalinity of the given water sample.
9.	Conductometric titration -Mixture of acids.
10.	Estimation of hydrochloric acid using pH meter.

Total: 30

REFERENCES:

1.	Tamilarasan K. and Prabu K.,"Physics Laboratory Manual', 1st Edition, SCM Publishers, Erode, 2020.
2.	Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., "Chemistry Laboratory Manual", 1st Edition, Rajaganapathy Publishers, Erode, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine the Young's modulus of a material using the concepts of elasticity and bending moment of a beam and to determine the rigidity modulus of a wire using the concepts of twisting couple and to compute the frequency of electrically vibrating rod using the concept of standing waves formed in fixed vibrating string.	Applying (K3), Precision (S3)
CO2	determine the wavelength of a semiconductor laser beam using the concept of diffraction of light, and to compute the acceptance angle and the numerical aperture of an optical fiber using the concepts of total internal reflection and divergence of light in air and estimate the amount of hardness for the given water sample by EDTA method, and the amount of alkalinity for the given water sample.	Applying (K3), Precision (S3)
CO3	demonstrate the conductivity meter and pH meter to estimate the amount of the given solution.	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										
CO2				3										
CO3				3										

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

20MEL11 – ENGINEERING PRACTICES LABORATORY

(Common to Civil, Mechanical, Mechatronics, Automobile Engineering, Chemical & Food Technology Branches)

Programme & Branch	BE (Civil, Mech, MTS, Auto) & BTech (Chem, FT)	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	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 Exercises / Experiments:

	PART A – MECHANICAL ENGINEERING
1.	To prepare square or rectangular shaped MS plates using power tools for cutting, polishing and shaping to the required dimensions.
2.	To carryout drilling, tapping and assembly on the given MS plates.
3.	To carryout thread forming on a GI/PVC pipes and prepare water leak proof water line from overhead tank.
4.	To prepare a wood or plywood box/tray/any innovative models using modern power tools like cutting machine, router, jigsaw, power screw driver etc.
5.	Welding practice through arc welding / simulator
	PART B – ELECTRICAL AND ELECTRONICS ENGINEERING
1.	Safety Aspects of Electrical Engineering, Electrical Symbols, Components Identification, Fuse selection and installation, Circuit Breakers selection
2.	Wiring circuit for fluorescent lamp and Stair case wiring
3.	Measurement of Earth resistance
4.	Soldering of Simple Circuits and trouble shooting
5.	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), Precision (S3)
CO2	identify and use appropriate modern power tools and complete the exercises/models accurately	Applying (K3), Precision (S3)
CO3	select fuses and Circuit breakers	Understanding (K2), Manipulation (S2)
CO4	perform house wiring and realize the importance of earthing	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	2		3	3	2	1			3	3		3		
CO2	2		3	3	2				3	3		3		
CO3	3		3	3	1				2	2		3		
CO4	3		3	3	1				2	3		3		
CO5	3		3	3	1				2	2		3		

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

20VEC11 – YOGA AND VALUES FOR HOLISTIC DEVELOPMENT

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

Preamble	Providing Value Education to improve the Students' character - understanding yogic life and physical health - maintaining youthfulness - Measure and method in five aspects of life	
Unit - I	**Physical Health:**	**2**
Manavalakalai (SKY) Yoga: Introduction - Education as a means for youth empowerment - Greatness of Education - Yoga for youth Empowerment. **Simplified Physical Exercises:** Need and Objectives of Simplified Physical Exercise - Hand, Leg, Breathing, Eye exercises - Kapalabathi, Makarasana Part I, Makarasana Part II, Body Massage, Acu pressure, Relaxation exercises - Benefits. **Yogasanas:** Pranamasana - Hastha Uttanasana - Pada Hasthasana - Aswa Sanjalana Asana - Thuvipatha asva Sanjalana asana - Astanga Namaskara - Bhujangasana - Atha Muktha Savasana - Aswa Sanjalana Asana - Pada Hasthasana - Hastha Uttanasana - Pranamasana. **Pranayama:** Naddi suddi - Clearance Practice - Benefits.		
Unit - II	**Life Force:**	**2**
Reasons for Diseases: Body Function - Reason for Diseases and Prevention - Natural reasons (Genetic / imprints, Planetary Position, Natural calamities and climatic changes) - Unnatural reasons (Food habits, Thoughts, Deeds). **Philosophy of Kaya kalpa:** Enriching Bio-Magnetism - Physical body - Sexual vital fluid - Life force - Bio-Magnetism - Mind. **Maintaining youthfulness:** Postponing old age - Transformation of food into seven components - Importance of sexual vital fluid - Measure and method in five aspects of life - Controlling undue Passion. **Kayakalpa practice:** Aswini Mudra - Ojas breath - Benefits of Kaya Kalpa.		
Unit - III	**Mental Health:**	**2**
Mental Frequencies: Beta, Apha, Theta and Delta wave - Agna Meditation explanation - benefits. **Shanti meditation:** Shanthi Meditation explanation – benefits. **Thuriya Meditation:** Thuriya Meditation explanation – benefits. **Benefits of Blessing:** Self blessing (Auto suggestion) - Family blessing - Blessing the others - World blessing - Divine protection.		
Unit - IV	**Values:**	**2**
Human Values: Self control - Self confidence - Honesty Contentment - Humility – Modesty - Tolerance - Adjustment - Sacrifice – Forgiveness - Purity (Body, Dress, Environment) - Physical purity - Mental purity - Spiritual purity. **Social Values:** Non violence – Service. Patriotism – Equality. Respect for parents and elders - care and protection - Respect for teacher. Punctuality - Time Management.		
Unit - V	**Morality (Virtues):**	**2**
Importance of Introspection: I - Mine (Ego, Possessiveness). Six Evil Temperaments - Greed - Anger - Miserliness - Immoral sexual passion - Inferiority and superiority Complex – Vengeance. Maneuvering of Six Temperaments: Contentment - Tolerance - Charity - Chastity - Equality - Pardon (Forgiveness). Five essential Qualities acquired through Meditation: Perspicacity - Magnanimity - Receptivity - Adaptability - Creativity (Improved Memory Power).		

Lecture:10, Practical:10, Total:20

TEXT BOOK:

1. Thathuvagnani Vethathiri Maharishi, "Yoga for Youth Empowerment", Vethathiri Publications, 2019.

REFERENCES:

1. Thathuvagnani Vethathiri Maharishi, "Yoga for Modern Age", Vethathiri Publications, 2019.
2. Thathuvagnani Vethathiri Maharishi, "Simplified Physical Exercises", Vethathiri Publications, 2019.
3. Neelam Sharma, "Holistic Education and Yoga", Shipra Publications, 2017.
4. Dr. Joseph Murphy, "The Power of Your Subconscious Mind", Pushpak Publication, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the importance of physical health and practice simplified physical yoga exercise.	Applying (K3)
CO2	understand the importance of Kayakalpa exercise to enrich Bio-Magnetism and practice it.	Applying (K3)
CO3	understand the significance of meditation and do meditation to get sound mind.	Applying (K3)
CO4	understand the human and social values to provide service to society.	Applying (K3)
CO5	understand the evil temperaments and five essential qualities acquired through meditation	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		
CO3						3		3				1		
CO4						3		2	1			1		
CO5						3		3				1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

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

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

20EGT21 ADVANCED COMMUNICATION SKILLS
(Common to all Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	20EGT11 – English Language Skills	2	HS	3	0	0	3

Preamble	This course is designed to impart required levels of fluency in using the English Language at B1Level in the Common European Framework (CEFR).	
Unit - I	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – VI**	9
Listening – Job and career related descriptions and conversations – requests of different kinds and the responses – **Speaking -** Career choices and professional skills – making requests and responding to requests – **Reading** – Using texts about jobs and careers – about different societies and cultural differences – **Writing** – Resumes, CVs and job oriented advertisements – business and career related emails – **Grammar &Vocabulary** – Gerunds and elements of comparison – requests and indirect requests.		
Unit - II	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – VII**	9
Listening – Expository and narrative descriptions – information about different cultures, nations and societies. **Speaking** – Narrating and describing – talking about other countries and other cultures – **Reading** – Using texts about media and information technology – living abroad and experiencing different cultures – **Writing** – Blog writing – brochures and tourist pamphlets – **Grammar & Vocabulary** – The past tense forms - noun phrases and relative clauses.		
Unit - III	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – VIII**	9
Listening – Consumerism – product description – complaints and redressal – environmental issues – ecology – saving the planet – **Speaking** – Talking about problems, issues, complaints – solutions and redressal – talking about environmental issues – **Reading** – Using texts on segregating wastes – recycling and reusing – texts on environmental issues – **Writing** – Online reviews, articles and writing web content – **Grammar & Vocabulary** – Phrases and sentences used for describing problems – passives – prepositions and infinitives.		
Unit - IV	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – IX**	9
Listening – Education, learning and the choice of courses – various services needed in daily life – self-improvement for success in life – **Speaking** - Discussions about educational and career oriented issues – talking about everyday services – giving advice and self improvement – **Reading** – Reading about learning strategies and learning styles – using texts about personality development – **Writing** – Writing about hobbies – pastime and individual skills – writing short articles on everyday life and personality development – **Grammar & Vocabulary** – Using of "would" and certain gerund forms – use of modals, verbs, gerunds, negative questions and infinitives.		
Unit - V	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – X**	9
Listening – Historical narratives – biographies and learning about the future – important life events, milestones and happenings of the past – **Speaking** – Talking about the past, present and the future – talking about important events in life – **Reading** – Texts about new technologies and future science – using texts about social organization, culture and social practices – **Writing** – Biographical sketches – historical events – famous personalities, stages of life and getting along with people – **Grammar & Vocabulary** – Future tense forms – time clauses and certain "if clauses".		

Total: 45

TEXT BOOK:

1.	Jack C. Richards, Jonathan Hull, and Susan Proctor, "Interchange - Student's Book 3", 4th Edition, Cambridge University Press, New York, 2017.

REFERENCES:

1.	Sanjay Kumar and Pushp Lata, "Communication Skills: A Workbook based on AICTE Syllabus", Oxford University Press, 2018.
2.	Board of Editors, "Skills Annexe: Functional English for Success", Orient BlackSwan, Hyderabad, 2013.

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 spoken excerpts critically and infer Unspoken and implied meanings.	Applying (K3)
CO3	read different genres of texts, infer implied meanings and critically analyze and evaluate them for ideas as well as for method of presentation.	Analyzing (K4)
CO4	write effectively and persuasively and produce different types of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluative writing.	Creating (K6)
CO5	speak effectively, to express opinions clearly, initiate and sustain a discussion and also negotiate using appropriate communicative strategies.	Creating (K6)

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	1	1		
CO2									2	3		1		
CO3						1				3	1	1		
CO4										3		2		
CO5									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		13	30	33	-	17	100
CAT2		13	33	37	-	17	100
CAT3		20	30	33	-	17	100
ESE		6	40	36	-	18	100

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

20MAC21 - MULTIVARIABLE CALCULUS AND COMPLEX ANALYSIS

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	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 and complex integrals, vector calculus and analytic functions to the students for solving the problems related to various engineering disciplines.	
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 – 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 – Green's, Stoke's and Gauss divergence theorems (without proof) – Verification of the above theorems and evaluation of integrals using them.		
Unit - IV	**Analytic Functions:**	**9**
Functions of a complex variable – Analytic functions – Necessary and sufficient conditions (excluding proof) – Cauchy–Riemann equations (Statement only) – Properties of analytic function (Statement only) – Harmonic function – Construction of analytic function – Conformal mapping: w = z + a, az, 1/z – Bilinear transformation.		
Unit - V	**Complex Integration:**	**9**
Introduction – Cauchy's theorem (without proof) – Cauchy's integral formula – Taylor's and Laurent series – Singularities – Classification – Cauchy's residue theorem (without proof) – Applications: Evaluation of definite integrals involving sine and cosine functions over the circular contour.		

List of Exercises / Experiments:

1.	Finding ordinary and partial derivatives
2.	Computing extremes of a single variable function
3.	Evaluating double and triple integrals
4.	Finding the area between two curves
5.	Computing gradient, divergence and curl of point functions
6.	Applying Milne-Thomson method for constructing analytic function
7.	Determination of Mobius transformation for the given set of points
8.	Finding poles and residues of an analytic function

***Alternate week**

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

TEXT BOOK:

1.	Ravish R. Singh, Mukul Bhatt "Engineering Mathematics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

REFERENCES:

1.	Kreyszig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley Sons, 2011.
2.	Dass H K, "Higher Engineering Mathematics", 3rd Revised Edition, S.Chand and Co., New Delhi, 2014.
3.	Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics – I", 2nd Edition, Pearson India Education, New Delhi, 2018.
4.	MATLAB Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	compute extremal values which arise in function of several variables.	Applying (K3)
CO2	solve Problems involving Double and Triple integrals.	Understanding (K2)

CO3	apply the concept of vectors in engineering problems.	Applying (K3)
CO4	identify, construct and apply analytic functions in electrostatics and fluid flow problems.	Applying (K3)
CO5	evaluate complex integrals which are extensively applied in engineering.	Applying (K3)
CO6	compute maxima and minima of a single variable function, gradient, curl and divergence of a vector function using MATLAB.	Understanding (K2), Manipulation (S2)
CO7	evaluate Double, Triple integrals and determine area between two curves using MATLAB	Applying (K3), Manipulation (S2)
CO8	construct analytic function, find bilinear transformation and compute poles and residues 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												
CO2	3	3	2											
CO3	3	3												
CO4	3	3												
CO5	3	3	2											
CO6					3									
CO7					3									
CO8					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)**

20PHT22 - MATERIALS SCIENCE AND METALLURGY

(Common to Mechatronics Engineering & Automobile Engineering Branches)

Programme & Branch	BE - Mechatronics Engineering & BE - Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	**Applied Physics**	**2**	**BS**	**3**	**0**	**0**	**3**

Preamble	This course aims to impart the knowledge on the physics of ferrous metals and alloys, non-ferrous metals and alloys, and advanced functional materials. It also describes failures and testing of materials and the select characterization techniques and the applications of aforementioned materials in Mechatronics and Automobile Engineering and provides motivation towards innovations.	
Unit - I	**Ferrous Metals and Alloys:**	**9**
Introduction – Iron ore - Composition and classification of pig iron and cast iron–Manufacture of pig iron and cast iron – Solid solution alloys – Vegards law – Lever rule - Mechanical mixtures -Iron-Carbon equilibrium diagram - Effect of impurities on cast iron - Types of cast iron: Grey cast iron – White cast iron – Chilled cast iron - Mottled cast iron - Malleable cast iron - Ductile cast iron – Alloy cast iron – Wrought iron – Steel: Carbon steel - Alloy steels –Tool and die Steel - Special Steels: High speed steel – Stainless steel - Heat resisting steels - Shock resisting steels.		
Unit - II	**Non-Ferrous Metals and Alloys:**	**9**
Introduction - Aluminum and Aluminum alloys: Duralumin, Magnalumin - Copper and Copper alloys: Brass, Bronze, Gun Metal, German Silver - Nickel and Nickel alloys: Monel, Inconel, Nichrome, Nimonic - Chromium and Chromium alloys: Chrome moly, Stellite - Lead and Lead alloys: Solder lead, Antimonial lead.		
Unit - III	**Advanced Functional Materials:**	**9**
Metallic glasses: Preparation, properties and applications – Shape memory alloys: Characteristics and applications – Superconductors: Properties and applications (Cryotron and Magnetic levitation) – Carbon fibers – Basic requirements of biomaterials – Biocompatibility – Classification of biomaterials – Metallic and alloy biomaterials (qualitative): Cobalt–chromium alloys and Titanium and titanium alloys.		
Unit - IV	**Failures and Testing of Materials:**	**9**
Failures of materials: Elastic and plastic deformation, slip and twinning – Types of fracture: Ductile, Brittle – Creep – Fatigue. Testing of Mechanical and Physical Properties: Testing of materials under tension, compression and shear loads – Hardness testing (Brinell, Vickers and Nanohardness) – Bending and torsion testing.		
Unit - V	**Materials Characterization:**	**9**
Importance of materials characterization - X-ray diffraction (qualitative) - Scanning electron microscope and Energy dispersive X-ray analysis: principle, construction and working - Transmission electron microscope: principle, construction and working - Spectroscopy: IR and UV-visible spectroscopy - Raman spectroscopy (qualitative) - Thermal analysis: Thermo gravimetric analysis – Differential scanning calorimetry.		

Total: 45

TEXT BOOK:

1.	William D. Callister Jr. and David G. Rethwisch, “Callister’s Materials Science and Engineering (Adapted by R.Balasubramaniam)”, 2nd Edition, Wiley India Pvt Ltd., New Delhi, 2014.

REFERENCES:

1.	Donald K. Askeland, Pradeep P. Fulay and Wendelin J. Wright, “The Science and Engineering of Materials”, 6th Edition, Centage Learning, Singapore, 2011.
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 and Metallurgy”, 1st Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the basic concepts of phase rule, cooling curve and binary phase diagram (Fe-C) to explain the composition, properties and applications of the select ferrous metals and their alloys (iron and steel).	Applying (K3)
CO2	apply the basic concepts of phase rule, cooling curve and binary phase diagram (Cu-Ni) to explain the composition, properties and applications of the select non-ferrous metals and their alloys (Aluminum, Copper, Nickel, Chromium, Lead and their alloys).	Applying (K3)
CO3	utilize appropriate methods to prepare select advanced functional materials (metallic glasses, shape memory alloys, superconductors, carbon fibers and bio-materials) and to comprehend their properties and applications.	Applying (K3)
CO4	make use of the concepts of extensive properties of matter to describe the failures of materials (mechanism of plastic deformation, dislocation, slip and twinning) and types of fracture (ductile, brittle, creep, fatigue) and testing of mechanical and physical properties (under tension, compression and shear loads, hardness, bending and torsion testing).	Applying (K3)
CO5	apply the concepts of X ray diffraction, matter wave, absorption of light, Raman effect and thermogram to describe the principle and working of the select material 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	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	20	40	40				100
CAT2	30	30	40				100
CAT3	25	35	40				100
ESE	20	40	40				100

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

20CYT22 - CHEMISTRY FOR MECHANICAL SYSTEMS

Programme & Branch	**BE - Mechanical Engineeing, BE - Mechatronics Engineering & BE - Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Applied Chemistry**	**2**	**BS**	**3**	**0**	**0**	**3**

Preamble	This course aims to provide knowledge for mechanical, mechatronics and automobile engineering students on the requirements and properties of few important materials and create awareness among the present generation about the various energy sources.	
Unit - I	**Chemistry of Materials :**	**9**
Lubricants – functions - requirements – classification with examples - properties : viscosity, viscosity index, flash and fire point, cloud and pour point, oiliness, aniline point and carbon residue - **Explosives** – requirements - classification - manufacture of important explosives (TNT, GTN and RDX) - **Rocket propellants** - properties and classification - **Refractory bricks** - criteria of a good refractory material - classification – properties: refractoriness, RUL, porosity, thermal spalling, thermal conductivity and dimension stability - general method of manufacturing of refractories- **Insulators** - classification with examples: thermal insulators and electrical insulators - characteristics of insulating materials.		
Unit - II	**Energy storing Devices:**	**9**
Batteries -Introduction – Cells – Batteries – discharging and charging of battery - characteristics of battery -Types of Batteries – Primary batteries – silver button cell- Secondary battery – Ni-Cd battery. **Fuel Cells:** Importance and classification of fuel cells - description, principle, components, applications and environmental aspects of fuel cells: alkaline fuel cells, phosphoric acid, molten carbonate and direct methanol fuel cells.		
Unit - III	**Analytical Techniques:**	**9**
Introduction - Beer Lambert's law - principle, instrumentation and applications of UV-Vis Spectroscopy, Colorimetry, Infra Red Spectroscopy, Flame Photometry, Atomic Absorption Spectroscopy.		
Unit - IV	**Renewable Energy Resources:**	**9**
Introduction – global energy consumption scenario- types of energy resources - nuclear energy - nuclear power reactor - breeder reactors - applications and disadvantages of nuclear energy - design, working, advantages and disadvantages of solar energy, hydropower, wind energy, geothermal energy, tidal and wave power, ocean thermal energy - biomass and biofuels - hydrogen as an alternate fuel - hydrogen production - advantages ,disadvantages and applications - nanotechnology for energy sector.		
Unit - V	**Industrial Metal Finishing:**	**9**
Introduction – technological importance of metal finishing- methods of metal finishing - manufacturing of electronic component-PCB fabrication- essential of metal finishing: polarization, decomposition potential and overpotential - surface preparation - **Electroplating** – process - effect of plating variables on the nature of electrodeposit - electroplating of chromium and silver. **Electroless plating** - electroless copper plating on printed circuit board - electroless nickel plating process -Distinction between electroplating and electroless plating- advantages of electroless plating.		

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., “Environmental Science”, Revised Edition, Pearson Education, New Delhi, 2019.
2.	Palanna O., “Engineering Chemistry”, McGraw Hill Education, New Delhi, 2017.
3.	Payal B.Joshi & Shashank Deep, “Engineering Chemistry”, Oxford University Press, New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the knowledge of lubricants, refractories and insulators in mechanical systems.	Understanding (K2)
CO2	use the concepts of batteries, fuel cells and their applications in various fields.	Applying (K3)
CO3	apply the principle of various analytical techniques for specific applications	Applying (K3)
CO4	explain the role of renewable energy resources to attain sustainability	Understanding (K2)
CO5	employ the concept of coating techniques in industrial metal finishing	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	1					3							
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)**

20AUT21 - MECHANICS OF FLUIDS AND HYDRAULIC MACHINES

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Statics and Dynamics	2 / 4	PC	3	1	0	4

Preamble	This course provides knowledge to apply governing laws of fluid mechanics to design and evaluate engineering systems and hydraulic machines by assessing various parameters.	
Unit - I	**Fluid Properties and Fluid Statics:**	**9+3**
Fluid definition and classification - Properties of fluids - Density, specific weight, specific volume, specific gravity, viscosity, compressibility, bulk modulus, capillarity and surface tension - Properties of engine oil, gear oil and grease. Fluid static pressure – Pascal's law - Absolute and gauge pressures - Manometers - Types and pressure measurement - Pressure measurement in intake manifold, hydraulic brake lines and fuel lines. Buoyancy and stability.		
Unit - II	**Fluid Dynamics:**	**9+3**
Types of flow - Streamlines, Streaklines, Pathlines and Timelines - Continuity equation in two dimensions - Euler's equation along a streamline - Bernoulli's equation - venturimeter, orificemeter and pitot tube - Flow through nozzles - Fuel velocity and discharge for overhead fuel tanks.		
Unit - III	**Flow through Pipes and Dimensional Analysis:**	**9+3**
Flow through pipes - minor and major head losses, hydraulic gradient and total energy lines - Flow through pipes in series and parallel - Power transmission through pipes - Power requirement for brake fluid distribution. Dimensionless numbers - Dimensional analysis: Buckingham's π theorem - Modelling a prototype for wind tunnel test.		
Unit - IV	**Hydraulic Turbines:**	**9+3**
Definition of turbine - Impulse and Reaction turbines - Working principle, velocity triangle and efficiency - Specific speed and unit quantities - Application of turbines.		
Unit - V	**Hydraulic Pumps:**	**9+3**
Positive displacement pumps - classification, working principle and discharge - Oil pump and fuel pump in automobile engines. Centrifugal pump - working principle, velocity triangle and efficiency. Priming, cavitation, net positive suction head and specific speed - Water pump in automobile engines - Pumps in series and parallel.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Yunus A. Cengel and John M. Cimbala., " Fluid Mechanics ", 3rd Edition, McGraw Hill Education India Pvt. Ltd, New Delhi , 2017.

REFERENCES:

1. Bruce R. Munson, " Fluid Mechanics ", 7th Edition, Wiley, United States of America, 2015.
2. Bansal R.K , " Fluid Mechanics and Hydraulics Machines ", 10th Edition, Laxmi Publications, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	recall types and properties of fluids, calculate fluid static pressure and analyze the stability of floating bodies	Applying (K3)
CO2	solve the problems related to kinematics and dynamics of fluid for designing overhead fuel tanks	Applying (K3)
CO3	solve the problems on flow through pipes and pipe networks for finding power requirement to transmit brake fluid and give dimensions for prototype to conduct wind tunnel test	Applying (K3)
CO4	design hydraulic turbines for optimum performance	Applying (K3)
CO5	design pumps for optimum performance in automotive subsystems	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								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	10	40	50				100
CAT2	10	40	50				100
CAT3	10	40	50				100
ESE	10	40	50				100

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

20AUT22 - MANUFACTURING TECHNOLOGY

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Practices Laboratory	2	ES	3	0	0	3

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**
Rolling: Introduction, 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 and forging operations		
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. (Numerical problems in Lathe, Drilling and Milling 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: types, causes and cure - 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		

Total:45

TEXT BOOK:

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

REFERENCES:

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	demonstrate the various foundry techniques like pattern making, molding, casting, melting furnaces and inspection	Understanding (K2)
CO2	categorize various forming processes involving bulk forming and sheet metal operations	Understanding (K2)
CO3	choose the metal removal processes according to the material and geometrical design	Applying (K3)
CO4	select the metal joining processes based on the properties of base metal	Understanding (K2)
CO5	recommend the various metal finishing processes for surface finishing operations	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	2	2								2	3	
CO2	3	3	3	3								2	3	
CO3	3	3	2	2								2	3	
CO4	3	3	1	1								2	3	
CO5	3	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	80					100
CAT2	20	60	20				100
CAT3	20	80					100
ESE	10	70	20				100

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

20PHL23 - PHYSICAL SCIENCES LABORATORY II

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

Preamble	This course aims to impart hands on training in the determination of physical parameters such as Young's modulus, specific resistance, thickness of a thin film and particle size, thermal conductivity, wavelength of Hg spectrum and to develop the skills in handling different basic instruments. This course also aims to impart the significance of Cl^-, Cr^{6+}, DO, Cu^{2+} and Polymer ic material in mechanical systems and thereby, to improve the analytical capability.

List of Exercises / Experiments:

1.	Determination of the Young's modulus of a stainless steel using non-uniform bending method.
2.	Determination of the specific resistance of a non-ferrous material using Carey Foster's Bridge.
3.	Determination of the thickness of a metallic glass thin film using air-wedge arrangement.
4.	Determination of the thermal conductivity of a bio-ceramic material using Lee's disc arrangement.
5.	Determination of wavelength of Hg spectrum using spectrometer grating.
6.	Estimation of chloride ion in the given water sample using Argentometric method.
7.	Estimation of chromium (Cr^{6+}) in wastewater sample.
8.	Determination of dissolved oxygen in the given wastewater sample.
9.	Estimation of molecular weight of the polymer using viscometer.
10.	Estimation of copper in the given solution by Iodometric method.

Total: 30

REFERENCES:

1.	Tamilarasan K. and Prabu K., "Physics Laboratory Manual", 1st Edition, SCM Publishers, Erode, 2020.
2.	Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., "Chemistry Laboratory Manual", 1st Edition, Kalaikathir Publishers, Coimbatore, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine the Young's modulus of stainless steel using the concepts of elasticity and bending moment of a beam and to determine the specific resistance of non-ferrous materials using the concept of electrical conductivity, and to determine the thickness of metallic glass thin films using the concept of interference of light.	Applying (K3), Precision (S3)
CO2	determine the thermal conductivity of bio-ceramic materials using concept of heat conduction through materials, and to determine the wavelength of electromagnetic waves (visible part of Hg spectrum) using the concept of diffraction of light. Demonstrate the viscometer to estimate the molecular weight of the polymer and to determine the amount of chloride and copper in the given solution.	Applying (K3), Precision (S3)
CO3	estimate the amount of chromium and DO in the given wastewater.	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											
CO2			3											
CO3			3											

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

20AUL21 - MANUFACTURING TECHNOLOGY LABORATORY

Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Practices Laboratory**	**2**	**ES**	**0**	**0**	**2**	**1**

Preamble	This course provides hands-on training to various manufacturing processes and to produce the machine elements using different machine tools.

List of Exercises / Experiments:

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

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	develop the various machine elements using centre lathe through single point and multi point cutting tool	Applying (K3), Precision (S3)
CO2	develop the various machine elements using special machines like milling machine, shaper, drilling machine, surface and cylindrical grinder	Applying (K3), Precision (S3)
CO3	develop mold cavity using sand casting process and metal joints using welding technology	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	3					2	2		2	3	
CO2	3	3	2	3					2	2		2	3	
CO3	3	3	2	3					2	2		2	3	

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

20MAT31 - PROBABILITY AND PARTIAL DIFFERENTIAL EQUATIONS

(Common to AUTO, CIVIL, MECH, MTS, CHEM & FT branches)

Programme & Branch	B.E. & Civil Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	BS	3	1	0	4

Preamble	To provide the skills for solving the real time engineering problems involving partial differential equations and impart knowledge in applying probability concepts in their respective fields and express functions in terms of Fourier series.	
Unit - I	**Random Variables:**	**9+3**
Introduction to Probability – Definition of random variable – Discrete and Continuous random variables – Probability Mass and Probability density functions – Mathematical expectation and Variance – Moments – Moment generating functions.		
Unit - II	**Standard Probability Distributions:**	**9+3**
Discrete Distributions: Binomial distribution – Poisson distribution – Geometric distribution – Continuous Distributions: Uniform distribution – Exponential distribution – Normal distribution.		
Unit - III	**Fourier Series:**	**9+3**
Dirichlet's conditions – General Fourier series – Change of interval – Odd and even functions – Half range Sine series – Half range Cosine series – Harmonic analysis.		
Unit - IV	**Partial Differential Equations:**	**9+3**
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+3**
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).		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Ravish R Singh, Mukul Bhatt "Engineering Mathematics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

REFERENCES:

1.	Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons, Limited, 2019.
2.	Veerarajan T., "Transforms and Partial Differential Equations", 3rd Reprint, Tata Mc Graw Hill Education Pvt. Ltd., New Delhi, 2013.
3.	Jay L. Devore., "Probability and Statistics for Engineering and the Sciences", 9th Edition, Cengage Learning, USA, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the concept of random variables.	Applying (K3)
CO2	implement the exact distribution for solving engineering problems.	Applying (K3)
CO3	express the given function or data in terms of Fourier series.	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)

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											
CO2	3	3	2											
CO3	3	2												
CO4	3	3	1											
CO5	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	10	10	80	-	-	-	100
CAT2	10	10	80	-	-	-	100
CAT3	10	10	80	-	-	-	100
ESE	10	20	70	-	-	-	100

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

Programing in C

20CSC33– FUNDAMENTALS OF DATA STRUCTURES

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

Programme & Branch	Automobile, Civil, Mechanical, Chemical, Food Technology	Sem.	Category	L	T	P	Credit
Prerequisites	**Programming in C**	**3**	**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) Precision (S3)
CO2	make use of arrays and linked lists to create Stack and Queue ADTs.	Applying (K3) Precision (S3)
CO3	utilize Tree ADT to develop simple application	Applying (K3) Precision (S3)
CO4	make use of Graph ADT for standard problems	Applying (K3) Precision (S3)
CO5	illustrate the use of standard sorting and Hashing Techniques	Applying (K3) Precision (S3)

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
ESE	5	35	60				100

* ±3% may be varied (CAT 1 & 2 – 60 marks & ESE – 100 marks)

20AUT31 - MECHANICS OF DEFORMABLE BODIES

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

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**
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. Application – Piston and door hinges. Stresses in the compound bars. Strain energy.		
Unit - II	**Analysis of Stresses in Two Dimensions:**	**9**
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. Applications - Connecting rod and Crankshaft. Hoop and longitudinal stresses in thin cylindrical and spherical shells - Changes in dimensions and volume. Application - Air cylinders in pneumatic braking system and oil tanker.		
Unit - III	**Loads and Stresses in Beams:**	**9**
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. Application - Chassis frame.		
Unit - IV	**Deflection of Beams and Columns:**	**9**
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**
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. Application - Axle shaft, propeller shaft and springs used in suspension systems.		

Total:45

TEXT BOOK:

1.	Beer F.P and Johnston E.R., "Mechanics of Materials", 7th Edition, McGraw Hill Education, New Delhi, 2017.

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	predict mechanical behavior of materials under simple tension or compression for varying cross sections.	Applying (K3)
CO2	calculate principal stresses and strains to analyze automotive components.	Applying (K3)
CO3	apply theory of simple bending to design automotive chassis frame.	Applying (K3)
CO4	calculate beam and column strength with help of slope and deflection for various loads.	Applying (K3)
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	1								1	3	
CO2	3	3	2	1								1	3	
CO3	3	3	2	1								1	3	
CO4	3	3	2	1								1	3	
CO5	3	3	3	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	10	30	60				100
CAT2	10	30	60				100
CAT3	10	30	50	10			100
ESE	10	10	60	20			100

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

20AUT32 - AUTOMOTIVE POWERTRAIN

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

Preamble	To explain the construction, working of IC engines and its subsystems with the need for various transmission systems in automobile.	
Unit - I	**SI Engines:**	**9**
Review of SI Engine operation - Combustion chamber - Stages of combustion in SI Engines - Fuel injection systems - Single point injection, MPFI and GDI - Carburetor working and its types - Ignition system and its types – Ignition timing parameters - Supercharging.		
Unit – II	**CI Engines:**	**9**
Review of CI Engine operation – Combustion chamber – Direct and indirect combustion chambers – Stages of combustion in CI Engines – Fuel Injection Systems – CRDI fuel injection system – Injection timing and quantity – Turbo charging.		
Unit – III	**Mechanical and Hydraulic Clutches:**	**9**
Need of Clutches – Types of clutches – Single plate clutch – Coil spring type and diaphragm spring type – Multiple Plate Clutch – Centrifugal clutch – Cone clutch – Clutch operating mechanism and its types. Fluid Coupling – Principle – Constructional details. Torque capacity and its Performance characteristics. Torque Converter – Principle – Constructional details – Performance characteristics.		
Unit – IV	**Gearbox:**	**9**
Gear box – Types – Construction – Function and design characteristics – Gear ratio calculations. Speed and torque characteristics of power transmission system. Planetary Gear Boxes – Principle of Planetary gear trains – Wilson Gear box, Cotal electromagnetic transmission. Gear shifting mechanisms. Hybrid Transmission – CVT, IVT, DCT and AMT. Automatic Transmission systems: Need and its hydraulic control system.		
Unit – V	**Hydrostatic and Electric drives:**	**9**
Hydrostatic drives – Principles and its types – Construction and working of typical Janny hydrostatic drive – Applications, advantages and its limitations - Control system for Hydrostatic Drive System - Introduction to Tandem operation of hybrid vehicles. Electric drives - Principles and its types - Modified Ward Leonard Control system - Advantages and limitations. Hybrid drives.		

Total: 45

TEXT BOOK:

1.	Ganesan V, "Internal Combustion Engines", 4th Edition, McGraw Hill Education, New Delhi, 2017 for Units I,II,III
2.	Yi Zhang and Chris Mi., "Automotive Power Transmission Systems", 1st Edition, Wiley, 2018 for Units IV,V

REFERENCES:

1.	Dr. Kirpal Singh., "Automobile Engineering Volume 1 & 2", 14th Edition, Standard Publishers Distributors, New Delhi, 2017 & 2018.
2.	Kenneth Newton, W. Steeds, W. Steeds., " The Motor Vehicle", 13th Edition, Society of Automotive Engineers, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain construction and working of SI engine, fuel supply systems, ignition system with their parameters.	Understanding (K2)
CO2	describe construction and working of CI engine, fuel supply system types and lubrication system.	Understanding (K2)
CO3	discuss the construction, working and selection of clutches for various transmission system.	Understanding (K2)
CO4	illustrate the construction and working of transmission systems suitable for automobile transmission for different vehicles.	Understanding (K2)
CO5	outline the various hydrostatic and electric drives for 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	3	3	1		1	1					1	3	
CO2	3	3	3	1		1	1					1	3	
CO3	3	3	3	1								1	3	
CO4	3	3	3	1								1	3	1
CO5	3	3	3	1		2	2					1	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	20	80					100

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

20AUT33 – THERMODYNAMICS

(Use of Standard Steam Table is Permitted)

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

Preamble	This course provides knowledge about the basic concept, laws of thermodynamics and its applications. Also provides adequate concepts of gas power cycles and calculation of properties for pure substances.	
Unit - I	**Basic Concepts of Thermodynamics:**	**9+3**
Basic concepts, concept of continuum, microscopic and macroscopic approach. Thermodynamic systems – Closed, open and isolated systems. Zeroth law of thermodynamics, concept of temperature and heat, property, state, path, process and quasi-static process. Specific heat capacities, internal energy, enthalpy, work - modes of work.		
Unit - II	**First Law of Thermodynamics:**	**9+3**
Introduction to first law of thermodynamics, Analysis of closed system. Energy – Property of a system, Specific heat, Enthalpy, Perpetual motion machine types. First law applied to flow processes, Mass and energy balance, Steady flow energy equation (SFEE) for various applications.		
Unit - III	**Second Law of Thermodynamics and Concept of Entropy:**	**9+3**
Second law of thermodynamics – Kelvin–Planck and Clausius statements of second law. Carnot cycle, Heat engine, reversed Carnot cycle – efficiency, Refrigerator, Heat pump - COP. Reversibility and irreversibility. Thermodynamic temperature scale, Clausius inequality. Concept of entropy, entropy of ideal gas, principle of increase of entropy – Carnot's theorem, absolute entropy, Basic concepts of availability.		
Unit - IV	**Gas Power Cycles:**	**9+3**
Air standard cycle - Otto, Diesel, Dual and Brayton cycles - Calculation of mean effective pressure and air standard efficiency - Actual and theoretical p-v diagrams, port and valve timing diagram of engines - Engine performance calculations.		
Unit - V	**Properties of Pure Substance:**	**9+3**
Thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, p-v, p-T, T-s, h-s diagrams, p-v-T surface. Thermodynamic properties of steam – Steam table - Mollier chart. Introduction to Rankine cycle - Calculations of work done and heat transfer in non-flow and flow processes.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Yunus A. Cengel and Michael A. Boles., "Thermodynamics: An Engineering Approach", 8th Edition, McGraw Hill Education, New Delhi, 2017.

REFERENCES:

1. Nag P.K., "Engineering Thermodynamics", 6th Edition, McGraw Hill Education, New Delhi, 2017.
2. Ganesan V., "Thermodynamics: Basic and Applied", 1st Edition, McGraw Hill Education India Pvt. Ltd, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the basic concepts of thermodynamics process and systems.	Applying (K3)
CO2	solve and analyze the flow processes using first law of thermodynamics.	Analyzing (K4)
CO3	analyze the problems related to heat engine, heat pump and refrigerator by second law of thermodynamics.	Analyzing (K4)
CO4	calculate the efficiency of various cycles and analyze the performance of an engine.	Analyzing (K4)
CO5	estimate the thermodynamic properties of pure substances using steam table.	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								2	3	
CO2	3	3	2	1								2	3	
CO3	3	3	2	1								2	3	
CO4	3	3	3	1		2	2					2	3	
CO5	3	3	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	10	30	40	20			100
CAT2	10	20	30	40			100
CAT3	10	30	40	20			100
ESE	10	10	40	40			100

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

20AUT34 - AUTOMOTIVE ELECTRICAL SYSTEMS AND DRIVES

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	ES	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 – characteristics – 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.		
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 – 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 Exercises / Experiments:

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.	Fault identification and characteristic analysis of starting cum charging system
8.	Speed control of induction motor
9.	Position control of stepper motor
10.	Speed control of BLDC motor

Lecture: 45, Practical: 30, Total: 75

TEXT BOOK:

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

REFERENCES:

1.	Wei Liu, "Introduction to Hybrid Vehicle System Modeling and Control", 1st Edition, Wiley, New Delhi, 2015.
2.	Robert Bosch GmbH, " Bosch Automotive Electrics and Automotive Electronics ", 5th Edition, Springer, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the vehicle wiring harness, working of field devices and circuit diagrams for various sub systems.	Understanding (K2)
CO2	illustrate the circuit diagram for starting and charging system with characteristics of starter motor and alternator.	Understanding (K2)
CO3	explain the various ignition systems with advance and retard mechanisms.	Understanding (K2)
CO4	describe various power electronic devices with characteristics and functions.	Understanding (K2)
CO5	discuss types of electric motors with different control strategies.	Understanding (K2)
CO6	design and implement electrical circuits for automotive applications.	Applying (K3), Manipulation (S2)
CO7	analyze the characteristics and diagnose the faults in charging and starting systems.	Analyzing (K4), Manipulation (S2)
CO8	carryout the conventional speed control techniques for AC and DC machines.	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									1		3
CO2	3	3	2									1		3
CO3	3	3	2									1		3
CO4	3	3	2									1		3
CO5	3	3	2									1		3
CO6	3	3	2	1	2				3	1		1		3
CO7	3	3	2	1	2				3	1		1		3
CO8	3	3	2	1	2				3	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)**

20AUL31 - MECHANICS OF DEFORMABLE BODIES LABORATORY

Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**3**	**PC**	**0**	**0**	**2**	**1**
Preamble	This course provides hands on experience in testing of materials to evaluate mechanical properties.						

List of Exercises / Experiments:

1.	Tension test on a Mild steel rod
2.	Double shear test on Mild steel and Aluminum rods
3.	Torsion test on Mild Steel Rod
4.	Impact test on Metal specimen (Izod and Charpy Test)
5.	Deflection test on Cantilever beam and Simply Supported Beam (Aluminum, Steel and Wood)
6.	Test on Helical springs (open and closed coil)
7.	Preparation and Determination of compressive strength and shear strength of green sand and dry sand
8.	Sieve analysis – Determination of AFS fineness number
9.	Rockwell and Brinell hardness measurement for different materials
10.	Microstructure of Low Carbon and Eutectoid steel
11	Microstructure of Grey cast-iron and spheroidal cast iron
12	Microstructure of Copper and Aluminum alloys

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	analyze the properties and mechanical behavior of structural components.	Analyzing (K4), Manipulation (S2)
CO2	demonstrate the preparation and testing of molding sands.	Applying (K3), Manipulation (S2)
CO3	analyze various metals and alloys with microstructure.	Analyzing (K4), 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	1	1				3	2		1	3	
CO2	3	2	1	1	1				3	2		1	3	
CO3	3	1	1	1	1				3	2		1	3	
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

20AUL32 - AUTOMOTIVE POWERTRAIN LABORATORY

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	PC	0	0	2	1
Preamble	This course provides hands on experience about dismantling cum assembling of engine and transmission components.						

List of Exercises / Experiments:

1.	Dismantling and assembling of four stroke IC engines and its systems
2.	Dismantling and assembling of Cooling and Lubricating system
3.	Dismantling and assembling of Turbocharger and Supercharger
4.	Performance test on Diesel engine using eddy current dynamometer
5.	Heat balance test on Diesel engines using eddy current dynamometer
6.	Emission test on Diesel and Petrol engines using exhaust gas analyzer
7.	Retardation test on Multi cylinder Petrol engine
8.	Dismantling and assembling of Single plate and Multi-plate Clutches
9.	Dismantling and assembling of Constant mesh gearboxes
10.	Dismantling and assembling of Synchromesh gearboxes
11.	Dismantling and assembling of a Continuously Variable Transmission system (CVT)
12.	Study of Automatic transmission 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	dismantle and assemble various automobile engine components.	Applying (K3), Precision (S3)
CO2	analyze performance and emission characteristics of IC engine.	Analyzing (K4), Manipulation (S2)
CO3	dismantle and assemble various transmission systems of automobile.	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	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

20MAT41 – STATISTICS AND NUMERICAL METHODS

(Common to all Engineering and Technology Branches except ECE, CSE and IT)

Programme & Branch	B.E – Civil Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	BS	3	1	0	4

Preamble	To impart knowledge in testing of samples, ANOVA and interpolation. Also develop skills to apply numerical algorithms to identify roots of algebraic and transcendental equations and solve linear and ordinary differential equations.	
Unit - I	**Testing of Hypothesis:**	**9+3**
Introduction – Critical region and level of significance – Types of Errors – Large sample tests: Z-test for single proportion and difference of two sample proportions – Z-test for single mean and difference of means – Small sample tests: Student's t-test for testing significance of single mean and difference of means – F-test for comparison of variances – Chi-square test: Test of goodness of fit – Test of independence of attributes.		
Unit - II	**Design of Experiments:**	**9+3**
Introduction – Analysis of variance – One way classification: Completely Randomized Design – Two way classification: Randomized Block Design – Three way classification: Latin Square Design.		
Unit - III	**Solution to Algebraic and Transcendental Equations:**	**9+3**
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 - IV	**Interpolation, Numerical Differentiation and Integration:**	**9+3**
Interpolation: Interpolation with equal intervals: Newton's forward and backward difference formulae – Interpolation with unequal intervals: Lagrange's interpolation formula – Newton's divided difference formula. Numerical Differentiation and Integration: Differentiation using Newton's forward, backward and divided difference formulae – Numerical integration: Trapezoidal rule – Simpsons 1/3rd rule.		
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., "Statistics and Numerical Methods", 1st Edition, Tata McGraw Hill Publishing Company, New Delhi, 2018.

REFERENCES:

1.	Walpole R.E., Myers R.H., Myers S.L. and Ye K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2012.
2.	Jay L. Devore., "Probability and Statistics for Engineering and the Sciences", 9th Edition, Cengage Learning, USA, 2016.
3.	Steven C. Chapra, Raymond P. Canale., "Numerical Methods for Engineers", 7th Edition, McGraw-Hill Education, 2014.
4.	Ravish R.Singh, Mukul Bhatt "Engineering Mathematics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply statistical tests for solving engineering problems involving small and large sample tests.	Applying (K3)
CO2	handle experimental data with the knowledge of ANOVA.	Applying (K3)
CO3	apply various numerical techniques to solve algebraic and transcendental equations	Applying (K3)
CO4	compute intermediate values of given data, numerical derivatives and integral values	Applying (K3)
CO5	obtain 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	3	2	3										
CO2	3	2	1	3										
CO3	3	3	2											
CO4	3	2												
CO5	3	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	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	30	60				100

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

20AUT41 - THERMAL ENGINEERING AND HEAT TRANSFER

(Use of Heat and Mass Transfer Data Book and Refrigeration Table is Permitted)

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Thermodynamics	4	PC	3	1	0	4

Preamble	This course provides knowledge on performance calculation of air compressors, refrigeration, air conditioning system, psychrometry and to solve problems on various modes of heat transfer.	
Unit - I	**Air Compressors:**	**9+3**
Introduction – Fans - Blowers – Compressor – Rotary, centrifugal and reciprocating air compressors. Reciprocating compressor - Single stage and double stage air compressor - Workdone – Intermediate pressure - Effect of clearance volume - Volumetric efficiency - Isothermal efficiency - Free air delivery (FAD).		
Unit - II	**Refrigeration Cycles and Air-conditioning Systems:**	**9+3**
Vapour compression and vapour absorption refrigeration systems (VCRS and VARS) - Carnot cycle for refrigeration system - COP calculations - Air conditioning system - Summer air conditioning system - Hot and dry weather - Hot and wet weather - Winter air conditioning system.		
Unit - III	**Psychrometry:**	**9+3**
Properties of atmospheric air, calculations of properties of air - vapour mixtures. Psychrometric charts. Psychrometric processes – Sensible heat exchange processes. Latent heat exchange processes. Adiabatic mixing, evaporative cooling - Psychrometric Chart - Problems.		
Unit - IV	**Conductive and Convective Heat Transfer:**	**9+3**
Basic Concepts - Mechanism of heat transfer - Conduction, convection and radiation - General Differential equation of heat conduction - Fourier law of conduction - Cartesian - One Dimensional steady state heat conduction - Conduction through plane Wall, cylinders and spherical systems - Composite systems - Conduction with internal heat Generation - Extended surfaces. Basic Concepts of Convection - Convective heat transfer coefficients - Boundary layer concept - Types of convection - Forced convection - Free convection		
Unit - V	**Heat Exchanger and Radiation Heat Transfer:**	**9+3**
Fundamentals of Heat exchanger- Classification - Parallel flow – Counter Flow – Cross Flow – LMTD Method -Basic Concepts of radiation - Laws of radiation - Stefan Boltzman Law, Kirchoff Law - Black body radiation - Grey body radiation – Shape factor algebra – Electrical analogy – Radiation shields – Introduction to gas radiation.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Ganesan V, "Thermodynamics: Basic and Applied", 1st Edition, McGraw Hill Education India Pvt. Ltd, New Delhi, 2018 for Units I,II.
2.	Yunus A. Cengel, Afshin J. Ghajar, “Heat and Mass Transfer – Fundamentals and Applications”, 6th Edition, McGraw Hill Education (India) Private Limited, Noida, 2020 for Units III, IV, V.

REFERENCES:

1.	Sachdeva R.C., "Fundamentals of Engineering Heat and Mass Transfer", 5th Edition, New Age International, New Delhi, 2017.
2.	Arora C.P., "Refrigeration and Air Conditioning", 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 various efficiency in single and double stage compressor.	Analyzing (K4)
CO2	apply the concepts of thermodynamics in R&AC systems and analyze the cooling load calculations.	Applying (K3)
CO3	apply the psychrometric concepts in various processes.	Applying (K3)
CO4	recognize the conduction mode of heat transfer and solve the problems on steady state, transient heat conduction and convective heat transfer.	Analyzing (K4)
CO5	analyze various heat exchanger performance and radiative heat transfer.	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	1					2	3	
CO2	3	3	3	1								2	3	
CO3	3	3	3	1		3	3					2	3	
CO4	3	3	2	1								2	3	
CO5	3	3	2	1		1	3					2	3	

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

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

20AUT42 - AUTOMOTIVE CHASSIS

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

Preamble	This course provides knowledge on construction and working of various automotive chassis and its components.	
Unit - I	**Chassis and Frames:**	**9**
Classification of vehicles. Chassis construction – conventional - integral and semi integral type. Types of chassis layout based on powertrain location. Frame - Material - types and load acting, selection of cross section.		
Unit - II	**Axles and Driveline:**	**9**
Front axle – Types. Propeller shaft – Final drive – Differential – Types. Rear Axle - Loads acting on the rear axle - Full floating axle - three quarter floating axle - semi floating axle. Twist beam rear axle - Multi axle vehicles.		
Unit - III	**Steering and Braking system:**	**9**
Steering Mechanism – Ackerman – Davis. Steering gearboxes – Types – Hydraulic power steering - Steering geometry - Importance of wheel alignment and wheel balancing. Need for braking systems - Drum and disc actuation - Construction and working – mechanical – hydraulic – pneumatic - power assisted and servo braking system.		
Unit - IV	**Suspension System:**	**9**
Introduction to damping theory. Functions of suspension system - Sprung and unsprung weight – Dependent suspension system - Independent suspension system - Types. Shock absorbers - Mono tube - twin tube - twin tube PSD - twin tube ASD and twin tube gas charged - Magnetic Rheological Dampers. Air suspension system. Active and semi active suspension systems.		
Unit - V	**Wheels and Tyres:**	**9**
Wheels and Rims - Types. Tyre - bias ply - radial ply - tubed and tubeless. Tread Pattern – Wet tyre – Dry tyre - Soft compound tyre – Hard compound tyre – Medium compound tyre. Tyre inflation - Tyre specifications - Load capacities - Rolling circumference and driving speed.		

Total: 45

TEXT BOOK:

1.	James D Halderman, “Automotive Chassis Systems", 8th Edition, Pearson Publication, 2020.

REFERENCES:

1.	Dr. Kirpal Singh, "Automobile Engineering Volume 1 & 2", 14th Edition, Standard Publishers Distributors, New Delhi, 2017 & 2018.
2.	Kumbhar, V.S, Awari, G.K, and Tirpude, R.B., Automotive Systems: Principles and Practice. United States: CRC Press, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	discuss the construction of chassis and select suitable cross section for chassis frame with respect to application.	Understanding (K2)
CO2	summarize the various axle arrangements and driveline in automobiles.	Understanding (K2)
CO3	describe the functions of various steering and braking systems in automobiles.	Understanding (K2)
CO4	explain the construction and working of suspension systems and their types.	Understanding (K2)
CO5	illustrate the different types of wheels and tyres for automotive 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								1	3	
CO2	3	2	2	1								1	3	
CO3	3	2	2	1		2						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)**

20AUL41 – FUELS AND LUBRICANTS LABORATORY

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Automotive Powertrain	4	PC	0	0	2	1
Preamble	This course provides hands on experience for testing fuels and lubricants to find various properties.						

List of Exercises / Experiments:

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.	Analyzing (K4), 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

20AUL42 - 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 hands on experience in dismantling and assembling of automotive chassis components.						

List of Exercises / Experiments:

1.	Study and Measurement of Light and Heavy Commercial Vehicle Frame
2.	Study the layout of steering systems with different Steering gearboxes
3.	Dismantling and Assembling of Transaxle gearbox
4.	Dismantling and Assembling of Transfer case
5.	Dismantling and Assembling of Propeller shaft
6.	Dismantling and Assembling of Differential
7.	Dismantling and Assembling of Constant Velocity Joint and UV Joint
8.	Dismantling and Assembling of front Axle
9.	Dismantling and Assembling of Rear Axle
10.	Dismantling and Assembling of Braking system
11.	Dismantling and Assembling of suspension system
12.	Identify various specifications of wheels and tyres in a passenger vehicle

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 braking and steering systems in an automobile.	Applying (K3), Manipulation (S2)
CO3	dismantle and assemble suspension system, wheels and tyres of a vehicle.	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	1	1	3				3	1		1	3	
CO2	2	2	1	1	3				3	1		1	3	
CO3	2	2	1	1	3				3	1		1	3	

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

20EGL31 - ENGLISH FOR WORKPLACE COMMUNICATION LABORATORY

(Common to all BE/BTech Engineering and Technology branches)

Prog. & Branch	All BE/BTech Engineering & Technology branches	Sem.	Category	L	T	P	Credit
Prerequisite	Nil	III / IV	HS	0	0	2	1

Preamble:	This course is designed to impart required levels of fluency in using the English Language at B1/B2 level in the CEFR through activities, hands-on training and application.	
Unit -I	**Listening:**	**6**
Techniques for effective listening and note taking; listening to audio scripts, podcasts and TED talks; listening to discourse samples of native speakers and imitating; improving pronunciation; introduction to the basics of phonetics and understanding different accents.		
Unit -II	**Reading:**	**6**
Speed reading skills; reading to gain knowledge; reading newspaper articles to improve writing; academic journals to enrich vocabulary and word power; reading aloud with proper stress and intonation; reading to draw inferences.		
Unit -III	**Soft Skills:**	**6**
Importance of soft skills at workplace - understanding soft skills through case studies - developing positive attitude; goal setting; time management; team work; telephone etiquette; developing professionalism, interpersonal skills and work ethics.		
Unit -IV	**Writing:**	**6**
Introduction to pre-writing, style and mechanics of writing; mind mapping; creating content from an outline; paragraph and resume writing; nuances of academic writing; writing Statement of Purpose (SOP), editing, revising and proof reading for clarity and readability; structural and grammatical accuracy.		
Unit -V	**Speaking:**	**6**
Verbal and non-verbal communication; fluency and spoken English; introducing oneself and others; making presentations on topics using prepared material; mock interviews; dynamics of Group Discussion.		

List of Exercises / Experiments:

1. Mock Interview
2. Presentation
3. Reading Aloud
4. Group Discussion
5. Soft Skills through Case Studies
6. Listening Test

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Jeff Butterfield, "Soft Skills for Everyone", 1st Edition, Cengage Learning, New Delhi, 2011.
2.	Bob Dignen, Steve Flinders and Simon Sweeney, "Professional English for Work and Life, English 365, Student's Book 2", 1st Edition, Cambridge University Press, New Delhi, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	acquire effective listening and reading skills	Understanding (K2), Imitation (S1)
CO2:	acquire and demonstrate appropriate professional skills for the workplace	Applying (K3), Naturalization (S5)
CO3:	speak fluently and write meaningfully in English in the given context	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	PSO1	PSO2
CO1									2	3		2		
CO2									2	3		2		
CO3									3	3		3		

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

20GET41 - UNIVERSAL HUMAN VALUES
(Common to All BE/BTech branches)

Programme & Branch	All BE/BTech Engineeirng & Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	**NIL**	**3 / 4**	**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	3	3	3	3				
CO2						3	3	3	3	3				
CO3						3	3	3	3	3				
CO4						3	3	3	3	3				
CO5						3	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	25	75					100
CAT2	25	75					100
CAT3	NA						
ESE	NA						

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

20AUT51 - 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**
Classification - Gear ratio - Velocities - Simple, Compound, Reverted and Epicyclic gear trains - Tabulation method. Kinematics layout of sliding mesh and constant mesh gear box.		
Unit - IV	**Balancing of Masses:**	**9**
Rotating masses – Single mass - single plane - Several mass – Single and different plane. Reciprocating masses - Primary and secondary balancing. Balancing - Single and multi-cylinder engines - Radial V engine - Direct and reverse crank method.		
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	analyze static and dynamic balancing of various mechanical systems.	Analyzing (K4)
CO5	analyze the fluctuation of speed in governors and gyroscopic effect.	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	1	2		1	1					1	3	
CO2	3	3	2	2		1	1					1	3	
CO3	3	3	2	2		1	1					1	3	
CO4	3	2	1	2		1	1					1	3	
CO5	3	3	2	2		1	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	10	30	60				100
CAT2	10	30	60				100
CAT3	10	20	40	30			100
ESE	10	20	40	30			100

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

20AUT52 - 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 - Operation amplifiers - Wheatstone bridge - Multiplexers – 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 - Microprocessor 8085 architecture – Pin configuration – Registers - 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.	https://nptel.ac.in/courses/108/107/108107029/
2.	https://nptel.ac.in/courses/108/105/108105102/

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate about 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 8085 microprocessor programs for simple automotive applications.	Applying (K3)
CO5	explain about 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	2									2		3
CO5	3	3	2			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	20	60	20				100

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

20AUT53 - VEHICLE DYNAMICS

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 dynamics of road vehicle, handling and stability.	
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	**Tyre Dynamics:**	**9**
Tyre forces and moments - Tyre axis system - Rolling resistance of a tyre - Tyre soil interaction - Conicity and ply steer. Cornering properties of tyres and camber thrust. Various tyre 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.		

Total:45

TEXT BOOK:

1.	Wong J.Y, "Theory of Ground Vehicles", 4th Edition, John Wiley & Sons, New Jersey, 2008.

REFERENCES:

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	assess the acceleration performance of a vehicle.	Applying (K3)
CO2	estimate the braking performance of a vehicle.	Applying (K3)
CO3	calculate the forces generated in a tire by applying different models.	Applying (K3)
CO4	determine the handling characteristics of a vehicle.	Applying (K3)
CO5	predict the ride characteristics 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	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	20	20	60				100
CAT2	20	20	60				100
CAT3	20	20	60				100
ESE	10	10	80				100

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

20AUL51 - COMPUTER AIDED DESIGN LABORATORY

Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Drawing**	**5**	**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 Exercises / Experiments:

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
4.	Design vehicle chassis frame using CAD tools
5.	Develop 3D Part modeling of Flange coupling and Knuckle joint
6.	Design simple gear trains using CAD tools
7.	Model disc brake assembly using CAD tools
8.	Develop 3D Part modeling of automotive Leaf spring
9.	Develop the independent suspension system using CAD Tools
10.	Model Auto car body using CAD tools
11.	Simulate the Automotive mechanism by using CAD tools
12.	Fabricate the CAD model of Automotive component using 3D printer

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

20AUL52 - 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 Exercises / Experiments:

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), Manipulation (S2)
CO2	analyze the characteristics of various transducers in the measurement system.	Analyzing (K4), Manipulation (S2)
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	2	1	1	2				3	2		2		3
CO2	3	2	1	1	2				3	2		2		3
CO3	3	3	1	1	2				3	2		2		3

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

20AUL53 - VEHICLE DYNAMICS SIMULATION 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 in modeling and simulating various automotive systems to evaluate their performance						

List of Exercises / Experiments:

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

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 and analyze longitudinal dynamics of a vehicle	Applying (K3), Precision (S3)
CO2	Estimate handling and tyre characteristics of a vehicle	Applying (K3), Precision (S3)
CO3	Compute and analyze ride comfort 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	1	3				1	1		2	3	
CO2	3	3	2	1	3				1	1		2	3	
CO3	3	3	2	1	3				1	1		2	3	

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

20GEL51 - PROFESSIONAL SKILLS TRAINING I
(Common to all BE/ BTech / MSc /MCA /BSc Branches)

Programme & Branch	B.E. & Automobile Engineering	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 – 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 & 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 – Writing a fresher's CV / Résumés – 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: 80

TEXT BOOK:

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

REFERENCES:

1	Bailey Stephen, "Academic Writing: A practical guide for students", Routledge, New York, 2011.
2	Raman, Meenakshi and Sharma, Sangeeta, "Technical Communication - Principles and Practice", 3rd Edition, Oxford University Press, New Delhi, 2015.

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 individual and 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**						

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

20AUT61 – 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	6	PC	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", 10th Edition, McGraw-Hill Education, Singapore, 2015.
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	3	3			1					1	3	
CO2	3	3	3	3			1					1	3	
CO3	3	3	3	3			1					1	3	
CO4	3	3	3	3			1					1	3	
CO5	3	3	3	3			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	10	15	75				100
CAT2	10	15	75				100
CAT3	10	15	55	20			100
ESE	10	15	55	20			100

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

20AUT62 - AUTOMOTIVE CONTROL SYSTEM

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 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 step, ramp and impulse signals. Second order system - Time domain specifications - Steady-state error constants - Position, velocity and acceleration error constants. Root-locus plots - Simple problems.		
Unit - III	**Frequency Response and Stability Analysis:**	**9**
Frequency domain specifications - Peak resonance, resonant frequency, bandwidth and cut-off rate. Stability in the frequency domain - Gain and phase margins - Bode plot - Control systems design using frequency response. Stability analysis in time domain - Routh-Hurwitz criterion of stability - Lag, Lead and Lag - Lead compensators design.		
Unit - IV	**State Variable Analysis:**	**9**
Introduction - General state space representation - Converting transfer function to state space and vice versa - Applications - Controllability - Controller design - Observability - Observer design.		
Unit - V	**Automotive Control Techniques:**	**9**
Proportional control - Integral control - Derivative control - PI and PID control actions - Tuning rules - Introduction to optimal control and rule based control techniques - Applications - Fuel control - Spark timing control - Idle speed control - Cruise control - Automatic transmission control - ABS control.		

Total:45

TEXT BOOK:

1. Nagrath I J & Gopal M, "Control System Engineering", 6th Edition, New Age International, New Delhi, 2018.

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.

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	identify the system elements and their representations in state space form	Applying (K3)
CO5	explain about the basics of vehicle control system design	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	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	50	40				100
ESE	10	20	70				100

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

20AUT63 - 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**
Microprocessor - Microcontroller - 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 - Object detection on car reverse using ultrasonic sensor - 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 89C51 microcontroller.	Understanding (K2)
CO2	write assembly language programs for 8051 microcontroller.	Applying (K3)
CO3	develop assembly language programs for interfacing peripheral devices with 8051 microcontroller.	Applying (K3)
CO4	write assembly language programs for sensor interfacing with microcontroller.	Applying (K3)
CO5	explain the role of 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	2	1			1					1		3
CO2	3	2	1	1			1					1		3
CO3	3	2	2	1			1					1		3
CO4	3	3	2	1			1					1		3
CO5	3	3	3	1			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	10	60	30				100
CAT2	10	20	70				100
CAT3	10	40	50				100
ESE	10	30	60				100

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

20AUL61 - COMPUTER AIDED ANALYSIS LABORATORY

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Mechanics of Deformable Bodies Laboratory	6	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 Exercises / Experiments:

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

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		1	3	
CO2	3	3	2	2	3				1	3		1	3	
CO3	3	3	2	2	3				1	3		1	3	

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

20AUL62 – 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 Exercises / Experiments:

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.	Dismantling and assembling of brake, clutch and gear box for two and three wheelers
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		1		2	3	
CO2	3	2	1		3	2	1	1		1		2	3	
CO3	3	2	1		3	2	1	1		1		2	3	
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

20AUL63 - 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 in microcontroller.						

List of Exercises / Experiments:

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.	Interfacing of a traffic light 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	write and execute programs for an 8-bit microcontroller.	Applying (K3), Precision (S3)
CO2	interface various peripherals with an 8-bit microcontroller.	Applying (K3), Precision (S3)
CO3	design microcontroller-based automotive applications.	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	2				3	2		1		3
CO2	3	2	2	2	2				3	2		1		3
CO3	3	2	2	2	2				3	2		1		3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

20AUP61 - PROJECT WORK I

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	EC	0	0	4	2

Total: 60

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

20GEI61 PROFESSIONAL SKILLS TRAINING II
(Common to all BE/ BTech / MSc /MCA /BSc Branches)

Programme & Branch	B.E. & Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	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 & 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: 80

TEXT BOOK:

1	Thorpe, Showick and Edgar 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, 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 individual and 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				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	40	40				100
CAT2		50	50				100
CAT3		50	50				100
ESE	NA						

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

20GEP61 - COMPREHENSIVE TEST AND VIVA
(Common to all BE/BTech branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	EC	0	0	0	2

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	demonstrate knowledge in their respective programme domain.	Applying (K3)
CO2	defend any type of interviews, viva-voce, and aptitude tests conducted for career progression	Applying (K3)
CO3	exhibit professional etiquette and solve related 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	2					1	2	2	3	3	2
CO2	3	3	2	2					1	2	2	3	3	2
CO3	3	3	2	2					1	2	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

20GET71 – ENGINEERING ECONOMICS AND MANAGEMENT
(Common to All BE/BTech Engineering and Technology branches except Chemical Engineering)

Programme & Branch	B.E. & Automobile Engineering	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	1	2
CO2		1	2			2	2	2	2	2	3	2	1	2
CO3	1	2	1			2		2	2	2	3	2	2	2
CO4	1	2	1			2		2	2	2	3	2	1	2
CO5	2	2				2		2	2	2	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	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)**

20AUT71 - HYBRID AND ELECTRIC VEHICLES

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Automotive Electrical Systems and Drives	7	PC	3	0	0	3
Preamble	This course deals with modeling and simulation of electric and hybrid 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 - 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.	James Larminie and John Lowry., “Electric Vehicle Technology Explained”, 2nd Edition, Wiley India Pvt Ltd, New Delhi, 2018 for Units I,IV.
2.	Wei Liu., “Introduction to Hybrid Vehicle System Modeling and Control”, Wiley India Pvt Ltd, New Delhi, 2015 for Units II, III, V.

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.	Iqbal Husain, "Electric and Hybrid Vehicles", 2nd Edition, CRC Press, New Delhi, 2010.

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	evaluate battery management system and charging characteristics.	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	2					3	2	3
CO4	3	3	3	2	3	2	2					3	2	3
CO5	3	3	3	3	3	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	10	40	50				100

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

20AUP71 - PROJECT WORK II PHASE I

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	EC	0	0	6	3

Total: 90

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

20AUP81 - PROJECT WORK II PHASE II

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	8	EC	0	0	14	7

Total: 210

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

20AUE01 – TWO AND THREE WHEELER TECHNOLOGY

Programme& Branch	B.E. 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 power unit and their subsystems of a two wheeler.	Understanding (K2)
CO2	explain the two wheeler chassis systems.	Understanding (K2)
CO3	describe the types of brakes and wheels used in two wheeler.	Understanding (K2)
CO4	outline the construction and working concepts of electric two wheeler.	Understanding (K2)
CO5	summarize the types of three wheeler and its 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						2	3	
CO2	3	2	2			1						2	3	1
CO3	3	2	2			1						2	3	
CO4	3	3	2	2	2	2	3					2	3	2
CO5	3	2	2	1	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	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)**

20AUE02 - DIESEL AND ELECTRIC LOCOMOTIVES

Programme & Branch	**B.E. – 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 – Bogies – 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	**Signalling and Communications:**	**9**
Signalling and interlocking - Speed signalling – Centralizing signal boxes – Solid-state control systems for locomotives - Brown-Boveri System – Radio communications, signalling 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 with 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 signalling, 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	3	2	1								1	3	2
CO2	3	2	1	1								1	3	2
CO3	3	2	2	2								1	3	
CO4	3	3	2	2	3							1	3	2
CO5	3	1	1	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	10	50	40				100
CAT3	10	20	50	20			100
ESE	10	20	50	20			100

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

20AUE03 - 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	apply 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 flexible manufacturing layout for a machine cell	Applying (K3)
CO5	utilize various computer aided quality control techniques 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	2								1	2	
CO2	3	2	1	3								1	2	
CO3	3	2	1	3								1	2	
CO4	3	2	2	2								1	2	
CO5	3	2	2	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	25	65	10				100
CAT2	20	60	20				100
CAT3	25	65	10				100
ESE	20	60	20				100

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

20AUE04 - THEORY OF FUELS AND LUBRICANTS

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

Preamble	This course provides knowledge to understand the various characteristics of fuels and lubricants.	
Unit - I	**Manufacturing of fuels and lubricants**	**9**
Structure of petroleum, refining process, 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, bio lubricants, classification of lubricating oils, properties of lubricating oils, tests on lubricants. Grease, classification, properties, test used in grease.		
Unit - IV	**Properties and Testing of Fuels**	**9**
Thermo-chemistry of fuels, properties and testing of fuels, relative density, calorific value, flash point, fire point, distillation, vapour pressure, spontaneous ignition temperature, viscosity, pour point, flammability, ignitability, diesel index, API gravity, aniline point, carbon residue, copper strip corrosion.		
Unit - V	**Combustion and Fuel Rating**	**9**
SI Engines – flame propagation and mechanism of combustion, normal combustion, knocking, octane rating, fuel requirements. CI Engine, mechanism of combustion, diesel knock, cetane rating, fuel requirements. Additive – mechanism, requirements of an additive, petrol fuel additives and diesel fuel additives – specifications of fuels.		

Total:45

TEXT BOOK:

1.	Ganesan V, "Internal Combustion Engines", 4th Edition, McGraw Hill Education, New Delhi, 2017.

REFERENCES:

1.	M.L.Mathur and P.Sharma, “A course in internal combustion engines”, Dhanpatrai Publications, New Delhi, 2018.
2.	Wilfried J.Bartz, “Engine Oils and Automotive Lubrication”, 1st Edition, CRC press, New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	outline the refining process of fuels and manufacturing of lubricants	Understanding (K2)
CO2	summarize various types of frictions in engine and lubrication system	Understanding (K2)
CO3	explain the function and requirements of lubricants and its testing	Understanding (K2)
CO4	illustrate the properties and testing of fuels used in automobiles	Understanding (K2)
CO5	describe the combustion in SI and CI engine with additives	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	1	1		1	1					1	3	
CO2	3	1	1	1		1	1					1	3	
CO3	3	1	1	1		1	1					1	3	
CO4	3	1	1	1		1	1					1	3	
CO5	3	1	1	1		1	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)**

20AUE05 - HYDRAULICS AND PNEUMATICS

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Mechanics of Fluids and Hydraulic Machines	5	PE	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.	S. R. Majumdar, “Oil Hydraulic Systems: Principles and Maintenance”,1st Edition, McGraw Hill Education, 2017.
2.	Jagadeesha T, “Pneumatics: Concepts, Design and Applications” 1st Edition ,The Orient Blackswan, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the working 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 its applications.	Understanding (K2)
CO4	illustrate the construction and working principle of various components in pneumatic system.	Understanding (K2)
CO5	design the hydraulic and pneumatic circuits for various applications and its 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	3	2	2							1	3	
CO2	3	3	3	2	2							1	3	
CO3	3	3	3	2	2							1	3	
CO4	3	3	3	2	2							1	3	1
CO5	3	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	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)**

20AUE06 - PRINCIPLES OF FARM MACHINERIES

Programme & Branch	**B.E. – 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 about precision farming and tractor testing.	Understanding (K2)
CO3	explain the various types of soil tillage's and crop planting machines.	Understanding (K2)
CO4	summarize fertilizer and harvesting application equipment.	Understanding (K2)
CO5	identify the different types of special machineries 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	1	1		2	2					2	3	
CO2	3	2	1	1		2	2					2	3	
CO3	3	2	1	1		2	2					2	3	
CO4	3	2	1	1		2	2					2	3	
CO5	3	2	1	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	80					100
CAT3	20	80					100
ESE	20	80					100

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

20AUE07 - FINITE ELEMENT METHOD

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	**Machine Design**	**7**	**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	3	2								1	3	
CO2	3	3	3	2	2							1	3	
CO3	3	3	3	2	2							1	3	
CO4	3	3	3	3	2							1	3	
CO5	3	3	3	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	10	20	50	20			100
CAT2	15	15	20	50			100
CAT3	15	20	30	35			100
ESE	10	10	30	50			100

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

20AUE08 - IN-VEHICLE NETWORKING

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Automotive Embedded Systems	7	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	**Multiplexed Bus Concepts:**	**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 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)**

20AUE09 - VEHICLE BODY ENGINEERING

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	**Automotive Chassis**	**7**	**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 's 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 and heavy commercial vehicle body - Flat platform body, trailer, tipper body, tanker body and bus coaches. 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 body with constructional details.	Understanding (K2)
CO3	illustrate about various commercial vehicle body with constructional details.	Understanding (K2)
CO4	identify the materials used in body building and body repair works.	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	1	1		2	1					2	3	
CO2	3	2	1	1		2	1					2	3	
CO3	3	2	1	1		2	1					2	3	
CO4	3	2	1	1	1	2	1					2	3	
CO5	3	2	1	1	1	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	80					100
CAT3	20	80					100
ESE	20	80					100

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

20AUE10 - OPERATIONS RESEARCH

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	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 Inventory – 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 multiserver 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	Applying (K3)
CO4	identify inventory models and solve for optimality	Applying (K3)
CO5	assess queuing characteristics and compute the optimum replacement period for capital equipment and items that fail suddenly	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	2	2						2	2	3	
CO2	3	3	3	2	2						2	2	3	
CO3	3	3	3	2	2						2	2	3	
CO4	3	3	3	2	2						2	2	3	
CO5	3	3	3	2	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	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	10	50	40				100

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

20AUE11 – VEHICLE MAINTENANCE

Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Powertrain and Automotive Chassis**	**7**	**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	explain the maintenance cum troubleshooting aspects in electrical and air-conditioning 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		1	2	2		1		1	3	
CO2	3	2	2	1	2	1	2	2		1		1	3	
CO3	3	2	2	1		1	2	2		1		1	3	
CO4	3	2	2	1		1	2	2		1		1	3	
CO5	3	2	2	1		1	2	2		1		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)**

20AUE12 - COMPOSITE MATERIALS

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Materials Science and Metallurgy	7	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	illustrate the various manufacturing processes involved in the fabrication of composite material.	Understanding (K2)
CO3	analyze the performance of composite materials.	Analyzing (K4)
CO4	analyze and solve problems concerning the mechanics of composite materials.	Analyzing (K4)
CO5	apply design calculations 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	40	60					100
CAT2	20	40	20	20			100
CAT3	15	15	30	40			100
ESE	10	20	40	30			100

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

20AUE13 - 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 process	Applying (K3)
CO4	infer linear and angular measurements using various instruments and determine the surface roughness	Understanding (K2)
CO5	understand the form and profile measurement using Coordinate Measuring Machine (CMM) with 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	3	3	2							2	2	
CO2	3	3	3	2	3							2	3	
CO3	3	3	3	3	3							2	3	
CO4	3	3	3	3	3							2	3	
CO5	3	3	3	3	3							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	30	70					100
CAT2	20	60	20				100
CAT3	30	70					100
ESE	20	60	20				100

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

20AUE14 - 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.	Understanding (K2)
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	1									2	2	
CO2	3	3	1									2	2	
CO3	3	2	3									2	3	
CO4	3	2	2	1	3							2	3	
CO5	3	2	3	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	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)**

20AUE15 - DESIGN OF CHASSIS COMPONENTS

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 various chassis components.	
Unit - I	**Vehicle Frame and Suspension:**	**9**
Vehicle loads and chassis operating conditions – Moments and stresses on frame members – Design of frame for passenger and commercial vehicles – Design of leaf springs – Coil springs and torsion bar springs.		
Unit - II	**Front Axle and Steering Systems:**	**9**
Analysis of loads – Moments and stresses at different sections of front axle – Determination of bearing loads at Kingpin and Wheel spindle bearings – Choice of Bearings – Design of front axle beam – Condition for True Rolling – Turning Circle Radius – Ackermann Steering Principle – Ackermann linkage Geometry – Analytical Solution – Steering Gear box – Determination of Gear Ratio.		
Unit - III	**Design of Clutch and Gear Box:**	**9**
Torque capacity of clutch – Design of single plate clutch, multi-plate clutch, cone clutch, and centrifugal clutch –Design of clutch components – Gear train calculations – Determination of gear ratios for three, four and five speed gearboxes – acceleration, gradability and drawbar pull.		
Unit - IV	**Driveline and Rear Axle:**	**9**
Design of propeller shaft – Design aspects of final drive and differential gearing – Design details of full floating, semi-floating and three quarter floating rear shafts and rear axle housings.		
Unit - V	**Design of Braking System:**	**9**
Fundamentals – Calculations on stopping time and distance, weight transfer during braking - Brake linkages and actuating mechanisms – Design and analysis of brake shoes and friction pads. Optimization of drum and disc brake design – Hand brake types and its mechanism.		

Total:45

TEXT BOOK:

1.	Giri N.K., "Automobile Mechanics", 8th Edition, Khanna Publications, New Delhi, 2014.

REFERENCES:

1.	Khurmi R.S. & Gupta J.K., "A Text Book of Machine Design", 34th Edition, Eurasia Publishing House Pvt. Ltd., New Delhi, 2005.
2.	Dean Averns., "Automobile Chassis Design Book", 2nd Edition, Kotelian Sky Press, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	design and analyze frame members cum suspension components.	Analyzing (K4)
CO2	evaluate the design of front axle and steering system.	Applying (K3)
CO3	design various types of clutches and automotive gear boxes.	Applying (K3)
CO4	design driveline, differential and rear axle components.	Applying (K3)
CO5	design and analyze the various types of brakes.	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			1					1	3	
CO2	3	3	3	1			1					1	3	
CO3	3	3	3	2			1					1	3	
CO4	3	3	3	1			1					1	3	
CO5	3	3	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	10	10	50	30			100
CAT2	10	10	80				100
CAT3	10	10	50	30			100
ESE	10	10	50	30			100

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

20AUE16 - AUTOMOTIVE POLLUTION CONTROL

Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Powertrain**	**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.

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.	Understanding (K2)
CO3	describe the emission formation from CI Engines.	Understanding (K2)
CO4	explain the various measurement techniques for vehicle emission.	Understanding (K2)
CO5	discuss the various emission control techniques for automotive engines.	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		2	2					1	3	
CO2	3	2	2	1		2	2					1	3	
CO3	3	2	2	1		2	2					1	3	
CO4	3	2	2	1		2	2					1	3	
CO5	3	2	2	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	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)**

20AUE17 - TOTAL QUALITY MANAGEMENT

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

Preamble	This course deals with Quality concepts and TQM principles focusing on process quality to assure product quality to the customers. It also deals with the Basic and modern Quality management tools including ISO standards	
Unit - I	**Quality Concepts and Principles:**	**9**
Quality Concepts and Principles: Definition of Quality - Dimensions of Quality - Quality Planning - Quality costs - Basic concepts of Total Quality Management - Historical Review. Principles of TQM - Leadership –Concepts - Quality Council - Quality Statements - Strategic Planning - Deming Philosophy - Barriers to TQM Implementation.		
Unit - II	**Total Quality Management-Principles and Strategies:**	**9**
Total Quality Management-Principles and Strategies: Customer satisfaction –Customer Perception of Quality - Customer Complaints - Customer Retention - Employee Involvement –Motivation - Empowerment - Teams - Recognition and Reward - Performance Appraisal - Benefits. Continuous Process Improvement –Juran Trilogy - PDSA Cycle - 5S - Kaizen - Supplier Partnership –Partnering - sourcing - Supplier Selection - Supplier Rating - Relationship Development - Performance Measures		
Unit - III	**Control Charts for Process Control:**	**9**
Control Charts for Process Control: The seven tools of quality - Statistical Fundamentals –Measures of central Tendency and Dispersion - Population and Sample - Normal Curve - Control Charts for variables and attributes - Process capability - Concept of six sigma.		
Unit - IV	**TQM-Modern Tools:**	**9**
TQM-Modern Tools: The new seven tools of quality - Benchmarking-Need - Types and process; Quality Function Deployment-HOQ construction - case studies; Taguchi’s Robust design-Quality loss function - DOE; Total Productive Maintenance-uptime enhancement; Failure Mode and Effect Analysis-Risk Priority Number - Process - case studies.		
Unit - V	**Quality Systems:**	**9**
Quality Systems: Need for ISO 9000 and Other Quality Systems - ISO 9000 : 2015 Quality System –Elements - Implementation of Quality System - Documentation - Quality Auditing - Introduction to TS 16949 - QS 9000 - ISO 14000 - ISO 18000 - ISO 20000 - ISO 22000. Process of implementing ISO - Barriers in TQM implementation.		

Total: 45

TEXT BOOK:

1.	Dale H. Besterfield., "Total Quality Management", 3rd Edition, Pearson Education, New Delhi, 2011.

REFERENCES:

1.	Subburaj Ramasamy., "Total Quality Management", Tata McGraw Hill, New Delhi, 2008.
2.	Feigenbaum A.V., "Total Quality Management", 4th Edition, Tata McGraw Hill , New Delhi, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the need, history and principles of quality and TQM	Understanding (K2)
CO2	illustrate the principles and strategies of TQM	Understanding (K2)
CO3	make use of various tools and techniques of quality management	Applying (K3)
CO4	apply various quality tools and techniques in both manufacturing and service industry	Understanding (K2)
CO5	explain the concepts of quality management system and ISO.	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	1					2	1	1	2	1	3	3	
CO2	1	1					2	1	1	2	1	3	3	
CO3	3	2	2	2	2	2		1	1	2	1	3	3	
CO4	3	2	2	2	2			1	1	2	1	3	3	
CO5							3	1	1	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	30	70					100
CAT2	20	60	20				100
CAT3	30	70					100
ESE	30	50	20				100

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

20GEE01 - FUNDAMENTALS OF RESEARCH

Programme & Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course familiarize 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 - Outcome 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 - Measurement 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**
Reports and Presentations: 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”, Routledge, 2017.

REFERENCES:

1. Melville S, Goddard W. “Research Methodology: An Introduction For Science and Engineering Students”, Kenwyn: Juta & Co Ltd., 1996.
2. Kumar, Ranjit. “Research Methodology: A step-by-step guide for beginners”, SAGE Publications Limited, 2019.

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.	Analyzing (K4)
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	1	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	1	1		3	3	3	2	2	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

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		40	35	25			100
CAT2		30	40	30			100
CAT3				50	50		100
ESE		25	25	25	25		100

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

20AUE18 - 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	outline modal analysis theory and its 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	3	2	1		2	2					1	3	
CO2	3	2	3	1		2	2					1	3	
CO3	3	3	3	1		2	2					1	3	
CO4	3	3	2	1		2	2					1	3	
CO5	3	2	2	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	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)**

20AUE19 - 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	recognize the basic components of an Air conditioning systems.	Understanding (K2)
CO3	outline the electrical and electronic components present in air-conditioning system.	Understanding (K2)
CO4	describe the troubleshooting procedure of air-conditioning system.	Understanding (K2)
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	2			1	2					2	3	1
CO2	3	3	3			1	2					2	3	1
CO3	3	3	3			1	2					2	3	1
CO4	3	3	2			1	2					2	3	1
CO5	3	3	2			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	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)**

20AUE20 - MICRO ELECTRO MECHANICAL SYSTEMS

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

Preamble	This course provides introduction to the basic concepts of sensors, actuators and scaling laws of micro system. It introduces the phenomenon of fabrication, manufacturing and packaging of Micro System. It familiarizes students to design and develop a micro product for various applications.	
Unit - I	**Microsystems:**	**9**
Overview-Microsystems - Working principle of Microsystems - Scaling laws - Scaling in geometry - Scaling in rigid body dynamics - Scaling in electrostatic forces - Scaling in electromagnetic forces - Scaling in electricity - Scaling in fluid mechanics - Scaling in heat transfer.		
Unit - II	**Microsensors and Actuators:**	**9**
Micro sensors - Micro actuation techniques - Micropump – Micromotors – Microvalves – Microgrippers - Micro accelerometers.		
Unit - III	**Micro System Fabrication:**	**9**
Substrates - Single crystal silicon wafer formation - MEMS materials - Photolithography - Ion implantation - Diffusion - Oxidation - CVD - Physical Vapor Deposition - Deposition by epitaxy – Etching process.		
Unit - IV	**Micro System Manufacturing and Design:**	**9**
Bulk Micro manufacturing - Surface Micromachining – LIGA – SLIGA. Micro system packaging – Materials - Die level - Device level - System level - Packaging techniques - Surface bonding - Wire bonding – Sealing - Design considerations.		
Unit - V	**Micro System Applications:**	**9**
Applications of micro system in – Automotive - Bio medical – Aerospace – Telecommunications field. Basic exposure to software for MEMS design – Micro system Design using CAD tool.		

Total:45

TEXT BOOK:

1. Tai-Ran Hsu., "MEMS and Microsystems: Design and Manufacture", 1st Edition, McGraw Hill Education, India, 2017.

REFERENCES:

1. Marc J. Madou., "Fundamentals of Microfabrication", 3rd Edition, CRC Press, New York, 2011.
2. Dan Zhang, Bin Wei., "Advanced Mechatronics and MEMS Devices II", Springer, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	express Scaling laws of micro system	Applying (K3)
CO2	interpret the concepts of micro sensors and micro actuators	Understanding (K2)
CO3	choose the fabrication process of microsystem	Applying (K3)
CO4	identify the micro machining process and packaging	Applying (K3)
CO5	design and develop the micro system for various 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	1								2	3	2
CO2	3	3	2	1								2	2	2
CO3	3	3	3	2	3							2	3	2
CO4	3	3	3	2	3							2	2	2
CO5	3	3	3	2	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	20	40	40				100
CAT2	20	40	40				100
CAT3	10	40	30	20			100
ESE	15	35	30	20			100

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

20AUE21 - 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 about value engineering concepts and its importance in an organization.	Understanding (K2)
CO2	explain about value engineering plan for a product.	Understanding (K2)
CO3	illustrate product cost based on value engineering principles in terms of its values, functions and worthiness.	Understanding (K2)
CO4	summarize and select appropriate methods, standards and apply them on value engineering project and propose appropriate training.	Understanding (K2)
CO5	discuss querying theory and FAST to prefect 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	1			2					3	3	
CO2	3	2	1	1			2					3	3	
CO3	3	2	1	1			2					3	3	
CO4	3	2	1	1			2					3	3	
CO5	3	2	1	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	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)**

20AUE22 - DESIGN OF ENGINE COMPONENTS

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Machine Design	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	3	2								1	3	
CO2	3	3	2	1								1	3	
CO3	3	3	2	1								1	3	
CO4	3	3	3	2								1	3	
CO5	3	3	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	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)**

20AUE23 - AUTONOMOUS VEHICLE TECHNOLOGY

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

Preamble	This course deals about the technologies involved in 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 in autonomous vehicle.	Understanding (K2)
CO2	describe about the advanced driver assistance systems.	Understanding (K2)
CO3	illustrate automated driving technologies with sensor positioning.	Understanding (K2)
CO4	discuss about the role of artificial intelligence in autonomous vehicle.	Understanding (K2)
CO5	compare autonomous vehicles for various manufactures.	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	1		2	2					3		3
CO2	3	3	2	1		2	2					3		3
CO3	3	3	2	1		2	2					3		3
CO4	3	3	2	1		2	2					3		3
CO5	3	3	2	1		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	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)**

20AUE24 - AUTOMOTIVE SAFETY AND ERGONOMICS

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.	Understanding (K2)
CO5	discuss the pedestrian protection and computer simulations in safety tests.	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	1		2	2					1	3	
CO2	3	2	1	1		2	2					1	3	1
CO3	3	2	1	1		2	2					1	3	1
CO4	3	2	2	1		2	2					1	3	1
CO5	3	2	2	1		2	2					1	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	20	80					100

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

20AUE25 - 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	demonstrate Radiographic principles and test on material defects	Understanding (K2)
CO5	discuss other non-destructive testing techniques and select 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			2					1		1	2	
CO2	3	2			2					1		1	2	
CO3	3	3			3					1		1	2	
CO4	3	3			3					1		1	2	
CO5	3	2			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	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)**

20AUE26 - 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	improve and manage variables with quality assurance, process charts.	Applying (K3)
CO2	identify the process charts for attributes and out of control process.	Applying (K3)
CO3	evaluate the acceptance sampling methods and its impacts on producer’s and consumer’s risk.	Applying (K3)
CO4	infer reliability data analysis and get acquainted with various reliability prediction and evolution methods.	Applying (K3)
CO5	explain 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			2				2	2	3	
CO2	3	3	2	2			2				2	2	3	
CO3	3	3	2	2			2				2	2	3	
CO4	3	3	2	2			2				2	2	3	
CO5	3	3	2	2			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	30	60				100
CAT3	10	50	40				100
ESE	10	40	50				100

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

20AUE27 - 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 for Units I,II.
2.	Amar K. Mohanty, Manjusri Misra., "Natural Fibers, Biopolymers, and Bio composites", 2nd Edition, CRC Taylor and Francis, 2005 for Units III,IV,V.

REFERENCES:

1.	Georgios Koronis, Arlindo Silva., "Green Composites for Automotive Applications", 1st Edition, Woodhead Publishing Limited, 2017.
2.	Caroline Baillie. Green Composites., "Polymer Composites and the Environment", 1st Edition, Woodhead Publishing Limited, 2005.

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	exemplify making of green composite materials from liquefied biomass.	Understanding (K2)
CO3	illustrate the making and characteristics of green fibers.	Understanding (K2)
CO4	discuss the properties, process and usage of biodegradable materials.	Understanding (K2)
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					1	3	
CO2	3	3	1	1		1	2					1	3	
CO3	3	3	1	1		1	2					1	3	
CO4	3	3	1	1		1	2					1	3	
CO5	3	3	1	1		1	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	20	60	20				100

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

20AUE28 - AUTOMOTIVE TESTING

Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Powertrain 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	analyze the fuel consumption by road rest procedure for various driving cycles.	Applying (K3)
CO4	illustrate the suspension system test procedure.	Understanding (K2)
CO5	describe the steering system test 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	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	80					100
ESE	20	60	20				100

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

20AUE29 – ALTERNATE ENERGY SOURCES FOR AUTOMOBILES

Programme & Branch	**B.E. – Automobile Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Automotive Powertrain**	**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	20	10			100
CAT2	10	40	30	20			100
CAT3	10	40	30	20			100
ESE	10	40	30	20			100

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

20AUE30 - 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**
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.	Applying (K3)
CO4	analyze operation cost and revenues of transport operation.	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	1	1				3	3	2		1	3	1	3	
CO2	1	1				3	3	2		1	3	1	3	
CO3	1	1				3	3	2		1	3	1	3	
CO4	1	1				3	3	2		1	3	1	3	
CO5	1	1				3	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	20	80					100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	60	20				100

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

20AUE31 - ADVANCED THEORY OF IC ENGINES

Programme & Branch	B.E. – Automobile Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Automotive Powertrain	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	illustrate the homogenous charge compression ignition performance with various injection techniques.	Understanding (K2)
CO3	describe about HCCI engine with alternate fuels used for novel combustion.	Understanding (K2)
CO4	exemplify the performance and possible outcomes of low temperature and premixed combustion technology.	Understanding (K2)
CO5	discuss about the performance of RCCI engine with alternative 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	1		2						1	3	
CO2	3	2	1	1		2						1	3	
CO3	3	2	1	1		2						1	3	
CO4	3	2	1	1		2						1	3	
CO5	3	2	2	1		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	20	80					100

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

20AUE32 - 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	illustrate the PLM in automotive industries	Understanding (K2)
CO2	describe the components of PLM	Understanding (K2)
CO3	explain the product visualization using CAD	Understanding (K2)
CO4	describe the suitable PLM modules in 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	3	2	1			2					1	3	
CO2	3	3	2	1			2					1	3	
CO3	3	3	2	1	3		2					1	3	
CO4	3	3	2	1			2					1	3	
CO5	3	3	2	1			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	20	80					100

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

20AUE33 - 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, labour cost and over heads, 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, 2009.

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	compare production plans or schedules to optimize production.	Understanding (K2)
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	apply various cost estimation techniques.	Applying (K3)
CO5	identify various costs involved for producing a 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			2				3	1	3	
CO2	3	2	1	1			2				3	1	3	
CO3	3	2	1	1			2				3	1	3	
CO4	3	2	1	1			2				3	1	3	
CO5	3	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	10	60	30				100
CAT3	10	50	40				100
ESE	10	40	50				100

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

20AUE34 - 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.	Apply (K3)
CO3	apply suitable algorithm and primary LMS tools to solve the problems.	Apply (K3)
CO4	solve the given problem using secondary LMS tools.	Apply (K3)
CO5	explain the various rules of 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		1					2	1	3	
CO2	3	2	1	1		1					2	1	3	
CO3	3	2	1	1		1					2	1	3	
CO4	3	2	1	1		1					2	1	3	
CO5	3	2	1	1		1					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	30	50	20				100
CAT2	30	40	30				100
CAT3	30	50	20				100
ESE	30	40	30				100

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

20AUE35 – 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 manifesto and design movements - Idea of narrative in design - Spreading the word and generating a mission statement - Understanding the interplay between brand and design brief - Creating a design brief – Case study: Mazda Motorsports.		
Unit - II	**Ideate:**	**9**
Explore various vehicle packages and technical solutions based on the needs of target customer and market opportunity – Powertrain implications - Structure and a framework for vehicle architecture - Explore unique visual DNA for a vehicle based on objectives - Begin to explore surface language - Selecting key directions and identifying themes - Understanding segmentation and competitive benchmarking.		
Unit - III	**Develop:**	**9**
Case Study: Ford Mustang (phase 1) - Character development and processing imagery - Establishing an architectural and visual foundation - Design development in full-size - Refining proposals and making a final selection - Case Study: Ford Mustang (phase 2) - Creating an initial design prototype - Final theme selection – Final cut.		
Unit - IV	**Model:**	**9**
Virtual 3D and the 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 for different types of models making.		
Unit - V	**Build and Launch:**	**9**
Vetting an idea - Engineering, processing, and testing - Market research - Early-stage vetting for designers - Presenting to 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 concept and styling.	Understanding (K2)
CO2	associate the suitable computer aided design tools for communication of ideas.	Understanding (K2)
CO3	explain the computer aided styling for new product styling	Understanding (K2)
CO4	discuss the global standards in new product development.	Understanding (K2)
CO5	infer the customer insight and develop an innovative product.	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			2			2	3	
CO2	3	2	2		3	2			2			2	3	
CO3	3	2	3		3	2			2			2	3	
CO4	3	2	3		3	2			2			2	3	
CO5	3	2	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	80					100
CAT3	20	80					100
ESE	20	80					100

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

20AUE36 – 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 of mechanical energy based non-traditional machining processes in manufacturing.	Understanding (K2)
CO2	illustrate the knowledge on machining electrically conductive material through electrical energy.	Understanding (K2)
CO3	discuss the concepts of machining hard material 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	1	1								1	3	
CO2	3	2	1	1								1	3	
CO3	3	2	1	1								1	3	
CO4	3	2	1	1								1	3	
CO5	3	2	1	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)**

20AUO01 - 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**	**4**	**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 Exercises / Experiments:

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:

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	identify the IC engine components and exhaust system along with its function	Understanding (K2)
CO2	explain the various types of transmission system	Understanding (K2)
CO3	summarize suspension, brake and steering systems of automobile	Understanding (K2)
CO4	illustrate the types of chassis and circuit for automotive electrical systems	Understanding (K2)
CO5	explain automotive accessories and alternate fuel sources for automobiles	Understanding (K2)
CO6	dismantle and assemble petrol and diesel engines	Applying (K3), Manipulation (S2)
CO7	dismantle and assemble transmission and steering systems	Applying (K3), Manipulation (S2)
CO8	find the wiring fault in a vehicle and understand the working principle of horn, wiper and starter motor	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											
CO2	3	3	2											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	3	2											
CO6	1	2	1		3				2	1				
CO7	1	1	1		3				2	1				
CO8	1	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	20	80					100

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

20AUO02 - 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**	**5**	**OE**	**3**	**0**	**2**	**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 systems:**	**9**
Introduction - Requirements of the charging system - Charging system principles – Alternators - Smart charging - Advanced Charging system technology - Alternator developments		
Unit - II	**Starting systems:**	**9**
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 - III	**Ignition systems:**	**9**
Ignition system fundamentals - Electronic ignition - Electronic spark advance - Distributor less ignition - Coil on plug (COP) ignition - spark plugs		
Unit - IV	**Fuel control:**	**9**
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 - V	**Engine management:**	**9**
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.		

List of Exercises / Experiments:

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.	Fault identification and characteristic analysis of starting and charging system
8.	Speed control of Induction motor
9.	Position control of Stepper motor
10.	Speed control of BLDC motor

Lecture: 45, Practical: 30, Total: 75

TEXT BOOK:

1.	Tom Denton., "Automobile Electrical and Electronic Systems", 5th Edition, Routledge, United Kingdom, 2017.

REFERENCES:

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	explain about charging systems used in automobile	Understanding (K2)
CO2	illustrate the working of starting systems used in automobile	Understanding (K2)
CO3	describe the layout and types of ignition system used in gasoline engine	Understanding (K2)
CO4	summarize about the elements of fuel injection systems in engines.	Understanding (K2)
CO5	explain about the role of electronic control in engine management system	Understanding (K2)
CO6	design and implement electrical circuits for automotive applications	Applying (K3), Manipulation (S2)
CO7	analyze the characteristics and diagnose the faults in charging and starting systems	Applying (K3), Manipulation (S2)
CO8	carryout the conventional speed control techniques for AC and DC machines	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									1		
CO2	3	3	2									1		
CO3	3	3	2									1		
CO4	3	3	2									1		
CO5	3	3	2									1		
CO6	3	3	2						2	1		1		
CO7	3	3	2	1	2				2	1		1		
CO8	3	3	2	1	2				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	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)**

20AUO03 - 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	6	OE	3	0	0	3

Preamble	This course provides knowledge on maintenance and servicing of various systems in automobiles.	
Unit - I	**Maintenance procedure and tools:**	**9**
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**
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**
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**
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**
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.		

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 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	explain the maintenance in auto electrical and air-conditioning 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		1	2	2		1		1		
CO2	3	2	2	1	2	1	2	2		1		1		
CO3	3	2	2	1		1	2	2		1		1		
CO4	3	2	2	1		1	2	2		1		1		
CO5	3	2	2	1		1	2	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	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)**

20AUO04 - 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	8	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	Applying (K3)
CO4	analyze operation cost and revenues of transport operation	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	1	1				3	3	2	2	1	3	1		
CO2	1	1				3	3	2	2	1		1		
CO3	1	1				3	3	2	2	1		1		
CO4	1	1				3	3	2	2	1	2	1		
CO5	1	1				3	3	2	2	1	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	20	80					100

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

20AUO05 - AUTONOMOUS VEHICLES

(Offered by Department of Automobile Engineering)

Programme& Branch	All BE/BTech Branches except 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	summarize about introduction to automated driving vehicles with safety systems	Understanding (K2)
CO2	illustrate about the advanced driver assistance systems	Understanding (K2)
CO3	explain automated driving technologies with artificial intelligence	Understanding (K2)
CO4	describe about the social and human issues with global review	Understanding (K2)
CO5	differentiate autonomous vehicles with different case studies	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											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	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	80					100
CAT2	20	80					100
CAT3	20	50	30				100
ESE	10	70	20				100

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

20MAO01 - MATHEMATICAL FOUNDATIONS OF MACHINE LEARNING

(Offered by Department of Mathematics)

Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**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**
Definition – Subspaces – Linear dependence and independence – Basis and dimension – Row space, Column space and Null Space – Rank and nullity		
Unit - II	**Linear Transformations:**	**9+3**
Introduction – Kernel and range – Matrices of linear transformations – Change of basis – Rank and nullity.		
Unit - III	**Inner Product Spaces:**	**9+3**
Norms – Inner products – Length and Distance – Angle and Orthogonality – Orthonormal Basis – Gram-Schmidt Process – QR-Decomposition – Orthogonal Projection – Rotations.		
Unit - IV	**Matrix Decomposition And Continuous Optimization:**	**9+3**
Cholesky decomposition – Singular Value Decomposition, Continuous Optimization: Introduction – Unconstrained Optimization – Gradient Descent method – Constrained Optimization – Lagrange Multipliers method – Convex Optimization		
Unit - V	**Linear Regression And Support Vector Machines:**	**9+3**
Parameter Estimation – Maximum Likelihood estimation – Bayesian linear regression – Bayesian parameter estimation of Gaussian distribution, Support Vector Machines: Introduction – Margin and support vectors – Kernels – Primal support vector machine – Dual support vector machine.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Howard Anton and Chris Rorres, "Elementary Linear Algebra", 9th Edition, John Wiley and Sons, New Delhi, 2011 for Units I, II, III.
2.	Deisenroth M.P., Faisal A.A. and Ong C.S., "Mathematics for Machine Learning", 1st Edition, Cambridge University Press, 2019 for Units IV, V.

REFERENCES:

1.	David C. Lay, Steven R. Lay and 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.	Duda R.O., Hart E. and Stork D.G., "Pattern Classification", 2nd Edition, John Wiley and Sons, New Delhi, 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	apply the concepts of linear mappings in machine learning.	Applying (K3)
CO3	use the concept of inner product space and decompose the given matrix by means of orthonormal vectors.	Applying (K3)
CO4	apply the knowledge of factorisation of matrices and optimization techniques in clustering and classification of data.	Applying (K3)
CO5	describe the concepts of parameter estimation and support vector machine.	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	1												
CO3	3	2												
CO4	3	3	1	1	1									
CO5	3	2	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	10	50	40				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	5	25	70				100

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

20MAO02 - GRAPH THEORY AND ITS APPLICATIONS
(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	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 – Representations of graphs: Adjacency matrix – Incidence matrix.		
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 – Tree traversal.		
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	**Basic Algorithms:**	**9+3**
Shortest paths – Shortest path algorithms: Dijkstra's algorithm – Warshall's algorithm – Minimum Spanning tree – Minimal spanning tree algorithms: Prim's algorithm – Krushkal's algorithm – Optimal assignment – Kuhn and Munkres algorithm – Travelling salesman problem: Two optimal algorithm – Closest Insertion Algorithm.		
Unit - V	**Network Flows and Applications:**	**9+3**
Flows and cuts in networks - Max-flow Min-cut Theorem – Algorithms: Flow Augmenting Path – Ford-Fulkerson Algorithm for Maximum Flow – Edmonds and Karp algorithm.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall, New Delhi, 2010.

REFERENCES:

1.	Douglas B.West, "Graph Theory", 2nd Edition, Prentice Hall, New Delhi, 2017.
2.	Jonathan L. Gross & Jay Yellen, "Graph Theory and its Applications", 2nd Edition, CRC Press, New York, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the types of graphs and illustrate isomorphism on graphs.	Understanding (K2)
CO2	use the concepts and properties of different types of trees in data structures.	Applying (K3)
CO3	estimate the chromatic partition, chromatic polynomial and matching of a given graph.	Applying (K3)
CO4	apply various graph theoretic algorithms to communication and network problems.	Applying (K3)
CO5	identify the maximal flow in network by means of 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	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	10	50	40				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)**

20MAO03 - NUMBER THEORY AND CRYPTOGRAPHY
(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**NIL**	**5**	**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 and Canonical Decompositions:**	**9+3**
Division algorithm- Base-b representations – number patterns – Prime and composite numbers – Fibonacci and Lucas numbers – Fermat 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 congruences – Fermat's Little theorem – Euler's 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 – Miller-Rabin 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", 1st Edition, Cengage Learning India, New Delhi, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand various the concepts of divisibility and canonical decompositions.	Understanding (K2)
CO2	obtain knowledge in theory of congruences and solution of linear congruences.	Applying (K3)
CO3	use different number theoretic function suitably in cryptography.	Applying (K3)
CO4	apply various Primality test and factorisation algorithms to network security problems.	Applying (K3)
CO5	identify 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)**

20MAO04 - ADVANCED LINEAR ALGEBRA
(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	OE	3	0	0	3

Preamble	To provide the skills for applying linear equations, decomposition of matrices and linear transformations in real time engineering problems and impart knowledge of vector spaces.	
Unit - I	**Linear Equations:**	**9**
System of linear equations – Row reduction and echelon forms – Vector equations – Matrix equations – Solution sets of linear systems – Applications of Linear systems: Matrix operations – inverse of a matrix, Matrix factorization – Applications to computer graphics.		
Unit - II	**Vector Spaces:**	**9**
Definition – Subspaces – Linear dependence and independence – Basis and dimension – Row space, Column space and Null Space – Rank and nullity.		
Unit - III	**Inner Product Space:**	**9**
Inner products – Angle and Orthogonality in inner product spaces – Orthonormal Bases – Gram-Schmidt Process – QR-Decomposition – Orthogonal Projection – Least square technique.		
Unit - IV	**Linear Transformations:**	**9**
General linear transformation – Kernel and range – Matrices of linear transformations – Change of basis – Rank and nullity.		
Unit - V	**Eigenvalues and Eigenvectors:**	**9**
Definition – Orthogonal Diagonalization – Quadratic forms – Quadratic surfaces – Singular value decomposition – Applications.		

Total: 45

TEXT BOOK:

1.	Howard Anton & Chris Rorres, "Elementary Linear Algebra", 11th Edition, John Wiley & Sons, USA, 2014.

REFERENCES:

1.	David C. Lay, Steven R. Lay & Judith McDonald, "Linear Algebra and its Applications", 5th Edition, Pearson Education, New Delhi, 2016.
2.	Gareth Williams, "Linear Algebra with Applications", 8th Edition, Jones & Barlett Learning, USA, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	use the concepts of matrices and vectors in the solution of a system of linear equations.	Applying (K3)
CO2	understand the concepts of vector spaces.	Understanding (K2)
CO3	understand the concept of inner product space and decompose the given matrix by means of orthonormal vectors.	Understanding (K2)
CO4	transform the system from one dimension to another and represent the pertinent linear transformation in matrix form.	Applying (K3)
CO5	apply the knowledge of quadratic forms and techniques of singular value decomposition for problems arising in power/control system analysis, signals and 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	1											
CO2	3	1												
CO3	3	1	1											
CO4	3	2	1											
CO5	3	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	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)**

20MAO05 - OPTIMIZATION TECHNIQUES

(Offered by Department of Mathematics)

Programme & Branch	**All Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**6**	**OE**	**3**	**0**	**0**	**3**

Preamble	To provide the skills for solving the real time engineering problems involving linear, non-linear, transportation and assignment problems and also impart knowledge in project management and game theoretic concepts.	
Unit - I	**Linear Programming:**	**9**
Introduction – Formulation of Linear Programming Problem – Advantages of Linear Programming methods – Limitations of Linear Programming models – Standard form of LPP – Graphical Method – Simplex Method – Artificial variable techniques – Big M Method.		
Unit - II	**Transportation Problem:**	**9**
Mathematical Formulation of Transportation Problem – Initial basic feasible solution – North West Corner Method – Least Cost Method – Vogel's approximation method – Optimal solution – MODI Method – Degeneracy – Unbalanced transportation problem – Maximization transportation problem.		
Unit - III	**Assignment Problem and Theory of Games:**	**9**
Assignment Problem: Mathematical model of Assignment problem – Hungarian Method – Unbalanced assignment problem. Theory of Games: Two-person zero-sum game – Pure strategies - Game with mixed strategies – Rules of Dominance – Solution methods: Algebraic method – Matrix method – Graphical method.		
Unit - IV	**Project Management:**	**9**
Basic Concept of network Scheduling – Construction of network diagram – Critical path method – Programme evaluation and review technique – Project crashing – Time-cost trade-off procedure.		
Unit - V	**Non-Linear Programming:**	**9**
Formulation of non–linear programming problem – Constrained optimization with equality constraints – Kuhn-Tucker conditions – Constrained optimization with inequality constraints.		

Total: 45

TEXT BOOK:

1.	Kanti Swarup, Gupta P.K. & Man Mohan, "Operation Research", 14th Edition, Sultan Chand & Sons, New Delhi, 2014.

REFERENCES:

1.	Sharma J.K., "Operations Research – Theory and Applications", 4th Edition, Macmillan Publishers India Ltd., New Delhi, 2009.
2.	Gupta P.K. & Hira D.S., "Operations Research: An Introduction", 6th Edition, S.Chand and Co. Ltd, New Delhi, 2008.

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 algorithms in engineering problems.	Applying (K3)
CO3	use assignment and game theory concepts in practical situations.	Applying (K3)
CO4	handle the problems of Project Management using CPM and PERT.	Applying (K3)
CO5	solve various types of Non-linear Programming 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	2	1											
CO2	3	1	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	5	10	85				100
CAT2	5	10	85				100
CAT3	5	10	85				100
ESE	5	10	85				100

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

20PHO01 - THIN FILM TECHNOLOGY
(Offered by Department of Physics)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**4**	**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 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, UV-vis spectroscopy, Four probe resistivity – Applications (qualitative): Thin film resistors, Thin film capacitors, Thin film diodes, Thin film transistors, 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", McGraw Hill Inc., 1970 for Units I,II,III, IV.
2. Zhang S., Li L. and Kumar A., "Materials Characterization Techniques", CRC Press, 2009 for Unit V.

REFERENCES:

1. Ohring M., "Material Science of Thin Films", Academic Press, 1992.
2. Goswami A., "Thin Film Fundamentals", New Age International Pvt. Ltd., 2003.
3. Chopra K.L., "Thin Film Phenomena", McGraw Hill Inc., 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	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	20	40	40				100
CAT3	20	35	45				100
ESE	20	40	40				100

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

20PHO02 - 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	6	OE	3	0	0	3

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**
Importance of materials characterization - Classification of characterization techniques - Destructive and non-destructive techniques - Crystalline materials - Reciprocal lattice - Theory of X-ray diffraction - Powder and Single crystal X-ray diffraction: Instrumentation, XRD pattern, Systematic procedure for structure determination, Particle size determination, Strain calculation - Applications of X ray diffraction measurements.		
Unit - II	**Raman Spectroscopy:**	**9**
Introduction – Pure rotational Raman spectra – Vibrational Raman spectra – Polarization of light and Raman effect – Structure determination – Instrumentation – Near-Infra-Red FT Raman Spectroscopy.		
Unit - III	**Electron Microscopy:**	**9**
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, Short details of each component and working - Field Emission Gun - Field Emission Scanning electron microscope - Merits of Transmission electron microscope.		
Unit - IV	**Scanning Tunneling Microscopy:**	**9**
Introduction to quantum mechanical tunneling - Basic principles of scanning tunneling microscopy - Two modes of scanning - Interpreting scanning tunneling microscopic images -Applications of scanning tunneling microscopy.		
Unit - V	**Ultra Violet and Visible Spectroscopy:**	**9**
Regions of UV-Visible radiation - Colour and light absorption - The chromophore concept - Beer's and Lambert's laws – Theory of electronic transition - Frank Condon principle – Instrumentation and Working of UV vis spectrometer - Applications of UV visible spectroscopy.		

Total:45

TEXT BOOK:

1.	Cullity B.D. and Stock S.R., "Elements of X-ray diffraction ", 3rd Edition, Pearson Education, India, 2003 for Units I,II,III,IV.
2.	Banwell C.N., "Fundamentals of Molecular Spectroscopy", Tata McGraw-Hill Publications, New Delhi, 2007 for Unit V.

REFERENCES:

1.	Holt D.B. and Joy D.C., "SEM micro characterization of semiconductors", Academic Press, New Delhi, 1989.
2.	Willard H.H., Merritt L.L., John A. Dean and Settle F.A., "Instrumental Methods of Analysis", 7th Edition, CBS Publishers and Distributors, New Delhi.
3.	Elton N. Kaufman, "Characterization of Materials (Volume1&2)", Wiley-Interscience, 2003.

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	make use of the concept of Raman effect and Raman spectroscopy to determine the crystal structure and related structural parameters of materials.	Applying (K3)
CO3	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)
CO4	utilize the concept and phenomenon of quantum mechanical tunneling to interpret the surface image at the atomic level recorded using scanning tunneling microscopy.	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	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	20	40	40				100
CAT2	20	40	40				100
CAT3	20	35	45				100
ESE	20	40	40				100

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

20CYO01 - CORROSION SCIENCE AND ENGINEERING

(Offered by Department of Chemistry)

Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**OE**	**3**	**1**	**0**	**4**

Preamble	Corrosion science and engineering aims to equip the students to have wide range knowledge of corrosion and prevention methods in order to meet the industrial needs.	
Unit - I	**Corrosion and its units:**	**9+3**
Importance of corrosion prevention in various industries: direct and indirect effects of corrosion –free energy and oxidation potential criterion of uniform corrosion –Pilling Bedworth ratio and it consequences –units corrosion rate – mdd (milligrams per square decimeter per day) and mpy (Mils per year) –importance of pitting factor – Pourbaix diagrams of Mg, Al and Fe – and their limitations.		
Unit - II	**Mechanism of Corrosion:**	**9+3**
Localized corrosion: electro chemical mechanism Vs. chemical mechanism – Galvanic corrosion – Area effect in anodic and cathodic metal coatings, Organic coatings of bimetallic systems – prediction using emf Series and Galvanic series – Crevice corrosion – Mechanism of differential oxygenation corrosion – Auto catalytic mechanism of pitting due to crevice or differential oxygenation corrosion – Principles and procedures of cathodic protection: Sacrificial anodes and external cathodic current impression – stray current corrosion.		
Unit - III	**Types of Corrosion:**	**9+3**
Inter-granular corrosion: Stainless steels – cause and mechanism (Cr- Depletion theory) – Weld decay and knife line attack – Stress corrosion and fatigue corrosion – Theory of critical corrosion rate in corrosion fatigue. Cavitation damage – Fretting damage – Atmospheric corrosion – Bacterial corrosion – Marine corrosion –High temperature oxidation of metals – Ionic diffusion through protective oxides.		
Unit - IV	**Kinetics of Corrosion:**	**9+3**
Kinetic aspects of corrosion: Over potential activation and concentration over potentials – Exchange current density – Mixed potential theory – corrosion rates of Fe and Zn in air – free acid – effect of oxidizing agents – Phenomenon of passivation – Theories – effect of oxidizing agents and velocity of flow on passivating metals – effect of galvanic coupling of Fe and Ti respectively with Platinum – Noble metal alloying – anodic protection.		
Unit - V	**Prevention of Corrosion:**	**9+3**
Corrosion in inhibition: Inhibitors of corrosion – passivators, adsorbing inhibitors, V.P. inhibitors. Prevention of galvanic crevice, inter granular, Stress and fatigue corrosion at the design stage and in service conditions – control of catastrophic oxidation and Hydrogen disease -control of Bacterial corrosion – Langelier saturation Index and its uses. Corrosion prevention by Coatings – Surface pre- treatment – Hot dip, diffusion and cladded coatings – Phosphating and its uses.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Winston R. & Uhlig H.H., "Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering", 4th Edition, A John Wiley & Sons Inc. Publication, New Jersey, 2008.

REFERENCES:

1. McCafferty E., "Introduction to Corrosion Science", Springer, New York, 2010.
2. Fontanna, "Corrosion Engineering (Materials Science and Metallurgy Series)", McGraw Hill International Education, Singapore, 2005.
3. Pietro Pedeferri, "Corrosion Science and Engineering", Springer Nature Switzerland AG, Switzerland, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate the importance of direct and indirect corrosion to familiarize for industrial needs.	Understanding (K2)
CO2	demonstrate the mechanism of different types of corrosion with respect to the environment.	Applying (K3)
CO3	organize the various types and theory of corrosion to understand the corrosion problems.	Applying (K3)
CO4	utilize the theories and kinetics of corrosion to interpret with the real time applications.	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)**

20CYO02 - INSTRUMENTAL METHODS OF ANALYSIS

(Offered by Department of Chemistry)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	BS	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 – elucidation of NMR spectra and quantitative analysis.		
Unit - III	**Surface Studies:**	**9+3**
Surface study – x-ray emission spectroscopy (XES), electron spectroscopy for chemical analysis (ESCA) - UV photo electron spectroscopy (UPS)- X- ray photo electron spectroscopy (XPS) - Auger emission 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)- Inductively coupled plasma mass spectroscopy (ICP-MS) - Secondary Ion Mass Spectroscopy (SIMS) 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 titrimetry.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Willard H.H., Merritt L.L., Dean J.A & Settle F.A., "Instrumental Methods of Analysis", 7th Edition, CBS Publishers & Distributors, New Delhi, 2012.

REFERENCES:

1.	Chatwal G.R. & Anand Sham K., "Instrumental Methods of Chemical Analysis", 5th Edition, Himalaya Publishing House, Girgaon, Mumbai, 2019.
2.	Srivastava A.K. & Jain P.C., "Instrumental Approach to Chemical Analysis", 4th Edition, S Chand and Company Ltd, New Delhi, 2012.
3.	Sharma B.K., "Instrumental Method of Chemical Analysis", Krishna Prakashan Media Pvt. Ltd., Meerut, 2014.

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)**

20CYO03 - WASTE AND HAZARDOUS WASTE MANAGEMENT
(Offered by Department of Chemistry)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**6**	**BS**	**3**	**0**	**0**	**3**

Preamble	Waste and Hazardous waste management aims to equip the students to have a wide-range knowledge on waste management	
Unit – I	**Solid Waste Management:**	**9**
Solid wastes: Definition, types, sources, classification and composition of solid waste- Solid waste management system – Factors affecting solid waste management system – Solid waste processing technologies – incineration, combustion, stabilization, solidification, chemical fixation, encapsulation, composting, vermicomposting – Energy from waste –Biogasification –Anaerobic digestion, pyrolysis, refuse derived fuels; Landfill leachate and gas management, Landfill bioreactors – Recycling of household and commercial waste, recycling of paper, recycling of tire, recycling of plastics – Health and Environmental effects of Solid Waste – SWM: Indian scenario –Characteristics and quantity of various wastes.		
Unit – II	**Hazardous Waste Management:**	**9**
Hazardous waste Management: Identification and sources – characteristics and categorization – collection, segregation, packaging, labelling, transportation, processing (3R) – risk assessment and waste management treatment and disposal – storage and leak detection – site selection criteria, manifest system and records – Indian scenario – Responsibilities of various authorities. Radioactive Waste Management: Definition, sources, classification, collection, segregation, treatment and disposal.		
Unit – III	**E-Waste and Biomedical Waste Management:**	**9**
E-Waste Management: Definition, sources, classification, collection, segregation, treatment and disposal. Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste – categories and classification of biomedical waste – hazard of biomedical waste – need for disposal of biomedical waste – waste minimization – waste segregation and labelling – waste handling and collection- Treatment – autoclaving, Incineration, Chemical Disinfection – Disposal – Infection control Practices- status in India.		
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, Electroplating industries, Dairy, Sugar, Paper, distilleries, Steel plants, Refineries, fertilizer, thermal power plants – Wastewater reclamation concepts.		
Unit – V	**Solid Waste Management Legislation:**	**9**
Solid waste management plan – Solid Waste (Management and Handling) Rules, 2000, 2016 and amendments if any – Biomedical Waste (Management and Handling) Rules, 2016; Notification of Ash utilization 1999, 2003, 2009, 2015 and amendments if any – Plastic Waste Management Rules, 2016 – E-Waste Management Rules, 2016 – Bio-Medical Waste Management Rules, 2016 – Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 – Construction and Demolition Waste Management Rules, 2016.		

Total:45

TEXT BOOK:

1.	John Pichtel, “Waste Management Practices: Municipal, Hazardous, and Industrial”, 2nd Edition, CRC Press, Boca Raton, Florida, 2014 for Unit II, III.
2.	Sharma U.C. & Neetu Singh, “Environmental Science and Engineering, Volume 5: Solid Waste Management”, 2nd Edition, Studium Press, United State of America, 2017 for Unit I,IV,V.

REFERENCES:

1.	VanGuilder & Cliff, "Hazardous Waste Management: An Introduction", Har Cdr Edition, Mercury Learning & Information, Herndon, VA, 2011.
2.	Karen Hardt, "Solid Waste Management", 1st Edition, Callisto Reference, Germany, 2018.
3.	Majeti Narasimha Vara Prasad, Meththika Vithanage & Anwesha Borthakur, "Handbook of Electronic Waste Management: International Best Practices and Case Studies", 1st Edition, Butterworth-Heinemann, United Kingdom, 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	select the various disposal methods of hazardous wastes like radioactive wastes.	Understanding (K2)
CO3	organize the appropriate method for managing e-waste and biomedical wastes.	Applying (K3)
CO4	identify to plan minimization of industrial wastes.	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)**

20GEO01 – GERMAN 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	**Basics of Language**	**4,5,6,8**	**HS**	**4**	**0**	**0**	**4**

Preamble	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	**Accommodation (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	**Working Environment Communication (ArbeitenSie):**	**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, nichtdürfen, 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, ZumSchl*		

Total:60

TEXT BOOK:

1.	"Stefanie Dengler, Paul Rusch, Helen Schmitz, TanjaSieber, "Netzwerk Deutsch alsFremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs", Goyal Publishers, Delhi, 2015.

REFERENCES:

1.	https://ocw.mit.edu – Massachusetts Institute of Technology Open Courseware Refer: German 1 for undergraduate students
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	understanding letters and simple texts	Remembering (K1)
CO2	assimilating vocabulary on accommodation and invitation	Understanding (K2)
CO3	comprehend concept of time, telephonic conversation and job-related information	Understanding (K2)
CO4	understanding how to do shopping in a German store	Understanding (K2)
CO5	understanding 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	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	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	25	75					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)**

20GEO02 – JAPANESE LANGUAGE LEVEL 1

(Offered by Department of Electronics and Communication Engineering)

Programme& Branch	All BE/BTech Engineering & Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Basics of Language	4/5/6/8	HS	4	0	0	4

Preamble	To understand the basics of Japanese language 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 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-110 Kanjis		
Unit - V	**Introduction to Counters:**	**12**
How to use numbers-How to use quantifiers-Past form of adjectives and Nouns-Way to say preference-Way of expression degrees of an action-Other necessary particles-How to use numbers-How to use quantifiers-Past form of adjectives		

Total:60

TEXT BOOK:

1.	"MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1.	MargheritaPezzopane, "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	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	Understanding (K2)
CO5	comprehend concept of time, counters 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	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	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	25	75					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)**

20GEO03 - DESIGN THINKING FOR ENGINEERS

(Offered by Department of Computer Science and Engineering)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Problem Solving and Programming	6	OE	3	0	0	3

Preamble	In this course, systematic process of thinking which empowers even the most traditional thinker to develop new, innovative solutions to the problem at handare studied with an emphasis on bringing ideas to life based on how real users think, feel and behave.	
Unit - I	**Introduction::**	**9**
Introduction – Need for design thinking – Design and Business – The Design Process – Design Brief –Visualization – Four Questions, Ten Tools – Explore – STEEP Analysis – Strategic Priorities – Activity System – Stakeholder Mapping – Opportunity Framing.		
Unit - II	**Visualization:**	**9**
Introduction – Visualization – Journey Mapping – Value Chain Analysis – Mind Mapping – Empathize –Observations – Need Finding – User Personas.		
Unit - III	**Brainstorming:**	**9**
Introduction – Brainstorming – Concept Development – Experiment – Ideation – Prototyping – Idea Refinement.		
Unit - IV	**Assumption Testing:**	**9**
Introduction – Assumption Testing – Rapid Prototyping – Engage – Storyboarding.		
Unit - V	**Customer Co-Creation Learning Launch:**	**9**
Introduction – Customer Co-Creation Learning Launch – Leading Growth and Innovation – Evolve– Concept Synthesis – Strategic Requirements – Evolved Activity Systems – Quick Wins.		

Total:45

TEXT BOOK:

1.	Jeanne Liedtka and Tim Ogilvie, "Designing for Growth: A Design Thinking Tool Kit for Managers", Columbia University Press, 2011.

REFERENCES:

1.	Lee Chong Hwa, "Design Thinking The Guidebook", Design Thinking Master Trainers of Bhutan, 2017.
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	outline the basic concepts of design thinking	Understanding (K2)
CO2	make use of the mind mapping process for designing any system	Applying (K3)
CO3	develop many creative ideas through structured brainstorming sessions.	Applying (K3)
CO4	develop rapid prototypes to bring the ideas into reality	Applying (K3)
CO5	plan the implementation of the any system considering the real time feedback	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	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	70	20				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)**

20GEO04 - 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	8	OE	3	0	0	3

Preamble	This course will inspire the students to think innovation concepts and ideas for business model developments.	
Unit - I	**Innovation and Design Thinking:**	**9**
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**
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**
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**
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**
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		

Total:45

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	2	2
CO2	3	3	3	3	2	2	2	2	3	3	3	3	2	2
CO3	2	2	3	3	3	3	3	3	3	3	3	3	2	2
CO4				3	2	2	2	3	3	3	3	3	2	2
CO5				3	2	2		3	2	3	3	3	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	30	40	10			100
CAT2	20	30	40	20			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)**

20GEO05 - 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	**4/5/6/8**	**HS**	**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, Speakin 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.

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	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	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	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)**

20GEO06 - 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	4/5/6/8	HS	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.

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	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	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	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)**

20GEO07 - 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**	**4/5/6/8**	**HS**	**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	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	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	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)**

20GEO08 - 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	4/5/6/8	HS	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)**

20GEO09 - 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**	**4/5/6/8**	**HS**	**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)**

20GEO10 - 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**	**4/5/6/8**	**HS**	**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)**

20GEO11 - 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 and 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 and 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", 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.						

20GEO12 - NCC STUDIES (AIR WING) – I
(Offered by Department of Information Technology)

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, honing qualities such as self-discipline, self-confidence, self-reliance and dignity of labour in the cadets.	
Unit – I	**NCC Organization and National Integration:**	**9**
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.		
Unit – II	**Drill and Weapon Training:**	**9**
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).		
Unit – III	**Principles of Flight:**	**9**
Laws of motion-Forces acting on aircraft–Bernoulli's theorem-Stalling-Primary control surfaces – secondary control surfaces-Aircraft recognition.		
Unit - IV	**Aero Engines:**	**9**
Introduction of Aero engine-Types of engine-piston engine-jet engines-Turboprop engines-Basic Flight Instruments-Modern trends.		
Unit – V	**Aero Modeling:**	**9**
History of aero modeling-Materials used in Aero-modeling-Types of Aero-models – Static Models-Gliders-Control line models-Radio Control Models-Building and Flying of Aero-models.		

Lecture :45, Practical30, 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" by DG NCC, New Delhi.
2	"Cadets Handbook – Specialised Subjects SD/SW" by DG NCC, New Delhi.
3	"NCC OTA Precise" by DGNCC, 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 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 airplanes 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.						

20GEO13 - FRENCH LANGUAGE LEVEL 1

Programme & Branch	**All Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**5/6/7/8**	**HS**	**3**	**1**	**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
3.	.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)**

20GEO14 - FRENCH LANGUAGE LEVEL 2

Programme & Branch	**All Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**5/6/7/8**	**HS**	**3**	**1**	**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

TEXTBOOK:

1.	A2 – Saison

REFERENCES:

1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G
3.	.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		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)**

20GEO15 - FRENCH LANGUAGE LEVEL 3

Programme& Branch	**All Engineering courses**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**5/6/7/8**	**HS**	**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
3.	.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	know about Letter writing, Creating Ads, Expressing Desires, and Instructing Others.	Understanding (K2)
CO4	understand rules for travel and Enhancing communications.	Understanding (K2)
CO5	express 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)**

20GEO16 - SPANISH LANGUAGE LEVEL 1

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Fundamentals of Spanish Language	5/6/7/8	HS	3	1	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)**

20GEO17 - SPANISH LANGUAGE LEVEL 2

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Fundamentals of Spanish Language	5/6/7/8	HS	3	1	0	4

Preamble	This course aims to help the Learner to acquire the vocabulary as per the framework of Spanish language A2 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 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, 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	understand the Spanish 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 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)**

20GEO18 - SPANISH LANGUAGE LEVEL 3

Programme & Branch	**All Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of Spanish Language**	**5/6/7/8**	**HS**	**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 (Seamos creatives):**	**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 INTERNACIONAL 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	know about Letter writing, Creating Ads, Expressing Desires and Instructing Others.	Understanding (K2)
CO4	understand rules for travel and Enhance communications.	Understanding (K2)
CO5	express 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)**

20GEO19 - ENTREPRENEURSHIP DEVELOPMENT
(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	8	EC	3	0	0	3

Preamble	The purpose of this course to create entrepreneurial awareness among engineering students.	
Unit - I	**Entrepreneurship Concepts:**	**9**
Meaning and concept of entrepreneurship - Role of Entrepreneurship in Economic Development - Factors affecting Entrepreneurship – Creativity and Innovation – Entrepreneurship vs Intrapreneurship.		
Unit - II	**Entrepreneur:**	**9**
Definition - Entrepreneurial Motivation factors - Characteristics of Entrepreneurs - Distinction between an Entrepreneur and the Manager.		
Unit - III	**Business Plan:**	**9**
Objectives of a Business Plan - Business Planning Process - Opportunity Identification and selection - Contents of a Business Plan – Common errors in Business Plan formulation.		
Unit - IV	**Entrepreneurial Eco System:**	**9**
Forms of Business Ownership - Sources of Finance - Institutional Support to Entrepreneurs – Institutional Finance to Entrepreneurs.		
Unit - V	**Small Business Management:**	**9**
Definition of Small Scale Industries - Strengths and Weaknesses of Small Business - Growth Strategies in Small Scale Enterprises - Sickness in Small Enterprises – Symptoms -Causes and remedies.		

Total:45

TEXT BOOK:

1.	Gordon E & Natarajan K, "Entrepreneurship Development", 6 Edition, Himalaya Publishing House, Mumbai, 2017.

REFERENCES:

1.	Sangeeta Sharma, "Entrepreneuship Development", 1 Edition, PHI Learning Private Ltd., , New Delhi , 2017.
2.	Charantimath Poornima .M, "Entrepreneurship Development and Small Business Enterprises", 3 Edition, Pearson Education, Noida, 2018.
3.	Robert D. Hisrich, Michael P. Peters & Dean A. Shepherd, "Entrepreneurship", 10 Edition, McGraw Hill, Noida, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the concepts of entrepreneurship and its importance	Understanding (K2)
CO2	demonstrate the traits of an entrepreneur and the sources of entrepreneurial motivation	Applying (K3)
CO3	assess the components of business plan	Analyzing (K4)
CO4	appraise the sources of finance and institutions supporting entrepreneurship	Evaluating (K5)
CO5	interpret the causes of sickness of small scale enterprises	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
CO2											3		3	3
CO3											3		3	3
CO4											3		3	3
CO5											3		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	20	20	20	40			100
CAT3	20	20	20	20	20		100
ESE	10	30	20	20	20		100

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

20MAO01 - MATHEMATICAL FOUNDATIONS FOR MACHINE LEARNING
(Common to all Engineering and Technology Branches)

Programme & Branch	All Engineering and Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**4**	**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**
Definition – Subspaces – Linear dependence and independence – Basis and dimension – Row space, Column space and Null Space – Rank and nullity.		
Unit - II	**Linear Transformations:**	**9+3**
Introduction – Kernel and range – Matrices of linear transformations – Change of basis – Rank and nullity.		
Unit - III	**Inner Product Spaces:**	**9+3**
Norms – Inner products – Length and Distance – Angle and Orthogonality – Orthonormal Basis – Gram-Schmidt Process – QR-Decomposition – Orthogonal Projection – Rotations.		
Unit - IV	**Matrix Decomposition and Continuous Optimization:**	**9+3**
Matrix Decomposition: Cholesky decomposition – Singular Value Decomposition. Continuous Optimization: Introduction – Unconstrained Optimization – Gradient Descent method – Constrained Optimization – Lagrange Multipliers method – Convex Optimization.		
Unit - V	**Linear regression and Support Vector Machines:**	**9+3**
Linear Regression: Parameter Estimation – Maximum Likelihood estimation – Bayesian linear regression. Support Vector Machines: Introduction – Linear and Non-linear Support vector machine – Margin and support vectors – Hard and Soft margins in Support vector machines – Kernels – Primal support vector machine – Dual support vector machine.		

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.	EthemAlpaydin, “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	apply the concepts of linear mappings in machine learning.	Applying (K3)
CO3	understand the concept of inner product space and decompose the given matrix by means of orthonormal vectors.	Understanding (K2)
CO4	apply the knowledge of factorisation of matrices and optimization techniques in clustering and classification of data.	Applying (K3)
CO5	describe the concepts of parameter estimation and support vector machine.	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	1												
CO3	3	2												
CO4	3	3		1	1									
CO5	3	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	10	50	40				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	5	25	70				100

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

20MAO02 - GRAPH THEORY AND ITS APPLICATIONS
(Common to all Engineering and Technology branches)

Programme & Branch	All Engineering and Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**4**	**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 – Representations of graphs: Adjacency matrix – Incidence matrix.		
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 – Finding all spanning trees of a graph – Fundamental circuits.		
Unit - III	**Graph Coloring:**	**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 – Finding all spanning trees of a graph – Fundamental circuits.		
Unit - IV	**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.		
Unit - V	**Graph Theoretic Algorithms:**	**9+3**
Shortest paths – Shortest path algorithms: Dijkstra's algorithm – Warshall's algorithm – The Chinese Postman Problem – Fleury's Algorithm – Travelling salesman problem – Minimum Spanning tree – Minimal spanning tree algorithms: Prim's algorithm – Krushkal's algorithm – Optimal assignment – Kuhn and Munkres algorithm.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	NarsinghDeo, "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	understand basic graph theoretic concepts.	Understanding (K2)
CO2	intrepret the concepts 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	identify the maximal flow in network by means of algorithms.	Applying (K3)
CO5	apply various graph theoretic algorithms to communication and network 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	2	1											
CO2	3	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	10	50	40				100
CAT2	10	30	60				100
CAT3	10	20	70				100
ESE	10	35	55				100

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

20MAO03 - DATA ANALYTICS USING R PROGRAMMING
(Common to all Engineering and Technology Branches)

Programme & Branch	All Engineering and Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	0	3

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.		

Total: 45

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.

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)
CO2	understand the concepts of decision, looping structures and functions.	Understanding (K2)
CO3	apply R programming to descriptive statistics.	Applying (K3)
CO4	apply the libraries for data manipulation and data visualization in R.	Applying (K3)
CO5	use R studio to identify the probability and test statistical hypothesis.	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											
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	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)**

20MAO04 - NUMBER THEORY AND CRYPTOGRAPHY

(Common to all Engineering and Technology branches)

Programme & Branch	**All Engineering and Technology branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**0**	**0**	**3**

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 and Canonical Decompositions:**	**9**
Division algorithm- Base-b representations – number patterns – Prime and composite numbers – Fibonacci and Lucas numbers – Fermat numbers – GCD – Euclidean Algorithm – Fundamental theorem of Arithmetic – LCM.		
Unit - II	**Theory of Congruences:**	**9**
Basic concepts – Properties of congruences – Linear congruences – Solution of congruences – Fermat's Little theorem – Euler's theorem – Chinese remainder theorem.		
Unit - III	**Number Theoretic Functions:**	**9**
Introduction – Functions τ and σ – Mobius function – Greatest integer function – Euer's Phi function – Euler's theorem – Properties of Euler's function – Applications to Cryptography.		
Unit - IV	**Primality testing and Factorization:**	**9**
Primality testing: Fermat's pseudo primality test – Solvay-Strassen test – Miller-Rabin test – Fibonacci test – Lucas test – Integer factorization: Trial division – Pollard's Rho method – Quadratic sieve method.		
Unit - V	**Classical Cryptographic Techniques:**	**9**
Introduction – Substitution techniques – Transposition techniques – Encryption and decryption – Symmetric and asymmetric key cryptography – Steganography.		

Total: 45

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)**

20MAO05 -ADVANCED LINEAR ALGEBRA
(Common to all Engineering and Technology branches)

Programme & Branch	All Engineering and Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	To provide the skills for solving linear equations, decomposition of matrices and linear transformations in real time engineering problems and impart knowledge of vector spaces.	
Unit - I	**Linear Equations:**	**9**
System of linear equations – Row reduction and echelon forms – Vector equations – Matrix equations – Solution sets of linear systems – Applications of Linear systems: Matrix operations – inverse of a matrix, Matrix factorization – Applications to computer graphics.		
Unit - II	**Vector Spaces:**	**9**
Definition – Subspaces – Linear independence – Basis and dimension – Row space, Column space and Null Space – Rank and nullity.		
Unit - III	**Inner Product Spaces:**	**9**
Inner products – Angle and Orthogonality in inner product spaces – Orthonormal Bases – Gram-Schmidt Process – QR-Decomposition – Orthogonal Projection – Least square technique.		
Unit - IV	**Linear Transformations:**	**9**
General linear transformation – Kernel and range – Matrices of linear transformations – Change of basis – Rank and nullity.		
Unit - V	**Quadratic form and Matrix Decomposition:**	**9**
Quadratic forms – Quadratic surfaces – Hermitian, Unitary and Normal matrices – LU decomposition – Singular value decomposition.		

Total: 45

TEXT BOOK:

1.	Howard Anton and Chris Rorres, “Elementary Linear Algebra”, 11th Edition, John Wiley & Sons, New Delhi, 2014.

REFERENCES:

1.	David C. Lay, Steven R. Lay, Judith McDonald, "Linear Algebra and its Applications", 5th Edition, Pearson Education, New Delhi, 2016.
2.	Gareth Williams, “Linear Algebra with Applications”, 9th Edition, Jones & Bartlett Publishers, Canada, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the concepts of matrices and vectors in solving the system of linear equations.	Applying (K3)
CO2	understand the concept of vector spaces.	Understanding (K2)
CO3	apply the concept of inner product spaces in orthogonalization.	Applying (K3)
CO4	apply the concepts of linear transformation to engineering problems	Applying (K3)
CO5	apply the knowledge of quadratic forms and matrix decompositions in practical 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	2	1											
CO2	3	1												
CO3	3	1	1											
CO4	3	2	1											
CO5	3	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	20	70				100
CAT2	10	40	50				100
CAT3	10	20	70				100
ESE	10	30	60				100

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

20MAO06 - OPTIMIZATION TECHNIQUES
(Common to all Engineering and Technology branches)

Programme & Branch	All Engineering and Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	To provide the skills for solving the real time engineering problems involving linear and non-linear problems and also impart knowledge in project management and game theoretic concepts.	
Unit - I	**Linear Programming:**	**9**
Introduction – Formulation of Linear Programming Problem – Basic assumptions – Limitations of Linear Programming models – Standard form of LPP – Graphical Method – Simplex Method – Artificial variable techniques – Big M Method.		
Unit - II	**Transportation and Assignment problems:**	**9**
Transportation problem: Mathematical Formulation of Transportation Problem – Initial basic feasible solution – North West Corner Method – Least Cost Method – Vogel's approximation method – Optimal solution – MODI Method – Degeneracy – Unbalanced transportation problem – Maximization transportation problem. Assignment Problem: Mathematical model of Assignment problem – Hungarian Method – Unbalanced assignment problem.		
Unit - III	**Theory of Games:**	**9**
Two-person zero-sum game – Pure strategies - Game with mixed strategies – Rules of Dominance – Solution methods: Algebraic method – Matrix method – Graphical method.		
Unit - IV	**Network Scheduling:**	**9**
Basic Concept of network Scheduling – Construction of network diagram – Critical path method – Programme evaluation and review technique – Project crashing – Time-cost trade-off procedure.		
Unit - V	**Non-Linear Programming:**	**9**
Formulation of non–linear programming problem – Constrained optimization with equality constraints – Kuhn-Tucker conditions – Constrained optimization with inequality constraints.		

Total: 45

TEXT BOOK:

1.	Hamdy A. Taha, "Operations Research: An Introduction", 10th Edition, Dorling Kindersley, Pvt. Ltd, Uttar Pradesh, 2016.

REFERENCES:

1.	Sharma J.K, "Operations Research – Theory and Applications", 4th Edition, Macmillan Publishers India Ltd, New Delhi, 2009.
2.	Gupta P.K. and Hira D.S., "Operations Research: An Introduction", 6th Edition, S.Chand and Co. Ltd., New Delhi, 2008.
3.	KantiSwarup, Gupta P.K. and Man Mohan, "Operation Research", 14th Edition, Sultan Chand & Sons, New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve linear programming problems.	Applying (K3)
CO2	apply transportation algorithms in engineering problems	Applying (K3)
CO3	use assignment and game theory concepts in practical situations	Applying (K3)
CO4	handle the problems of Project Management using CPM and PERT	Applying (K3)
CO5	solve various types of Non-linear Programming 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	2	1											
CO2	3	1	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	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)**

20PHO01 - THIN FILM TECHNOLOGY
(Common to all Engineering and Technology branches)

Programme & Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	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 for Units I, II, III & IV.
2	Sam Zhang, Lin Li and Ashok Kumar, Materials Characterization Techniques, 1st edition, CRC Press, Boca Raton, 2008, for 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	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	20	40	40				100
ESE	20	40	40				100

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

20PHO02- HIGH ENERGY STORAGE DEVICES

(Common to all Engineering and Technology branches)

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 and Optical storage:**	**9+3**
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+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 1- 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, 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	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 and optical storage systems to illustrate the respective device fabrication 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	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	20	40	40				100
ESE	20	40	40				100

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

20PHO03 - STRUCTURAL AND OPTICAL CHARACTERIZATION OF MATERIALS
(Common to all Engineering and Technology branches)

Programme & Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	0	3

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**
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, Strain calculation - Applications of X ray diffraction measurements.		
Unit - II	**Electron Microscopy:**	**9**
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, Short details of each component and working – Field emission scanning electron microscope – Different types of filaments - Wavelength dispersive x-ray analysis – Three parameter equation for quantitative composition analysis.		
Unit - III	**Scanning Tunneling Microscopy:**	**9**
Introduction to quantum mechanical tunneling - Basic principles of scanning tunneling microscopy - Two modes of scanning - Interpreting scanning tunneling microscopic images -Applications of scanning tunneling microscopy.		
Unit - IV	**Raman Spectroscopy:**	**9**
Introduction – Pure rotational Raman spectra – Vibrational Raman spectra – Polarization of light and Raman effect – Structure determination – Instrumentation – Near-Infra-Red FT Raman Spectroscopy.		
Unit - V	**Ultra Violet &Visible Spectroscopy:**	**9**
Regions of UV-Visible radiation - Colour and light absorption - The chromophore concept - Beer's and Lambert's laws – Theory of electronic transition - Frank Condon principle – Instrumentation and Working of UV vis spectrometer - Applications of UV visible spectroscopy.		

Total: 45

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	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	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)**

20CYO01 - INSTRUMENTAL METHODS OF ANALYSIS
(Common to all Engineering and Technology branches)

Programme & Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	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 – elucidation of 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 Emission 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)**

20CYO02 - CORROSION SCIENCE AND ENGINEERING
(Common to all Engineering and Technology branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	Corrosion science and engineering aims to equip the students to have a wide-range knowledge of corrosion and prevention methods in order to meet the industrial needs.	
Unit – I	**Corrosion and its Units**	**9+3**
Localized corrosion: 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 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 corrosion		
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 – Their and limitations–Methods of Determining Corrosion Rates - Weight Loss Method, Weight Gain Method and Chemical Analysis of Solution.		
Unit - III	**Types of Corrosion**	**9+3**
Introduction - (i) Crevice - differential aeration corrosion, (ii) pitting – mechanism, factors (iii) intergrannular- chromium depletion theory, weld decay and knife line attack, (iv) stress - SCC mechanism, and fatique- Cavitation damage – Fretting damage, (v) stray current corrosion - causes and its control.		
Unit - IV	**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 – V	**Prevention of Corrosion**	**9+3**
Inhibitors – types of inhibitors, chemisorption of inhibitors, effect of concentration, effect of molecular structure, V.P. 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		

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, Revie 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	organize the various types of corrosion to understand the corrosion problems	Applying (K3)
CO4	utilize the theories corrosion to interpret with the real time applications	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)**

20CYO03 - CHEMISTRY OF COSMETICS IN DAILY LIFE
(Common to all Engineering and Technology branches)

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 provide knowledge for engineering students on chemistry of cosmetics.	
Unit 1	**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) - Polymers in Cosmetics - Polymer Solubility and Compatibility, polymer conformation - Basics of Dispersions - Electrical Charges Associated With Surfaces and Barriers – Basics of emulsion (stability, Ostwald Ripening, Prevention of Creaming and Sedimentation).		
Unit 2	**Structuring Materials 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 - Precautions on Cosmetic Ingredients - Future Challenges in Cosmetics Material Development.		
Unit 3	**Polymers in Cosmetic Products**	**9+3**
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 4	**Powders and Fragrance in Cosmetics**	**9+3**
Inorganic Pigments – extender pigment, coloured pigment, white pigment, pearlescent Pigments – organic pigments - extender pigment, coloured pigment. Fragrance – Introduction – natural products – aroma chemicals - fragrance creation and duplication - fragrance applications - encapsulation and controlled release – malodor - natural, green, organic, and sustainable fragrances.		
Unit 5	**Preparation of Cosmetics**	**9+3**
Brief introduction of the following cosmetic preparation and a detailed study on their quality control: shampoo, tooth paste, skin powder, skin creams, hair creams, nail polish, after shave lotion, bath and toiletries, lipstick and hair dyes, perfumes, depilatories.		

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, JayeshGadiya, MeenakshiDhanawat 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 form cosmetics	Applying (K3)
CO3	interpret the polymers in cosmetics	Understanding (K2)
CO4	develop knowledge about Powders and Fragrance in Cosmetics	Applying (K3)
CO5	apply the preparation methodology of cosmetics to explain the 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)**

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20CYO04 - CHEMISTRY OF NUTRITION FOR WOMEN HEALTH
(Common to all Engineering and Technology branches)

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 provide knowledge for engineering students on components of health and fitness and the role of nutrition for women health.	
Unit - I	**Nutrition**	**9+3**
Energy- Functions, sources and concept of energy balance, Functions, Recommended Dietary Allowances, dietary sources, effects of deficiency and/ or excess consumption on health of the following nutrients: • Carbohydrates and dietary fibre, 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	**Role of women in national development**	**9+3**
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.		
Unit - III	**Women and health**	**9+3**
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 - IV	**Nutrition during Lactation and for Infants**	**9+3**
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 - V	**Physical fitness and nutrition**	**9+3**
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.		

Lecture:45,Tutorial:15, Total: 60

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	Interpret the various role of women in society	Understanding (K2)
CO3	Explain the disease pattern and policies towards women health	Understanding (K2)
CO4	Develop knowledge about nutrition during lactation and for infants	Applying (K3)
CO5	Utilize the knowledge of physical fitness and nutrition towards achieving a good health	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	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)**

20CYO05 - CHEMISTRY CONCEPTS FOR COMPETITIVE EXAMINATIONS
(Common to all Engineering and Technology branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	0	3

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**
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**
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**
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**
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**
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.		

Total: 45

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", 6th Edition, 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 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)**

20CYO06 - WASTE AND HAZARDOUS WASTE MANAGEMENT
(Common to all Engineering and Technology branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	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, segregation of waste-generation, 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, dairy industries.		
Unit - V	**SOLID WASTE MANAGEMENT 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 Units - 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	select the various disposal methods of hazardous wastes like radioactive wastes	Understanding (K2)
CO3	organize the appropriate method for managing e-waste and biomedical waste	Applying (K3)
CO4	identify to plan minimization of industrial wastes	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)**

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE-638060

(AUTONOMOUS)

BOARD OF AUTOMOBILE ENGINEERING

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.	20AUH01	Automotive Communication Protocols	4	Nil	5
2.	20AUJ01	Power Electronics and Drives	4	Basics of Electrical and Electronic Circuits	5
3.	20AUH02	Automotive IOT Technologies	4	Nil	6
4.	20AUH03	Advanced Energy Storage Management	3	Nil	6
5.	20AUH04	Advanced Vehicle Technologies	3	Automotive Electrical Systems and Drives, Automotive Sensors and Controllers	7
		TOTAL	**18**		

20AUH01 - 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)

20AUJ01 - 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)
CO2	describe the working principle of AC – DC and DC – AC converters	Understanding (K2)
CO3	express the construction and working of DC – DC and AC – AC converters	Applying (K3)
CO4	select a suitable power converter for a given DC drive	Understanding (K2)
CO5	choose an appropriate power converter for a given AC drive	Applying (K3)
CO6	examine and estimate the performance of AC and DC converters	Analyzing (K4), Manipulation (S2)
CO7	demonstrate and execute the performance of Inverter and AC voltage controller	Analyzing (K4), Manipulation (S2)
CO8	design and build a suitable power converter	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		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
CO6	2	3	2	2	1								3	2
CO7	3	3	2	2	1								3	3
CO8	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	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)

20AUH02 - 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)

20AUH03 - 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)

20AUH04 - 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)