KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

Estd : 1984

REGULATIONS, CURRICULUM & SYLLABI - 2022

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

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

BACHELOR OF ENGINEERING DEGREE

IN

MECHATRONICS ENGINEERING

DEPARTMENT OF MECHATRONICS 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 MECHATRONICS ENGINEERING

VISION

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

MISSION

Department of Mechatronics Engineering is committed to:

MS1: Disseminate knowledge through effective teaching-learning process to develop technically competent and ethically strong Mechatronics professionals.

MS2: Foster continuous interdisciplinary learning and research to meet real-world challenges by nurturing innovation through state-of-the-art facilities.

MS3: Promote societal based consultancy and training services in collaboration with Industries and R&D organizations.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of Mechatronics Engineering will

PEO1: Utilize the fundamental knowledge of basic sciences and engineering to succeed in their profession

PEO2: Design and Develop Mechatronics products and processes for real world applications

PEO3: Exhibit professional and managerial capabilities with ethical conduct and have an aptitude for continuous learning

MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

PROGRAM OUTCOMES (POs)	
Graduates of Mechatronics 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 Mechatronics Engineering will**:**	
PSO1	Design and develop Mechatronic systems by synergistic combination of mechanical engineering, electronic controls and systems
PSO2	Adapt multidisciplinary approach to solve real world industrial problems

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	2	2	2	2	1	1	1	1	2	1	2	2	2
PEO2	3	3	3	3	2	1	1	1	2	2	2	2	3	3
PEO3	1	1	1	1	1	2	2	3	2	2	3	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638060

(Autonomous)

REGULATIONS 2022

CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION

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

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

1. DEFINITIONS AND NOMENCLATURE

In these Regulations, unless otherwise specified:

i. "University" means ANNA UNIVERSITY, Chennai.

ii. "College" means KONGU ENGINEERING COLLEGE.

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

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

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

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

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

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

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

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

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

2. PROGRAMMES AND BRANCHES OF STUDY

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

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

3. ADMISSION REQUIREMENTS

3.1 First Semester Admission

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

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

(OR)

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

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

3.2 Lateral Entry Admission

The candidates who hold a Diploma in Engineering / Technology awarded by the State Board of Technical Education, Tamilnadu or its equivalent are eligible to apply for

Lateral entry admission to the third semester of BE / BTech.

(OR)

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

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

4. STRUCTURE OF PROGRAMMES

4.1 Categorisation of Courses

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

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

4.2 Credit Assignment and Honours Degree

4.2.1. Credit Assignment

Each course is assigned certain number of credits as follows:

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

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

4.2.2 Honours Degree

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

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

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

*Title by KEC

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

4.3 Employability Enhancement Courses

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

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

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

(OR)

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

(OR)

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

4.3.2 Comprehensive Test and Viva

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

4.3.3 Full Time Project through Internships

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

A candidate is permitted to go for full time projects through internship in seventh

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

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

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

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

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

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

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

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

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

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

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

4.5 Flexibility to Add or Drop Courses

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

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

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

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

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

5. DURATION OF THE PROGRAMME

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

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

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

6. COURSE REGISTRATION FOR THE EXAMINATION

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

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

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

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

7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS

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

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

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

7.3 Theory Courses

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

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

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

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

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

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

7.4 Theory cum Practical Courses

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

7.5 Practical Courses

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

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

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

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

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

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

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

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

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

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

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

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

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

7.7 Project Work I / Industrial Training

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

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

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

7.8 Professional Skills Training

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

7.9 Comprehensive Test and Viva

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

7.10 Entrepreneurships/ Start ups

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

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

7.11 In-Plant Training

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

7.12 One / Twe Credit Courses

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

7.13 Online Course

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

7.14 Self Study Course

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

7.15 Audit Course

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

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

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

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

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

7.16 Mandatory Courses

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

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

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

8. REQUIREMENTS FOR COMPLETION OF A SEMESTER

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

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

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

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

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

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

8.1.5 Candidate's progress is satisfactory.

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

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

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

9. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION

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

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

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

10. PROVISION FOR WITHDRAWAL FROM EXAMINATIONS

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

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

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

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

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

11. PROVISION FOR BREAK OF STUDY

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

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

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

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

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

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

12. PASSING REQUIREMENTS

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

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

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

13. REVALUATION OF ANSWER SCRIPTS

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

14. SUPPLEMENTARY EXAMINATION

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

15. AWARD OF LETTER GRADES:

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

Marks / Examination Status	Letter Grade	Grade Point
Based on the relative grading	O (Outstanding)	10
	A+ (Excellent)	9
	A (Very Good)	8
	B+ (Good)	7
	B (Average)	6
	C (Satisfactory)	5
Less than 50	U (Reappearance)	0
Successfully Completed	SC	0
Withdrawal	W	-
Absent	AB	-
Shortage of Attendance in a 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-2022 (vide clause 11.3)

iv. No disciplinary action pending against him / her.

17. CLASSIFICATION OF THE DEGREE AWARDED

17.1 First Class with Distinction:

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

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

(OR)

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

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

17.2 First Class:

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

- Should have passed the examination in all the courses of all eight

semesters (six semesters for lateral entry candidates) within ten consecutive semesters (eight consecutive semesters for lateral entry candidates) excluding authorized break of study (vide clause 11) after the commencement of his / her study.

- Withdrawal from the examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 6.50

17.3 Second Class:

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

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

17.5 Honors Degree:

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

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

18. MALPRACTICES IN TESTS AND EXAMINATIONS

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

19. AMENDMENTS

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

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B.E. MECHATRONICS ENGINEERING CURRICULUM - R2022
(For students admitted during 2022-23)

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	4	2			2	3		15	8.92
BS	8	8		4					20	11.90
ES	8	8	4						20	11.90
PC	3	4	16	16	15	8			62	36.91
PE					3	3	9	3	18	10.72
OE					4	4	3	3	14	8.34
EC				2	2	6	5	4	19	11.31
Semester wise Total	**23**	**24**	**22**	**22**	**24**	**23**	**20**	**10**	**168**	**100.00**

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

CATEGORISATION OF COURSES

HUMANITIES AND SOCIAL SCIENCE INCLUDING MANAGEMENT (HS)

Sl.No.	Course Code	Course Name	L	T	P	C	Pre-requisites	Sem
1.	22EGT11	Communication Skills - I	3	0	0	3	Nil	I
2.	22VEC11	Yoga and Values for Holistic Development	--	--	--	1	Nil	I
3.	22EGT21	Communication Skills - II	3	0	0	3	Nil	II
4.	22TAM01	Heritage of Tamils	1	0	0	1	Nil	II
5.	22TAM02	Tamils and Technology	1	0	0	1	Nil	III
6.	22EGL31	Communication Skills Development Laboratory	0	0	2	1	Nil	III
7.	22GET31	Universal Human Values	2	0	0	2	Nil	VI
8.	22GCT71	Engineering Economics and Management	3	0	0	3	Nil	VII
Total Credits to be earned						15		

BASIC SCIENCE (BS)

Sl.No.	Course Code	Course Name	L	T	P	C	Pre-requisites	Sem
1.	22MAC11	Matrices and Ordinary Differential Equations	3	1*	2*	4	Nil	I
2.	22PHT13	Physics for Mechatronics Engineering	3	0	0	3	Nil	I
3.	22PHL13	Physics Laboratory for Mechatronics Engineering	0	0	2	1	Nil	I
4.	22MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	Nil	II
5.	22CYT23	Chemistry for Mechatronics Engineering	3	0	0	3	Nil	II
6.	22CYL22	Chemistry Laboratory for Mechanical Engineering	0	0	2	1	Nil	II
7.	22MAT41	Numerical Methods for Engineers	3	1	0	4	Nil	IV
Total Credits to be earned						20		

ENGINEERING SCIENCE (ES)

Sl.No.	Course Code	Course Name	L	T	P	C	Pre-requisites	Sem
1.	22CSC11	Problem Solving and Programming in C	3	0	2	4	Nil	I
2.	22MET11	Engineering Drawing	2	1	0	3	Nil	I
3.	22MEL11	Engineering Practices Laboratory	0	0	2	1	Nil	I
4.	22CSC21	Data Structures using C	3	0	2	4	Nil	II
5.	22MTT22	Electron Devices and Digital Circuits	3	0	0	3	Nil	II
6.	22MTL21	Electron Devices and Digital Circuits Laboratory	0	0	2	1	Nil	II
7.	22ITC32	Introduction to Python	3	0	2	4	Nil	III
Total Credits to be earned						20		

PROFESSIONAL CORE (PC)

Sl.No.	Course Code	Course Name	L	T	P	C	Sem	Domain/ Stream
1.	22MET12	Engineering Mechanics	3	0	0	3	I	PD
2.	22MTT21	Fluid Mechanics and Thermodynamics	3	1	0	4	II	PS
3.	22MTT31	Strength of Materials	3	1	0	4	III	PD
4.	22MTT32	Theory of Machines	3	1	0	4	III	PD
5.	22MTT33	Systems and Control Engineering	3	0	0	3	III	AE
6.	22MTT34	Electrical Machines	3	0	0	3	III	PD
7.	22MTL31	Electrical Machines and Control Laboratory	0	0	2	1	III	AE
8.	22MTL32	Computer Aided Drafting Laboratory	0	0	2	1	III	PD
9.	22MTC41	Computer-Aided Design and Analysis	3	0	2	4	IV	PD
10.	22MTT41	Manufacturing Processes	3	0	0	3	IV	PS
11.	22MTT42	Sensors and Signal Conditioning	3	0	0	3	IV	AE
12.	22MTC42	Graphical System Design	3	0	2	4	IV	AS
13.	22MTL41	Sensors and Signal Conditioning Laboratory	0	0	2	1	IV	AE
14.	22MTL42	Manufacturing Processes Laboratory	3	0	0	3	IV	PS
15.	22MTC51	Fluid Power Systems	2	0	2	3	V	PS
16.	22MTC52	Power Electronics and Drives	3	0	2	4	V	AE
17.	22MTT51	CNC and Metrology	3	0	0	3	V	AE

18.	22MTT52	Microcontroller Programming and Applications	3	0	0	3	V	AE
19.	22MTL51	CNC and Metrology Laboratory	0	0	2	1	V	AE
20.	22MTL52	Microcontroller Programming and Applications Laboratory	0	0	2	1	V	AE
21.	22MTT61	Programmable Automation Controllers	3	0	0	3	VI	AE
22.	22MTT62	Mechanics of Serial Manipulator	3	0	0	3	VI	AS
23.	22MTL61	Programmable Automation Controllers Laboratory	0	0	2	1	VI	AE
24.	22MTL62	Robotics and Control Laboratory	0	0	2	1	VI	AS
		Total Credits to be earned				62		

PROFESSIONAL ELECTIVE (PE)

Sl. No.	Course Code	Course Name	L	T	P	C	Domain/ Stream
		Semester V					
		Elective - I					
1	22MTE01	Design of Mechanical Elements	3	0	0	3	PD
2	22MTE02	Heat and Mass Transfer	3	0	0	3	PD
3	22MTE03	Operations Research	3	0	0	3	PS
4	22MTE04	Machine Drawing	3	0	0	3	PD
5	22MTE05	Introduction to Industrial Internet of Things	3	0	0	3	AE
6	22MTE06	Advanced Control Theory	3	0	0	3	AS
7	22MTE07	Automotive Engineering	3	0	0	3	PD
8	22MTE08	Virtual Instrumentation: Theory and Applications	3	0	0	3	AE
9	22MTE09	Power Converters and Electric Drives	3	0	0	3	AE
		Semester VI					
		Elective - II					
10	22MTE10	Applied Finite Element Method	3	0	0	3	PD
11	22MTE11	Precision Equipment Design	3	0	0	3	PS
12	22MTE12	Computer Integrated Manufacturing	3	0	0	3	PS
13	22MTE13	Embedded Programming for Mechatronics	3	0	0	3	AE
14	22MTE14	Machine Learning	3	0	0	3	AS
15	22MTE15	Process Control and Instrumentation	3	0	0	3	AE
16	22MTE16	Automotive Electronics	3	0	0	3	AE
		Semester VII					
		Elective - III					
17	22GEE01	Total Quality Management	3	0	0	3	GE
18	22MTE17	Bio Mechatronics	3	0	0	3	AS
19	22MTE18	Precision Manufacturing	3	0	0	3	PS
20	22MTE19	Digital Twin and Industry 5.0	3	0	0	3	AE
21	22MTE20	Optimal and Adaptive Control	3	0	0	3	AS
		Elective - IV					
22	22GEE02	Fundamentals of Research	3	0	0	3	GE
23	22MTE21	Electric and Hybrid Vehicles	3	0	0	3	PD
24	22MTE22	Machine Tool Control and Condition Monitoring	3	0	0	3	PS
25	22MTE23	Additive Manufacturing	3	0	0	3	PS
26	22MTE24	Industrial Automation Protocols	3	0	0	3	AE
		Elective - V					
27	22MTE25	Robot Programming	3	0	0	3	AS

28	22MTE26	Drone Technology	3	0	0	3	AS
29	22MTE27	Maintenance Engineering	3	0	0	3	PS
30	22MTE28	Machine Vision and Image Processing	3	0	0	3	AE
31	22MTE29	MEMS and NEMS	3	0	0	3	PD
		Semester VIII					
		Elective – VI					
32	22MTE30	Mobile Robotics	3	0	0	3	AS
33	22MTE31	Product Design and Development	3	0	0	3	PD
34	22MTE32	Battery Management System	3	0	0	3	PS
35	22MTE33	Production Management	3	0	0	3	PS
36	22MTE34	Cyber Physical Systems	3	0	0	3	AE
37	22MTE35	Agricultural Robotics and Automation	3	0	0	3	AE
38	22MTE36	Aircraft Mechatronics	3	0	0	3	AS
Total Credits to be earned						18	

* Domain/Stream Abbreviations: AE- Automation Engineering, AS – Autonomous Systems, PD – Product Design, PS – Production System, GE – General Engineering

EMPLOYABILITY ENHANCEMENT COURSES (EC)

Sl.No.	Course Code	Course Name	L	T	P	C	Sem
1.	22GCL41	Professional Skills Training I / Industrial Training I*				2	IV
2.	22GCL51	Professional Skills Training II / Industrial Training II*				2	V
3.	22MTP61	Project Work I	0	0	8	4	VI
4.	22GEP61	Comprehensive Test and Viva				2	VI
5.	22MTP71	Project Work II Phase I	0	0	10	5	VII
6.	22MTP81	Project work II Phase II	0	0	8	4	VIII
Total Credits to be earned						**19**	

MANDATORY COURSES (MC)

Sl.No.	Course Code	Course Name	L	T	P	C	Sem
1.	22MNT11	Student Induction Program #				0	I
2.	22MNT31	Environmental Science	2	0	0	0	III
Total Credits to be earned							

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)

(Common to all departments except offering department)

LIST OF OPEN ELECTIVES TO OTHER DEPARTMENTS						
Course Code	Course Title	Hours/Week			Credit	CBS
		L	T	P		
SEMESTER V						
22MTO01	Design of Mechatronics Systems	3	1	0	4	OE
22MTX01	Data Acquisition and Virtual Instrumentation	3	0	2	4	OE
22MTX02	Factory Automation	3	0	2	4	OE

SEMESTER VI						
22GEO04	Innovation and Business Model Development	3	1	0	4	OE
22MTO02	Robotics	3	1	0	4	OE
22MTO03	3D Printing and Design	3	1	0	4	OE
SEMESTER VII						
22GEO05	Entrepreneurship Development	3	0	0	3	OE
22MTO04	Drone System Technology	3	0	0	3	OE
SEMESTER VIII						
22MTO05	Micro and Nano Electromechanical Systems	3	0	0	3	OE

B.E. MECHATRONICS ENGINEERING CURRICULUM - R2022
(For students admitted during 2023-24)

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	5	4	1			2	3		15	8.93
BS	8	8		4					20	11.90
ES	10	7	4						21	12.50
PC		3	15	17	16	8	3		62	36.90
PE					3	3	6	3	15	8.93
OE					4	4	3	3	14	8.34
EC				2	2	7	6	4	21	12.50
Semester wise Total	**23**	**22**	**20**	**23**	**25**	**24**	**21**	**10**	**168**	**100.00**

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

CATEGORISATION OF COURSES

HUMANITIES AND SOCIAL SCIENCE INCLUDING MANAGEMENT (HS)

Sl.No.	Course Code	Course Name	L	T	P	C	Pre-requisites	Sem
1.	22EGT11	Communication Skills - I	3	0	0	3	Nil	I
2.	22TAM01	Heritage of Tamils	1	0	0	1	Nil	I
3.	22VEC11	Yoga and Values for Holistic Development	--	--	--	1	Nil	I
4.	22EGT21	Communication Skills - II	3	0	0	3	Nil	II
5.	22TAM02	Tamils and Technology	1	0	0	1	Nil	II
6.	22EGL31	Communication Skills Development Laboratory	0	0	2	1	Nil	III
7.	22GET31	Universal Human Values	2	0	0	2	Nil	VI
8.	22GCT71	Engineering Economics and Management	3	0	0	3	Nil	VII
Total Credits to be earned						15		

BASIC SCIENCE (BS)

Sl.No.	Course Code	Course Name	L	T	P	C	Pre-requisites	Sem
1.	22MAC11	Matrices and Ordinary Differential Equations	3	1*	2*	4	Nil	I
2.	22PHT13	Physics for Mechatronics Engineering	3	0	0	3	Nil	I
3.	22PHL13	Physics Laboratory for Mechatronics Engineering	0	0	2	1	Nil	I
4.	22MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	Nil	II
5.	22CYT23	Chemistry for Mechatronics Engineering	3	0	0	3	Nil	II
6.	22CYL22	Chemistry Laboratory for Mechanical Engineering	0	0	2	1	Nil	II
7.	22MAT41	Numerical Methods for Engineers	3	1	0	4	Nil	IV
Total Credits to be earned						20		

ENGINEERING SCIENCE (ES)

Sl.No.	Course Code	Course Name	L	T	P	C	Pre-requisites	Sem
1.	22CSC11	Problem Solving and Programming in C	3	0	2	4	Nil	I
2.	22MET11	Engineering Drawing	2	1	0	3	Nil	I
3.	22GCL12	Foundation Lab – Electrical, IoT and Web	0	0	6	3	Nil	I
4.	22CSC21	Fundamentals of Data Structures	3	0	2	4	Nil	II
5.	22GCL11	Foundation Lab - Manufacturing, Design and Robotics	0	0	6	3	Nil	II
6.	22ITC32	Introduction to Python	3	0	2	4	Nil	III
Total Credits to be earned						21		

PROFESSIONAL CORE (PC)

Sl.No.	Course Code	Course Name	L	T	P	C	Sem	Domain/ Stream
1.	22MET12	Engineering Mechanics	3	0	0	3	II	PD
2.	22MTT21	Fluid Mechanics and Thermodynamics	3	1	0	4	III	PS
3.	22MTT33	Systems and Control Engineering	3	0	0	3	III	AE
4.	22MTT41	Manufacturing Processes	3	0	0	3	III	PS
5.	22MTT22	Electron Devices and Digital Circuits	3	0	0	3	III	AE
6.	22MTL42	Manufacturing Processes Laboratory	0	0	2	1	III	PS
7.	22MTL21	Electron Devices and Digital Circuits Laboratory	0	0	2	1	III	AE
8.	22MTC41	Computer-Aided Design and Analysis	3	0	2	4	IV	PD
9.	22MTT31	Strength of Materials	3	1	0	4	IV	PD
10.	22MTT32	Theory of Machines	3	1	0	4	IV	PD
11.	22MTT34	Electrical Machines	3	0	0	3	IV	PD
12.	22MTL31	Electrical Machines and Control Laboratory	0	0	2	1	IV	AE
13.	22MTL32	Computer Aided Drafting Laboratory	0	0	2	1	IV	PD
14.	22MTT51	CNC and Metrology	3	0	0	3	V	AE
15.	22MTT52	Microcontroller Programming and Applications	3	0	0	3	V	AE
16.	22MTC53	Fluid Power System Design	3	0	2	4	V	PS
17.	22MTC54	Sensors and Signal Processing	3	0	2	4	V	AE
18.	22MTL51	CNC and Metrology Laboratory	0	0	2	1	V	AE

19.	22MTL52	Microcontroller Programming and Applications Laboratory	0	0	2	1	V	AE
20.	22MTT61	Programmable Automation Controllers	3	0	0	3	VI	AE
21.	22MTT62	Mechanics of Serial Manipulator	3	0	0	3	VI	AS
22.	22MTL61	Programmable Automation Controllers Laboratory	0	0	2	1	VI	AE
23.	22MTL62	Robotics and Control Laboratory	0	0	2	1	VI	AS
24.	22MTT71	Industrial Internet of Things	3	0	0	3	VII	AE
Total Credits to be earned						62		

PROFESSIONAL ELECTIVE (PE)

Sl. No.	Course Code	Course Name	L	T	P	C	Domain/ Stream
		Semester V					
		Elective - I					
1	22MTE01	Design of Mechanical Elements	3	0	0	3	PD
2	22MTE02	Heat and Mass Transfer	3	0	0	3	PD
3	22MTE03	Operations Research	3	0	0	3	PS
4	22MTE04	Machine Drawing	3	0	0	3	PD
5	22MTE05	Introduction to Industrial Internet of Things	3	0	0	3	AE
6	22MTE06	Advanced Control Theory	3	0	0	3	AS
7	22MTE07	Automotive Engineering	3	0	0	3	PD
8	22MTE08	Virtual Instrumentation: Theory and Applications	3	0	0	3	AE
9	22MTE09	Power Converters and Electric Drives	3	0	0	3	AE
		Semester VI					
		Elective - II					
10	22MTE10	Applied Finite Element Method	3	0	0	3	PD
11	22MTE11	Precision Equipment Design	3	0	0	3	PS
12	22MTE12	Computer Integrated Manufacturing	3	0	0	3	PS
13	22MTE13	Embedded Programming for Mechatronics	3	0	0	3	AE
14	22MTE14	Machine Learning	3	0	0	3	AS
15	22MTE15	Process Control and Instrumentation	3	0	0	3	AE
16	22MTE16	Automotive Electronics	3	0	0	3	AE
		Semester VII					
		Elective - III					
17	22GEE01	Total Quality Management	3	0	0	3	GE
18	22MTE17	Bio Mechatronics	3	0	0	3	AS
19	22MTE18	Precision Manufacturing	3	0	0	3	PS
20	22MTE19	Digital Twin and Industry 5.0	3	0	0	3	AE
21	22MTE20	Optimal and Adaptive Control	3	0	0	3	AS
		Elective - IV					
22	22GEE02	Fundamentals of Research	3	0	0	3	GE
23	22MTE21	Electric and Hybrid Vehicles	3	0	0	3	PD
24	22MTE22	Machine Tool Control and Condition Monitoring	3	0	0	3	PS
25	22MTE23	Additive Manufacturing	3	0	0	3	PS
26	22MTE24	Industrial Automation Protocols	3	0	0	3	AE
27	22MTE25	Robot Programming	3	0	0	3	AS
28	22MTE26	Drone Technology	3	0	0	3	AS
29	22MTE27	Maintenance Engineering	3	0	0	3	PS

30	22MTE28	Machine Vision and Image Processing	3	0	0	3	AE
31	22MTE29	MEMS and NEMS	3	0	0	3	PD
		Semester VIII					
		Elective – V					
32	22MTE30	Mobile Robotics	3	0	0	3	AS
33	22MTE31	Product Design and Development	3	0	0	3	PD
34	22MTE32	Battery Management System	3	0	0	3	PS
35	22MTE33	Production Management	3	0	0	3	PS
36	22MTE34	Cyber Physical Systems	3	0	0	3	AE
37	22MTE35	Agricultural Robotics and Automation	3	0	0	3	AE
38	22MTE36	Aircraft Mechatronics	3	0	0	3	AS
Total Credits to be earned						18	

* Domain/Stream Abbreviations: AE- Automation Engineering, AS – Autonomous Systems, PD – Product Design, PS – Production System, GE – General Engineering

EMPLOYABILITY ENHANCEMENT COURSES (EC)

Sl.No.	Course Code	Course Name	L	T	P	C	Sem
1.	22GCL41	Professional Skills Training I / Industrial Training I*				2	IV
2.	22GCL51	Professional Skills Training II / Industrial Training II*				2	V
3.	22MTP62	Project Work I	0	0	4	5	VI
4.	22GEP61	Comprehensive Test and Viva				2	VI
5.	22MTP72	Project Work II Phase I	0	0	8	6	VII
6.	22MTP81	Project work II Phase II	0	0	14	4	VIII
Total Credits to be earned						**21**	

MANDATORY COURSES (MC)

Sl.No.	Course Code	Course Name	L	T	P	C	Sem
1.	22MNT11	Student Induction Program #				0	I
2.	22MNT31	Environmental Science	2	0	0	0	III
Total Credits to be earned						0	

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)

(Common to all departments except offering department)

LIST OF OPEN ELECTIVES TO OTHER DEPARTMENTS						
Course Code	**Course Title**	**Hours/Week**			**Credit**	**CBS**
		L	**T**	**P**		
SEMESTER V						
22MTO01	Design of Mechatronics Systems	3	1	0	4	OE
22MTX01	Data Acquisition and Virtual Instrumentation	3	0	2	4	OE
22MTX02	Factory Automation	3	0	2	4	OE
SEMESTER VI						
22GEO04	Innovation and Business Model Development	3	1	0	4	OE

22MTO02	Robotics	3	1	0	4	OE
22MTO03	3D Printing and Design	3	1	0	4	OE
SEMESTER VII						
22GEO05	Entrepreneurship Development	3	0	0	3	OE
22MTO04	Drone System Technology	3	0	0	3	OE
SEMESTER VIII						
22MTO05	Micro and Nano Electromechanical Systems	3	0	0	3	OE

B.E. – MECHATRONICS ENGINEERING (Total Credit: 168) - R2022 (For Students admitted during 2022-23)

Sem	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	Credits
I	22EGT11 Communication Skills - I (3-0-0-3)	22MAC11 Matrices and Ordinary Differential Equations (3-1-2-4)	22PHT12 Physics for Mechanical Engineering (3-0-0-3)	22MET12 Engineering Mechanics (3-0-0-3)	22CSC11 Problem Solving and Programming in C (3-0-2-4)	22MET11 Engineering Drawing (2-1-0-3)	22MEL11 Engineering Practices Laboratory (0-0-2-1)	22PHL12 Physics Laboratory for Mechanical Engineering (0-0-2-1)	22VEC11 Yoga and Values for Holistic Development (0-0-0-1)		23
II	22EGT21 Communication Skills - II (3-0-0-3)	22MAC21 Multivariable Calculus and Complex Analysis (3-1-2-4)	22CYT23 Chemistry for Mechanical Engineering (3-0-0-3)	22MTT21 Fluid Mechanics & Thermodynamics (3-1-0-4)	22CSC21 Data Structure Using C (3-0-2-4)	22MTT22 Electron Devices and Digital Circuits (3-0-0-3)	22TAM01 Heritage of Tamils (1-0-0-1)	22MTL22 Electron Devices and Digital Circuits Laboratory (0-0-2-1)	22CYL22 Chemistry Laboratory for Mechanical Systems (0-0-2-1)		24
III	22ITC32 Introduction to Python (3-0-2-4)	22MTT31 Strength of Materials (3-1-0-4)	22MTT32 Theory of Machines (3-1-0-4)	22MTT33 Systems and Control Engineering (3-0-0-3)	22MTT34 Electrical Machines (3-0-0-3)	22TAM02 Tamils and Technology (1-0-0-1)	22MTL31 Electrical Machines and Control Laboratory (0-0-2-1)	22MTL32 Computer Aided Drafting Laboratory (0-0-2-1)	22EGL31 Communication Skills Development Laboratory (0-0-2-1)	22MNT31 Environmental Science (2-0-0-0)	22
IV	22MAT41 Numerical Methods for Engineers (3-1-0-4)	22ITC32 Computer Aided Design and Analysis (3-0-2-4)	22MTT41 Manufacturing Processes (3-0-0-3)	22MTT42 Sensors and Signal Conditioning (3-0-0-3)	22MTC42 Graphical System Design (3-0-2-4)	22MTL41 Sensors and Signal Conditioning Laboratory (0-0-2-1)	22MTL42 Manufacturing Processes laboratory (0-0-2-1)	22GCL41 Professional Skills Training I/Industrial Training I* (0-0-0-2)			22
V	22MTC51 Fluid Power Systems (2-0-2-3)	22MTC52 Power Electronics and Drives (3-0-2-4)	22MTT51 CNC and Metrology (3-0-0-3)	22MTT52 Microcontroller Programming and Applications (3-0-0-3)	Professional Elective I (3-0-0-3)	Open Elective I (3-1/0-0/2-4)	22MTL51 CNC and Metrology Laboratory (0-0-2-1)	22MTL52 Microcontroller Programming and Applications Laboratory (0-0-2-1)	22GCL51 Professional Skills Training II/ Industrial Training II* (0-0-0-2)		24
VI	22MTT61 Programmable Automation Controllers (3-0-0-3)	22MTT62 Mechanics of Serial Manipulator (3-0-0-3)	Professional Elective II (3-0-0-3)	Open Elective II (3-1/0-0/2-4)	22MTL61 Programmable Automation Controllers Laboratory (0-0-2-1)	22MTL62 Robotics and Control Laboratory (0-0-2-1)	22MTP61 Project Work I (0-0-8-4)	22GCT31 Universal Human Values (2-0-0-2)	22GEP61 Comprehensive Test and Viva (0-0-0-2)		23
VII	22GCT71 Economics and Management for Engineers (3-0-0-3)	Professional Elective III (3-0-0-3)	Professional Elective IV (3-0-0-3)	Professional Elective V (3-0-0-3)	Open Elective III (3-0-0-3)	22MTP71 Project Work II Phase I (0-0-10-5)					19

VIII	Professional Elective VI (3-0-0-3)	Open Elective IV (3-0-0-3)	22MTP81 Project Work II Phase II (0-0-8-4)								13

B.E. – MECHATRONICS ENGINEERING (Total Credit: 168) - R2022 (For Students admitted during 2023-24)

Sem	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	Credits
I	22EGT11 Communication Skills - I (3-0-0-3)	22MAC11 Matrices and Ordinary Differential Equations (3-1-2-4)	22PHT12 Physics for Mechanical Engineering (3-0-0-3)	22CSC11 Problem Solving and Programming in C (3-0-2-4)	22MET11 Engineering Drawing (2-1-0-3)	22TAM01 Heritage of Tamils (1-0-0-1)	22PHL12 Physics Laboratory for Mechanical Engineering (0-0-2-1)	22GCL11 Foundation Lab-Manufacturing, Design & Robotics (0-0-6-3)	22VEC11 Yoga and Values for Holistic Development (0-0-0-1)		23
II	22EGT21 Communication Skills - II (3-0-0-3)	22MAC21 Multivariable Calculus and Complex Analysis (3-1-2-4)	22CYT23 Chemistry for Mechanical Engineering (3-0-0-3)	22CSC21 Fundamentals of Data Structure (3-0-2-4)	22MET12 Engineering Mechanics (3-0-0-3)	22CYL22 Chemistry Laboratory for Mechanical Systems (0-0-2-1)	22GCL12 Foundation Lab-Electrical, IoT & Web (0-0-6-3)	22TAM02 Tamils and Technology (3-0-0-3)			22
III	22ITC32 Introduction to Python (3-0-2-4)	22MTT21 Fluid Mechanics & Thermodynamics (3-1-0-4)	22MTT33 Systems and Control Engineering (3-0-0-3)	22MTT41 Manufacturing Processes (3-0-0-3)	22MTT22 Electron Devices and Digital Circuits (3-0-0-3)	22MTL42 Manufacturing Processes laboratory (0-0-2-1)	22MTL22 Electron Devices and Digital Circuits Laboratory (0-0-2-1)	22MNT31 Environmental Science (2-0-0-0)	22EGL31 Communication Skills Development Laboratory (0-0-2-1)		20
IV	22MAT41 Numerical Methods for Engineers (3-1-0-4)	22ITC32 Computer Aided Design and Analysis (3-0-2-4)	22MTT31 Strength of Materials (3-1-0-4)	22MTT32 Theory of Machines (3-1-0-4)	22MTT34 Electrical Machines (3-0-0-3)	22MTL31 Electrical Machines and Control Laboratory (0-0-2-1)	22MTL32 Computer Aided Drafting Laboratory (0-0-2-1)	22GCL41 Professional Skills Training I/Industrial Training I* (0-0-0-2)			23
V	22MTT51 CNC and Metrology (3-0-0-3)	22MTT52 Microcontroller Programming and Applications (3-0-0-3)	22MTC53 Fluid Power System Design (3-0-2-4)	22MTC54 Sensors and Signal Processing (3-0-2-4)	Professional Elective I (3-0-0-3)	Open Elective I (3-1/0-0/2-4)	22MTL51 CNC and Metrology Laboratory (0-0-2-1)	22MTL52 Microcontroller Programming and Applications Laboratory (0-0-2-1)	22GCL51 Professional Skills Training II/ Industrial Training II* (0-0-0-2)		25

VI	22MTT61 Programmable Automation Controllers (3-0-0-3)	22MTT62 Mechanics of Serial Manipulator (3-0-0-3)	Professional Elective II (3-0-0-3)	Open Elective II (3-1/0-0/2-4)	22MTL61 Programmable Automation Controllers Laboratory (0-0-2-1)	22MTL62 Robotics and Control Laboratory (0-0-2-1)	22MTP62 Project Work I (0-0-4-5)	22GCT31 Universal Human Values (2-0-0-2)	22GEP61 Comprehensive Test and Viva (0-0-0-2)		24
VII	22GCT71 Economics and Management for Engineers (3-0-0-3)	22MTT71 Industrial Internet of Things (3-0-0-3)	Professional Elective III (3-0-0-3)	Professional Elective IV (3-0-0-3)	Open Elective III (3-0-0-3)	22MTP72 Project Work II Phase I (0-0-8-6)					21
VIII	Professional Elective VI (3-0-0-3)	Open Elective IV (3-0-0-3)	22MTP81 Project Work II Phase II (0-0-14-4)								10

COURSE MAPPING WITH PO & PSO

Sem	Course code	Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
I	22EGT11	Communication Skills - I						✓			✓	✓	✓	✓		
	22MAC11	Matrices and Ordinary Differential Equations	✓	✓	✓		✓									
	22PHT13	Physics for Mechatronics Engineering	✓	✓	✓						✓	✓		✓	✓	✓
	22MET12	Engineering Mechanics	✓	✓	✓	✓								✓	✓	✓
	22CSC11	Problem Solving and Programming in C	✓	✓	✓	✓	✓				✓	✓		✓		
	22MET11	Engineering Drawing	✓	✓	✓		✓					✓		✓		
	22MEL11	Engineering Practices Laboratory	✓		✓	✓	✓	✓			✓	✓		✓	✓	✓
	22PHL13	Physics Laboratory for Mechatronics Engineering	✓	✓	✓	✓					✓	✓		✓	✓	✓
	22VEC11	Yoga and Values for Holistic Development						✓		✓	✓					
	22TAM01	Heritage of Tamils						✓		✓	✓	✓		✓		
	22GCL11	Foundation Lab – Manufacturing, Design & Robotics	✓	✓	✓		✓				✓	✓		✓		
II	22EGT21	Communication Skills - II						✓			✓	✓	✓	✓		
	22MAC21	Multivariable Calculus and Complex Analysis	✓	✓	✓	✓	✓							✓	✓	✓
	22CYT23	Chemistry for Mechatronics Engineering	✓	✓	✓	✓										
	22MTT21	Fluid Mechanics and Thermodynamics	✓	✓	✓	✓								✓	✓	✓

	22CSC21	Data Structures using C	✓	✓	✓	✓									
	22MTT22	Electron Devices and Digital Circuits	✓	✓	✓		✓							✓	✓	✓
	22TAM02	Tamils and Technology						✓		✓	✓	✓		✓		
	22MTL21	Electron Devices and Digital Circuits Laboratory	✓	✓	✓		✓				✓	✓		✓	✓	✓
	22GCL12	Foundation Lab – Electrical, IoT & Web	✓	✓	✓	✓					✓					
	22CYL22	Chemistry Laboratory for Mechanical Systems	✓	✓	✓	✓			✓							
III	22ITC32	Introduction to Python	✓	✓	✓	✓										
	22MTT31	Strength of Materials	✓	✓	✓	✓	✓							✓	✓	✓
	22MTT32	Theory of Machines	✓	✓	✓	✓	✓							✓	✓	✓
	22MTT33	Systems and Control Engineering	✓	✓	✓	✓	✓							✓	✓	✓
	22MTT34	Electrical Machines	✓	✓	✓	✓					✓	✓		✓	✓	✓
	22GCL12	Foundation Lab – Electrical, IoT & Web	✓	✓	✓	✓					✓					
	22MTL31	Electrical Machines and Control Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
	22MTL32	Computer Aided Drafting Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
	22EGL31	Communication Skills Development Laboratory									✓	✓		✓		
	22MNT31	Environmental Science	✓	✓	✓				✓							
IV	22MAT41	Numerical Methods for Engineers	✓	✓	✓											
	22MTC41	Computer-Aided Design and Analysis	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓
	22MTT41	Manufacturing Processes	✓	✓	✓	✓								✓	✓	✓
	22MTT42	Sensors and Signal Conditioning	✓	✓		✓								✓	✓	✓
	22MTC42	Graphical System Design	✓	✓	✓	✓	✓							✓	✓	✓
	22MTL41	Sensors and Signal Conditioning Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
	22MTL42	Manufacturing Processes Laboratory	✓	✓	✓	✓					✓	✓		✓	✓	✓
	22GCL41	Professional Skills Training I / Industrial Training I*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
V	22MTC51	Fluid Power Systems	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓
	22MTC52	Power Electronics and Drives	✓	✓	✓		✓							✓	✓	✓
	22MTT51	CNC and Metrology	✓	✓	✓	✓	✓							✓	✓	✓
	22MTT52	Microcontroller Programming and Applications	✓	✓	✓		✓							✓	✓	✓
	22MTC53	Fluid Power System Design	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓
	22MTC54	Sensors and Signal Processing	✓	✓	✓	✓								✓	✓	✓
	22MTL51	CNC and Metrology Laboratory	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓

	22MTL52	Microcontroller Programming and Applications Laboratory	✓	✓	✓	✓	✓				✓			✓	✓	✓
	22GCL51	Professional Skills Training II / Industrial Training II *	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
VI	22MTT61	Programmable Automation Controllers	✓	✓	✓	✓	✓							✓	✓	✓
	22MTT62	Mechanics of Serial Manipulator	✓	✓	✓	✓	✓							✓	✓	✓
	22MTL61	Programmable Automation Controllers Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
	22MTL62	Robotics and Control Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
	22MTP61	Project Work I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	22MTP62	Project Work I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	22GET31	Universal Human Values						✓		✓						
VII	22GCT71	Engineering Economics and Management	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
	22MTT71	Industrial Internet of Things	✓	✓	✓	✓	✓							✓	✓	✓
	22MTP71	Project Work II Phase I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	22MTP72	Project Work II Phase I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
VIII	22MTP81	Project Work II Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		PROFESSIONAL ELECTIVES														
V	22MTE01	Design of Mechanical Elements	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE02	Heat and Mass Transfer	✓	✓		✓		✓						✓	✓	✓
	22MTE03	Operations Research	✓	✓	✓	✓	✓						✓	✓	✓	✓
	22MTE04	Machine Drawing	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE05	Introduction to Industrial Internet of Things	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE06	Advanced Control Theory	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE07	Automotive Engineering	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓
	22MTE08	Virtual Instrumentation: Theory and Applications	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE09	Power Converters and Electric Drives	✓	✓	✓	✓	✓							✓	✓	✓
VI	22MTE10	Applied Finite Element Method	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE11	Precision Equipment Design	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE12	Computer Integrated Manufacturing	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE13	Embedded Programming for Mechatronics	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE14	Machine Learning	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE15	Process Control and Instrumentation	✓	✓	✓	✓	✓							✓	✓	✓

	22MTE16	Automotive Electronics	✓	✓	✓	✓	✓							✓	✓	✓
VII	22GEE01	Total Quality Management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	22MTE17	Bio Mechatronics	✓	✓	✓	✓	✓	✓						✓	✓	✓
	22MTE18	Precision Manufacturing	✓	✓	✓	✓	✓						✓	✓	✓	✓
	22MTE19	Digital Twin and Industry 5.0	✓	✓	✓	✓	✓						✓	✓	✓	✓
	22MTE20	Optimal and Adaptive Control	✓	✓	✓	✓	✓							✓	✓	✓
	22GEE02	Fundamentals of Research	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	22MTE21	Electric and Hybrid Vehicles	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓
	22MTE22	Machine Tool Control and Condition Monitoring	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE23	Additive Manufacturing	✓	✓	✓	✓	✓						✓	✓	✓	✓
	22MTE24	Industrial Automation Protocols	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE25	Robot Programming	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE26	Drone Technology	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE27	Maintenance Engineering	✓	✓	✓			✓					✓	✓	✓	✓
	22MTE28	Machine Vision and Image Processing	✓	✓	✓	✓	✓							✓	✓	✓
VIII	22MTE29	MEMS and NEMS	✓	✓	✓	✓								✓	✓	✓
	22MTE30	Mobile Robotics	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE31	Product Design and Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	22MTE32	Battery Management System	✓	✓	✓	✓	✓						✓	✓	✓	✓
	22MTE33	Production Management	✓	✓	✓	✓	✓						✓	✓	✓	✓
	22MTE34	Cyber Physical Systems	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE35	Agricultural Robotics and Automation	✓	✓	✓	✓	✓							✓	✓	✓
	22MTE36	Aircraft Mechatronics	✓	✓	✓	✓	✓		✓					✓	✓	✓
		OPEN ELECTIVES														
	22MTO01	Design of Mechatronics Systems	✓	✓	✓	✓	✓							✓		
	22MTX01	Data Acquisition and Virtual Instrumentation	✓	✓	✓	✓	✓							✓		
	22MTX02	Factory Automation	✓	✓	✓	✓	✓				✓	✓		✓		
	22GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	22MTO02	Robotics	✓	✓	✓	✓	✓							✓		
	22MTO03	3D Printing and Design	✓	✓	✓	✓	✓						✓	✓		
	22GEO05	Entrepreneurship Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

	22MTO04	Drone System Technology	✓	✓	✓	✓	✓							✓		
	22MTO05	Micro and Nano Electromechanical Systems	✓	✓	✓	✓								✓		

B.E. MECHATRONICS ENGINEERING CURRICULUM - R2022
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SEMESTER I									
Course Code	**Course Title**	**Hours/Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory / Theory with Practical									
22EGT11	Communication Skills - I	3	0	0	3	40	60	100	HS
22MAC11	Matrices and Ordinary Differential Equations	3	1*	2*	4	50	50	100	BS
22PHT13	Physics for Mechatronics Engineering	3	0	0	3	40	60	100	BS
22MET12	Engineering Mechanics	3	0	0	3	40	60	100	PC
22CSC11	Problem Solving and Programming in C	3	0	2	4	50	50	100	ES
22MET11	Engineering Drawing	2	1	0	3	40	60	100	ES
Practical / Employability Enhancement									
22MEL11	Engineering Practices Laboratory	0	0	2	1	60	40	100	ES
22PHL13	Physics Laboratory for Mechatronics Engineering	0	0	2	1	60	40	100	BS
22VEC11	Yoga and Values for Holistic Development	--	--	--	1	100	0	100	HS
22MNT11	Student Induction Program	---	---	---	0	100	0	100	MC
	Total Credits to be earned				**23**				

* Alternate Weeks

SEMESTER II									
Course Code	**Course Title**	**Hours/Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory / Theory with Practical									
22EGT21	Communication Skills – II	3	0	0	3	40	60	100	HS
22MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	50	50	100	BS
22CYT23	Chemistry for Mechatronics Engineering	3	0	0	3	40	60	100	BS
22MTT21	Fluid Mechanics and Thermodynamics	3	1	0	4	40	60	100	PC
22CSC21	Data Structures using C	3	0	2	4	50	50	100	ES
22MTT22	Electron Devices and Digital Circuits	3	0	0	3	40	60	100	ES
22TAM01	Heritage of Tamils	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22MTL21	Electron Devices and Digital Circuits Laboratory	0	0	2	1	60	40	100	ES
22CYL22	Chemistry Laboratory for Mechanical Systems	0	0	2	1	60	40	100	BS
	Total Credits to be earned				**24**				

***** Alternate Weeks

B.E. MECHATRONICS ENGINEERING CURRICULUM - R2022
(For students admitted during 2022-23)

SEMESTER III									
Course Code	Course Title	Hours/Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory / Theory with Practical									
22ITC32	Introduction to Python	3	0	2	4	50	50	100	ES
22MTT31	Strength of Materials	3	1	0	4	40	60	100	PC
22MTT32	Theory of Machines	3	1	0	4	40	60	100	PC
22MTT33	Systems and Control Engineering	3	0	0	3	40	60	100	PC
22MTT34	Electrical Machines	3	0	0	3	40	60	100	PC
22TAM02	Tamils and Technology	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22MTL31	Electrical Machines and Control Laboratory	0	0	2	1	60	40	100	PC
22MTL32	Computer Aided Drafting Laboratory	0	0	2	1	60	40	100	PC
22EGL31	Communication Skills Development Laboratory	0	0	2	1	60	40	100	HS
22MNT31	Environmental Science	2	0	0	0	100	0	100	MC
	Total Credits to be earned				**22**				

SEMESTER IV									
Course Code	Course Title	Hours/Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory / Theory with Practical									
22MAT41	Numerical Methods for Engineers	3	1	0	4	40	60	100	BS
22MTC41	Computer-Aided Design and Analysis	3	0	2	4	100	0	100	PC
22MTT41	Manufacturing Processes	3	0	0	3	40	60	100	PC
22MTT42	Sensors and Signal Conditioning	3	0	0	3	40	60	100	PC
22MTC42	Graphical System Design	3	0	2	4	50	50	100	PC
Practical / Employability Enhancement									
22MTL41	Sensors and Signal Conditioning Laboratory	0	0	2	1	60	40	100	PC
22MTL42	Manufacturing Processes Laboratory	0	0	2	1	60	40	100	PC
22GCL41	Professional Skills Training I / Industrial Training I *	--	--	--	2	100	0	100	EC
	Total Credits to be earned				**22**				

* 80hrs of Training

B.E. MECHATRONICS ENGINEERING CURRICULUM - R2022
(For students admitted during 2022-23)

SEMESTER V									
Course Code	Course Title	Hours/Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory / Theory with Practical									
22MTC51	Fluid Power Systems	2	0	2	3	50	50	100	PC
22MTC52	Power Electronics and Drives	3	0	2	4	50	50	100	PC
22MTT51	CNC and Metrology	3	0	0	3	40	60	100	PC
22MTT52	Microcontroller Programming and Applications	3	0	0	3	40	60	100	PC
	Professional Elective - 1	3	0	0	3	40	60	100	PE
	Open Elective – 1	3	1/0	0/2	4	40/50	60/50	100	OE
Practical / Employability Enhancement									
22MTL51	CNC and Metrology Laboratory	0	0	2	1	60	40	100	PC
22MTL52	Microcontroller Programming and Applications Laboratory	0	0	2	1	60	40	100	PC
22GCL51	Professional Skills Training II / Industrial Training II *	--	--	--	2	100	0	100	EC
	Total Credits to be earned				**24**				

* 80hrs of Training

SEMESTER VI									
Course Code	Course Title	Hours/Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory / Theory with Practical									
22MTT61	Programmable Automation Controllers	3	0	0	3	40	60	100	PC
22MTT62	Mechanics of Serial Manipulators	3	0	0	3	40	60	100	PC
	Professional Elective – 2	3	0	0	3	40	60	100	PE
	Open Elective - 2	3	1/0	0/2	4	40/50	60/50	100	OE
Practical / Employability Enhancement									
22MTL61	Programmable Automation Controllers Laboratory	0	0	2	1	60	40	100	PC
22MTL62	Robotics and Control Laboratory	0	0	2	1	60	40	100	PC
22MTP61	Project Work I	0	0	8	4	50	50	100	EC
22GET31	Universal Human Values	2	0	0	2	100	0	100	HS
22GEP61	Comprehensive Test and Viva	---	---	---	2	100	0	100	EC
	Total Credits to be earned				**23**				

B.E. MECHATRONICS ENGINEERING CURRICULUM - R2022
(For students admitted during 2022-23)

SEMESTER VII									
Course Code	**Course Title**	**Hours/Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory / Theory with Practical									
22GCT71	Engineering Economics and Management	3	0	0	3	40	60	100	HS
	Professional Elective 3	3	0	0	3	40	60	100	PE
	Professional Elective 4	3	0	0	3	40	60	100	PE
	Professional Elective 5	3	0	0	3	40	60	100	PE
	Open Elective 3	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22MTP71	Project Work II Phase I	0	0	10	5	50	50	100	EC
	Total Credits to be earned				**19**				

SEMESTER VIII									
Course Code	**Course Title**	**Hours/Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory / Theory with Practical									
	Professional Elective 6	3	0	0	3	40	60	100	PE
	Open Elective 4	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22MTP81	Project Work II Phase II	---	---	8	4	50	50	100	EC
	Total				**13**				

Total Credits: 168

PROFESSIONAL ELECTIVE (PE)

Sl. No.	Course Code	Course Name	L	T	P	C	Domain/ Stream
		Semester V					
		Elective - I					
23	22MTE01	Design of Mechanical Elements	3	0	0	3	PD
24	22MTE02	Heat and Mass Transfer	3	0	0	3	PD
25	22MTE03	Operations Research	3	0	0	3	PS
26	22MTE04	Machine Drawing	3	0	0	3	PD
27	22MTE05	Introduction to Industrial Internet of Things	3	0	0	3	AE
28	22MTE06	Advanced Control Theory	3	0	0	3	AS
29	22MTE07	Automotive Engineering	3	0	0	3	PD
30	22MTE08	Virtual Instrumentation: Theory and Applications	3	0	0	3	AE
31	22MTE09	Power Converters and Electric Drives	3	0	0	3	AE
		Semester VI					
		Elective - II					
32	22MTE10	Applied Finite Element Method	3	0	0	3	PD
33	22MTE11	Precision Equipment Design	3	0	0	3	PS
34	22MTE12	Computer Integrated Manufacturing	3	0	0	3	PS
35	22MTE13	Embedded Programming for Mechatronics	3	0	0	3	AE
36	22MTE14	Machine Learning	3	0	0	3	AS
37	22MTE15	Process Control and Instrumentation	3	0	0	3	AE
38	22MTE16	Automotive Electronics	3	0	0	3	AE
		Semester VII					
		Elective - III					
39	22GEE01	Total Quality Management	3	0	0	3	GE
40	22MTE17	Bio Mechatronics	3	0	0	3	AS
41	22MTE18	Precision Manufacturing	3	0	0	3	PS
42	22MTE19	Digital Twin and Industry 5.0	3	0	0	3	AE
43	22MTE20	Optimal and Adaptive Control	3	0	0	3	AS
		Elective - IV					
44	22GEE02	Fundamentals of Research	3	0	0	3	GE
23	22MTE21	Electric and Hybrid Vehicles	3	0	0	3	PD
24	22MTE22	Machine Tool Control and Condition Monitoring	3	0	0	3	PS
25	22MTE23	Additive Manufacturing	3	0	0	3	PS
26	22MTE24	Industrial Automation Protocols	3	0	0	3	AE
		Elective - V					
32	22MTE25	Robot Programming	3	0	0	3	AS
33	22MTE26	Drone Technology	3	0	0	3	AS
34	22MTE27	Maintenance Engineering	3	0	0	3	PS
35	22MTE28	Machine Vision and Image Processing	3	0	0	3	AE
36	22MTE29	MEMS and NEMS	3	0	0	3	PD
		Semester VIII					
		Elective – VI					
32	22MTE30	Mobile Robotics	3	0	0	3	AS

39	22MTE31	Product Design and Development	3	0	0	3	PD
40	22MTE32	Battery Management System	3	0	0	3	PS
41	22MTE33	Production Management	3	0	0	3	PS
42	22MTE34	Cyber Physical Systems	3	0	0	3	AE
43	22MTE35	Agricultural Robotics and Automation	3	0	0	3	AE
44	22MTE36	Aircraft Mechatronics	3	0	0	3	AS
Total Credits to be earned						18	

* Domain/Stream Abbreviations: AE- Automation Engineering, AS – Autonomous Systems, PD – Product Design, PS – Production System, GE – General Engineering

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)

(Common to all departments except offering department)

S.No.	Course Code	Course Title	Hours/Week			Credit	Sem
			L	T	P		
1	22MTO01	Design of Mechatronics Systems	3	1	0	4	V
2	22MTX01	Data Acquisition and Virtual Instrumentation	3	0	2	4	V
3	22MTX02	Factory Automation	3	0	2	4	V
4	22GEO04	Innovation and Business Model Development	3	1	0	4	VI
5	22MTO02	Robotics	3	1	0	4	VI
6	22MTO03	3D Printing and Design	3	1	0	4	VI
7	22GEO05	Entrepreneurship Development	3	0	0	3	VII
8	22MTO04	Drone System Technology	3	0	0	3	VII
9	22MTO05	Micro and Nano Electromechanical Systems	3	0	0	3	VIII

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SEMESTER I									
Course Code	**Course Title**	**Hours/Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory / Theory with Practical									
22EGT11	Communication Skills - I	3	0	0	3	40	60	100	HS
22MAC11	Matrices and Ordinary Differential Equations	3	1*	2*	4	50	50	100	BS
22PHT13	Physics for Mechatronics Engineering	3	0	0	3	40	60	100	BS
22CSC11	Problem Solving and Programming in C	3	0	2	4	50	50	100	ES
22MET11	Engineering Drawing	2	1	0	3	40	60	100	ES
22TAM01	Heritage of Tamils	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22PHL13	Physics Laboratory for Mechatronics Engineering	0	0	2	1	60	40	100	BS
22GCL12	Foundation Laboratory – Electrical, IoT and Web	0	0	6	3	100	0	100	ES
22VEC11	Yoga and Values for Holistic Education	--	--	--	1	100	0	100	HS
22MNT11	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									
22EGT21	Communication Skills - II	3	0	0	3	40	60	100	HS
22MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	50	50	100	BS
22CYT23	Chemistry for Mechatronics Engineering	3	0	0	3	40	60	100	BS
22CSC21	Fundamentals of Data Structures	3	0	2	4	50	50	100	ES
22MET12	Engineering Mechanics	3	0	0	3	40	60	100	PC
22TAM02	Tamils and Technology	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22CYL22	Chemistry Laboratory for Mechanical Systems	0	0	2	1	60	40	100	BS
22GCL11	Foundation Laboratory – Manufacturing, Design and Robotics	0	0	6	3	100	0	100	ES
	Total Credits to be earned				**22**				

***** Alternate Weeks

B.E. MECHATRONICS ENGINEERING CURRICULUM - R2022
(For students admitted during 2023-24)

SEMESTER III									
Course Code	**Course Title**	**Hours/Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory / Theory with Practical									
22ITC32	Introduction to Python	3	0	2	4	50	50	100	ES
22MTT21	Fluid Mechanics and Thermodynamics	3	1	0	4	40	60	100	PC
22MTT33	Systems and Control Engineering	3	0	0	3	40	60	100	PC
22MTT41	Manufacturing Processes	3	0	0	3	40	60	100	PC
22MTT22	Electron Devices and Digital Circuits	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
22MTL42	Manufacturing Processes Laboratory	0	0	2	1	60	40	100	PC
22MTL21	Electron Devices and Digital Circuits Laboratory	0	0	2	1	60	40	100	PC
22MNT31	Environmental Science	2	0	0	0	100	0	100	MC
22EGL31	Communication Skills Development Laboratory	0	0	2	1	60	40	100	HS
	Total Credits to be earned				**20**				

SEMESTER IV									
Course Code	**Course Title**	**Hours/Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory / Theory with Practical									
22MAT41	Numerical Methods for Engineers	3	1	0	4	40	60	100	BS
22MTC41	Computer-Aided Design and Analysis	3	0	2	4	100	0	100	PC
22MTT31	Strength of Materials	3	1	0	4	40	60	100	PC
22MTT32	Theory of Machines	3	1	0	4	40	60	100	PC
22MTT34	Electrical Machines	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
22MTL31	Electrical Machines and Control Laboratory	0	0	2	1	60	40	100	PC
22MTL32	Computer Aided Drafting Laboratory	0	0	2	1	60	40	100	PC
22GCL41	Professional Skills Training I / Industrial Training I *	--	--	--	2	100	0	100	EC
	Total Credits to be earned				**23**				

* 80hrs of Training

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(For students admitted during 2023-24)

SEMESTER V									
Course Code	Course Title	Hours/Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory / Theory with Practical									
22MTT51	CNC and Metrology	3	0	0	3	40	60	100	PC
22MTT52	Microcontroller Programming and Applications	3	0	0	3	40	60	100	PC
22MTC53	Fluid Power System Design	3	0	2	4	50	50	100	PC
22MTC54	Sensors and Signal Processing	3	0	2	4	50	50	100	PC
	Professional Elective 1	3	0	0	3	40	60	100	PE
	Open Elective 1	3	1/0	0/2	4	40/50	60/50	100	OE
Practical / Employability Enhancement									
22MTL51	CNC and Metrology Laboratory	0	0	2	1	60	40	100	PC
22MTL52	Microcontroller Programming and Applications Laboratory	0	0	2	1	60	40	100	PC
22GCL51	Professional Skills Training II / Industrial Training II *	--	--	--	2	100	0	100	EC
	Total Credits to be earned				**25**				

* 80hrs of Training

SEMESTER VI									
Course Code	Course Title	Hours/Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory / Theory with Practical									
22MTT61	Programmable Automation Controllers	3	0	0	3	40	60	100	PC
22MTT62	Mechanics of Serial Manipulator	3	0	0	3	40	60	100	PC
	Professional Elective 2	3	0	0	3	40	60	100	PE
	Open Elective 2	3	1/0	0/2	4	50/40	50/60	100	OE
Practical / Employability Enhancement									
22MTL61	Programmable Automation Controllers Laboratory	0	0	2	1	60	40	100	PC
22MTL62	Robotics and Control Laboratory	0	0	2	1	60	40	100	PC
22MTP62	Project Work I	0	0	4	5	50	50	100	EC
22GET31	Universal Human Values	2	0	0	2	100	0	100	HS
22GEP61	Comprehensive Test and Viva	---	---	---	2	100	0	100	EC
	Total Credits to be earned				**24**				

B.E. MECHATRONICS ENGINEERING CURRICULUM - R2022
(For students admitted during 2023-24)

SEMESTER VII									
Course Code	**Course Title**	**Hours/Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory / Theory with Practical									
22GCT71	Engineering Economics and Management	3	0	0	3	40	60	100	HS
22MTT71	Industrial Internet of Things	3	0	0	3	40	60	100	PC
	Professional Elective 3	3	0	0	3	40	60	100	PE
	Professional Elective 4	3	0	0	3	40	60	100	PE
	Open Elective 3	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22MTP72	Project Work II Phase I	0	0	8	6	50	50	100	EC
	Total Credits to be earned				**21**				

SEMESTER VIII									
Course Code	**Course Title**	**Hours/Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory / Theory with Practical									
	Professional Elective 5	3	0	0	3	40	60	100	PE
	Open Elective 4	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22MTP81	Project Work II Phase II	---	---	14	4	50	50	100	EC
	Total Credits to be earned				**10**				

Total Credits: 168

PROFESSIONAL ELECTIVE (PE)

Sl. No.	Course Code	Course Name	L	T	P	C	Domain/ Stream
		Semester V					
		Elective - I					
23	22MTE01	Design of Mechanical Elements	3	0	0	3	PD
24	22MTE02	Heat and Mass Transfer	3	0	0	3	PD
25	22MTE03	Operations Research	3	0	0	3	PS
26	22MTE04	Machine Drawing	3	0	0	3	PD
27	22MTE05	Introduction to Industrial Internet of Things	3	0	0	3	AE
28	22MTE06	Advanced Control Theory	3	0	0	3	AS
29	22MTE07	Automotive Engineering	3	0	0	3	PD
30	22MTE08	Virtual Instrumentation: Theory and Applications	3	0	0	3	AE
31	22MTE09	Power Converters and Electric Drives	3	0	0	3	AE
		Semester VI					
		Elective - II					
32	22MTE10	Applied Finite Element Method	3	0	0	3	PD
33	22MTE11	Precision Equipment Design	3	0	0	3	PS
34	22MTE12	Computer Integrated Manufacturing	3	0	0	3	PS
35	22MTE13	Embedded Programming for Mechatronics	3	0	0	3	AE
36	22MTE14	Machine Learning	3	0	0	3	AS
37	22MTE15	Process Control and Instrumentation	3	0	0	3	AE
38	22MTE16	Automotive Electronics	3	0	0	3	AE
		Semester VII					
		Elective - III					
39	22GEE01	Total Quality Management	3	0	0	3	GE
40	22MTE17	Bio Mechatronics	3	0	0	3	AS
41	22MTE18	Precision Manufacturing	3	0	0	3	PS
42	22MTE19	Digital Twin and Industry 5.0	3	0	0	3	AE
43	22MTE20	Optimal and Adaptive Control	3	0	0	3	AS
		Elective - IV					
44	22GEE02	Fundamentals of Research	3	0	0	3	GE
23	22MTE21	Electric and Hybrid Vehicles	3	0	0	3	PD
24	22MTE22	Machine Tool Control and Condition Monitoring	3	0	0	3	PS
25	22MTE23	Additive Manufacturing	3	0	0	3	PS
26	22MTE24	Industrial Automation Protocols	3	0	0	3	AE
32	22MTE25	Robot Programming	3	0	0	3	AS
33	22MTE26	Drone Technology	3	0	0	3	AS
34	22MTE27	Maintenance Engineering	3	0	0	3	PS
35	22MTE28	Machine Vision and Image Processing	3	0	0	3	AE
36	22MTE29	MEMS and NEMS	3	0	0	3	PD
		Semester VIII					
		Elective – V					
32	22MTE30	Mobile Robotics	3	0	0	3	AS
39	22MTE31	Product Design and Development	3	0	0	3	PD

40	22MTE32	Battery Management System	3	0	0	3	PS
41	22MTE33	Production Management	3	0	0	3	PS
42	22MTE34	Cyber Physical Systems	3	0	0	3	AE
43	22MTE35	Agricultural Robotics and Automation	3	0	0	3	AE
44	22MTE36	Aircraft Mechatronics	3	0	0	3	AS
Total Credits to be earned						18	

* Domain/Stream Abbreviations: AE- Automation Engineering, AS – Autonomous Systems, PD – Product Design, PS – Production System, GE – General Engineering

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)

(Common to all departments except offering department)

S.No.	Course Code	Course Title	Hours/Week			Credit	Sem
			L	T	P		
1	22MTO01	Design of Mechatronics Systems	3	1	0	4	V
2	22MTX01	Data Acquisition and Virtual Instrumentation	3	0	2	4	V
3	22MTX02	Factory Automation	3	0	2	4	V
4	22GEO04	Innovation and Business Model Development	3	1	0	4	VI
5	22MTO02	Robotics	3	1	0	4	VI
6	22MTO03	3D Printing and Design	3	1	0	4	VI
7	22GEO05	Entrepreneurship Development	3	0	0	3	VII
8	22MTO04	Drone System Technology	3	0	0	3	VII
9	22MTO05	Micro and Nano Electromechanical Systems	3	0	0	3	VIII

22EGT11 - COMMUNICATION SKILLS I							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech. Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**I**	**HS**	**3**	**0**	**0**	**3**

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

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

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

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

LIST OF EXPERIMENTS / EXERCISES:

1.	Introduction to MATLAB
2.	Computation of eigen values and eigen vectors
3.	Plotting and visualizing single variable functions
4.	Solving first and second order ordinary differential equations
5.	Solution of Simultaneous first order ODEs
6.	Solving second order ODE by variation of parameters
7.	Determining Laplace and inverse Laplace transform of basic functions
8.	Solution of Second order ODE by employing Laplace transforms

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

TEXT BOOK:

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

REFERENCES/ MANUAL / SOFTWARE:

1.	Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

***Alternate week**

22PHT13 – PHYSICS FOR MECHATRONICS ENGINEERING							
Programme & Branch	**BE- Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**0**	**0**	**3**
Preamble	This course aims to impart the knowledge on elasticity, thermal properties, laser, quantum physics, conducting materials and semiconducting materials. It also describes the applications of aforementioned topics in mechatronics engineering.						
Unit – I	**Properties of matter:**						**9**
Beams – Bending of beams – Expression for bending moment – Depression at free end of cantilever – Young's modulus by uniform bending method – Thermal properties – Modes of heat transfer – Thermal conductivity – Radial and cylindrical heat flow – Conduction through compound media (series and parallel).							
Unit – II	**Laser and Applications:**						**9**
Stimulated absorption – Spontaneous emission – Stimulated emission – Einstein's coefficients and their relations – Population inversion – Pumping – Nd:YAG laser – CO_2 laser – Homojunction semiconductor laser – Industrial applications: laser welding, laser cutting, laser drilling – Holography.							
Unit – III	**Quantum physics and Applications:**						**9**
Blackbody radiation – Planck's theory – Compton scattering – Matter waves – Properties – Heisenberg uncertainty principle (qualitative) – Schrodinger's time-independent and time-dependent wave equations – Physical significance of wave function – Particle in a one-dimensional box.							
Unit – IV	**Conducting materials:**						**9**
Conductors – Classical free electron theory of metals – Electrical and thermal conductivities – Wiedemann-Franz law – Lorentz number – Draw backs of classical theory – Quantum free electron theory (qualitative) – Fermi distribution function – Effect of temperature on Fermi function – Density of energy states – Carrier concentration in metals.							
Unit – V	**Semiconducting materials and Devices:**						**9**
Intrinsic semiconductor – Carrier concentration – Fermi level – Electrical conductivity and band gap – Extrinsic semiconductors – Carrier concentration in n-type and p-type semiconductors – Hall effect – Determination of Hall coefficient – Applications – Solar cell: Principle, construction and working.							
							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. (Units I,II,III,IV,V)

REFERENCES:

1.	Hitendra K. Malik and A.K. Singh, "Engineering Physics", 2nd Edition McGraw-Hill Education , New Delhi, 2018.
2.	Tamilarasan K. and Prabu K., "Materials Science", 1st Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2018.
3.	Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai and Sons, New Delhi, 2009.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	use the concepts of elasticity and bending moment of a beam to compute Young's modulus. Also to apply the concepts of heat flow to comprehend the heat conduction in compound media.	Applying (K3)
CO2	apply the concepts of stimulated emission of radiation to explain the working of lasers and also to realize the applications of laser in engineering and technology.	Applying (K3)
CO3	use the concepts of quantum mechanics to describe the behavior of electrons in a metal by solving Schrodinger's wave equations.	Applying (K3)
CO4	apply the concepts of classical and quantum free electron theory of metals to compute the electrical and thermal conductivities of metals. To comprehend the effect of temperature on Fermi function and to compute the expressions for density of states and carrier concentration in metals.	Applying (K3)
CO5	use the concept of density of states to compute the carrier concentration, electrical conductivity and band gap of intrinsic semiconductors and to compute the carrier concentration of extrinsic semiconductors, and also to explain the phenomenon related to Hall Effect and the working of solar cell.	Applying (K3)

Mapping of COs with POs and PSOs

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

22MET12 - ENGINEERING MECHANICS							
(Common to Mechanical & Mechatronics Engineering branches)							
Programme & Branch	**B.E. - Mechanical Engineering, B.E. - Mechatronics Engineering branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**-**	**1/2**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides introduction to the basic concepts of forces, inertia, centroid and moment of area along with their effects. It introduces the phenomenon of friction and its effects. It familiarizes students to cognitive learning in applied mechanics and develops problem-solving skills.	
Unit - I	**Statics of Particles**	**9**
Introduction – Laws of Mechanics – Parallelogram and Triangular Law of Forces – Principle of Transmissibility – Coplanar Forces – Resolution and Composition of Force - Free Body Diagram – Equilibrium of a Particle in Plane – Forces in Space - Vectorial representationof Forces – Equilibrium of a Particle in Space.		
Unit - II	**Statics of Rigid Bodies**	**9**
Moments: Moment of a Force about a Point and about an Axis – Vectorial Representation of Moments and Couples – Varignon's Theorem – Equivalent Systems of Forces – Single Equivalent Force. Types of Supports and their Reactions – Requirements of Stable Equilibrium – Equilibrium of Rigid Bodies in Two Dimensions – Trusses: Method of Joints - Method of Sections- Equilibrium of Rigid Bodies in Three Dimensions.		
Unit - III	**Properties of Surfaces and Solids**	**9**
Determination of Areas and Volumes — First Moment of Area and Centroid of Sections — T Section - I Section - Angle Section - Hollow Section From Primary Simpler Sections — Second Moment of Plane Areas — Parallel Axis Theorem and Perpendicular Axis Theorem - T Section - I Section - Angle Section - Hollow Section — Polar Moment of Inertia — Product of Inertia - Principal Moment of Inertia of Plane Area - Mass Moment of Inertia – Relation to Area Moments of Inertia.		
Unit - IV	**Friction and Rectilinear motion of particles**	**9**
Friction: Surface Friction – Laws of Dry Friction – Sliding Friction – Static and Kinetic Friction – Ladder Friction – Wedge Friction – Belt Friction. Rectilinear Motion of Particles: Displacement - Velocity and Acceleration and their Relationship – Relative Motion- Curvilinear Motion — Projectile Motion.		
Unit - V	**Dynamics of Particles and Kinematics of Rigid body**	**9**
Dynamics of Particles: Newton's Law, Work - Energy and Impulse - Momentum Principles — Impact of Elastic Bodies. Kinematics of Rigid Body: Translation - Rotation about a Fixed Axis – General Plane Motion. Kinetics of Rigid Body.		
		Total:45

TEXT BOOK:

1.	Rajasekaran S and Sankarasubramanian G, "Fundamentals of Engineering Mechanics", 3rd Edition, Vikas Publishing, Chennai, 2017.

REFERENCES:

1.	Beer Ferdinand P., Russel Johnston Jr., David F. Mazure, Philip J. Cornwell, Sanjeev Sanghi, "Vector Mechanics for Engineers: Statics and Dynamics", 12th Edition, McGraw Hill Education, Chennai, 2019.
2.	Hibbeler R.C., "Engineering Mechanics", 14th Edition, Pearson Education, New Delhi, 2017.
3.	Meriam J L, Kraige L G , Bolton J.N., " Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 9th edition, Wiley student edition, 2021

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	Applying (K3)
CO2	calculate the moment produced by various force systems and conclude the static equilibrium equations for rigid body system	Analyzing (K4)
CO3	compute the centroid, centre of gravity and moment of inertia of geometrical shapes and solids respectively	Applying (K3)
CO4	manipulate the effect of dry friction and its applications	Applying (K3)
CO5	apply the different principles to study the motion of a body and analyse their constitutive equations	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	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	5	5	70	20			100
CAT2	5	5	70	20			100
CAT3	5	5	70	20			100
ESE	5	5	70	20			100

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

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

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

LIST OF EXPERIMENTS / EXERCISES:	
1.	Programs for demonstrating the use of different types of format Specifiers
2.	Programs for demonstrating the use of different types of operators like arithmetic, logical, relational, and ternary operators
3.	Programs for demonstrating the use of using decision making statements
4.	Programs for demonstrating the use of repetitive structures
5.	Programs for demonstrating one-dimensional arrays
6.	Programs for demonstrating two-dimensional arrays
7.	Programs to demonstrate modular programming concepts using functions
8.	Programs to demonstrate recursive functions.
9.	Programs to demonstrate strings (Using built-in and user-definedfunctions)
10.	Programs to illustrate the use of pointers
11.	Programs to illustrate the use of structures and unions
12.	Programs to implement file Handling
	Lecture:45, Practical:30, Total:75

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

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

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

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

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

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

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

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

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

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

TEXT BOOK:

1.	S.Muthuramalingam, M.Saravanakumar, Heritage of Tamils, Yes Dee Publishing Pvt Ltd, 2023.

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

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

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

LIST OF EXPERIMENTS / EXERCISES:

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

REFERENCES/ MANUAL /SOFTWARE:

1.	Engineering Practices Laboratory Manual.

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

Mapping of COs with POs and PSOs

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

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

22GCL12 – FOUNDATION LAB – ELECTRICAL, IOT AND WEB							
(Common to all BE/BTech branches)							
Programme& Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 /2**	**ES**	**0**	**0**	**6**	**3**

Preamble	This course is designed to provide a foundational knowledge on engineering with hands-on experience on the house wiring, Internet of Things and Web Technologies.

LIST OF EXPERIMENTS / EXERCISES:

	PART A – Electrical Installation (30 Hours)
1.	Develop wiring diagrams using software tools.
2.	Identify and select suitable components for Energy Measurement and Circuit Protection
3.	Design a wiring circuit integrating Energy Meter, MCB and RCCB
4.	Develop a wiring circuit for incandescent lamp and fluorescent lamp
5.	Develop and Investigate Simple and Staircase Wiring for Residential Applications
6.	Design the Wiring Circuits for Calling Bell System and Dimmable Light
7.	Create wiring circuits for power loads
8.	Measurement of Earth Resistance and its connections.
	PART B – Internet of Things (30 Hours)
1.	Design a Single layer PCB layout designing
2.	Fabricate Single layer PCB printing
3.	Assembling, soldering and desoldering practice on single layer PCB
4.	GPIO programming in ESP8266
5.	Sensor and actuator interfacing with internet enabled microcontroller device
6.	Sensor and actuator calibration
7.	Integration of microcontroller based system with Cloud platform
	PART C – Web Technologies (30 Hours)
1.	Design a website for an application using HTML and CSS.
2.	Convert the designed website into responsive website using Bootstrap.
3.	Add dynamism to the website by using JavaScript and embed the Social Media components to the website.
4.	Incorporate database interaction to the website.
5.	Deploy the developed website in the server.
	Total:90

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	Eric T.Freeman,Elisabeth Robson, ”Head First JavaScript Programming A Brain-Friendly Guide”, 1st Edition, O’Reilly , 2014.
3.	Eric T.Freeman,Elisabeth Robson, ”Head First HTML and CSS”,2nd Edition, O’Reilly , 2012
4.	Lynn Beighley,”Head First SQL”,1st Editin, O’Reilly,2007.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	design electrical wiring circuits for buildings based on their requirement	Applying(K3), Precision (S3)
CO2	develop IoT based solutions and PCB for real world use cases.	Applying (K3), Precision (S3)
CO3	design and host an interactive dynamic website.	Applying(K3), Precision (S3)

Mapping of COs with POs and PSOs

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

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

22PHL13 - PHYSICS LABORATORY FOR MECHATRONICS ENGINEERING							
Programme & Branch	**BE - Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**0**	**0**	**2**	**1**

Preamble	This course aims to impart hands on training in the determination of the physical parameters such as Young's modulus, rigidity modulus, wavelength of laser, angle of divergence of a laser beam, particle size, thermal conductivity, specific resistance, band gap, Hall coefficient, wavelength of Hg spectrum, thickness of a thin film, and also to impart skills on writing coding / developing project / product related to societal requirement.

LIST OF EXPERIMENTS / EXERCISES:

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 given metallic wire using torsional pendulum.
3.	Determination of the wavelength and the angle of divergence of semiconductor laser.
4.	Determination of the particle size of a given powder using laser.
5.	Determination of the thermal conductivity of a bad conductor using Lee's disc.
6.	Determination of the specific resistance of the given metallic wire using Carey Foster's bridge.
7.	Determination of the band gap of a given semiconducting material using post-office box / Determination of Hall coefficient of a material using Hall effect arrangement.
8.	Determination of the wavelength of mercury spectrum using spectrometer grating.
9.	Determination of the thickness of a thin film using air-wedge arrangement.
10.	Writing coding for any one of the above experiments / developing a project / a product.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine the Young's modulus of a material using the concepts of elasticity and bending moment of a beam, and the rigidity modulus of a wire using the concepts of twisting couple. To determine the wavelength and angle of divergence of the laser and the particle size of a powder material using the concept of diffraction of light.	Applying (K3), Precision (S3)
CO2	determine the thermal conductivity of a bad conductor using the concept of heat conduction through materials and the specific resistance of a given wire using the principle of Wheatstone bridge. To determine the band gap of a semiconductor by means of variation of resistance with temperature or to determine the Hall coefficient of a material using the concept of Hall effect.	Applying (K3), Precision (S3)
CO3	determine the wavelength of electromagnetic waves (visible part of Hg spectrum) using the concept of diffraction of light. To determine the thickness of thin films using the concept of interference of light and also to write coding/ do project/ develop product.	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

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

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

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

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

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

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

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

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MAC21 - MULTIVARIABLE CALCULUS AND COMPLEX ANALYSIS							
(Common to CIVIL, MECH, MTS, ECE, EEE, EIE & FT branches)							
Programme & Branch	**B.E & Civil, Mech, MTS, ECE, EEE, EIE & FT 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 – Applications: Maxima and minima – Constrained maxima and minima – Lagrange's multiplier method.		
Unit – II	**Multiple Integrals:**	**9**
Double integration in cartesian coordinates – Change of order of integration – Application: Area between two curves – Triple integration in cartesian coordinates – Volume as triple integrals.		
Unit – III	**Vector Calculus:**	**9**
Directional derivative – Gradient of a scalar point function – Divergence of a vector point function – Curl of a vector – Solenoidal and Irrotational vectors – Vector Integration: Introduction – Green's, Stoke's and Gauss divergence theorems (without proof) – Verification of the above theorems and evaluation of integrals using them.		
Unit – IV	**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 – Applications: Fluid flow – 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 EXPERIMENTS / EXERCISES:	
1.	Finding ordinary and partial derivatives
2.	Computing extreme values of function of two variables
3.	Evaluating double and triple integrals
4.	Finding the area between two curves
5.	Computing gradient, divergence and curl of point functions
6.	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

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

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

REFERENCES/ MANUAL / SOFTWARE:	
1.	Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.
2.	Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi
3.	Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics - I", 2nd Edition, Pearson India Education, New Delhi, 2018.

4.	Grewal B.S, “Higher Engineering Mathematics" 44thEdition, Khanna Publishers, New Delhi, 2018.
5.	MATLAB – Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	compute the total derivatives and extreme values of multivariable functions.	Applying (K3)
CO2	evaluate multiple integrals and apply them to compute the area and volume of the regions.	Applying (K3)
CO3	apply the concepts of derivatives and line integrals of vector functions in engineering problems.	Applying (K3)
CO4	construct analytic functions and bilinear transformations and determine the image of given region under the given conformal mapping.	Applying (K3)
CO5	apply the techniques of complex integration to evaluate real and complex integrals over suitable closed curves.	Applying (K3)
CO6	demonstrate MATLAB programming to understand the concepts of functions of two variables, vector operators, multiple integrals and complex variables.	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

***Alternate week**

22CYT23 – CHEMISTRY FOR MECHATRONICS ENGINEERING							
Programme & Branch	**B.E & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**BS**	**3**	**0**	**0**	**3**

Preamble	This course aims to emphasize the engineering students to realize the importance of electrochemistry, electrochemical storage devices, polymeric, composite & engineering materials and the need for corrosion & its control methods.

Unit – I	**ELECTROCHEMISTRY**	**9**

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

Unit – II	**ELECTROCHEMICAL STORAGE DEVICES**	**9**

Batteries: Introduction**-** types of batteries – discharging and charging of battery – characteristics of battery – battery rating – various tests on battery – primary battery: silver button cell – secondary battery: Ni-Cd battery –modern battery: lithium-ion battery – maintenance of batteries – choice of batteries for electric vehicle applications. **Fuel Cells:** Introduction-Importance and classification of fuel cells – description, principle, components and applications of fuel cells: H_2-O_2 fuel cell, alkaline fuel cell, molten carbonate fuel cell and direct methanol fuel cell.

Unit – III	**CORROSION AND ITS CONTROL METHODS**	**9**

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

Unit – IV	**POLYMER AND COMPOSITE MATERIALS**	**9**

Polymers: Introduction – terminology – structure and property relationship of polymers (mechanical, thermal) –rubbers (elastomers) – natural rubber- processing of latex- vulcanization of rubber – synthetic rubber- preparation, properties and applications of polyurethane-polymethyl methacrylate (PMMA) – conducting polymer–biodegradable polymer- synthesis, properties and applications of polylactic acid. **Composites:** Introduction-types- polymer composites – synthesis, properties and applications of kevlar fibre- fibre reinforced plastics (FRP) – properties and uses.

Unit – V	**CHEMISTRY OF ENGINEERING MATERIALS**	**9**

Lubricants: Introduction – classification – properties : viscosity, viscosity index, flash and fire point, cloud and pour point, oiliness, aniline point and carbon residue. **Explosives:** Introduction – classification – manufacture of important explosives (TNT, GTN and RDX). **Rocket propellants:** Introduction – properties and classification. **Abrasives**: Introduction-properties of abrasives – types of abrasives: i) natural abrasives – diamond, corundum and quartz ii) synthetic abrasives – silicon carbide, boron carbide – industrial applications of abrasives. **Adhesives**: Introduction-requisites of a good adhesive-advantages and disadvantages of adhesive bonding- adhesive action-classification of adhesives-industrial applications of adhesives.

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", Pearson Education, New Delhi, Revised Edition 2019.
2. Dara .S.S, "A Text book of Engineering Chemistry", S. Chand and company Ltd., 2021.
3. Sunita Rattan, " A Text book of Engineering Chemistry", S.K. Kataria & Sons Publishers, First edition, 2018, Reprint-2022.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the principles of electrochemistry for various applications	Applying (K3)
CO2	use the concepts of batteries, fuel cells and their applications in various fields.	Applying (K3)
CO3	make use of corrosion control methods to solve corrosion related issues.	Applying (K3)
CO4	categorize and utilize the polymer and composite materials for various applications	Applying (K3)
CO5	utilize the concepts of lubricants, explosives and adhesives for various applications.	Applying (K3)

Mapping of Cos with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

22MTT21 - FLUID MECHANICS AND THERMODYNAMICS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Physics for Mechatronics Engineering, Matrices and ordinary Differential Equations**	**2/3**	**PC**	**3**	**1**	**0**	**4**

Preamble	This course provides knowledge in Fluid Statics, kinematics and Dynamics. It also helps to understand the basics of Thermodynamics.

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, Capillary and Surface Tension – Fluid statics: Concept of fluid static pressure – Pascal's law – Absolute and Gauge pressures – Manometers: Types and Pressure measurement – Concept of Buoyancy and Floatation.

Unit – II	**Fluid Kinematics and Fluid Dynamics:**	**9+3**

Fluid Kinematics: Types of fluid flow - Continuity equation in two and three dimensions - Velocity and Acceleration of fluid particle - Velocity potential function and Stream function. Fluid dynamics: Euler's equation along a streamline -Bernoulli's equation and applications – Venturi meter, Orifice meter and Pitot tube

Unit – III	**Viscous Flow, Flow through Pipes and Dimensional analysis**:	**9+3**

Viscous flow: Shear stress, pressure gradient relationship -Flow of viscous fluid through circular pipe - Flow through pipes: Loss of head due to friction - Minor head losses -Hydraulic gradient and Total energy lines – Flow through pipes in series and in parallel – Power transmission through pipes. Dimensionalanalysis: Buckingham's theorem

Unit – IV	**Basics of Thermodynamics and First Law of Thermodynamics:**	**9+3**

Thermodynamics - Microscopic and macroscopic point of view - Systems, properties, process, path, cycle. Thermodynamic equilibrium - Zeroth law of Thermodynamics - internal energy, enthalpy, specific heat capacities CV and CP, Relationship between CV and CP. First law of Thermodynamics - Application toclosed and open systems – Steady Flow Energy Equation (SFEE) – Simple problems.

Unit – V	**Second Law of Thermodynamics and Entropy:**	**9+3**

Second Law of thermodynamics - Kelvin Planck and Clausius Statements -Equivalents of Kelvin Planck and Clausius statements. Reversibility - Irreversibility, reversible cycle - Heat engine, heat pump and refrigerator. Carnot cycle and Clausius theorem, the property of entropy, the inequality of Clausius - Entropy principle - General expression for entropy – Simple problems in entropy.

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Bansal R.K., "Fluid Mechanics and Hydraulic Machines", 9th Edition, Laxmi Publications, New Delhi, 2015.

REFERENCES:

1. Nag P.K., "Engineering Thermodynamics", 5th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2013.
2. Cengel Yunus A. and Boles Michael A., "Thermodynamics: An Engineering Approach", 5th Edition, McGraw-Hill, New York, 2010.
3. Frank M. White, "Fluid Mechanics", 7th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2009.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped** **(Highest Level)**
CO1	understand Fluid Properties and Fluid Statics	Understanding (K2)
CO2	solve the problems related to kinematics and dynamics of fluid flow	Applying (K3)
CO3	calculate the energy losses in flow through pipes	Analysing (K4)
CO4	analyze the basic concepts, first law of thermodynamics and its applications	Applying (K3)
CO5	interpret concepts of second law of thermodynamics and entropy	Analysing (K4)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	5	10	75	10	-	-	100
CAT2	5	10	75	10	-	-	100
CAT3	5	10	75	10			
ESE	5	10	75	10	-	-	100

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

22CSC22 – DATA STRUCTURES USING C							
(Common to ECE, EEE, EIE and MTS Branches)							
Programme & Branch	**BE - ECE, EEE, EIE and MTS Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Programming in C**	**2**	**PC**	**3**	**0**	**2**	**4**

Preamble	This course is indented to introduce the concept of elementary data structures and notion of algorithms to novice learner from cross disciplines in Engineering and Technology.	
Unit – I	**List:**	**9**
Data Structures - Abstract Data Types (ADT) - List ADT and Array Implementation - Linked List - Doubly Linked List - Circular Linked List – Application : Polynomial Addition		
Unit – II	**Stack and Queues:**	**9**
Stack ADT – Array and Linked List implementation of Stacks - Application: Balancing Parenthesis- Infix to Postfix Conversion - 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–Priority Queues (Binary Heap)- Application: Expression Tree		
Unit – IV	**Graphs:**	**9**
Graphs – Definitions – Elementary Graph Operations- Traversals – Shortest-Path Algorithms: Unweighted Shortest Paths – Dijkstra"s Algorithm – Minimum Spanning Tree: Prim"s Algorithm- Kruskal"s Algorithm – Applications: Biconnectivity.		
Unit – V	**Sorting and Hashing:**	**9**
Sorting - Preliminaries – Insertion Sort – Quicksort – Merge sort – Heapsort – 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.	Convert a given In-fix Expression into Post-fix Expression using Stack ADT
8.	Evaluate the Post-fix Expression using Stack ADT
9.	Implementation of Binary Search Tree traversals
10.	Implementation of sorting algorithms: Insertion and Quick sort

Lecture:45, Practical:30, Total:75

TEXT BOOK:

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

REFERENCES/ MANUAL / SOFTWARE:

1.	Horowitz Sahni, Andreson Freed, "Fundamentals of Data Structures in C", 2nd Edition, Universities Press, Hyderabad, 2011.
2.	Langsam Y.M., Augenstein J. and Tenenbaum A. M., “Data Structures using C and C++”, 2nd Edition, Pearson Education, 2015.

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	50				100
CAT2	5	35	60				100
CAT3	5	35	60				100
ESE	5	35	60				100

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

22CSC21 – FUNDAMENTALS OF DATA STRUCTURES							
(Common to Civil, Mechanical, Automobile, Chemical Branches)							
Programme & Branch	**BE - Civil, Mechanical, Automobile & BTech – Chemical Engineering Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Programming in C**	**2**	**ES**	**3**	**0**	**2**	**4**

Preamble	This course is indented to introduce the concept of elementary data structures and notion of algorithms to novice learner from cross disciplines in Engineering and Technology.

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

LIST OF EXPERIMENTS / EXERCISES:

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

Lecture:45, Practical:30, Total:75

TEXT BOOK:

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

REFERENCES/ MANUAL / SOFTWARE:

1.	Horowitz Sahni, Andreson Freed, "Fundamentals of Data Structures in C", 2nd Edition, Universities Press, Hyderabad, 2011.
2.	Langsam Y.M., Augenstein J. and Tenenbaum A. M., "Data Structures using C and C++", 2nd Edition, Pearson Education, 2015.

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

Mapping of Cos with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

22MTT22 – ELECTRON DEVICES AND DIGITAL CIRCUITS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2/3**	**ES**	**3**	**0**	**0**	**3**
Preamble	This course provides an insight on basic laws and theorems of circuits and network. It gives an introduction to the basic concepts of semiconductor devices. It provides knowledge on the design of combinational and sequential digital circuits.						
Unit – I	**Basic Network Laws and Theorem:**						**9**
Voltage, Current, Energy and Power- Resistance, Inductance and Capacitance series and Parallel circuit- Ohm's Law- Kirchhoff's Current Law- Kirchhoff's Voltage Law- Star –Delta Transformation- Mesh Analysis- Nodal Analysis — Super Position Theorem.							
Unit – II	**Semiconductor Devices:**						**9**
Conductors, Semiconductors and Insulators – Properties of Semiconductors – PN Junction Diode – Rectifiers and Filters – Zener Diodes – Zener Diode Voltage Regulator– Junction Transistors: Principle of Operation of CE Configurations, Static Characteristics – CE Transistor as an Amplifier and Switch.							
Unit – III	**Digital Electronics:**						**9**
Boolean Algebra – Number systems – Complements – Boolean postulates and laws – De-Morgan's Theorem – Minimization of Boolean expressions – Canonical forms – Minimization: Karnaugh map, Don't care conditions. Logic Gates – Implementations of Logic Functions using gates, NAND – NOR implementations.							
Unit – IV	**Combinational Circuits:**						**9**
Half Adder – Full Adder – Half Subtractor – Full Subtractor – Multiplexer – Demultiplexer – Encoder / Decoder.							
Unit – V	**Sequential Circuits:**						**9**
RS, JK, JKMS, D and T Flip flops – Excitation tables –Realization of one flip flop using other flip flops – Design of Synchronous and asynchronous counters – shift register.							
							Total:45
TEXT BOOK:							
1.	Ravish R.Singh, "Network Analysis and Synthesis", 2nd Edition 2019, McGraw Hill Education (India) Private Limited, New Delhi for Units I & II.						
2.	Anandkumar A., "Fundamentals of Digital Circuits", 4nd Edition, Prentice Hall of India, New Delhi, 2016, for Units III, IV & V.						
REFERENCES:							
1.	Floyd, Electronic Devices, "10th Edition, Pearson Education", New Delhi, 2018.						
2.	Morris Mano M., "Digital Design", 6th Edition, Pearson Education, Noida, 2018.						

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply the basic laws and theorems for electric circuits	Applying (K3)
CO2	interpret the basic characteristics of semiconductor devices	Understanding (K2)
CO3	verify the Boolean functions using logic gates	Applying (K3)
CO4	design the combinational circuits	Applying (K3)
CO5	design the sequential circuits	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		2							3	3	1
CO2	2	1	1		2							3	3	1
CO3	3	2	1		2							3	3	1
CO4	3	3	1		2							3	3	1
CO5	3	3	1		2							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	25	65				100
CAT2	05	30	65				100
CAT3	05	30	65				100
ESE	05	40	55				100

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

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

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

TEXT BOOK:

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

REFERENCES:

1.	கீழடி-வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்.(தொல்லியல் துறை வெளியீடு)
2.	பொருநை-ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

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

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

TEXT BOOK:

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

REFERENCES:

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

10.	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

22GCL11 – FOUNDATION LAB – MANUFACTURING, DESIGN AND ROBOTICS							
(Common to All BE/BTech branches)							
Programme& Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**ES**	**0**	**0**	**6**	**3**

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

LIST OF EXPERIMENTS / EXERCISES:

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

REFERENCES/ MANUAL /SOFTWARE:

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

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	develop the prototype model using mechanical operations like welding, forming and machining processes	Applying (K3), Precision (S3)
CO2	sketch 3D model and enhance the prototype using modern machines like 3D printer, CNC milling machine, CNC Laser cutter and CNC Router	Applying (K3), Precision (S3)
CO3	design and develop the autonomous robot for real-time 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	3	3		2				3	2		2		
CO2	3	3	3		3				3	2		2		
CO3	3	3	3		2				3	2		2		

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

22MTL21 - ELECTRON DEVICES AND DIGITAL CIRCUITS LABORATORY							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2/3**	**ES**	**0**	**0**	**2**	**1**

Preamble	This course provides hands on training to analyze the characteristics of semiconductor devices and design of digital circuits.

LIST OF EXPERIMENTS / EXERCISES:

1.	Verification of Ohm's law, Kirchhoff's Law
2.	Verification of Series and Parallel Circuits
3.	Characteristics of semiconductor diode and zener diode
4.	Input and output characteristics of transistor under CE configuration
5.	Half wave and Full wave rectifier
6.	Verification of Boolean theorems using digital logic gates
7.	Design and implementation of binary adder and subtractor
8.	Design and implementation of multiplexer and de-multiplexer
9.	Design and implementation of encoder and decoder
10.	Design of asynchronous counter
11.	Design of synchronous counter
12.	Design of Shift Register

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	verify basic laws of DC circuit and boolean function	Understanding (K2), Imitation (S1)
CO2	analyze the characteristics of semiconductor devices and its application	Applying (K3), Manipulation (S2)
CO3	design the combinational circuits and the sequential circuits	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

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

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

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

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

LIST OF EXPERIMENTS / EXERCISES:

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

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1. Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., “Chemistry Laboratory Manual”, 1st Edition, Rajaganapathy Publishers, Erode, 2022.

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

Mapping of Cos with POs and PSOs

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

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

22ITC32 - INTRODUCTION TO PYTHON							
(Offered by Department of Information Technology)							
Programme & Branch	**All B.E./B.Tech. Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Problem Solving and Programming in C**	**3**	**ES**	**3**	**0**	**2**	**4**

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

LIST OF EXPERIMENTS / EXERCISES:

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

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Reema Thareja., "Introduction to Python using problem solving approach", 3rd impression, Oxford University Press., New Delhi, 2017.

REFERENCES/ MANUAL / SOFTWARE:

1.	Nageswara Rao, “Core Introduction to Python”, 2nd Edition, DreamTech Press, New Delhi, 2018.
2.	Jake Vander Plas ,” Python Data Science Handbook Essential Tools for Working with Data”, O’Reilly publishers,1st Edition,2016.

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MTT31- STRENGTH OF MATERIALS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Mechanics, Matrices and Ordinary Differential Equations**	**3/4**	**PC**	**3**	**1**	**0**	**4**

Preamble	To understand the concepts of types of stress, strain, strain energy, principal stress, principal planes and biaxial state of stress in thin cylinders and spherical shells. Also, estimate and draw the shear force and bending moment diagram due to external loads and the bending stresses of the beams. Evaluation of Slope and deflection of beams using different methods and buckling load of a columns and struts. Torsion on circular shaft and estimation of stress acting on the helical coil springs.

Unit – I	**Deformation of Solids and Strain Energy:**	**9+3**
Deformation of Solids: Stability- Strength- Stiffness- Tensile- Compressive and Shear stresses - Strain - Poisson's ratio –lateral strain- simple and compound bars - Introduction to Standards and various theories of failure – Relation between elastic constants – Thermal stresses. Strain Energy: Uniaxial loads- gradually applied load- suddenly applied load and impact load.		
Unit – II	**Analysis of State of Stress and Biaxial stresses:**	**9+3**
Analysis of State of Stress: Biaxial state of stress – thin cylinders and shells – Deformation in Thin cylinders and spherical shells. Biaxial stresses: stresses at a point on inclined planes – Principal planes and stresses – Mohr's circle for biaxial stress- Maximum shear stress.		
Unit – III	**Transverse Loading on Beams and Stresses in Beams:**	**9+3**
Transverse Loading on Beams: Types - transverse loading in beams-shear force and bending moment in beams – cantilevers-simply supported and overhanging beams-Point of contraflexure. Stresses in Beams: Theory of simple bending – analysis of stress-load carrying capacity.		
Unit – IV	**Deflection of Beams and Columns:**	**9+3**
Deflection of Beams: Elastic curve of neutral axis of the beam under normal loads – evaluation of beam deflection and slope - Double integration method and Macaulay's method. Columns: End condition –equivalent length of column – Euler's equation – slenderness ratio – Rankine's formula for columns.		
Unit – V	**Torsion on Circular Shafts and Torsion on Springs:**	**9+3**
Torsion on Circular Shafts: Torsion– shear stress distribution – hollow and solid circular section - Torsional rigidity – Torsional stiffness -torsion on stepped shaft. Torsion on springs: Wahl's correction factor of springs stresses in helical springs under torsion loads-stiffness and deflection of springs under axial load.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Rajput R.K, "Strength of Materials". 6th Edition, S.Chand & Co., New Delhi, 2018.

REFERENCES:

1.	Rattan S.S, "Strength of Materials". 3rd Edition, Tata McGraw Hill Education Private Ltd., New Delhi, 2017.
2.	Timoshenko S.P, "Elements of Strength of Materials". 10th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2010.
3.	Amrita Virtual Laboratory

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	analyze the stress, strain and strain energy of simple bars	Applying(K3)
CO2	analyze the biaxial state of stresses at a point in a body, thin cylinders and spherical shells	Applying(K3)
CO3	construct the shear force and bending moment diagrams and analyze the bending stresses of beams	Applying(K3)
CO4	estimate the slope and the deflection of beams and strengths of the columns	Applying(K3)

CO5	analyze the torsion behavior of shafts and coil springs	Applying(K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

22MTT32-THEORY OF MACHINES							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Drawing, Engineering Mechanics**	**3/4**	**PC**	**3**	**1**	**0**	**4**

Preamble	This course deals with the study of relative motion between the various parts of a machine and forces which act on them.	
Unit – I	**Kinematics of Basic Mechanisms:**	**9+3**
Terminology and Definitions – Kinematics of Links, Pairs and Chains - Degree of Freedom Mobility-Kutzbach criterion - Grashoff's law-Kinematic Inversions of 4-bar and slider crank mechanism - Displacement, velocity and acceleration -analysis in simple mechanisms -Graphical Method velocity and acceleration polygons –Relative velocity method, instantaneous centre method – Analytical synthesis of slider crank mechanism - Klien's construction for slider crank mechanism.		
Unit – II	**Force Analysis and Balancing of reciprocating engine:**	**9+3**
Inertia forces and D'Alembert's principle–Inertia force analysis in reciprocating engines – Gas forces – Equivalent masses – Bearing loads – Crank shaft torque – Turning Moment Diagrams of 2&4 stroke Engines - Static and dynamic balancing –Balancing of rotating masses –Balancing of single cylinder Engine –Balancing of in line Multi-cylinder Engine		
Unit – III	**Kinematics of Cams, Followers and Gear Trains:**	**9+3**
Cams- Types of cams and followers, displacement, velocity and acceleration curves for uniform velocity, uniform acceleration and retardation, SHM and Cycloidal curves. Layout of cam profile - Types with reciprocating and oscillating followers like knife – Edge follower, roller - Theory of Gearing – gear nomenclature, law of gearing, Gear trains – types, velocity and torque calculation- Parallel axis and epicyclic gear trains.		
Unit – IV	**Free and Damped Vibrations:**	**9+3**
Basic features of vibratory systems–types–Single degree of freedom system –Longitudinal Vibrations, Transverse vibration of beams–Natural frequency by energy method, Dunkerly's method-Critical speed damped free vibration of single degree freedom system-Types of damping–free vibration with viscous damping, Critically damped system, under damped system.		
Unit – V	**Torsional Systems and Gyroscope**	**9+3**
Torsional systems- Natural frequency of single, two and three rotor systems, Torsionally Equivalent System – Stepped shaft. Automatic control of mechanical systems- Transfer function- viscous damped output- Gyroscopes –Gyroscopic couples – Gyroscopic effects in automobiles, ships and air planes.		
Lecture:45, Tutorial:15, Total:60		

TEXT BOOK:

1.	Rattan S.S, "Theory of Machines", 5th Edition, McGraw Hill Education, New Delhi, 2019.

REFERENCES:

1.	Khurmi R.S & Gupta K, "Theory of Machines", 14th Revised Edition, S. Chand & Co. Ltd, New Delhi, 2020.
2.	Shigley J.E & Uicker J.J, "Theory of Machines and Mechanisms", 4th Edition, Oxford University Press, England, 2014.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	create simple mechanisms based on the degrees of freedom and apply the concepts of kinematics to compute the velocity and acceleration for simple mechanisms	Applying (K3)
CO2	assess inertia force, torque for reciprocating mechanisms and analyze the static and dynamic unbalance of revolving and reciprocating masses	Applying (K3)
CO3	design and analyze the profile of various cam and gear mechanisms for different applications	Applying (K3)
CO4	evaluate, analyze and demonstrate the frequencies of free and damped vibrations	Applying (K3)
CO5	evaluate torsional vibration and predict the gyroscopic effect in automobile, aero plane and ship 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	2	1	1	1	2							2	2	3
CO2	2	3	3	2								2	2	3
CO3	2	3	3	3	3							2	3	3
CO4	2	3	3	2								2	3	3
CO5	2	3	3	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	10	10	80				100
CAT2	10	10	80				100
CAT3	10	10	80				100
ESE	5	10	85				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22MTT33 - SYSTEMS AND CONTROL ENGINEERING							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Multivariable Calculus and Complex Analysis**	**3**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course introduces the fundamental concepts of signals and systems and provides an understanding of the concepts of control system in the design and analysis of feedback systems.	
Unit – I	**Fundamentals of signals and systems:**	**9**
Standard continuous time signals – Classification of continuous time systems – Laplace transforms: Properties and theorems – Region of Convergence (ROC) of various classes of systems. Classification of control Systems: Open loop and Closed loop systems –Key elements of mechatronics system – Mechatronics systems: Key elements, Design Process.		
Unit – II	**System Modeling:**	**9**
Mathematical modelling (Differential equation, Transfer function and State space model): Electrical systems - Mechanical systems - Electromechanical systems (DC motor with/without Gears). Reduction of multiple subsystems: Block diagram reduction - Signal flow graphs.		
Unit – III	**Time Response Analysis:**	**9**
Type and Order of System - First order system - Second order system: Classification and nature of response - Response of second order underdamped System for step input - Time domain specifications – Error analysis – Concepts of stability: Routh Hurwitz Criterion.		
Unit – IV	**Frequency Response Analysis:**	**9**
Frequency domain specifications – Bode plot - Polar plot - Nyquist stability criterion.		
Unit – V	**Compensator Design:**	**9**
Need for compensator - Types of compensation - Root Locus Technique - Design of lag and lead compensator using Root Locus.		
		Total:45

TEXT BOOK:

1.	Salivahanan S., Rengaraj R. & Venkatakrishnan G.R., "Control Systems Engineering", 1st Edition, Pearson Education India, New Delhi, 2015.

REFERENCES:

1.	Anand Kumar A., "Signals and systems", 3rd Edition, PHI Learning, New Delhi, 2013.
2.	Nagrath I.J. & Gopal M., "Control Systems Engineering", 7th Edition, New Age International Publishers, New Delhi, 2021.
3.	Norman S. Nise, "Control Systems Engineering", 8th Edition, Wiley India Private Ltd, New Delhi, 2019.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	interpret various types of continuous time signals and systems using Laplace transform	Applying (K3)
CO2	develop mathematical model of electrical, mechanical and electromechanical systems	Applying (K3)
CO3	analyze the first and second order systems in time domain response	Applying (K3)
CO4	analyze the first and second order systems in frequency domain	Applying (K3)
CO5	design of compensator for uncompensated open loop system	Applying (K3)

Mapping of COs with POs and PSOs

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

CO2	3	2	1	1	2							2	3	3
CO3	3	2	1	1	2							2	3	3
CO4	3	2	1	1	2							2	3	3
CO5	3	2	1	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	10	10	80				100
CAT2	10	10	80				100
CAT2	10	10	80				100
ESE	05	05	90				100

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

22MTT34 - ELECTRICAL MACHINES							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3/4**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides the knowledge about construction, working principle, starting and speed control techniques and performance analysis of various electrical machines used in real time application.	
Unit – I	**DC Machine**	**9**
Introduction- Electromagnetism – Static and Dynamic induced EMF – Problems - Construction and Principle of operation of DC machines – Types - Back EMF - EMF equation and Torque calculation, Performance calculation of series and shunt motor – Starters: 3-point starter – Speed control: Armature and Field control.		
Unit – II	**Transformer and Synchronous Machines**	**9**
Construction and Principle of operation of single-phase transformer-EMF equation- Transformer loss calculation using OC and SC test. Alternator: Synchronous machine : Construction and operating characteristics – EMF equation – Efficiency calculation – Starting method - Single phase synchronous generator		
Unit – III	**Three phase Induction Motor**	**9**
Construction and Principle of operation- Torque and Power calculation -Starters: DOL and Star/Delta starter. Speed control: Voltage, Frequency, V/f – Applications. Induction generator.		
Unit – IV	**Fractional Kilowatt Motors**	**9**
Single phase Induction motor: Construction and Principle of operation - Torque and Power calculation -Types-Applications. Stepper motor: Classifications- Construction and Principle of operation– Applications - Universal motor		
Unit – V	**Special Machines**	**9**
Servo mechanism – DC Servo motor - AC Servo motor – Applications. Construction, Operation and Applications of: Brushless permanent magnet DC motor – Switched reluctance motor-Linear induction motor.		
		Total:45

TEXT BOOK:

1.	D P Kothari & I J Nagrath., "Electric Machines", 5th Edition, Tata McGraw-Hill., New Delhi, 2018.

REFERENCES:

1.	Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2019
2.	Venkataratnam K, "Special Electrical Machines", 1st Edition, Universities Press, New Delhi, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	select DC Machines for industrial applications	Applying (K3)
CO2	interpret the performance characteristics of transformer and synchronous machines	Applying (K3)
CO3	analyze the performance of three phase induction motor for industrial applications	Applying (K3)
CO4	interpret the purpose of fractional kilowatt motors for real time applications	Applying (K3)
CO5	choose the appropriate special machines based on the modern industrial needs	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	3	3
CO2	3	3	3	3								2	3	3
CO3	3	3	3	3								2	3	3
CO4	3	3	3	3								2	3	3
CO5	3	3	2	2					2	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	10	50	40				100
CAT2	10	50	40				100
CAT3	10	50	40				100
ESE	5	55	40				100

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

22MTL31 - ELECTRICAL MACHINES AND CONTROL LABORATORY							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Electronics Devices and Digital Circuits Laboratory**	**3/4**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course provides knowledge on the characteristics behaviour of electrical machines through practical realization. It is also intended to design, develop and analyze the open loop and closed loop control systems.

LIST OF EXPERIMENTS / EXERCISES:

1.	Load characteristics of DC series motor
2.	Speed control of DC shunt motor
3.	Open circuit and short circuit tests on single phase transformer
4.	Load test on three phase alternator
5.	Load test on three phase squirrel cage induction motor
6.	Regulation of three phase alternator by EMF method
7.	Displacement analysis of mechanical translational and rotational system
8.	Response of first order system and electromechanical system using gears
9.	Closed loop control of position control system and electrohydraulic servo system
10.	Design of compensators for first order system
11.	Calibration of force sensor and potentiometer for angle measurement
12.	Actuator position response for different loads and surface angle control

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2019.
2.	Salivahanan S., Rengaraj R. & Venkatakrishnan G.R. , "Control Systems Engineering", 1st Edition, Pearson Education India, New Delhi, 2015.
3.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze the performance characteristics of DC machines, AC machines and transformers	Analyzing (K4), Precision (S3)
CO2	design, develop and analyze the control systems concepts for real time applications	Creating (K6), Precision (S3)
CO3	design, develop and implement compensator and controller for closed loop system	Creating (K6), Precision (S3)

Mapping of Cos with POs and PSOs

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

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

22MTL32 - COMPUTER AIDED DRAFTING LABORATORY							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Drawing**	**3/4**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course aids to design the mechanical and electrical components drawing using computer-aided tool.

LIST OF EXPERIMENTS / EXERCISES:

1.	Introduction to machine drawing - dimensioning, sectional views, abbreviations and conventions, welding symbols, surface finish symbols, limits, fits and tolerances.
2.	Free hand sketching of machine elements - keys, pin joints, fasteners, hexagonal and square head bolts and nuts, conventional representation of threads.
3.	Part and assembly drawing of spigot and cotter joint for Robotic arm using AUTOCAD.
4.	Part and assembly drawing of bearings / valves using AUTOCAD.
5.	Part and assembly drawing of connecting rod using AUTOCAD.
6.	Part and assembly drawing of Robotic Manipulator using AUTOCAD.
7.	Circuit design of solid-state emergency light and beeper circuit using AUTOCAD Electrical.
8.	Design of DC power supply unit using AUTOCAD Electrical.
9.	Line diagram of wiring of a drawing hall using AUTOCAD Electrical.
10.	Connection diagram of 3-point starter and DOL starter using AUTOCAD Electrical.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	AUTOCAD Software

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the drawings of various machine parts conforming IS conventions	Applying (K3), Manipulation (S2)
CO2	design the technical drawings of mechatronics related components with exact dimensions through appropriate views	Applying (K3), Manipulation (S2)
CO3	develop electrical and electronic drawing circuits for real time application	Applying (K3), Manipulation (S2)

Mapping of Cos with POs and PSOs

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

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

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

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

LIST OF EXPERIMENTS / EXERCISES:

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

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Lab Manual
2.	Orell Digital Language Lab Software

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

Mapping of Cos with POs and PSOs

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

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

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

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

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

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

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

22MAT41- NUMERICAL METHODS FOR ENGINEERS							
(Common to AUTO, CIVIL, MECH, MTS and FT Branches)							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**BS**	**3**	**1**	**0**	**4**

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

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1											
CO2	3	2	2											
CO3	3	3	2											
CO4	3	2	1											
CO5	3	3	3											
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	10	80	-	-	-	100
CAT2	10	10	80	-	-	-	100
CAT3	10	10	80	-	-	-	100
ESE	10	10	80	-	-	-	100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22MTC41 - COMPUTER AIDED DESIGN AND ANALYSIS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**PC**	**3**	**0**	**2**	**4**

Preamble	This course provides an insight on modeling and analyzing of different components using CAD packages and CAE tools	
Unit – I	**Sketching and Drafting:**	**9**
Sketch entities – lines, rectangles, circles, arcs, ellipses, centerlines; Sketch tools – offset, convert, trim; Sketch relations; Reference geometry – planes, axis, mate; references; Drawing views; Annotations		
Unit – II	**3D Modelling and evaluations:**	**9**
Boss and cut features – extrudes, revolves, sweeps, lofts; Fillets and chamfers; Linear, circular, and fill patterns; Dimensions; Feature conditions – start and end; Mass properties; Materials		
Unit – III	**3D Assembly and simulations:**	**9**
Inserting components; Standard mates – coincident, parallel, perpendicular, tangent, concentric, distance, angle; Reference geometry – planes, axis, mate references		
Unit – IV	**Basic Structural and Thermal analysis:**	**9**
Introduction to the Finite Element Method; General Steps of the Finite Element Method; Solid Modeling; Meshing – Free, Mapped; Material Properties; Stiffness matrix ; Boundary Conditions; Solvers; Post Processing – Stress, Strain, Deformation, Displacement		
Unit – V	**Non-linear, modal and harmonic analysis:**	**9**
Modelling- Working with Boolean operations, Importing of 3D models; Meshing- Hybrid meshing, Mesh Extrusion, Volume Sweeping; Solvers- Solver Setup, Load Step Options, Solving Multiple Load Step Post-processing- Time History Postprocessor, Factor of Safety plot, Design Insight plot		

LIST OF EXPERIMENTS / EXERCISES:

1.	Basic Sketching Exercise
2.	Modeling of machine building components
3.	Modeling of robotic accessories
4.	Part and Assembly of shafts, keys and couplings
5.	Part and Assembly of spigot and cotter joint for Robotic arm
6.	Assembly and Simulation of four bar and slider crank mechanisms
7.	Assembly and simulation of a 4 axis Robotic arm
8.	Linear Structural Analysis of 2D and 3D shafts
9.	Thermal analysis of a typical heat exchanger
10.	Structural analysis of a mechanism under different loading conditions

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Ibrahim Zeid, "Mastering CAD/CAM.", 2nd Edition, McGraw Hill Education, New Delhi, 2006.

REFERENCES/ MANUAL / SOFTWARE:

1.	David C. Planchard, "SOLIDWORKS 2021 Reference Guide: A comprehensive reference guide with over 260 standalone tutorials", 1st edition, SDC Publications; 2021
2.	Mary Kathryn Thompson & John Martin Thompson, "ANSYS Mechanical APDL for Finite Element Analysis", 1st Edition, Butterworth-Heinemann, Elsevier, 2017
3.	Modeling and Analysis Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply industry standards in the preparation of technical mechanical drawings.	Applying (K3) Manipulation (S2)
CO2	create and evaluate the three-dimensional solid models	Applying (K3) Manipulation (S2)
CO3	assemble and simulate the three-dimensional solid models	Applying (K3) Manipulation (S2)
CO4	solve structural and thermal analysis problems using FEA techniques	Applying (K3) Precision (S3)
CO5	solve the modal and harmonic problems using analysis tools	Analysing (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	1	2	2				2	3	2	3	3	3
CO2	2	1	1	2	2				2	3	2	3	2	2
CO3	3	2	1	2	2				2	2	2	3	3	3
CO4	3	3	1	2	2				2	1	2	3	3	3
CO5	3	3	1	2	2				2	3	2	3	3	3

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

ASSESSMENT PATTERN – THEORY

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

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

22MTT41 - MANUFACTURING PROCESSES							
Programme & Branch	**B.E.-Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4/3**	**PC**	**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 that are used 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 - Explosion 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 machine types and operations.		
		Total:45

TEXT BOOK:

1.	Kaushish J.P., "Manufacturing Processes", 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2013.

REFERENCES:

1.	Kalpakjian S. and Schmid R., "Manufacturing Engineering and Technology", 8th Edition, Pearson Education, India, 2020.
2.	Rao P.N., "Manufacturing Technology, Volume I & II", 5th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2018.

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 process according to the material and geometrical design	Applying (K3)
CO4	select the metal joining process 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	2	2
CO2	3	3	3	2								2	2	2
CO3	3	3	3	2								2	2	2
CO4	3	3	3	2								2	2	2
CO5	3	2	2	2								2	2	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	85		-	-	-	100
CAT2	10	70	20	-	-	-	100
CAT3	15	85					100
ESE	5	80	15	-	-	-	100

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

22MTT42 - SENSORS AND SIGNAL CONDITIONING							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Physics for Mechatronics Engineering, Electron Devices and Digital Circuits**	**4**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides an understanding of measurement methods, construction and working principle of sensors and signal conditioning circuits.	
Unit – I	**Introduction to Measurement Systems:**	**9**
Functional elements of measurement system – Methods of measurement – Classification of instruments – Instrument Standards - Measurement system errors - Error analysis – Static and dynamic characteristics of transducers – Classification of transducers – Selection of transducers – Smart Sensors.		
Unit – II	**Non-Electrical Transducers:**	**9**
Temperature Measurement: Filled system thermometer, Bimetallic thermometer. Pressure transducers: Elastic transducers, Bourdon gauge, Bellows and Diaphragm. Vacuum measurement: McLeod gauge, Thermal conductivity gauge – Ionization gauge. Flow measurement: Rotameter – Orifice. Level measurement: Float gauges.		
Unit – III	**Electrical Transducers:**	**9**
Resistive transducers: Potentiometer, RTD, Thermistor – Thermocouple – Strain gauge – Torque measurement – Force measurement – Radiation measurement using pyrometers. Inductive transducer: LVDT, RVDT – Capacitive transducer.		
Unit – IV	**Basics of Operational Amplifiers:**	**9**
General operational amplifier stages – Pin diagram & internal circuit diagrams of IC 741, Ideal characteristics, DC and AC performance characteristics. Op – AMP Applications**:** Inverting and Non-inverting amplifiers, V-to-I and I-to-V converters, Adder, Subtractor, Integrator, Differentiator, Instrumentation amplifier		
Unit – V	**Signal Converters and Conditioning:**	**9**
Converters: Design of S/H circuit, D/A converter (weighted resistor and R- 2R ladder types), A/D converters (Flash type, Successive approximation types) using op-amps. **Signal Conditioning:** DC bridges: Classification of resistances – Wheatstone bridge. AC bridges: Introduction –Sources and Detectors – Maxwell's inductance bridge – Wien's bridge		
		Total:45

TEXT BOOK:

1.	Sawhney. A.K, "A Course in Electrical and Electronics Measurements and Instrumentation", 18th Edition, Dhanpat Rai & Company Private Limited, New Delhi, 2015. (Unit-I,II &III)
2.	D Choudhury Roy., "Linear Integrated Circuits ", 5th Edition, New Academic Science, New Delhi, 2018. (Unit-IV& V)

REFERENCES:

1.	John G. Webster, "Measurement, Instrumentation, and Sensors Handbook", 2nd Edition, CRC Press, United States, 2018.
2.	Ramon Pallas.Amey and John G.Webster, "Sensors and Signal Conditioning", 2nd Edition, John Wiley & Sons, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer the basic concepts of measurement system	Understanding (K2)
CO2	select suitable non-electrical, electrical transducers and sensors for various measurements	Understanding (K2)
CO3	identify suitable electrical transducers and sensors for electrical measurements	Understanding (K2)
CO4	Infer the basic concepts of operational amplifier and its various applications	Understanding (K2)
CO5	select a suitable signal conditioning system to enhance the quality of signal	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3		3								1	2	2
CO2	2	3		3								1	3	3
CO3	2	3		3								1	3	3
CO4	2	3		3								1	3	3
CO5	2	3		3								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	15	85					100
CAT2	15	70	15				100
CAT3	15	70	15				
ESE	10	70	20				100

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

22MTC42 - GRAPHICAL SYSTEM DESIGN							
(Offered by Department of Mechatronics Engineering)							
Programme& Branch	**B.E. Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**PC**	**3**	**0**	**2**	**4**

Preamble	This course provides the fundamental knowledge on Graphical System Design programming, data acquisition and interfacing techniques of Virtual Instrumentation (VI)\.	
Unit - I	**Basics of Virtual Instrumentation:**	**9**
Architecture of a Graphical System Design based virtual instrument - Data Flow programming - Graphical user interface platform - G programming and modular programming - Graphical programming palettes: Control, Functions and tool palettes – Data Types: Numeric, String, and Boolean.		
Unit - II	**VI Programming Techniques:**	**9**
Structures: Loops, Shift Registers, Case, Event, Timed, Flat-sequence - Expression node - Formula nodes - Arrays/Clusters - Waveform Generation - File I/O: Read/ Write - Variables: Local/Global - Sub-VI.		
Unit - III	**Data Acquisition Hardware Interface:**	**9**
Basics of DAQ hardware and software - Concepts of data acquisition and terminology - Installing hardware and drivers - NI-MAX Configuring and addressing the hardware - Communicating between the Real-time Target and Host PC		
Unit - IV	**Data Logging, Control, and Monitoring**	**9**
Measuring/Generating the Analog Input/Output: Simulating the Hardware and Validating the Measurement - Generating and Reading Digital Signal - Triggering - Timing and Synchronization Methods - Programming with the NI-DAQmx		
Unit - V	**Real time Applications:**	**9**
Instrument control: Signal processing tools - Measuring Temperature, Strain, Force, Pressure, Sound, Vibration, and Acceleration, Edges, Frequency, and Duty Cycle. Vision and Motion, Vision Acquisition and Vision Assistant tool .		

Experiments:	
1.	Data acquisition using LabVIEW for temperature measurement with thermocouple.
2.	Data acquisition using LabVIEW for temperature measurement with RTD/ Thermistor.
3.	Creation of a CRO using LabVIEW and measurement of frequency and amplitude from external source.
4.	Create function generator using LabVIEW and display the amplitude and frequency on CRO (externally connected).
5.	Demonstrate amplitude modulation considering modulating and carrier wave from external source.
6.	Interface LEDs to DAQ output and implement the counter operation.
7.	Data acquisition using LabVIEW for load / strain measurement using suitable transducers.
8.	Demonstrate binary to grey code converter (& vice versa) using DAQ card.
9.	Data acquisition using LabVIEW for distance/humidity measurement using suitable transducers.
10.	Reading audio input with Microphones and output using DAQ card.

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Jeffery Travis & Jim Kring, "LabVIEW for Everyone: Graphical programming made easy and Fun", 3rd Edition, Pearson Education, India, 2009. (Unit-I, II & III)
2.	Gary W. Jonson and Richard Jennings “Labview Graphical Programming”, Fourth Edition, McGraw Hill, New York, 2017. (Unit – IV & V)

REFERENCES:

1.	Gupta, Joseph & John, "Virtual Instrumentation using LabVIEW", 2nd Edition, Tata McGraw Hill, India, 2010.
2.	Rick Bitter, Taqi Mohiuddin & Matt Nawrocki, "LabVIEW Advanced Programming Techniques", 2nd Edition, Taylor & Francis Group, New York, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the basic concepts of Virtual Instrumentation	Understanding (K2) Imitation (S1)

CO2	interpret the different software tools in Virtual Instrumentation	Applying (K3) Manipulation (S2)
CO3	interface data acquisition hardware with software	Applying (K3) Manipulation (S2)
CO4	develop programming concepts with data logging and control	Applying (K3) Manipulation (S2)
CO5	design graphical programming solutions to real world problems	Applying (K3) Precision (S3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	35	50				100
CAT2	10	35	55				100
CAT3	10	35	55				100
ESE	5	40	55				100

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

22MTL41 - SENSORS AND SIGNAL CONDITIONING LABORATORY							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course enables the student to understand and analyze the concept behind working of various types of Sensors used in Industries and their practice.

LIST OF EXPERIMENTS / EXERCISES:	
1.	Measurement of temperature using Thermistor
2.	Measurement of temperature using Thermocouple & RTD
3.	Measurement of displacement using POT, LVDT & Capacitive transducer
4.	Measurement of Torque, Strain and Force using strain gauge
5.	Flow measurement using Orifice meter and Rotameter
6.	Diaphragm based Pressure measurement
7.	Capacitive based Level Measurement
8.	Measurement of magnetic field strength using hall effect sensor
9.	Remote monitoring using IoT and Instrumentation amplifier
10.	Measurement and monitoring of unknown Resistance for a given case study using Wheatstone Bridge& IoT
11.	Measurement and monitoring of unknown Inductance for a given case study using Maxwell Bridge& IoT
12.	Measurement and monitoring of unknown Capacitance for a given case study using Schering Bridge& IoT
	Total:30

REFERENCES/ MANUAL /SOFTWARE:	
1.	Laboratory Course Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	identify and measure the physical parameters using sensors and signal conditioning units.	Applying (K3), Imitation (S1)
CO2	utilize the measurement systems to characterize the given physical quantity	Applying (K3), Manipulation (S2)
CO3	experiment with measurement bridges and to interface sensors with IoT module	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	2				2	2		2	3	3
CO2	3	2	1	3	2				2	2		2	3	3
CO3	3	2	1	3	2				2	2		2	3	3

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

22MTL42- MANUFACTURING PROCESSES LABORATORY							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4/3**	**PC**	**0**	**0**	**2**	**1**

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

LIST OF EXPERIMENTS / EXERCISES:

1.	Lathe operations: Step turning, Taper turning and Knurling
2.	Lathe operation: Thread Cutting
3.	Lathe operation: Eccentric turning
4.	Milling machine operations: Spur gear milling / Contour / Key way milling
5.	Shaper / Planner machine operations: 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 mould 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 welding

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	Kaushish J.P., "Manufacturing Processes", 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	develop the various mechanical components using centre lathe through single point and multi point cutting tools	Applying (K3), Precision (S3)
CO2	develop the various mechanical components using special machines like milling, shaper, grinding and drilling machines	Applying (K3), Precision (S3)
CO3	develop green sand moulds using standard patterns and create the joints using TIG / MIG welding setup	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	3	2					2	2		2	2	2
CO2	3	3	3	2					2	2		2	2	2
CO3	3	3	3	2					2	2		2	2	2

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

22GCL41 - PROFESSIONAL SKILLS TRAINING - I							
(Common to All BE/ BTech Engineering and Technology branches)							
Programme & Branch	**All BE/ BTech Engineering and Technology branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	EC	0	0	80	2
Preamble	This subject is to enhance the employability skills and to develop career competency						
Unit – I	**Soft Skills – I :**						**20**
Soft skills and its importance: Pleasure and pains of transition from an academic environment to work environment-Need for change- Fear, stress and competition in the professional world-Importance of positive attitude- Self motivation and continuous knowledge upgradation-Self-confidence. Professional grooming and practices: Basics of corporate culture-Key pillars of business etiquette- Basics of etiquette-Introductions and greetings-Rules of the handshake, earning respect, business manners-Telephone etiquette- Body Language.							
Unit – II	**Quantitative Aptitude and Logical Reasoning – I:**						**30**
Problem solving level I: Number System-LCM &HCF-Divisibility test-Surds and indices-Logarithms- Ratio-proportions and variation-Partnership-Time speed and distance-Data interpretation-data representation. Logical reasoning: Family tree-Deductions-Logical connectives-Binary logic Linear arrangements- Circular and complex arrangement							
Unit – III	**Written Communication & Verbal Aptitude**						**30**
Writing Skills: Writing strategies and formats Importance of Résumés Writing a Cover letter -Responding to Job Advertisements Professional e-mail Writing Responding to e-mails and business letters Technical Report writing Interpretation of Technical Data (Transcoding) Writing One-page Essays. Verbal Aptitude Synonyms Antonyms Homonyms One word substitution Idioms and Phrases Paired words Analogies Spelling test Cloze test using suitable verb forms using appropriate articles and prepositions; Spotting Errors Sentence Correction and Formation Grammar Based questions (Transformation : Active-Passive & Direct-Indirect); Rearranging Jumbled Sentences & Jumbled paragraphs, Identifying Facts, Inferences and Judgements statements							
							Total:45

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MTC51 - FLUID POWER SYSTEMS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**--**	**5**	**PC**	**2**	**0**	**2**	**3**

Preamble	This course provides knowledge and skill to generate, control and transmission of power using pressurized fluids	
Unit - I	**Fundamentals of Fluid Power System and Hydraulic pumps:**	**6**
Basics of fluid power system – Advantages and applications of Fluid power systems – Fluid properties – Pascal's Law and its application – Fluid power symbols – Hydraulic pumps: Gear, Vane and Piston pumps, Pump performance, Characteristics and Selection - Sizing of pumps (Numerical problems in Pumps).		
Unit - II	**Control Components of Hydraulic System:**	**6**
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 Electrohydraulic servo valves.		
Unit - III	**Pneumatic System and Actuators:**	**6**
Compressors: piston, screw and vane 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 (Numerical problems in Actuators).		
Unit - IV	**Fluid Power Circuit Design:**	**6**
Basic pneumatic circuits – Pneumatic vacuum systems –Electrical components and electrical controls for Fluid power circuits – Cascade Circuit design method (two / three cylinder circuits) – Accumulator – Types and application circuits – Pressure intensifier circuits – PLC applications in Fluid power circuit.		
Unit - V	**Industrial Circuits and Maintenance:**	**6**
Industrial circuits: Speed control circuits – Regenerative cylinder circuits – Pump unloading circuit – Double pump circuit – Counter balance valve circuit – Hydraulic cylinder sequencing circuit – Automatic cylinder reciprocating circuit – Cylinder synchronizing circuits – Fail safe circuits - Sealing devices: Types and materials – Installation, Maintenance and trouble shooting of Fluid Power systems.		

List of Exercises / Experiments:

1.	Design and testing of speed control circuits and synchronizing circuits
2.	Design and testing of Electro-hydraulic circuits. (i) with pressure sequence valve (ii) with hydraulic motor
3.	Design and testing of Sequential circuit with pneumatic control (with and without time delay)
4.	Design and testing of Electro Pneumatic sequential circuit with limit switches
5.	Design and testing of Pneumatic circuits with logic controls – AND valve and OR valve
6.	Design and simulation of Pneumatic, Hydraulic, Electro-pneumatic and Electro-hydraulic circuits using Simulation software
7.	Design and testing of Hydraulic circuit with Proportional control of Pressure and Flow
8.	Design and testing of sequential circuits using cascade method
9.	Design, testing and simulation of electro pneumatic circuit with timers and counters
10.	Position control and Profile Tracking of an Electro pneumatic and Electrohydraulic Servo Systems

Lecture: 30, Practical: 30, Total: 60

TEXT BOOK:

1.	Esposito Anthony, "Fluid Power with Applications", 7th Edition, Pearson Higher Education, New York, 2015.

REFERENCES:

1.	Jegadeesa T., "Hydraulics and Pneumatics", I.K International Publishing House Pvt. Ltd., New Delhi, 2015.

2.	Majumdar S.R., "Oil Hydraulic Systems – Principles and Maintenance", 2nd Edition, Tata McGraw-Hill, New Delhi, 2017.
3.	Majumdar S.R., "Pneumatic Systems – Principles and Maintenance", 2nd 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 fluid power components and their symbols as used in industry and also select suitable hydraulic components for different industrial applications	Understanding (K2) Imitation (S1)
CO2	select pneumatic components and fluid power actuators for low-cost automation	Understanding (K2) Imitation (S1)
CO3	design and construct a fluid power circuits real time applications	Applying (K3) Manipulation (S2)
CO4	design, construct and test fluid power circuits with pneumatic, electrical, PLC and logic control for low-cost automation	Applying (K3), Manipulation (S2)
CO5	develop and simulate fluid power circuits using simulation software for industrial applications	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	15	65	20				100
CAT3	10	30	60				100
ESE	05	60	35				100

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

22MTC52 - POWER ELECTRONICS AND DRIVES							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Electron Devices & Digital Circuits, Electrical Machines**	**5**	**PC**	**3**	**0**	**2**	**4**

Preamble	This course provides the basics of Power semiconductor devices. It gives the principle design of power converters and drives.	
Unit – I	**Power Electronics Devices:**	**9**
Concept of power electronics – 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 – TRIAC – Introduction to Wide band gap semiconductors (SiC and GaN) Power Devices.		
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 – 6 pulse and 12 pulse converters- Applications of AC-DC converter. Introduction to inverter –Single phase inverters and– PWM inverters		
Unit - III	**DC - DC and AC - AC Converter:**	**9**
DC Chopper – Control strategies – Principle of operation DC to DC Converters – Types – buck and boost converter operations – Applications – Single phase AC voltage controller – On - off control and phase control – Sequence control of AC voltage controller.		
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- concept of three phase VFD control		

List of Exercises / Experiments:

1	Steady state characteristics of Gate driver Circuit
2	Single phase fully controlled converter
3	Design of Buck Converter
4	Single phase AC voltage controller
5	Simulation of DC Converters
6	Simulation of AC Converters
7	Simulation of closed loop control of converter fed DC motor
8	Simulation of closed loop control of chopper fed DC motor

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Muhammad H. Rashid, "Power Electronics: Devices, Circuits & Applications", 4th Edition, Pearson, 2017. (Unit-I, II & III)
2.	Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2014. (Unit- IV & V)

REFERENCES:

1.	Singh M.D. & Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2013.
2.	Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2012.

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) Imitation (S1)
CO2	describe the working principle of AC – DC and DC – AC converters	Understanding (K2) Imitation (S1)
CO3	express the construction and working of DC – DC and AC – AC converters	Understanding (K2) Imitation (S1)
CO4	select a suitable power converter for a given DC drive	Applying (K3) Manipulation (S2)
CO5	choose an appropriate power converter for a given AC drive	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	2	2
CO2	3	2	1		2							2	2	2
CO3	3	2	1		2							2	2	2
CO4	3	2	1		2							2	2	2
CO5	3	2	1		2							2	2	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	70					100
CAT2	25	75					100
CAT3	30	50	20				100
ESE	20	60	20				100

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

22MTT51 - CNC AND METROLOGY							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Processes**	**5**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides the concepts of CNC machines, part programming for turning and machining centres 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 fed 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, 2019. (Units- I, II & III)
2.	Jain R.K, "Engineering Metrology", Khanna Publishers, New Delhi, 2022. (Units-IV & V)

REFERENCES:

1.	HMT Limited, "Mechatronics", Tata McGraw-Hill, New Delhi, 2017.
2.	Peter smid, “CNC Programming Handbook”, Industrial Press, Inc. 2020

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	Applying (K3)
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	Perform the form and profile measurement using Coordinate Measuring Machine (CMM) with machine vision system	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3								2	2	2
CO2	3	3	3		3							3	2	2
CO3	3	3	3	3	3							2	2	2
CO4	3	3	3	3	3							2	2	2
CO5	3	3	3	3	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	15	75	10				100
CAT2	15	70	15				100
CAT3	15	70	15				100
ESE	15	70	15				100

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

22MTT52 - MICROCONTROLLER PROGRAMMING AND APPLICATIONS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Electron Devices and Digital Circuits**	**5**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course is intended to provide the basic concepts of Microprocessor and Microcontrollers, its architecture, programming and interfacing with the use of Embedded C programming.	
Unit – I	**Introduction to Microprocessors:**	**9**
Introduction to 8085 Microprocessor: Architecture – Memory organization – Addressing modes – Instruction sets – Interrupts – Assembly Language Programming – Introduction to ARM (Cortex-M3) processor; Architecture – Registers – RISC and CISC Mechanism		
Unit – II	**8051 Microcontroller:**	**9**
Selection of Microcontrollers - 8051 Microcontroller Architecture – Pin configuration – Memory organization –Special function registers – PSW register – Addressing modes – Instruction sets – Assembly Language Programming		
Unit - III	**Embedded Programming using C:**	**9**
Introduction to Embedded C Compiler - Programming Structure, Data types, Infinite loops and handling interrupts in C - Hex file Creation; I/O port programming – Timer programming – Counter programming – Serial communication programming – Interrupt programming.		
Unit - IV	**Peripheral Interfacing:**	**9**
Introduction to Embedded C programming – Peripheral interfacing: Switch keypad, LCD – LED – A/D and D/A converters – High Power devices using relays. Speed control: DC Motor –Stepper motor, Servo motor.		
Unit – V	**Microcontroller for Mechatronic Systems:**	**9**
Interfacing – Temperature Control System – Pressure Control System – Flow & Level Control System– DC motor speed Control System - AC Power Control System – Traffic light control application.		
		Total:45

TEXT BOOK:

1.	Ramesh Goankar, "Microprocessor 8085 Architecture, Programming and Interfacing", 6th Edition, Penram International publishers, Mumbai, 2013. (Units-I, II & III)
2.	Mazidi Muhammad Ali, Mazidi Janice Gillispie and McKinlay Rolin, "The 8051 Microcontroller and Embedded Systems", 2nd Edition, Pearson Education, New Delhi, 2014. (Units -IV & V)

REFERENCES:

1.	Patel, "The 8051 Microcontroller based Embedded Systems", 1st Edition, Tata McGraw Hill Publishing Company, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the basic concepts of 8085 microprocessor and ARM Microprocessor	Understanding (K2)
CO2	discuss architecture and organization of 8051 Microcontroller	Understanding (K2)
CO3	Use software tools to solve 8051 Microcontroller programming and applications	Applying (K3)
CO4	Apply programming concepts to interface analog/digital I/Os with 8051 Microcontroller	Applying (K3)
CO5	design a Microcontroller based system for real-time applications	Analyzing (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	2	3	3		1							2	3	3
CO2	2	3	3		2							2	3	3
CO3	2	3	3		3							2	3	3
CO4	2	3	3		3							2	3	3
CO5	2	3	3		3							2	3	3

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	18	72	10				100
CAT2	18	62	20				100
CAT3	10	10	80				100
ESE	15	30	55				100

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

22MTC53 - FLUID POWER SYSTEM DESIGN							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**--**	**5**	**PC**	**3**	**0**	**2**	**4**

Preamble	This course provides knowledge and skill to generate, control and transmission of power using pressurized fluids	
Unit - I	**Fundamentals of Fluid Power System and Hydraulic pumps:**	**9**
Basics of fluid power system – Advantages and applications of Fluid power systems – Fluid properties – Pascal's Law and its application – Fluid power symbols – Hydraulic pumps: Gear, Vane and Piston pumps, Pump performance, Characteristics and Selection - Sizing of pumps (Numerical problems in Pumps).		
Unit - II	**Control Components of Hydraulic System:**	**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 Electrohydraulic servo valves.		
Unit - III	**Pneumatic System and Actuators:**	**9**
Compressors: piston, screw and vane 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 (Numerical problems in Actuators).		
Unit - IV	**Fluid Power Circuit Design:**	**9**
Basic pneumatic circuits – Pneumatic vacuum systems –Electrical components and electrical controls for Fluid power circuits – Cascade Circuit design method (two / three cylinder circuits) – Accumulator – Types and application circuits – Pressure intensifier circuits – PLC applications in Fluid power circuit.		
Unit - V	**Industrial Circuits and Maintenance:**	**9**
Industrial circuits: Speed control circuits – Regenerative cylinder circuits – Pump unloading circuit – Double pump circuit – Counter balance valve circuit – Hydraulic cylinder sequencing circuit – Automatic cylinder reciprocating circuit – Cylinder synchronizing circuits – Fail safe circuits - Sealing devices: Types and materials – Installation, Maintenance and trouble shooting of Fluid Power systems.		

List of Exercises / Experiments:

1.	Design and testing of speed control circuits and synchronizing circuits
2.	Design and testing of Electro-hydraulic circuits. (i) with pressure sequence valve (ii) with hydraulic motor
3.	Design and testing of Sequential circuit with pneumatic control (with and without time delay)
4.	Design and testing of Electro Pneumatic sequential circuit with limit switches
5.	Design and testing of Pneumatic circuits with logic controls – AND valve and OR valve
6.	Design and simulation of Pneumatic, Hydraulic, Electro-pneumatic and Electro-hydraulic circuits using Simulation software
7.	Design and testing of Hydraulic circuit with Proportional control of Pressure and Flow
8.	Design and testing of sequential circuits using cascade method
9.	Design, testing and simulation of electro pneumatic circuit with timers and counters
10.	Position control and Profile Tracking of an Electro pneumatic and Electrohydraulic Servo Systems

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Esposito Anthony, "Fluid Power with Applications", 7th Edition, Pearson Higher Education, New York, 2015.

REFERENCES:

1.	Jegadeesa T., "Hydraulics and Pneumatics", I.K International Publishing House Pvt. Ltd., New Delhi, 2015.

2.	Majumdar S.R., "Oil Hydraulic Systems – Principles and Maintenance", 2nd Edition, Tata McGraw-Hill, New Delhi, 2017.
3.	Majumdar S.R., "Pneumatic Systems – Principles and Maintenance", 2nd 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 fluid power components and their symbols as used in industry and also select suitable hydraulic components for different industrial applications	Understanding (K2) Imitation (S1)
CO2	select pneumatic components and fluid power actuators for low-cost automation	Understanding (K2) Imitation (S1)
CO3	design and construct a fluid power circuits real time applications	Applying (K3) Manipulation (S2)
CO4	design, construct and test fluid power circuits with pneumatic, electrical, PLC and logic control for low-cost automation	Applying (K3), Manipulation (S2)
CO5	develop and simulate fluid power circuits using simulation software for industrial applications	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	15	65	20				100
CAT3	10	30	60				100
ESE	05	60	35				100

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

22MTC54 - SENSORS AND SIGNAL PROCESSING							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Physics for Mechatronics Engineering, Electron Devices and Digital Circuits**	**5**	**PC**	**3**	**0**	**2**	**4**

Preamble	This course provides an understanding of measurement methods, construction and working principle of sensors and signal conditioning circuits.	
Unit – I	**Introduction to Measurement Systems:**	**9**
Functional elements of measurement system – Methods of measurement – Classification of instruments – Instrument Standards - Measurement system errors - Error analysis – Static and dynamic characteristics of transducers – Classification of transducers – Selection of transducers – Smart Sensors.		
Unit – II	**Non-Electrical Transducers:**	**9**
Temperature Measurement: Filled system thermometer, Bimetallic thermometer. Pressure transducers: Elastic transducers, Bourdon gauge, Bellows and Diaphragm. Vacuum measurement: McLeod gauge, Thermal conductivity gauge – Ionization gauge. Flow measurement: Rotameter – Orifice. Level measurement: Float gauges.		
Unit – III	**Electrical Transducers:**	**9**
Resistive transducers: Potentiometer, RTD, Thermistor – Thermocouple – Strain gauge – Torque measurement – Force measurement – Radiation measurement using pyrometers. Inductive transducer: LVDT, RVDT – Capacitive transducer.		
Unit – IV	**Basics of Operational Amplifiers:**	**9**
General operational amplifier stages – Pin diagram & internal circuit diagrams of IC 741, Ideal characteristics, DC and AC performance characteristics. Op – AMP Applications**:** Inverting and Non-inverting amplifiers, V-to-I and I-to-V converters, Adder, Subtractor, Integrator, Differentiator, Instrumentation amplifier		
Unit – V	**Signal Converters and Conditioning:**	**9**
Converters: Design of S/H circuit, D/A converter (weighted resistor and R- 2R ladder types), A/D converters (Flash type, Successive approximation types) using op-amps. **Signal Conditioning:** DC bridges: Classification of resistances – Wheatstone bridge. AC bridges: Introduction –Sources and Detectors – Maxwell's inductance bridge – Wien's bridge		

Experiments:

1.	Measurement of temperature using Thermistor
2.	Measurement of temperature using Thermocouple & RTD
3.	Measurement of displacement using POT, LVDT & Capacitive transducer
4.	Measurement of Torque, Strain and Force using strain gauge
5.	Flow measurement using Orifice meter and Rotameter
6.	Diaphragm based Pressure measurement
7.	Capacitive based Level Measurement
8.	Measurement of magnetic field strength using hall effect sensor
9.	Remote monitoring using IoT and Instrumentation amplifier
10.	Measurement and monitoring of unknown Resistance for a given case study using Wheatstone Bridge& IoT

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Sawhney. A.K, "A Course in Electrical and Electronics Measurements and Instrumentation", 18th Edition, Dhanpat Rai & Company Private Limited, New Delhi, 2015. (Unit-I,II &III)
2.	D Choudhury Roy., "Linear Integrated Circuits ", 5th Edition, New Academic Science, New Delhi, 2018. (Unit-IV& V)

REFERENCES:

1.	John G. Webster, "Measurement, Instrumentation, and Sensors Handbook", 2nd Edition, CRC Press, United States, 2018.
2.	Ramon Pallas.Amey and John G.Webster, "Sensors and Signal Conditioning", 2nd Edition, John Wiley & Sons, 2012.

COURSE OUTCOMES: **On completion of the course, the students will be able to**	**BT Mapped (Highest Level)**

CO1	infer the basic concepts of measurement system	Understanding (K2) Imitation (S1)
CO2	select suitable non-electrical, electrical transducers and sensors for various measurements	Understanding (K2) Imitation (S1)
CO3	identify suitable electrical transducers and sensors for electrical measurements	Understanding (K2) Manipulation (S2)
CO4	Infer the basic concepts of operational amplifier and its various applications	Understanding (K2) Manipulation (S2)
CO5	select a suitable signal conditioning system to enhance the quality of signal	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	2	3	2	3								1	2	2
CO2	2	3	2	3								1	3	3
CO3	2	3	2	3								1	3	3
CO4	2	3	2	3								1	3	3
CO5	2	3	2	3								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	15	85					100
CAT2	15	70	15				100
CAT3	15	70	15				
ESE	10	70	20				100

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

22MTL51- CNC AND METROLOGY LABORATORY							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Processes**	**5**	**PC**	**0**	**0**	**2**	**1**
Preamble	This practical course discusses about generation of CNC part programming and to understand about various measurement techniques.						

LIST OF EXPERIMENTS / EXERCISES:	
1.	Study of G codes and M codes for machining centre and turning centre
2.	Programming and machining of given component using CNC turning centre.
3.	Programming and machining of given component using CNC turning centre with canned cycles
4.	Programming and machining of given component using CNC turning centre by using drilling and boring tools
5.	CNC code generation of given component using MASTER CAM (Lathe) and interfacing it to CNC turning centre
6.	Programming and machining of Jig plate using CNC machining centre
7.	Programming and machining of key way milling operation using CNC machining centre
8.	CNC code generation of given component using MASTER CAM (Mill) and interfacing it to CNC machining centre
9.	Calibration of Vernier / Micrometer; static characteristic study- Measurement of Components like V block etc
10.	Calibration of Dial Gauge; static characteristic study; Use of dial gauge as measuring device and Comparator
11.	Measurement of micro components using Profile projector
12.	Study of Autocollimator, Surface roughness tester and coordinate measuring machine (CMM)
	Total:30

REFERENCES/ MANUAL /SOFTWARE:	
1.	Radhakrishnan P, "Computer Numerical Control Machines", New Central Book Agency, India, 2013.
2.	Jain R.K, "Engineering Metrology", Khanna Publishers, New Delhi, 22nd Edition, 2022.
3.	Laboratory manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	develop, simulate a profile using Mastercam and develop part program and execute the same using CNC machines	Applying (K3), Manipulation (S2)
CO2	interpret the fundamentals of calibration and measurements processes and perform the characteristics on instruments	Applying (K3), Manipulation (S2)
CO3	carry out the linear and angular measurements of various mechanical components	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	3	3	3	2						3	3	3
CO2	3	3	3	3	2				3	3		3	3	3
CO3	3	3	3	3	2				3	3		3	3	3

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

22MTL52 - MICROCONTROLLER PROGRAMMING AND APPLICATIONS LABORATORY								
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Electron Devices and Digital Circuits Laboratory**	**5**	**PC**	**0**	**0**	**2**	**1**
Preamble	This course emphasis on Microcontroller programming, simulation and interfacing of hardware for a real time applications.						

LIST OF EXPERIMENTS / EXERCISES:	
1.	Arithmetic functions using 8085 Microprocessor
2.	Arithmetic functions using 8051 Microcontroller
Embedded C program development and hardware Interfacing	
3.	Interfacing of switch, LED and seven segment LED
4.	Interfacing of LCD with 89c51 Microcontroller
5.	Interfacing DC motor programming with 89c51 Microcontroller
6.	Interfacing Stepper motor with 89c51 Microcontroller
7.	Interfacing Servo motor with 89c51 Microcontroller
8.	Actuation of pneumatic cylinders for the given application
9.	Interfacing of high power devices with 89c51 Microcontroller
10.	Interfacing sensors, Microcontroller with IoT module for the given application
	Total:30

REFERENCES/ MANUAL /SOFTWARE:	
1.	Mazidi Muhammad Ali, "The 8051 Microcontroller and Embedded Systems", 2nd Edition, Prentice Hall of India, New Delhi, 2013.
2.	Laboratory manual.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	solve simple arithmetic functions using 8085 microprocessor and 89C51 microcontroller	Applying (K3), Manipulation (S2)
CO2	develop Embedded C programming using 89C51 microcontroller to the interfacing circuits	Applying (K3), Precision (S3)
CO3	develop real-time Mechatronics applications using 89C51 microcontroller	Analyzing (K4), Precision (S3)

Mapping of Cos with POs and PSOs

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

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

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

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

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MTT61- PROGRAMMABLE AUTOMATION CONTROLLERS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Microcontroller Programming and Applications**	**6**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides deep knowledge about PLC programming, I/O interfacing and development of SCADA for industrial automation.	
Unit – I	**Device Layer Components:**	**9**
Discrete Input Devices: Pushbuttons –Proximity Sensors - Float Switch-Temperature switch – Pressure switch – Analog Input Devices: Temperature –Flow–Pressure sensors. Discrete Output Devices: Discrete: Relays – Contactors – DOL Starter - Solenoid valves- Analog Output Devices: Control valve – VFD.		
Unit – II	**Programmable Logic Controller:**	**9**
Introduction – Architecture of PLC – Principles of operation – Types of PLC – Programming Devices for PLC. I/O modules: Discrete I/O modules – Analog I/O modules- Special I/O modules – CPU processor memory module – PLC wiring: Sourcing and sinking concept- Selection, Maintenance and troubleshooting of PLC.		
Unit – III	**Programming of PLC:**	**9**
Types of PLC Programming- Construction of ladder logic diagram- Simple problems –Instructions: Binary level- Timer – Counter – Arithmetic – Data and program manipulation Instructions - Application case studies.		
Unit – IV	**Advanced PLC programming and Communication Protocols:**	**9**
Program control instructions- Analog PLC operation – Calculation for Digital count- HMI interface – Data communications: SPI – I2C – Data highway- DeviceNet- ControlNet-EtherNet/IP-Modbus-Fieldbus- Profibus.		
Unit – V	**SCADA:**	**9**
Introduction to HMI – SCADA: Definition – Elements of SCADA – SCADA control – Remote terminal units – Master station – Applications of SCADA- Developing SCADA for a given case study – Using Analog, Discrete I/O's with PLC and SCADA.		
		Total:45

TEXT BOOK:

1.	Petruzella Frank D., "Programmable Logic Controllers", 5th Edition, McGraw-Hill, New York, 2019.

REFERENCES:

1.	Stuart G McCrady, "Designing SCADA application software -A Practical Approach", Elsevier, Netherlands, 2013.
2.	Stuart Boyer A, "SCADA Supervisory Control and data acquisition", 4th Edition, ISA, France, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer discrete and analog field devices to be interfaced with PLC	Understanding (K2)
CO2	interpret architecture, I/O modules and communication protocols used in PLC	Understanding (K2)
CO3	develop the PLC programming using ladder logic diagram for simple industrial case studies	Applying (K3)
CO4	implement PLC and HMI for industrial applications	Analyzing (K4)
CO5	combine programming concepts of PLC and SCADA to develop industrial control functions	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	1	2	1	3	1							2	3	3

CO2	3	3	3	3	3							2	2	2
CO3	3	3	2	3	3							2	3	3
CO4	3	3	2	3	3							2	3	3
CO5	3	3	2	3	3							2	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	5	95					100
CAT2		10	90				100
CAT3		50	50				100
ESE	5	35	60				100

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

22MTT62- MECHANICS OF SERIAL MANIPULATORS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Mechanics, Theory of Machines**	**6**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course is intended to provide a detailed understanding of serial manipulator and mathematics behind position, motion and dynamics of serial manipulator.	
Unit - I	**Fundamentals of Serial Manipulator:**	**9**
History of robotics - Components of industrial robot – Joint notation scheme - Classification of robots - Robot specifications - Precision of movements - End Effectors: Types of end effectors - Mechanical Gripper: Gripper force analysis - Vacuum cup - Magnetic gripper - Special types of grippers -. Programming modes - Robot applications.		
Unit - II	**Frame Transformation:**	**9**
Descriptions: Position, Orientation and Frames - Matrix representation: Point, vector, frame and rigid body - Homogeneous Transformation matrices – Representation: Translation, Rotational and Combined transformation – Simple problems.		
Unit - III	**Robot Kinematics:**	**9**
Forward and inverse kinematics – Equations for position and orientation – Denavit-Hartenberg representation of forward kinematic equations: Two and Three link planer, PUMA and SCARA - Inverse kinematic equation: Two and three link planar.		
Unit - IV	**Differential Motions and Velocities:**	**9**
Introduction - Linear and angular velocities of a rigid body - Velocity propagation – Derivation of Jacobian for serial manipulator – Identification of singularities.		
Unit - V	**Trajectory Planning and Robot Dynamics:**	**9**
Joint space trajectory - Cartesian space trajectory – Simple problems. Robot Dynamics: Acceleration of a rigid body - Inertia of a link - Equation of motion: Legrangian formulation – Newton Euler formulation.		
		Total:45

TEXT BOOK:

1.	Saeed B. Niku, "Introduction To Robotics: Analysis, Control, Applications", 2nd Edition, Wiley India Pvt. Ltd., Noida, 2011. (Units -I, II & III)
2.	Craig John J., "Introduction to Robotics: Mechanics and Control", 3rd Edition, Pearson Education, New Delhi, 2017. (Units -IV & V)

REFERENCES:

1.	Groover M.P., "Industrial Robotics, Technology, Programming and Applications", 2nd Edition, McGraw-Hill, New Delhi, 2017.
2.	Saha S.K., "Introduction to Robotics", 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the features of a serial manipulator with end effector	Applying (K3)
CO2	compute position and orientation based on robot kinematic structure	Applying (K3)
CO3	develop the forward and inverse kinematics for serial manipulator	Applying (K3)
CO4	analyse the differential motions and velocity of serial manipulator	Applying (K3)
CO5	formulate trajectory and robot dynamics	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	2

CO2	3	3	2	2	1							2	3	2
CO3	3	3	2	2	1							2	3	2
CO4	3	3	2	2	1							2	3	2
CO5	3	3	2	2	1							2	3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

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

22MTL61-PROGRAMMABLE AUTOMATION CONTROLLERS LABORATORY							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Microcontroller Programming and Applications Laboratory**	**6**	**PC**	**0**	**0**	**2**	**1**
Preamble	This laboratory course provides practical realization of PLC programming, I/O interfacing and development of SCADA for industrial automation.						

LIST OF EXPERIMENTS / EXERCISES:	
1.	Introduction to PLC programming /simulation/communication software
2.	Logical testing of I/Os and its interfacing with PLC
3.	Level control using PLC with AUTO/Manual mode
4.	Linear and sequential actuation of Pneumatic cylinder with Timer and counter functions
5.	Development of HMI for real time parameter monitoring and control with Auto/Manual mode
6.	Speed control of motor using soft PLC
7.	Temperature control using PLC and HMI along with data logging and trending
8.	Pressure Measurement and Flow Control using PLC and HMI with alarm and trend
9.	Introduction to Servo control using PLC
10.	Servo control application: jogging and profiling
	Total:30

REFERENCES/ MANUAL /SOFTWARE:	
1.	Petruzella Frank D., "Programmable Logic Controllers", 5th Edition, McGraw-Hill, New York, 2019.
2.	Laboratory manual.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	build and simulate analog and discrete PLC programming	Applying (K3), Precision (S3)
CO2	develop hard wiring with PLC and field I/Os	Applying (K3), Precision (S3)
CO3	develop plant level automation for real process plant control using PLC and SCADA	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	2	3	1	2	3				2	1		2	3	3
CO2	2	3	2	1	3				2	1		2	2	2
CO3	3	3	1	2	3				2	1		2	3	3

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

22MTL62 - ROBOTICS AND CONTROL LABORATORY							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Microcontroller Programming and Applications Laboratory**	**6**	**PC**	**0**	**0**	**2**	**1**
Preamble	The laboratory course on Robotics and Control is intended to provide a practical realization of industrial robot and mobile robot for real time applications.						

LIST OF EXPERIMENTS / EXERCISES:	
1.	Study the functions of ABB IRB 1410 and Fanuc ER 4iA industrial robots: components, drive system and end effectors
2.	Creation of Tool Centre Point (TCP) and Work Object using ABB IRB 1410 industrial robot
3.	Robot programming exercises: Point-to-point and Continuous path programming using ABB Robot Studio
4.	Pick and place operation in teach mode using ABB IRB 1410 industrial robot
5.	Creation of Tool Centre Point (TCP) and Work Object using Fanuc ER 4iA industrial robot
6.	Robot programming exercises: Point-to-point and Continuous path programming using Fanuc ER 4iA
7.	Pick and place operation in teach mode using Fanuc ER 4iA industrial robot
8.	Motion and Velocity control using Fire Bird – V robot
9.	Path planning and Obstacle avoidance using QBot 2E
10.	Study of multifunctional Dobot Magician and its multiple accessories: Linear Rail Kit, 3D printer Kit, Conveyor Belt, and Profile sketching
11.	Vision based inspection and sorting of components using Dobot Magician
12.	Study the basic structures, functions and control of sixth generation Humanoid Robot: NAO[6]
	Total:30

REFERENCES/ MANUAL /SOFTWARE:	
1.	Laboratory Manual.
2.	ABB Robot Studio and Robo Guide Software.
3.	Fire Bird – V Software and Hardware manual.
4.	Dobot – Software and Hardware manual.
5.	Choregraphe – Software and NAO Robot manual.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	analyze the industrial robots work cell problems and develop robot programming through ON/OFF line mode	Applying (K3), Manipulation (S2)
CO2	develop an embedded programming for autonomous mobile robot	Applying (K3), Manipulation (S2)
CO3	develop the inspection and sorting systems using machine vision techniques	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	3	2	2				3	2		2	3	3
CO2	3	3	3	2	2				3	2		2	3	3
CO3	3	3	3	2	2				3	2		2	3	3

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

22MTP61 - PROJECT WORK I (2022 Batch)								
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**6**	**EC**	**0**	**0**	**8**	**4**
							Total: 120

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify and formulate the problem and conceptualize the methodology of the project	Applying (K3)
CO2	design the components and systems using Mechatronic principles	Analyzing (K4)
CO3	fabricate a Mechatronics system utilizing experimental skills	Creating (K6)
CO4	plan and execute the project as a team	Evaluating (K5)
CO5	Compile the findings and conclude with oral/written reports	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	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	2	2	2	2	2	3	2	3	3	3	2	3	3	3
CO5	3	3	3	3	2	3	2	3	3	3	2	3	3	3

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

22MTP62 - PROJECT WORK I (2023 Batch)								
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**6**	**EC**	**0**	**0**	**4**	**5**
							Total: 120

	COURSE OUTCOMES: **On completion of the course, the students will be able to**	**BT Mapped (Highest Level)**
CO1	identify and formulate the problem and conceptualize the methodology of the project	Applying (K3)
CO2	design the components and systems using Mechatronic principles	Analyzing (K4)
CO3	fabricate a Mechatronics system utilizing experimental skills	Creating (K6)
CO4	plan and execute the project as a team	Evaluating (K5)
CO5	Compile the findings and conclude with oral/written reports	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	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	2	2	2	2	2	3	2	3	3	3	2	3	3	3
CO5	3	3	3	3	2	3	2	3	3	3	2	3	3	3

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

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

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

TEXT BOOK:

1. Gaur R.R., Sangal R., Bagaria G.P., "A Foundation Course in Human Values and Professional Ethics", 1st edition, Excell Books Pvt. Ltd., New Delhi, 2016.

REFERENCES:

1. Ivan Illich, "Energy & Equity", The Trinity Press, USA, 1974.
2. Schumacher E.F., "Small is Beautiful: a study of economics as if people mattered", Britain, 1973.

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22GCT71 - ENGINEERING ECONOMICS AND MANAGEMENT							
(Common to All BE/BTech branches)							
Programme & Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**HS**	**3**	**0**	**0**	**3**
Preamble	The aim of the course is to create fundamental knowledge on management by introducing concepts like economics, national income, marketing, operations management, accounting principles etc.						
Unit – I	**Micro Economics**						**9**
Economics – Basics Concepts and Principles – Demand and Supply – Law of demand and Supply – Determinants – Market Equilibrium – Circular Flow of Economic Activities and Income.							
Unit – II	**Macro Economics, Business Ownership and Management concepts**						**9**
National Income and its Measurement Techniques. Inflation - Causes of Inflation – Controlling Inflation – Business Cycle - Forms of Business – Ownership Types. Management concepts: Taylor and Fayol's Principles – Functions of Management - Managerial Skills - Levels of Management - Roles of Manager.							
Unit – III	**Marketing Management**						**9**
Marketing - Core Concepts of Marketing - Four P's of Marketing - New Product Development – Intellectual Property Rights (IPR), Product Life Cycle - Pricing Strategies and Decisions.							
Unit – IV	**Operations Management**						**9**
Operations Management - Resources - Types of Production System - Site Selection, Plant Layout, Steps in Production Planning and Control - Inventory - EOQ Determination.							
Unit – V	**Financial Management**						**9**
Accounting Principles – Financial Statements and its Uses – Depreciation - Straight Line and Diminishing Balance Method – Break Even Analysis – Capital Budgeting - Significance –Traditional and Discounted Cash Flow Methods.							
							Total:45

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MTT71 - INDUSTRIAL INTERNET OF THINGS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Sensors and Signal Processing**	**7**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides the knowledge on Industrial Internet of Things (IIoT) fundamentals to enhance the existing automation system for monitoring the entire planning and product lifecycle.	
Unit - I	**Introduction:**	**9**
Introduction to Application-based IoT Protocols-Infrastructure-based 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	**IIoT Architectures:**	**9**
Introduction to Industry 4.0 - Overview of IOT components - Various architectures of IOT and IIOT, Industrial internet - Reference architecture; IIOT system components: Sensors- Gateways- Routers- Modem- Cloud brokers- Servers and its integration. WSN: WSN network design for Industrial IOT.		
Unit – III	**Sensor and Interfacing:**	**9**
Introduction to sensors – Transducers: Classification - Roles of sensors in IIoT- Design of sensor architecture- Special requirements for IIoT sensors- Role of actuators- Types of actuators. Protocols: HART -MODBUS - Ethernet -BACNet - M2M.		
Unit – IV	**Protocols and Cloud:**	**9**
Introduction to Industrial data transmission – Interbus – Bitbus - CC-link -Batibus - Controller area network - DeviceNet – LoRa & LoRaWAN -NB-IoT.		
Unit – V	**Industrial IoT- Application Domains:**	**9**
Healthcare, Power plants - Inventory management and quality control - Plant safety and security (Including AR and VR safety applications), Welding Technology – Oil - Chemical and pharmaceutical industry - Applications of UAVs in Industries.		
		Total:45

TEXT BOOK:

1.	Anandarup Mukherjee, Chandana Roy, Sudip Misra," Introduction to Industrial Internet of Things and Industry 4.0", 1st Edition, CRC Press,2020.

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 potentials in industrial environment	Understanding (K2)
CO2	infer the various components and architecture of IIoT	Understanding (K2)
CO3	interpret different IIoT sensors system architecture with interface standards	Applying (K3)
CO4	identify appropriate protocols and Cloud platforms for different IIoT challenges	Applying (K3)
CO5	build design thinking concepts for industrial IoT 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	2	2

CO2	2	2	2	2	3							1	2	2
CO3	2	2	2	2	3							1	2	2
CO4	2	2	2	2	3							1	2	2
CO5	3	3	3	3	3							2	3	3

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

ASSESSMENT PATTERN - THEORY

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

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

22MTP71 PROJECT WORK II PHASE I (2022 Batch)							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**EC**	**0**	**0**	**10**	**5**
							Total: 150

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify and formulate the problem and conceptualize the methodology of the project	Applying (K3)
CO2	design the components and systems using Mechatronic principles	Analyzing (K4)
CO3	fabricate a Mechatronics system utilizing experimental skills	Creating (K6)
CO4	plan and execute the project as a team	Evaluating (K5)
CO5	compile the findings and conclude with oral/written reports	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	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	2	2	2	2	2	3	2	3	3	3	2	3	3	3
CO5	3	3	3	3	2	3	2	3	3	3	2	3	3	3

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

22MTP72 PROJECT WORK II PHASE I (2023 Batch)							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**EC**	**0**	**0**	**8**	**6**
							Total: 150

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify and formulate the problem and conceptualize the methodology of the project	Applying (K3)
CO2	design the components and systems using Mechatronic principles	Analyzing (K4)
CO3	fabricate a Mechatronics system utilizing experimental skills	Creating (K6)
CO4	plan and execute the project as a team	Evaluating (K5)
CO5	compile the findings and conclude with oral/written reports	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	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	2	2	2	2	2	3	2	3	3	3	2	3	3	3
CO5	3	3	3	3	2	3	2	3	3	3	2	3	3	3

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

22MTP81 PROJECT WORK II PHASE II							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**8**	**EC**	**0**	**0**	**8**	**4**
							Total: 120

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze any complex engineering problem to provide appropriate research-based solution	Analyzing (K4)
CO2	design the components and systems using fundamental engineering principles	Analyzing (K4)
CO3	develop /fabricate a mechatronics system utilizing experimental / analytical / simulation skills	Creating (K6)
CO4	plan and execute the project as a team	Evaluating (K5)
CO5	compile the findings and conclude with oral / written reports	Applying (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	2	2	2	2	3	3	3	3	3	3
CO2	3	3	3	3	3	2	2	2	3	3	2	3	3	3
CO3	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO4	2	2	2	2	2	3	2	3	3	3	2	3	3	3
CO5	3	3	3	3	2	3	2	3	3	3	2	3	3	3

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

22MTE01 - DESIGN OF MECHANICAL ELEMENTS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Strength of Materials**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides systematic knowledge about design and analysis of machine elements and transmission elements for suitable product/process development.	
Unit – I	**Fundamental Principles of Design:**	**9**
The Design Process – Computer aided design, Optimum design – Factors Influencing Machine Design – Types of loads – Stress – Static, Varying, Thermal, and Impact – Factor of safety – Theories of failure – Stress concentration – Soderberg and Goodman's equation.		
Unit – II	**Design of Shafts, Keys and Couplings:**	**9**
Design of Solid and Hollow shafts – Based on Strength, Rigidity and Deflection – Torsional Rigidity – Lateral Rigidity – Material Constants. Design of Keys – Types – Key ways. Design of Rigid and Flexible Couplings.		
Unit – III	**Design of Spur, Helical, Bevel and Worm Gears:**	**9**
Design of spur, helical, bevel and worm gears – Multi speed gear box design –Spur gear – Forward Traverse. Gears based on interference.		
Unit – IV	**Design of Power screws, Journal Bearings and Springs:**	**9**
Power screws – Types of thread – Self-locking & Overhauling threads – Design of screw jack. Design of Journal Bearings – Cubic mean load– Calculation of Bearing dimensions – Design of Helical springs – Variable loads – Wahl's factor.		
Unit – V	**Design of Brakes and Clutches:**	**9**
Clutches – types – Design of Clutches – Single plate – Multi Plate Clutches. Brakes - Functions – Types – linings - Design of band brakes – Internal expanding shoe brake.		
		Total:45

TEXT BOOK:

1.	Bhandari V.B., "Design of Machine Elements", 4th Edition, Tata McGraw Hill, New Delhi, 2017.

REFERENCES:

1.	Richard G. Budynas and Keith Nisbett J., "Mechanical Engineering Design", 1st Edition, McGraw-Hill International Edition, New York, 2017.
2.	Robert L. Norton, "Machine Design", 5th Edition, Pearson Education, 2018.
3.	PSG Design Data Book

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze and select mechanical components for engineering applications	Applying (K3)
CO2	design the shafts, keys and couplings with proper assumptions	Applying (K3)
CO3	design and analyze the spur, helical, bevel, worm gear drives and multi speed gear box	Applying (K3)
CO4	design and analyze the power screws, journal bearings and springs	Applying (K3)
CO5	design and analyze the clutches and brakes	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	3	3	3								2	2	2
CO2	3	3	3		3							3	2	2
CO3	3	3	3	3	3							2	2	2
CO4	3	3	3	3	3							2	2	2
CO5	3	3	3	3	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	15	35	50				100
CAT2	15	35	50				100
CAT3	15	35	50				100
ESE	5	40	55				100

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

22MTE02 - HEAT AND MASS TRANSFER							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course is designed to provide basic concepts of various modes of heat transfer like conduction, convection and radiation. It also includes the thermal analysis and sizing of heat exchangers and the basic concepts of mass transfer.

Unit – I	**Conduction:**	**9**

Introduction- Modes of heat transfer - General Differential equation of Heat Conduction– Cartesian and Polar Coordinates – One Dimensional Steady State Heat Conduction –– plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction

Unit – II	**Convection:**	**9**

Free and Forced Convection – Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes

Unit – III	**Phase Change Heat Transfer and Heat Exchangers:**	**9**

Nusselt's theory of condensation – Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation - Heat Exchanger Types – Overall Heat Transfer Coefficient – Fouling Factors – Analysis – LMTD method – NTU method.

Unit – IV	**Radiation:**	**9**

Black Body Radiation – Grey body radiation – Shape Factor – Electrical Analogy – Radiation Shields. Radiation through gases

Unit – V	**Mass Transfer:**	**9**

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy –Convective Mass Transfer Correlation

Total:45

TEXT BOOK:

1.	Yunus A. Cengel, "Heat Transfer A Practical Approach", 5th Edition, Tata McGraw Hill, 2015

REFERENCES:

1.	Rajput R.K., "Heat and Mass Transfer", 5th Revised Edition, S.Chand & Co. Ltd., New Delhi, 2015.
2.	Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems	Applying (K3)
CO2	apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems	Applying (K3)
CO3	relate the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems	Applying (K3)
CO4	elucidate basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems	Applying (K3)
CO5	apply diffusive and convective mass transfer equations and correlations to solve problems for different applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	3		2		2						2	2	3
CO2	3	3		2		2						2	3	3
CO3	3	3		2		2						2	3	3
CO4	3	3		2		2						2	3	3
CO5	3	3		2		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	15	50	35				100
CAT2	15	50	35				100
CAT3	15	50	35				100
ESE	5	40	55				100

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

22MTE03 - OPERATIONS RESEARCH							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Matrices and Ordinary Differential Equations, Multivariable Calculus and Complex Analysis, Numerical Methods for Engineers**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course will enable the application of various techniques / decision making tools to solve scarce resource problems in engineering and business world.	
Unit - I	**Linear Models:**	**9**
Introduction-Phases of OR study – Formation of LPP – Standard and Canonical form of LPP- Solutions to LPP: Graphical Solution, Simplex Algorithm, Artificial Variables Technique – Big M method, Two Phase method.		
Unit - II	**Transportation, Assignment problems and Sequencing problems:**	**9**
Transportation-Mathematical formulation-Basic Feasible solutions-NWC, LCM, VAM. Optimality test – 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:**	**9**
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**
Types of Inventory- EOQ – Deterministic inventory models – Price break problems – stochastic inventory models- multi item deterministic models- selective inventory control techniques		
Unit - V	**Queuing 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.	Vohra N.D, "Quantitative Techniques in Management", 5th Edition, McGraw Hill Education, New Delhi, 2017.
2.	Taha, Hamdy A, "Operation Research: An Introduction", 10th Edition, Pearson Education, New Delhi, 2019.
3.	Hiller Frederick S., Lieberman Gerald J, Bodhibrata Nag, Preetam Basu, "An Introduction to Operations Research", 10th 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 and solve linear programming problems	Applying (K3)
CO2	propose solutions to transportation and assignment problems & identify optimal job sequence that minimizes the make span	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 / deteriorate with time	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	1	2
CO2	3	3	3	2	2						2	2	1	2
CO3	3	3	3	2	2						2	2	1	2
CO4	3	3	3	2	2						2	2	1	2
CO5	3	3	3	2	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	10	30	60				100
CAT2	10	20	50	20			100
CAT3	10	30	50	10			100
ESE	10	25	50	15			100

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

22MTE04 - MACHINE DRAWING							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Drawing, Design of Mechanical Elements**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course helps the student to communicate the necessary technical information required for manufacture and assembly of machine components. These drawings follow rules laid down by national and International Organizations. Students have to be familiar with industrial drafting practices and thorough understanding of production drawings to make themselves fit in industries.	
Unit – I	**Introduction:**	**9**
Need of Graphical Language - Importance of Machine Drawing - Tools (from Instruments to Current Software), Classification of Machine Drawings - Principles of Machine Drawing - BIS specifications for machine drawing- lines, scales, dimensioning - Conventional representation of Machine Elements, Abbreviations and Symbols.		
Unit – II	**Projections, Sectioning, Limits, Fits and Tolerance:**	**9**
Projections-Designation – Relative position of views – Examples-Sectioning-Introduction – Types – Conventions - Examples-Limits, Fits and Tolerance-Definitions - Classifications of Fits - System of Fits - Computations - Selection of Fits - Method of Indicating Fits on Drawings - Tolerance Grade - Computations of Tolerance - Positions of Tolerance - Fundamental of Deviations - Shaft and Hole Terminology - Method of Placing Limit Dimensions - Need of Geometrical Tolerance - Geometrical Characteristics of Symbols - Indication of Minimum Material Condition - Interpretation of Indication of Geometrical Tolerance – Examples.		
Unit – III	**Screwed Fastenings:**	**9**
Screw Thread Nomenclature - Threads Form - Conventional representations- Types of Bolts – Designation - Types of Nuts and Screw - Designation of Bolted Joints - Types of Nut Locking Arrangements – Special Types of Bolts and Nuts – Washers-Joints and Key-Types of Joints - Gib and Cotter Joints, Pin Joints and Knuckle Joints, Types of key-Welded Joints-Types of Welded Joints - Representation of Welds - Symbols and its conventions.		
Unit – IV	**Drawing of Projections and Drawing of Sectional Views:**	**9**
Drawing of Projections-Orthographic view to isometric view and Isometric view to orthographic view of simple machine elements, Importance of Bill of materials - Drawing of Sectional Views-Keys, Bolts and Nuts, Coupling: Flanged, Bush Type – Footstep Bearing, Piston, Connecting Rod, Cross heads.		
Unit – V	**Assembly Drawing of Mechanical Components:**	**9**
Introduction - Types of Assembly - Assembly procedures –Assembly of: Lathe Tail stock, Machine Vice, Pipe Vice, Simple Eccentric, Screw jack, Stuffing Box, Plummer Block, Swivel Bearing and Safety Valve.		
		Total:45

TEXT BOOK:

1.	Bhatt N. D. & Panchal V.M., "Machine Drawing", 49th Edition, Charotar Publishing House Pvt. Ltd, Gujarat, 2014.

REFERENCES:

1.	Sidheswar N, Kannaiah P & Sastry V.V., "Machine Drawing", 27th Edition, Tata-McGraw Hill Education, Chennai, 2004.
2.	Design Data Book: Data Book of Engineers, 2020.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	demonstrate the basic concepts and BIS conventions of machine drawing	Understanding (K2)
CO2	demonstrate and evaluate the projections, sectioning, limits, fits and tolerance	Applying (K3)
CO3	develop sketches for fasteners and different joints	Understanding (K2)
CO4	draw and create the projections and sectional views of various mechanical elements	Applying (K3)
CO5	construct assembly drawings of mechanical components conforming to BIS conventions	Applying (K3)

Mapping of COs with POs and PSOs													
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1								2	2	3
CO2	3	2	1	1								2	2	3
CO3	3	2	1	1								2	2	3
CO4	3	2	1	1								2	2	3
CO5	3	2	1	1								2	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	5	5	90				100
CAT2	5	5	90				100
CAT3		10	90				100
ESE	5	5	90				100
*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**							

22MTE05 - INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides the knowledge on Industrial Internet of Things (IIoT) fundamentals to enhance the existing automation system for monitoring the entire planning and product lifecycle.	
Unit - I	**Introduction:**	**9**
Introduction to Application-based IoT Protocols-Infrastructure-based 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	**IIoT Architectures:**	**9**
Overview of IOT components - Various architectures of IOT and IIOT, 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**
Introduction to sensors – Transducers: Classification - Roles of sensors in IIoT- Design of sensor architecture- Special requirements for IIoT sensors- Role of actuators- Types of actuators. Protocols: HART -MODBUS-Serial and Parallel -Ethernet - BACNet - M2M.		
Unit - IV	**Protocols and Cloud:**	**9**
Introduction to Industrial data transmission – Fieldbus – Profibus – Interbus – Bitbus - CC-link -Batibus - Controller area network, DeviceNet – LonWorks - ISA 100.11a -Wireless HART -LoRa & LoRaWAN -NB-IoT- IEEE 802.11AH.		
Unit - V	**Industrial IoT- Application Domains:**	**9**
Healthcare, Power plants - Inventory management and quality control - Plant safety and security (Including AR and VR safety applications), Facility management – Oil - Chemical and pharmaceutical industry - Applications of UAVs in Industries.		
		Total:45

TEXT BOOK:

1.	Anandarup Mukherjee, Chandana Roy, Sudip Misra," Introduction to Industrial Internet of Things and Industry 4.0", 1st Edition, CRC Press,2020.

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 potentials in industrial environment	Understanding (K2)
CO2	infer the various components and architecture of IIoT	Understanding (K2)
CO3	interpret different IIoT sensors system architecture with interface standards	Applying (K3)
CO4	identify appropriate protocols and Cloud platforms for different IIoT challenges	Applying (K3)
CO5	build design thinking concepts for industrial IoT 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	2	2

CO2	2	2	2	2	3							1	2	2
CO3	2	2	2	2	3							1	2	2
CO4	2	2	2	2	3							1	2	2
CO5	3	3	3	3	3							2	3	3

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

ASSESSMENT PATTERN - THEORY

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

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

22MTE06 - ADVANCED CONTROL THEORY							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Systems and Control Engineering**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	To understand and analyze the performance of linear and nonlinear system in state space domain with and without controllers.

Unit - I	**State Space Analysis in Continuous domain**	**9**

Review of state variable representation and state variable models in continuous systems. Conversion from transfer function to various state space model - Conversion of state space model to transfer function - Non-uniqueness of state model - Eigen values and eigen vectors - State transition matrix and its properties. Solutions of state equations - Free and forced responses.

Unit - II	**State Feedback Controllers and Observers**	**9**

Controllability and observability - Relation between transfer function and state model - Effect of sampling time on controllability and observability - State feedback controllers. State estimators: Full and reduced order observer. Steady state error in state model - PI feedback controller- Deadbeat Observers - Dead beat Control.

Unit - III	**Phase Plane Analysis**	**9**

Behavior of nonlinear systems, jump resonance, sub-harmonic oscillation- Singular points Phase plane analysis: Linear and nonlinear systems - Construction of phase portraits using isoclines- Limit cycle analysis.

Unit - IV	**Describing function Analysis**	**9**

Typical nonlinearities. Describing Function of nonlinearities - Review of Nyquist criterion for linear system - Nyquist stability criteria for nonlinear system - Limit cycle oscillations - Accuracy of Describing Function method.

Unit - V	**Lyapunov Stability Analysis**	**9**

Stability in the sense of Lyapunov - Second method of Lyapunov - Lyapunov stability analysis of linear time invariant systems and non-linear system - Krasovski's theorem - Variable gradient method of generating Lyapunov functions. Lyapunov analysis for non-autonomous systems.

Total:45

TEXT BOOK:

1. Gopal M, "Digital Control and State Variable Methods", 4th Edition, Tata McGraw-Hill, New Delhi, 2017. (Units- I, II & III)
2. Slotine and Li, "Applied Nonlinear Control", 2nd Edition, Prentice Hall Publishers, USA, 1991. (Units – IV & V)

REFERENCES:

1. Richard C. Dorf & Robert H. Bishop, "Modern Control Systems", 12th Edition, Pearson Publication, New Jercy, 2013.
2. Khalil, Hasan K., "Nonlinear Systems", 2nd Edition, Prentice Hall, New Jercy, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze the time domain characteristics of continuous systems in state space domain	Applying (K3)
CO2	design state feedback controllers and observers	Applying (K3)
CO3	apply the concepts in the design of state feedback controllers and observers	Applying (K3)
CO4	analyze the behavior of nonlinear systems using describing function method	Applying (K3)
CO5	analyze the stability of linear and nonlinear systems using Lyapunov stability method	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	2	1	1	2							2	3	3
CO2	3	2	1	1	2							2	3	3
CO3	3	2	1	1	2							2	3	3
CO4	3	2	1	1	2							2	3	3
CO5	3	2	1	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	10	10	80				100
CAT2	10	10	80				100
CAT3	10	10	80				100
ESE	05	05	90				100

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

22MTE07 - AUTOMOTIVE ENGINEERING							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**PE**	**3**	**0**	**0**	**3**

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 - 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, Liquid nitrogen, Ethanol and Hydrogen in Automobiles - Fuel Cells.		
		Total:45

TEXT BOOK:

1.	Kirpal Singh, "Automobile Engineering Volume I & II", 13th Edition, Standard Publishers, New Delhi, 2020.

REFERENCES:

1.	Tom Denton, "Automobile Electrical and Electronics Systems", 4th Edition, Edward Arnold Publishers, 2017.
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	Choose the different types of suspension, brake and steering systems of an automobile	Applying (K3)
CO4	identify the types of chassis and circuit for automotive electrical systems	Applying (K3)
CO5	explain automotive accessories and alternate fuel sources 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	2		1	2	1	1		1				2	2	1
CO2	2	2	2		1							1	2	1
CO3	2				1							1	2	1
CO4	2	3	3	2	2			1				3	3	2
CO5	2		3	3	3	3	3	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	30	70					100
CAT2	20	45	35				100
CAT3	20	45	35				100
ESE	15	55	30				100

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

22MTE08 - VIRTUAL INSTRUMENTATION: THEORY AND APPLICATIONS							
Programme& Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides the fundamental knowledge on Graphical System Design programming, data acquisition and interfacing techniques of Virtual Instrumentation (VI).	
Unit - I	**Basics of Virtual Instrumentation:**	**9**
Architecture of a Graphical System Design based virtual instrument - Data Flow programming - Graphical user interface platform - G programming and modular programming - Graphical programming palettes: Control, Functions and tool palettes – Data Types: Numeric, String, and Boolean.		
Unit - II	**VI Programming Techniques:**	**9**
Structures: Loops, Shift Registers, Case, Event, Timed, Flat sequence - Expression node - Formula nodes - Arrays/Clusters - Waveform Generation - File I/O: Read/ Write - Variables: Local/Global - Sub-VI.		
Unit - III	**Data Acquisition Hardware Interface:**	**9**
Basics of DAQ hardware and software - Concepts of data acquisition and terminology - Installing hardware and drivers - NI-MAX Configuring and addressing the hardware - Communicating between the Real-time Target and Host PC		
Unit - IV	**Data Logging, Control, and Monitoring**	**9**
Measuring/Generating the Analog Input/Output: Simulating the Hardware and Validating the Measurement - Generating and Reading Digital Signal - Triggering - Timing and Synchronization Methods - Programming with the NI-DAQmx		
Unit - V	**Real time Applications:**	**9**
Instrument control: Signal processing tools - Measuring Temperature, Strain, Force, Pressure, Sound, Vibration, and Acceleration, Edges, Frequency, and Duty Cycle. Vision and Motion, Vision Acquisition and Vision Assistant tool.		
		Total:45

TEXT BOOK:

1.	Jeffery Travis & Jim Kring, "LabVIEW for Everyone: Graphical programming made easy and Fun", 3rd Edition, Pearson Education, India, 2009.

REFERENCES:

1.	Gupta, Joseph & John, "Virtual Instrumentation using LabVIEW", 2nd Edition, Tata McGraw Hill, India, 2010.
2.	Rick Bitter, Taqi Mohiuddin & Matt Nawrocki, "LabVIEW Advanced Programming Techniques", 2nd Edition, Taylor & Francis Group, New York, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the basic concepts of Virtual Instrumentation	Understanding (K2)
CO2	interpret the different software tools in Virtual Instrumentation	Applying (K3)
CO3	interface data acquisition hardware with software	Applying (K3)
CO4	develop programming concepts with data logging and control	Applying (K3)
CO5	design graphical programming solutions to real world 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	3	3	2							2	3	3
CO2	3	3	3	3	2							2	3	3
CO3	3	3	3	3	2							2	3	3
CO4	3	3	3	3	2							2	3	3
CO5	3	3	3	3	2							2	3	3

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

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	35	50				100
CAT2	10	35	55				100
CAT3	10	35	55				100
ESE	5	40	55				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22MTE09 – POWER CONVERTERS AND ELECTRIC DRIVES							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Electron Devices & Digital Circuits, Electrical Machines**	**5**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides the basics of Power semiconductor devices. It gives the principle design of Power Converters and Electric Drives.	
Unit – I	**Power Electronics Devices:**	**9**
Concept of power electronics – 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 – TRIAC – Introduction to Wide band gap semiconductors (SiC and GaN) Power Devices.		
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 – 6 pulse and 12 pulse converters- Applications of AC-DC converter. Introduction to inverter –Single phase inverters and– PWM inverters		
Unit - III	**DC - DC and AC - AC Converter:**	**9**
DC Chopper – Control strategies – Principle of operation DC to DC Converters – Types – buck and boost converter operations – Applications – Single phase AC voltage controller – On - off control and phase control – Sequence control of AC voltage controller.		
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- concept of three phase VFD control		
		Total:45

TEXT BOOK:

1.	Muhammad H. Rashid, "Power Electronics: Devices, Circuits & Applications", 4th Edition, Pearson, 2017. (Unit-I, II & III)
2.	Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2014. (Unit- IV & V)

REFERENCES:

1.	Singh M.D. & Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2013.
2.	Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2012.

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	Understanding (K2)
CO4	select a suitable power converter for a given DC drive	Applying (K3)
CO5	choose an appropriate power converter for a given AC drive	Applying (K3)

Mapping of COs with POs and PSOs

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

CO3	3	2	1		2							2	2	2
CO4	3	2	1		2							2	2	2
CO5	3	2	1		2							2	2	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	25	75					100
CAT3	30	50	20				100
ESE	20	60	20				100

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

22MTE10 - APPLIED FINITE ELEMENT METHOD							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Strength of Materials**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course gives an introduction to the finite element method which uses different numerical methods for solving a system of governing equations over the domain of a continuous physical system, which is discretized into simple geometric shapes called as finite element.

Unit – I	**Introduction to FEA:**	

Introduction to finite element analysis – Discretization – Matrix algebra – Gauss elimination method – Governing equations for continuum – Classical Techniques in FEM. Weighted residual method – Ritz method. Potential energy approach – Galerkin approach for one and two dimensions.

Unit – II	**One Dimensional Elasticity Problems:**	**9**

1-D Finite element modeling – Bar Element – Beam Element- Coordinates and shape functions – Assembly of stiffness matrix and load vector –Formulation of Element Matrices and Equations - Analysis of Truss and Beam problems – Applications to Heat Transfer problems.

Unit – III	**Two Dimensional Elasticity Problems:**	**9**

Introduction to 2-D Finite element modeling – Plane stress – Plane Strain – Displacement Equations – Element Matrices – Element Equations – Formulation using Natural Coordinates. Applications to Temperature Effects and Torsion problems.

Unit – IV	**Axisymmetric Elements:**	**9**

Axisymmetric formulation – Element stiffness matrix and force vector – Galerkin approach – Body forces and temperature effects – Stress calculations – Boundary conditions – Applications to cylinders under internal or external pressures – Rotating discs.

Unit – V	**Isoparametric Elements for Two Dimensional Continuum:**	**9**

Four node quadrilateral elements – Shape functions – Element stiffness matrix and force vector – Numerical integration - Stiffness integration – Stress calculations.

Total:45

TEXT BOOK:

1.	Rao S.S, "The Finite Element Method in Engineering", 5th Edition, Butterworth-Heinemann, United States, 2014.

REFERENCES:

1.	Cook R.D., Malkus D.S., Plesha M.E. & Witt R.J., "Concepts and Applications of Finite Element Analysis", 4th Edition, John Wiley & Sons, New Jersey, 2007.
2.	Reddy J.N., "An Introduction to the Finite Element Method", McGraw Hill, New Delhi, 2006.
3.	

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the finite element concepts used for designing engineering components	Applying (K3)
CO2	solve one dimensional structural problems for different applications using element matrix equation	Analyzing (K4)
CO3	estimate the results for a 3D domain using simple two dimensional assumptions for different applications	Analyzing (K4)
CO4	solve and analyze the engineering problems using axisymmetric assumptions	Analyzing (K4)
CO5	apply the concepts of isoparametric elements and Numerical integration techniques in FEM	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1								3	3	3
CO2	3	2	1	1								3	3	3
CO3	3	3	3	3	2							3	3	3
CO4	3	3	2	2	1							3	3	3
CO5	3	2	1	1								3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	40				100
CAT2		35	35	30			100
CAT3		35	35	30			100
ESE	10	30	30	30			100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22MTE11 - PRECISION EQUIPMENT DESIGN							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Theory of Machines**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course equips the student to realize the precision equipment design and their related inspection methods, design strategies, machines and control.

Unit – I	**Introduction to Precision Equipment Design:**	**9**

Introduction, Fundamentals of Economic Analysis - Role of a Design Engineer - Classification of ultra-precision equipment. Principles of accuracy, repeatability and resolution, Beyond Intelligent manufacturing, Reconfigurable systems, Precision Machine Design Principles and methods, Basic requirements of Precision Machine tools.

Unit – II	**Error Assessment and Inspection:**	**9**

Introduction to Errors and error measurements, Propagation of errors, Motion errors principle –translational body, rotational body, geometric and kinematic errors, Other types of errors in machines – thermal, cutting force induced, environmental error, Methodologies of error elimination, Future vision in machine error inspection, CNC machine error assessment – positioning accuracy using a Laser interferometer, contouring assessment using kinematic ball bar system.

Unit – III	**Design Strategies and Machine Key Components:**	**9**

Design strategy for standard size machines, Steps in Design roadmap, Structure design of precision machines, Machine Key components – guide ways – selection, precision linear and rotating movement, Bearings – Design considerations and applications, Second order phenomena, Vibration isolation.

Unit – IV	**Parallel Kinematic Machines (PKM):**	**9**

Comparison of Serial and parallel systems, Precision design of a PKM – need of PKM, PKM Configurations and characteristic issues, Design principles – Kinematic modeling- Case study of 3 PRS and PSS system, Computation – Method of decomposition, Method of inversion.

Unit – V	**Precision Control:**	**9**

Fundamentals of motion control, system modeling and performance assessment, linear dynamics, nonlinear dynamics – force ripple, friction, hysteresis, incorporating nonlinear dynamics, Control design strategies – ripple compensation, RBF compensation, internal model control. Case Study – Design of piezoelectric actuator.

Total:45

TEXT BOOK:

1. Samir Mekid, "Introduction to Precision Machine Design and Error Assessment", CRC-Press, Taylor and Francis Group, New York, 2013.

REFERENCES:

1. Alexander H. Slocum, "Precision Machine Design", Prentice Hall Publishers, New Jersey, 2009.
2. Zhuangde Jiang & Shuming Yang, “Precision Machines”, Springer, Singapore, 2020.
3. Kai Cheng,” Machining Dynamics -Fundamentals, Applications and Practices”, Springer London 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	assess the suitability of equipment designs concepts for specific applications	Understanding (K2)
CO2	inspect the errors in various machines like CNC machines	Applying (K3)
CO3	choose the appropriate strategy and design the structure, guideways of a precision machine	Applying (K3)
CO4	design and model various parallel kinematic machines	Applying (K3)
CO5	develop the complete control of the mechanical system to achieve a better positioning and error compensation	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**	**3**	**3**
CO2	**3**	**3**	**3**	**2**	**2**							**2**	**3**	**3**
CO3	**3**	**3**	**3**	**2**	**2**							**2**	**3**	**3**
CO4	**3**	**3**	**3**	**2**	**2**							**2**	**3**	**3**
CO5	**3**	**3**	**3**	**2**	**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	15	50	35				100
CAT2	15	50	35				100
CAT3	15	50	35				100
ESE	5	55	40				100

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

22MTE12 - COMPUTER INTEGRATED MANUFACTURING							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Processes**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides the fundamental knowledge about computer integrated manufacturing and it deals with grouping technology, Cellular manufacturing, Computer aided process planning, Flexible manufacturing systems and computer aided quality control	
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, Concepts of Industry 4.0.		
Unit – II	**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 – III	**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 – 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	understand the CIM concepts in manufacturing industries	Understanding (K2)
CO2	identify the parts by using different coding methods	Applying (K3)
CO3	develop a process plan and material requirement plan for a product	Applying (K3)
CO4	design flexible manufacturing layout for a machine cell	Applying (K3)
CO5	utilize various computer aided quality control and inspection techniques	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1							2	3	3
CO2	2	2	1	3	2							2	2	2
CO3	2	2	1	3	2							2	2	2
CO4	2	2	2	2	3							2	3	2
CO5	2	2	2	2	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	15	70	15				100
CAT2	15	70	15				100
CAT3	15	70	15				100
ESE	5	75	20				100

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

22MTE13-EMBEDDED PROGRAMMING FOR MECHATRONICS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Microcontroller Programming and Applications**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge and skill on advanced Microcontrollers and Embedded programming for Mechatronics applications	
Unit - I	**ATMEGA 8 Microcontroller:**	**9**
Architecture of ATMEGA 8 – Pin Description–. Memory organization: Program memory – Data Memory - I/O Ports – Timers – Counters – Analog comparator – Serial Peripheral Interface – USART – External Hardware Interrupts – ADC.		
Unit - II	**ATMEGA 8 Embedded C Programming:**	**9**
I/O ports: Register configuration–programming – Timers: modes– programming – Counters – ADC: configuration registers–programming – External Hardware Interrupts: Types – programming.		
Unit - III	**ARM-32 bit Microcontroller**	**9**
Thumb-2 technology and applications of ARM- Architecture of ARM Cortex M3 : Various Units in the architecture- Debugging support- General Purpose Registers -Special Registers- Exceptions -Interrupts -Stack operation- Reset sequence.		
Unit - IV	**ARM Cortex M3 Instruction Sets and Programming**	**9**
Assembly basics- Instruction list and description- Useful instructions- Memory mapping- Bus interfaces and CMSIS- Embedded C language Programming.		
Unit - V	**Microcontroller and IoT for real time applications:**	**9**
IoT: Basics- Sensing- Actuation- Networking- Communication Protocols- Integration of Sensors- Actuators and Controller in IoT Module – Application of Case Study.		
		Total:45

TEXT BOOK:

1.	Jonathan W Valvano, "Embedded Systems: Introduction to ARM Cortex™-M3 Microcontroller",Volume1, Create Space Independent Publishing Platform, 2012.

REFERENCES:

1.	Data sheet – ATMEGA 8
2.	Steve Furber., "ARM System-on-Chip Architecture",2nd Edition, Pearson, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret architecture and interfacing concepts of ATMEGA 8 microcontroller	Understanding (K2)
CO2	develop embedded programming using ATMEGA 8microcontrollers	Applying (K3)
CO3	interpret architecture and interfacing concepts of ARM CORTEX M3 microcontroller	Understanding (K2)
CO4	build embedded programming using ARM CORTEX M3 microcontroller	Applying (K3)
CO5	analyze IoT based microcontroller hardware for real time applications	Applying (K3)

Mapping of COs with POs and PSOs

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

CO4	3	3	2	3	3							2	3	3
CO5	3	3	2	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	20	50	30				100
CAT2	20	50	30				100
CAT3	25	45	30				100
ESE	20	50	30				100

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

22MTE14-MACHINE LEARNING							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Matrices and Ordinary Differential Equations, Multivariable Calculus and Complex Analysis, Problem Solving and Programming in C**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course gives an introduction about supervised, unsupervised and reinforcement learning algorithms to find patterns or make predictions from empirical data.	
Unit - I	**Mathematical Modelling of Machine Learning:**	**9**
Learning problems - Designing a learning system - Perspectives and issues in machine learning – Concept learning – Task – Search – Finding maximally specific hypotheses – Version spaces and candidate elimination algorithm-Inductive bias.		
Unit - II	**Prediction & Artificial Neural Networks:**	**9**
Linear regression – Non-Linear regression -Decision tree learning: Decision tree representation – Problems – Basic decision tree learning algorithms – Hypotheses search – Issues. **Artificial Neural Networks**: Introduction – Representations – Problems – Perceptron – Multilayer network and Back propagation algorithm – Example.		
Unit - III	**Supervised Learning & Instance Based Learning:**	**9**
Bayesian learning: Bayes theorem – Concept learning – Maximum likelihood and Least-Squared error hypothesis - Bayes optimal classifier - Gibbs algorithm - Naïve bayes classifier – Example. **Instance Based Learning:** Introduction – k-Nearest neighbor learning – Locally weighted regression - Radial basis functions - Case-based reasoning.		
Unit - IV	**Unsupervised Learning:**	**9**
K – Means – K Medoids – Genetic algorithms: Introduction – Example – Hypothesis space search – Genetic programming- Models of evolution and learning – Parallelizing genetic algorithms.		
Unit - V	**Learning Sets of Rules:**	**9**
Learning sets of rules: Introduction – Sequential covering algorithms – First order rules – FOIL – Induction as inverted deduction – Inverting resolution – Reinforcement Learning: Introduction – Markov decision processes - Values- SARSA vs Q-Learning.		
		Total:45

TEXT BOOK:

1.	Tom M. Mitchell, "Machine Learning", 1st Edition, McGraw-Hill Education (India), New york, 2017.

REFERENCES:

1.	Stephen Marsland, "Machine Learning – An Algorithmic Perspective", 2nd Edition, Chapman and Hall/CRC Press, United Kingdom, 2014.
2.	Jiawei Han, Micheline Kamber, "Data Mining Concepts and Techniques", 3rd Edition, Elsevier, Morgan Kaufmann, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the perspectives of machine learning and formulating hypothesis	Understanding (K2)
CO2	apply Regression, Decision tree and Artificial neural networks for real world problems	Applying (K3)
CO3	design a parametric and non –parametric algorithms for solving a given problem	Applying (K3)
CO4	apply the principles of unsupervised learning and genetic algorithm for optimization	Applying (K3)
CO5	implement the learning rules and reinforcement learning algorithms on datasets	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2							2	3	1
CO2	3	3	2	2	3							2	3	1
CO3	3	3	2	3	3							2	3	1
CO4	3	3	2	3	3							2	3	1
CO5	2	3	2	3	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	60	30				100
CAT2	10	40	50				100
CAT3	10	40	50				100
ESE	10	30	60				100

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

22MTE15 - PROCESS CONTROL AND INSTRUMENTATION							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Microcontroller Programming and Applications, Systems and Control Engineering**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course imparts knowledge on process dynamics and process characteristics. It emphasizes on types of control, tuning of controllers and advanced control systems. This course also includes instrumentation needed for process control and applications of various process control systems.	
Unit - I	**Introduction to Process Dynamics:**	**9**
Process control - Automatic process control - Need for automatic process control in industry - Mathematical Modeling of Processes – First order process systems - level, Temperature and pressure - Second order process systems - Interacting and non-interacting systems - Batch and continuous process - Self regulation - Servo and regulatory operation.		
Unit - II	**Control Characteristics and Tuning:**	**9**
Automatic controller - Process characteristics - Control system parameters - Discontinuous controller modes - Continuous controller modes - Composite control modes. Evaluation criteria: Performance criteria - Controller tuning: Process reaction curve method - Ziegler-Nichols method.		
Unit - III	**Control Systems with Multiple Loops:**	**9**
Advanced control systems - Feed forward control - Cascade control - Ratio control - Selective control Systems - Split-Range control - Adaptive control - Inferential control – Multi variable control.		
Unit - IV	**Process Instrumentation:**	**9**
Signal converters: I/P and P/I converters – Control valves: Characteristics, Valve positioner, Selection of control valves - Introduction to transmitters, Two wire and four wire transmitters, Smart and intelligent transmitters.		
Unit - V	**Process Control Systems:**	**9**
Boiler, Reactor, Mixing controls, Evaporation, Dryer, Heat exchanger, Distillation process.		
		Total:45

TEXT BOOK:

1.	George Stephanopoulos, "Chemical Process Control-An Introduction to Theory and Practice", 1st Edition, Pearson, New Delhi, 2015.

REFERENCES:

1.	Johnson C.D., "Process Control Instrumentation Technology", 8th Edition, PHI Learning Pvt. Ltd., New Delhi, 2006.
2.	Krishnaswamy K., "Process Control", 2nd Edition, New Age International Pvt. Ltd., New Delhi, 2013.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	develop the dynamics of processes using mathematical approach and interpret the characteristics of processes	Applying (K3)
CO2	propose the suitable control modes and examine the tuning of controllers	Applying (K3)
CO3	select suitable control system for various industrial processes	Applying (K3)
CO4	choose the instrumentation to control the process	Understanding (K2)
CO5	apply suitable control for process control systems	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO 8	PO 9	PO1 0	PO11	PO1 2	PSO1	PSO2
CO1	3	2	1									2	3	3
CO2	3	2	2	2	3							2	3	3
CO3	3	2	3	3	3							2	3	3

CO4	3	2	3	3	3							2	3	3
CO5	3	2	3	3	3							2	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	65	15				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	5	60	35				100

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

22MTE16 - AUTOMOTIVE ELECTRONICS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with electronics and emission control systems in automobiles. It also provides the knowledge about different sensors, actuators and engine control units for improving the performance of automobiles.

Unit – I	**Introduction:**	**9**

Evolution of electronics in automobiles – Introduction to Euro I, Euro II, Euro III, Euro IV, Euro VI standards – Equivalent Bharat Standards. Charging systems: Working, Charging circuit diagram – Alternators – Requirements of starting system - Starter motors and starter circuits. Introduction to hybrid and electric vehicles.

Unit – II	**Sensors and Actuators:**	**9**

Working principle and characteristics of sensors: Airflow rate, Engine crankshaft angular position, Hall effect, Throttle angle, temperature, Exhaust gas oxygen sensor. Exhaust gas recirculation actuators, Stepper motor actuator and vacuum operated actuator.

Unit – III	**Ignition and Injection Systems:**	**9**

Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed ignition – Distribution less ignition - Direct ignition – Spark Plugs. Electronic fuel control - Engine fuelling and exhaust emissions – Electronic control of carburetion – Petrol fuel injection – Diesel fuel injection.

Unit – IV	**In-Vehicle Networks, Engine and Emission Systems:**	**9**

In vehicle networks: CAN, LIN, FLEXRAY, MOST, KWP2000. Control modes for fuel control-engine control subsystems – Ignition control methodologies – Engine management system. Catalytic converter – EGR – SCR – lean NOX Trap. Turbo charger & Super charger.

Unit – V	**Chassis and Safety Systems:**	**9**

Electronic transmission control. Traction control system – Adaptive cruise control – Antilock braking system - Electronic Stability Program – Electronic suspension system – Working of airbag and role of MEMS in airbag systems –Seat belt tensioners. Centralized door locking system – Climate control of cars, Automotive lighting circuits.

Total:45

TEXT BOOK:

1.	Tom Denton, "Automobile Electrical and Electronics Systems", 5th Edition, Routledge Taylor and Francis Publishers, London, 2018. (Units-I, II & III)
2.	Ribbens William B, "Understanding Automotive Electronics", 8th Edition, Butterworth- Heinemann, Burlington, 2017. (Units – IV & V)

REFERENCES:

1.	James D Halderman, "Automotive Electricity and Electronics", 6th Edition, Pearson Education, New York, 2020.
2.	Najamuz Zaman, “Automotive Electronics Design Fundamentals”, 1st Edition, Springer International Publishing, Switzerland, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	adapt to the continuous changes in emission norms of India and its supporting electronic systems	Understanding (K2)
CO2	identify the various sensors and actuators for automotive applications	Applying (K3)
CO3	explain the use of electronic ignition and injection system in automobiles	Understanding (K2)
CO4	understand about in-vehicle networking, engine and emission management system	Applying (K3)
CO5	apply the concepts of chassis and safety systems for automobile up gradation	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	2	3		1	2	2				2	1	2
CO2	1	1	3	1			1	1				1	3	3
CO3	3	1	2	1			1					2	3	3
CO4	3	1	3	3	2		1					2	3	3
CO5	2	2	1				1	1				3	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	30	40	30				100
CAT2	25	50	25				100
CAT3	20	45	35				100
ESE	15	65	20				100

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

22GEE01 - TOTAL QUALITY MANAGEMENT							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Numerical Methods for Engineers**	**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**
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**
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**
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**
The new seven tools of quality – Benchmarking: Need - Types and process; Quality Function Deployment(QFD)-HOQ construction - case studies; Taguchi's Robust design-Quality loss function - Design of Experiments (DOE); Total Productive Maintenance(TPM)-uptime enhancement; Failure Mode and Effect Analysis (FMEA)-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 ISO 14000 - IATF 16949 - TL 9000-IEC 17025- ISO 20000 - ISO 22000. Process of implementing ISO - Barriers in TQM implementation.		
		Total:45

TEXT BOOK:

1.	Besterfield Dale H., Besterfield Carol, Besterfield Glen H., Besterfield Mary, Urdhwareshe Hemant, Urdhwareshe Rashmi. "Total Quality Management", 5th Edition, Pearson Education, Noida, 2018.

REFERENCES:

1.	Subburaj Ramasamy, "Total Quality Management", McGraw Hill Education, New Delhi, 2017.
2.	James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, Cengage Learning, 2012.
3.	David Goetsch & Stanley Davis, "Quality Management for Organizational Excellence: Introduction to Total Quality", 8th Edition, Pearson, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	comprehend the quality principles and exhibit proper leadership style	Applying (K3)
CO2	interpret the principles and strategies of TQM and apply appropriately	Applying (K3)
CO3	choose appropriate control chart to monitor a process	Analyzing (K4)
CO4	apply various quality tools and techniques in both manufacturing and service industry	Analyzing (K4)
CO5	implement the concepts of quality management system and ISO.	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	2	3	2	2	1	1	2	3
CO2	1	1				3	2	3	3	3	1	1	2	3
CO3	3	2	2	2	2	2		1	2	2	1	1	2	3
CO4	2	2	2	2	2	2		1	2	2	1	1	2	3
CO5						3	3	2	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	60	20				100
CAT2	20	30	30	20			100
CAT3	20	30	30	20			100
ESE	20	30	30	20			100

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

22MTE17 - BIO MECHATRONICS							
Programme & Branch	**B.E. Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	The course focuses on the study of assistive, therapeutic and diagnostic devices to compensate the loss of human physiological functions or to enhance these functions.	
Unit - I	**Introduction to Bio-Mechatronics:**	**9**
Components of Bio mechatronic Systems - Physiological Systems - Sensors and Transducers - Electromechanical Actuators - Feedback Mechanisms - System Representation - Signal Acquisition - Digital Signal Processing		
Unit - II	**Control Mechanism of Biological Systems:**	**9**
Skeletal muscles servomechanism: muscle fibre anatomy – loop control, cardio vascular control mechanism: The Heart as a Pump - Heart-Lung Machines - Artificial Hearts - Heart Assist Devices, respiratory control mechanism: The Mechanics of Respiration - Lung Characteristics - Mechanical Ventilation		
Unit - III	**Prosthetic and Orthotic Devices:**	**9**
Introduction to prosthetics, Passive Prosthetics – walking dynamics, Knee and foot prosthesis. Active prosthesis - Control of Prosthetic Arms and Hands, Leg Mechanisms-Orthotic devices		
Unit - IV	**Wearable Mechatronics Devices:**	**9**
Wearable artificial kidney, wireless capsule endoscope, wearable exoskeletal rehabilitation system, wearable hand rehabilitation		
Unit - V	**Modelling of Bio-mechatronics:**	**9**
Introduction to model the skeletal system using open source software– human leg prosthesis and normal gait vs prosthesis leg analysis - upper extremity kinematic model		
		Total:45

TEXT BOOK:

1.	Graham M. Brooker, "Introduction to Bio-Mechatronics", Sci Tech Publishing, New Delhi, 2012.

REFERENCES:

1.	Raymond Tong Kaiyu, "Bio-mechatronics in Medicine and Healthcare", CRC Press, US, 2011.
2.	Jacob Segil, "Handbook of Biomechatronics", Academic Press, US, 2018.
3.	Leslie Cromwell, Fred J. Weibell & Erich A. Pfeiffer, “Bio-Medical Instrumentation and Measurements”, 2nd Edition, Pearson Education, New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	summarize the application of mechatronics in medicine	Understanding (K2)
CO2	explain the control mechanisms of biological systems	Understanding (K2)
CO3	explain the working of prosthetic and orthotic devices	Understanding (K2)
CO4	select appropriate dynamic models of bio mechatronic systems	Applying (K3)
CO5	apply computing tools to analyzing kinematic model	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	2	1	1	2	1						2	2	3
CO2	1	2	3	1	2	2						2	2	3
CO3	1	2	3	1	2	2						2	2	3
CO4	2	2	3	3	2	2						2	2	3
CO5	3	2	3	3	2	3						2	3	3

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

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	30				100
CAT2	20	50	30				100
CAT3	20	30	50				100
ESE	20	40	40				100
*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**							

22MTE18 - PRECISION MANUFACTURING							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Processes**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	To impart knowledge in unconventional manufacturing and high precision finishing methods.	
Unit – I	**Introduction and Mechanical Energy Based Processes:**	**9**
Unconventional machining processes – Need – Classification of modern machining processes. Abrasive Jet Machining (AJM)- Water Jet Machining (WJM)- Abrasive Water Jet Machining (AWJM)- Ultrasonic Machining (USM) - Working Principles – Equipment – Process parameters – MRR – SR.		
Unit – II	**Electrical Energy Based Processes:**	**9**
Electric Discharge Machining (EDM)- Working Principle – Equipment used - Process Parameters - Surface Finish - MRR - electrode / Tool – Power and control circuits - Tool Wear – Dielectric – Flushing – Applications., Wire cut EDM – Principles – Equipment –Types –Applications.		
Unit – III	**Chemical and Electro-Chemical Energy Based Processes:**	**9**
Chemical Machining- Etchants used – Maskant - Techniques of maskants - Process Parameters – Surface finish and MRR - Applications. Electro-Chemical Machining: Principles of ECM – equipment used - Surface Roughness and MRR - Electrical circuit - Process Parameters. ECG and ECH – Working principle – Applications.		
Unit – IV	**Thermal Energy Based Processes:**	**9**
Laser Beam Machining (LBM) - Process Parameters – Surface finish and MRR - Applications. Plasma Arc Machining (PAM) and Electron Beam Machining (EBM)- Beam control techniques – Working Principles – Equipment – Process parameters – MRR – Applications.		
Unit – V	**High Precision Finishing Processes:**	**9**
Abrasive Flow Finishing (AFM)- Introduction -Working Principles – Equipment – Process parameters – Application. Magnetic Abrasive Finishing (MAF)- Working Principles – Equipment – Process parameters – Application. Magneto Rheological Finishing (MRF): Working Principles – Equipment – Process parameters – Applications.		
		Total:45

TEXT BOOK:

1.	Gary F. Benedict, "Non-traditional Manufacturing Processes", Special Indian Edition, CRC Press, Florida, 2019.

REFERENCES:

1.	McGeough J.A, "Advanced Methods of Machining", Springer, Switzerland, 2014.
2.	Jain Vijay K, "Advanced Machining Processes", Allied Publishers Pvt. Ltd, New Delhi, 2009.
3.	Pandey P.C & Shan H.S, "Modern Machining Processes", Tata McGraw-Hill, New Delhi, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	choose mechanical energy based unconventional machining processes for various applications	Understanding (K2)
CO2	apply the electrical energy based processes for unconventional machining	Applying (K3)
CO3	utilize chemical and electro-chemical energy based processes for machining	Understanding (K2)
CO4	interpret thermal energy based processes for unconventional machining	Understanding (K2)
CO5	select the appropriate high precision finishing process for various 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	1						1	2	3	2
CO2	3	2	2	2	1						1	2	3	2
CO3	3	2	2	2	1						1	2	3	2
CO4	3	2	2	2	1						1	2	3	2
CO5	3	2	2	2	1						1	2	3	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	13	56	31				100
CAT2	13	56	31				100
CAT3	13	56	31				100
ESE	6	60	34				100

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

22MTE19 - DIGITAL TWIN AND INDUSTRY 5.0							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Programmable Automation Controllers**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides an fundamental concepts of Digital Twin to develop smart industry with pro-active decision making with automated maintenance management.	
Unit – I	**Introduction**	**9**
Digital twin – Definition - Types of Industry and its key requirements – Importance - Application of Digital Twin: Process -Product-Service industries- History of Digital Twin - Digital Twin role in industry innovation -Technologies/tools enabling Digital Twin.		
Unit - II	**Digital Twin in a Discrete Industry**	**9**
Basics of Discrete Industry – Trends in the discrete industry – control system requirements in a discrete industry – Digital Twin of a Product – Digital Thread in Discrete Industry -Data collection on analysis for product and production improvements.		
Unit - III	**Digital Twin in a Process Industry**	**9**
Basics of Process Industry – Trends in the process industry – control system requirements in a process industry – Digital Twin of a plant – Digital Thread in process Industry, Data collection and analysis for process improvements, process safety – Automation simulation – Introduction to Digital Enterprise		
Unit - IV	**Industry 5.0**	**9**
Industrial Revolutions, Industry 5.0 – Definition – Principles- Application of Industry 5.0 in process and discrete industries - Benefits of Industry 5.0 -Challenges in Industry 5.0 - Smart manufacturing -Internet of Things -Industrial Gateways -Basics of Communication requirements.		
Unit – V	**Advantages of Digital Twin**	**9**
Improvement in product quality -Production process - Process Safety - Identify bottlenecks and improve efficiency- Achieve flexibility in production- Continuous prediction and tuning of production process through Simulation - Market analysis and survey.		
		Total:45

TEXT BOOK:

1.	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019

REFERENCES:

1.	Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing, Switzerland, 2017
2.	Ibrahim Garbie, “Sustainability in Manufacturing Enterprises, Concepts, analyses and assessments for Industry 4.0”, Springer, Switzerland, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	acquire knowledge on digital twin and its importance in smart industry	Understanding (K2)
CO2	infer the importance of digital twin in discrete Industry	Understanding (K2)
CO3	interpret the significance of digital twin in process industry	Understanding (K2)
CO4	understand the concept of Smart Manufacturing using Industry 5.0	Understanding (K2)
CO5	able to correlate the digital twin knowledge in overall safety and production cycle	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	1						1	2	2	2
CO2	2	2	3	2	1						1	2	2	2
CO3	2	2	3	2	1						1	2	2	2

CO4	2	2	3	2	1						1	2	2	2
CO5	2	2	3	2	1						1	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	15	85					100
CAT2	15	85					100
CAT3	15	65	20				100
ESE	15	70	15				100

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

22MTE20 - OPTIMAL AND ADAPTIVE CONTROL							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Systems and Control Engineering**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	To provide the knowledge about fundamental concepts of optimal and adaptive control techniques.	
Unit - I	**Introduction**	**9**
Matrix properties and definitions – Quadratic forms and definiteness – State space form for continuous systems. Calculus of variations: Fundamental concepts – The functionals of a single function- Optimal Control Formulation: The Performance measure: Performance measures for optimal control problems, selecting a performance measure.		
Unit - II	**Linear Quadratic Optimal Control Systems**	**9**
Problem formulation – Linear regulator problem -Infinite time linear quadratic regulator – Meaningful interpretation of Riccati coefficient – Analytical solution of algebraic Riccati equation – Equivalence of open loop and closed loop. Design of LQR: Inverted pendulum, DC motor speed control.		
Unit - III	**Dynamic Programming**	**9**
The Optimal control law -Principle of optimality – Dynamic programming applied to routing problem – Recurrence relation of dynamic programming – Computational procedure for solving optimal control problems- Characteristics of dynamic programming solutions		
Unit - IV	**Self-Tuning Regulators**	**9**
Introduction to adaptive control -classification -Pole placement design, Direct and Indirect self-tuning regulators, continuous time self-tuners, minimum variance and moving average controllers, stochastic direct and indirect self-tuning regulators, linear quadratic self-tuning regulators		
Unit - V	**Model Reference Adaptive control**	**9**
The MIT rule- Lyapunov theory - Design of model reference adaptive controller using MIT rule and Lyapunov theory - Relation between MRAS and STR, Introduction to Adaptive back stepping.		
		Total:45

TEXT BOOK:

1.	Kirk, Donald E. "Optimal Control Theory: An Introduction" 1st Edition, Dover publications, USA, 2004. (Units -I, II & III)
2.	Karl J Astrom and Bjorn Wittenmark, "Adaptive Control", 2nd Edition reprint, Addison Wesley, USA, 2013. (Units – IV & V)

REFERENCES:

1.	Desineni Subbaram Naidu, "Optimal Control Systems" 1st Edition, CRC Press, London,2018.
2.	Rolf Isermann and Macro Munchhof, "Identification of dynamic systems an introduction with applications", 8th Edition, Springer Verlag, Berlin, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret optimal control problem	Understand(K2)
CO2	apply the concepts in the design of optimal controller using LQR concepts	Applying (K3)
CO3	develop optimal control solution for discrete systems using dynamic programming	Applying (K3)
CO4	infer knowledge on model reference adaptive control and self-tuning control systems	Understand (K2)
CO5	Implement the aspects of adaptive control and its applications	Applying (K3)

Mapping of COs with POs and PSOs

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

CO4	3	2	1	1	1							2	3	3
CO5	3	2	1	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	10	10	80				100
CAT2	10	10	80				100
CAT3	10	10	80				100
ESE	05	05	90				100

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

22GEE02 - FUNDAMENTALS OF RESEARCH							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course familiarizes the fundamental concepts/techniques adopted in research, problem formulation and also disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.	
Unit – I	**Introduction to Research**	**9**
Introduction to Research: Types and Process of Research - Outcomes of Research - Sources of Research Problem - Characteristics of a Good Research Problem - Errors in Selecting a Research Problem - Importance of Keywords.		
Unit – II	**Literature Review**	**9**
Literature Review: Literature Collection - Methods - Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.		
Unit – III	**Research Methodology**	**9**
Research Methodology: Appropriate Choice of Algorithms/Methodologies/Methods – Data Collection – Primary Data Analysis – Experimental Methods and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations.		
Unit – IV	**Journals and Papers**	**9**
Journals and Papers: Journals in Science/Engineering - Indexing and Impact factor of Journals. Plagiarism and Research Ethics. Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study.		
Unit – V	**Reports and Presentations**	**9**
How to Write a Report - Language and Style - Format of Project Report - Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc - Different Reference Formats. Presentation using PPTs. Research Tools.		
		Total:45

TEXT BOOK:

1.	Walliman, Nicholas. "Research Methods: The basics". 2nd edition, Routledge, 2017., for Units I, II, III, IV & V

REFERENCES:

1.	Mishra, S.B. and Alok, S. "Handbook of research methodology" Educreation Publishing, 2017
2.	Kumar, Ranjit. "Research Methodology: A step-by-step guide for beginners". SAGE Publications Limited, 2019.
3.	Nayak, J.K. and Singh, P. "Fundamentals of Research Methodology Problems and Prospects". SSDN Publishers & Distributors, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	list the various stages in research and categorize the quality of journals	Applying (K3)
CO2	formulate a research problem from published literature/journal papers	Evaluating (K5)
CO3	write, present a journal paper/ project report in proper format	Creating (K6)
CO4	select suitable journal and submit a research paper	Applying (K3)
CO5	compile a research report and the presentation	Applying (K3)

Mapping of COs with POs and PSOs

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

CO4	3	2	1	1	2	1	1	3	2	1	1	3	3	3
CO5	3	3	2	2	3	1	1	3	3	3	1	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

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

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

22MTE21 - ELECTRIC AND HYBRID VEHICLES							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with alternative sources of electric and hybrid vehicles and their subsystems.	
Unit – I	**Need for Alternative System:**	**9**
Need for hybrid and electric vehicles – main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. Case study on specification of electric and hybrid vehicles.		
Unit – II	**Energy Sources:**	**9**
Battery Parameters- – Different types of batteries – Lead Acid- Nickel Metal Hydride – Lithium ion-Sodium based- Metal Air. Battery Modeling- Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.		
Unit – III	**Electric Propulsion unit:**	**9**
Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.		
Unit – IV	**Sizing the drive system:**	**9**
Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.		
Unit – V	**Energy Management Strategies:**	**9**
Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Introduction to various charging techniques and schematic of charging stations.		
		Total:45

TEXT BOOKS:

1.	James Larminie, J. Lowry, “Electric Vehicle Technology Explained”, 2nd Edition, Wiley India Pvt Ltd, New Delhi, 2018. (Units – I, II & III)
2.	M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004. (Units – IV & V)

REFERENCES:

1.	S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”,Springer, 2015.
2.	Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, 3rd Edition, CRC Press, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the need for hybrid and electric vehicles as alternative sources	Applying (K3)
CO2	infer the different types of energy sources for hybrid and electric vehicles	Understanding (K2)
CO3	utilize the concept of electric propulsion unit	Applying (K3)
CO4	Able to size the drive system of electric and hybrid vehicles	Applying (K3)
CO5	select the energy management strategies for automobile up gradation	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	3		2	2	2				2	2	2
CO2	1	1	3	1			1	1				1	3	3
CO3	3	2	2	1			1					2	3	3
CO4	3	1	3	3	2		1					2	3	3
CO5	2	2	1				1	1				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	50	30				100
CAT2	25	50	25				100
CAT3	20	50	30				100
ESE	15	65	20				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22MTE22 - MACHINE TOOL CONTROL AND CONDITION MONITORING							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides the knowledge in machine tool control and condition monitoring based on Mechatronics principles.	
Unit – I	**Overview of Automatic Control in Machine Tools:**	**9**
Open loop and closed loop system in machine tools- process model formulation-transfer function. Control actions-block diagram representation of mechanical pneumatic and electrical systems. Process computer Peripherals - Data logger-Direct digital controlSupervisory computer control.		
Unit – II	**Adaptive Control and PLC:**	**9**
Adaptive control-types – ACC, ACO, Real time parameter estimation, Applications- adaptive control for turning, milling, grinding and EDM. Programmable logic controller-Functions-Applications in machine tools		
Unit – III	**Condition Monitoring:**	**9**
Cost comparison with and without CM – On-load testing and offload testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis.		
Unit – IV	**Vibration, Acoustic Emission and Sound Monitoring:**	**9**
Primary & Secondary signals, Online and Off -line monitoring. Fundamentals of Vibration, Sound, Acoustic Emission. Machine Tool Condition Monitoring through Vibration, Sound, Acoustic Emission, Case Studies.		
Unit – V	**Condition Monitoring through Other Techniques:**	**9**
Visual & temperature monitoring, Leakage monitoring, Lubricant monitoring, condition monitoring of Lube and Hydraulic systems, Thickness monitoring, Image processing techniques in condition monitoring.		
		Total:45

TEXT BOOK:

1.	Mishra R.C. & Pathak K., "Maintenance Engineering and Management", 2nd Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2012.

REFERENCES:

1.	Sushil Kumar Srivstava, "Industrial Maintenance Management", 6th Edition, S.Chand & Company Ltd, New Delhi, 2014
2.	Mikell P. Groover, "Automation, Production Systems and Computer-Integrated Manufacturing", 4th Edition, Pearson Education India, 2016
3.	Amiya Ranjan Mohanty, “Machinery Condition Monitoring: Principles and Practices”, CRC Press, 2015

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	comprehend the concepts of automatic control in machine tools	Understanding (K2)
CO2	choose the type of adaptive control and PLC for machining operations	Applying (K3)
CO3	identify condition monitoring techniques for various applications	Applying (K3)
CO4	apply the condition monitoring technique for the machine tool through vibration, acoustic emission and sound analysis	Applying (K3)
CO5	Illustrate the various monitoring techniques associated with machine tools	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

CO2	3	2	1		1							2	1	2
CO3	3	2	3	2	1							2	1	2
CO4	3	2	3	2	1							2	1	2
CO5	3	2	3	2	1							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	55	20				100
CAT2	25	55	20				100
CAT3	25	55	20				100
ESE	10	70	20				100

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

22MTE23 - ADDITIVE MANUFACTURING							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides scientific as well as technological aspects of various additive, and formative rapid manufacturing processes. Variety of applications also be covered ranging from rapid prototyping to mass customization.	
Unit – I	**Introduction to Additive Manufacturing:**	**9**
Evolution, fundamental fabrication processes, CAD for RPT, product design and rapid product development - Need for time compression in product development - Conceptual design - Detail design, Prototype fundamentals - Fundamentals of RP systems – RP process chain - 3D modelling -3D solid modeling software and their role in RPT - Data format - STL files- History of RP systems - Classification of RP systems - Benefits of RPT.		
Unit - II	**Liquid based RP systems:**	**9**
Stereo Lithography Apparatus (SLA): Principle, Photo polymers, Post processes, Process parameters, Machine details, Advantages. Solid Ground Curing (SGC): Principle, Process parameters, Process details, Machine details, Limitations. Solid Creation System (SCS): Principle, Process parameters, Process details, Machine details, Applications.		
Unit - III	**Solid based RP systems:**	**9**
Fusion Deposition Modeling (FDM): Principle, Raw materials, BASS, Water soluble support system, Process parameters, Machine details, Advantages and limitations. Laminated Object Manufacturing (LOM): Principle, Process parameters, Process details, Advantages and limitations. Solid Deposition Manufacturing (SDM): Principle, Process parameters, Process details, Machine details, Applications.		
Unit - IV	**Powder based RP systems:**	**9**
Selective Laser Sintering (SLS): Principle, Process parameters, Process details, Machine details, Advantages and applications. 3-Dimensional Printers (3DP): Principle, Process parameters, Process details, Machine details, Advantages and limitations. Laser Engineered Net Shaping (LENS): Principle, Process details, Advantages and applications.		
Unit – V	**Rapid Tooling and Applications of RP:**	**9**
Direct Rapid Tooling, Indirect Rapid Tooling: Soft tooling and Hard tooling. Applications of RP in Product design, Automotive industry, and Medical field – Conversion of CT/MRI scan data - Customized implant - Case studies -Reverse engineering.		
		Total:45

TEXT BOOK:

1.	Chua C.K.,Leong K..& Lim C.S., "Rapid prototyping: Principles and Applications", 3rd Edition, World scientific, Newjersy, 2010.

REFERENCES:

1.	Pham D.T. & Dimov S.S., "Rapid Manufacturing", Springer -Verlag, London, 2011.
2.	Amitabha Ghosh, "Rapid Manufacturing a Brief Introduction", Affiliated East West Press, New Delhi, 2011.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	develop 3D model for RP process in different file format	Applying (K3)
CO2	select the suitable liquid based rapid prototyping system for a specific application	Applying (K3)
CO3	identify the suitable solid based rapid prototyping system for a specific application	Applying (K3)
CO4	choose the suitable powder based rapid prototyping system for a specific application	Applying (K3)
CO5	apply the concepts of rapid prototyping in product design and development	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	55	30				100
CAT2	15	55	30				100
CAT3	15	55	30				100
ESE	6	60	34				100

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

22MTE24- INDUSTRIAL AUTOMATION PROTOCOLS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides the basic concepts of data networks and different industrial automation protocols standards and its functions in modern industrial world.	
Unit – I	**Introduction to Networks in Industrial Automation:**	**9**
Information flow requirements – Hierarchical communication model – Network requirements - Data Communication basics – OSI reference model – Industry network – Recent network.		
Unit - II	**Data Network Fundamentals:**	**9**
EIA 232 interface standard – EIA 485 interface standard – EIA 422 interface standard – Current loop and serial interface converters – Data link control protocol – Media access protocol: Command/response – Token passing and CSMA/CD – TCP/IP – Bridges – Routers – Gateways.		
Unit - III	**HART and MODBUS Protocol:**	**9**
Introduction – Evolution of signal standard – HART communication protocol – Communication modes – HART networks– HART commands – HART applications – MODBUS protocol structure –Transmission modes – Function codes – Troubleshooting.		
Unit - IV	**Fieldbus and Profibus:**	**9**
Introduction - General Fieldbus architecture, Basic requirements of Fieldbus standard, Fieldbus topology, Interoperability and Interchangeability. Profibus: Introduction, Profibus protocol stack, Profibus communication model, Communication objects, System operation and Troubleshooting – Foundation fieldbus versus Profibus.		
Unit – V	**AS-interface (AS-i), Devicenet and Industrial Ethernet:**	**9**
Introduction, Physical layer, Data link layer and Operating characteristics. Devicenet: Introduction, Physical layer, Data link layer and Application layer. Industrial Ethernet: Introduction – core elements of Ethernet, Ethernet frame format, toplolgy overview-Overview of Ethernet versions – 10Base Ethernet and 100Base Ethernet.		
		Total:45

TEXT BOOK:

1.	Bela G. Liptak & HalitEren, "Instrument Engineers Handbook: Process Software and Digital Networks", 4th Edition, CRS Press, New York, 2011.

REFERENCES:

1.	Mackay S., Wright E., Reynders D. & Park J., "Practical Industrial Data Networks: Design, Installation and Troubleshooting", Newnes Publication, Burlington, 2004.
2.	Jonas Berge, "Field Buses for Process Control: Engineering, Operation, and Maintenance", ISA Press, New York, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the basic network requirements for Industrial automation	Understanding (K2)
CO2	infer the fundamental knowledge of data networks	Understanding (K2)
CO3	able to identify the purpose of HART and MODBUS Protocol for Networked Industrial Automation	Understanding (K2)
CO4	infer the FIELDBUS and PROFIBUS requirements in industrial automation network	Applying (K3)
CO5	classify the functions of AS-I, Device net and Ethernet in industrial network	Applying (K3)

Mapping of COs with POs and PSOs

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

CO3	3	3	2	3	1							1	3	3
CO4	3	3	2	3	1							1	3	3
CO5	3	3	2	3	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	15	55	30				100
ESE	10	70	20				100

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

22MTE25 - ROBOT PROGRAMMING

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	**Problem Solving and Programming in C, Mechanics of Serial Manipulator**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course enables the student as industry ready robot programmer and application engineer.	
Unit – I	**Introduction to Robot Programming:**	**9**
Introduction – Robot Configuration – Robot Kinematics – Tool Centre Point - Co-ordinate systems – Interpolation – Jogging – Work Envelope –Singularities – Position – Orientation – Reachability – Accuracy – Robot Calibration – Robot System Components – Controller – Teach Pendent.		
Unit – II	**Introduction to RAPID Programming:**	**9**
RAPID Data – Controlling the Program Flow – RAPID Syntax. RAPID Robot Functionality – Move Instruction – User Interaction. Structure – RAPID Procedure – Modules – Structured Design - Arrays.		
Unit – III	**RAPID Data Types:**	**9**
Program Structure – Modules – Routines - Program Data – Data Types – Data Declarations -Expressions – Instructions – Decision Making – Motion settings – Motion – I/O Signals – Communication protocols.		
Unit – IV	**RAPID Instructions:**	**9**
Interrupts – Error recovery – Undo – System & time – Mathematical instruction- External computer communication – File Operations – RAPID Support Instructions – Calibration & Service – String Functions- Multitasking – Backward Execution		
Unit – V	**Applications of Robot Programming:**	**9**
Application development guidelines for handling – Arc welding – Spot welding. Offline programming – An Introduction to Robot studio – Design of Robot Cell – Cycle time study – Cost analysis.		
		Total:45

TEXT BOOK:

1.	ABB, Technical Reference Manual: RAPID – An overview Reference Manual.

REFERENCES:

1.	ABB, Technical Reference Manual: RAPID – Instructions, Functions and Data Types
2	ABB, Operating Manual: Robot Studio
3	ABB. Technical Reference Manual: Introduction to RAPID

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the parts of robot and its constraints in movement and operation	Understanding (K2)
CO2	Perform different rapid data functions	Applying (K3)
CO3	analyse the application constraints while using industrial robot	Applying (K3)
CO4	perform different rapid instructions	Understanding (K2)
CO5	design a simple work cell layout for robot applications	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	60	30				100
CAT2	10	40	50				100
CAT3	10	60	30				100
ESE	10	40	50				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22MTE26 - DRONE TECHNOLOGY							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Problem Solving and Programming in C, Theory of Machines**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course strives to identify and introduce Drones or UAVs (Unmanned Aerial Vehicles) as piloted by remote control or on-board computers through computer vision and artificial intelligence technologies.	
Unit – I	**Unit Title: Introduction to Unmanned Aerial Vehicles (UAV):**	**9**
Overview and background: history of UAVs, classifications of UAVs, lift generation method. Contemporary applications like military, government and civil areas.		
Unit – II	**Unit Title: Unmanned Aerial System (UAS) components:**	**9**
Platforms - configurations - characteristics – applications. Propulsion: internal combustion engines, turbine engines, electric systems. On-board flight control – Payloads: sensing/surveillance, weaponized UAS and delivery. Communications: command/control, telemetry. Launch/recovery systems - Ground control stations		
Unit – III	**Unit Title: Basic Concepts of Flight:**	**9**
Aerodynamics: lift, weight, thrust, and drag. Flight performance: climbing vs. gliding flight, range / endurance - Stability and control: flight axes, flight controls, autopilots. Emergency identification and handling - Fixed wing operations: Types of fixed wing drones, make, parts, terminology and operation.		
Unit – IV	**Unit Title: Drone Equipment Maintenance:**	**9**
Maintenance of drone, flight control box - Maintenance of ground equipment- batteries - Scheduled servicing - Repair of equipment - Fault finding and rectification - Weather and meteorology.		
Unit – V	**Unit Title: Regulatories and Regulations:**	**9**
Homeland regulatory: FCC, FAA. Regulations: FCC compliance, UAS registration, Federal Aircraft Regulations (FARs) - Safety considerations. Operational considerations like liability / legal issues, ethical implications.		
		Total:45

TEXT BOOK:

1.	Paul Fahlstrom, Thomas Gleason, "Introduction to UAV Systems", 5th Edition, John Wiley & Sons, New Jersey, 2022.

REFERENCES:

1.	Randal W. Beard & Timothy W. McLain, "Small Unmanned Aircraft: Theory and Practice", 1st Edition, Princeton University Press, Newjersy, 2012.
2.	Jha, "Theory, Design, and Applications of Unmanned Aerial Vehicles", 1st Edition, CRC press, Florida, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer knowledge on the development and potential of uav in professional activities	Understanding (K2)
CO2	interpret the features and characteristics of an unmanned aerial system	Applying (K3)
CO3	infer on flight operation and control using drone	Applying (K3)
CO4	realize the drone equipment maintenance and repair	Understanding (K2)
CO5	interpret the regulatory measures and regulations in UAV operation	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	3	2	3	1							2	3	3
CO2	2	3	2	3	1							2	3	3
CO3	2	3	2	3	1							2	3	3
CO4	2	3	2	3	1							2	3	3
CO5	2	3	2	3	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	15	65	20				100
CAT2	15	65	20				100
CAT3	30	70	-				100
ESE	5	65	30				100

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

22MTE27- MAINTENANCE ENGINEERING							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course enables the student to understand the principles, functions and practices adapted in industry for the successful management of maintenance activities and repair of machine elements	
Unit – I	**Principles and Maintenance System Planning**	**9**
Introduction to repair and Maintenance – Maintenance as business – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems: Maintenance systems – reactive, preventive or proactive systems – Maintainability – Inherent and overall availability – Mean time between failures, Mean time to repairs and mean down time.		
Unit – II	**Condition Based Maintenance:**	**9**
Introduction to Condition based monitoring of equipment and systems; Condition Monitoring Techniques -Vibration analysis– Ultrasonic detection techniques -Thermograph - lubrication methods and its analysis – Motor condition monitoring (MCM); Cost comparison with and without CM; On-load testing and off-load testing methods – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis.		
Unit – III	**Maintenance Techniques:**	**9**
Total Productive Maintenance (TPM) –Relationship between Overall Equipment Effectiveness (OEE) and world class Maintenance – seven modern tools –applications - Ladder of Maintenance improvement–Computerized online health monitoring of machine–data acquisition for effective management of Computerized Maintenance Management System (CMMS).		
Unit – IV	**Failure Analysis and Reliability Engineering and Safety in Maintenance:**	**9**
Defect/failure definition; Failure - rate –mode -reporting – date collection; Failure analysis - tools –fault tree analysis - event tree analysis-Root cause analysis – FMEA – FMECA - System Reliability- series, parallel and mixed configuration – reliability increasing techniques. Safety – Definition – methods of enhancing safety – modern industrial scenarios- safety tools – case studies.		
Unit – V	**Repair Methods of Mechanical and Electrical Equipment:**	**9**
Plain bearings – Rolling element bearings – Flexible coupling and chains for power transmission – overhead and gantry cranes – chain hoists – belt drives. Electrical motors – Maintenance of motor control components – Maintenance of Industrial Batteries.		
		Total:45

TEXT BOOK:

1.	Srivastava S.K., "Industrial Maintenance Management", 6th Edition, S. Chand & Co, New Delhi, 2016.

REFERENCES:

1.	Bhattacharya S.N., "Installation, Servicing and Maintenance", 2nd Edition, S.Chand & Co, New Delhi, 2015.
2.	Keith Mobley R., "Maintenance Engineering Handbook", 8th Edition, McGraw Hill Professional, New Delhi, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the principles and functions of maintenance in industry	Understanding (K2)
CO2	interpret the various condition-based maintenance principles	Understanding (K2)
CO3	plan and implement maintenance management systems	Understanding (K2)
CO4	synthesize the functional concepts of reliability and safety engineering	Understanding (K2)
CO5	apply various repair methods in basic machine elements	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	1	2
CO2	3	2	2			1						2	1	2
CO3	3	2	2			1					2	2	1	2
CO4	3	2	2			2						2	1	2
CO5	3	2	2			2					1	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	70	10				100
CAT2	20	70	10				100
CAT3	15	70	15				100
ESE	15	70	15				100
* ±3% may be varied (CAT 1,2 &3 – 50 marks & ESE – 100 marks)							

22MTE28 - MACHINE VISION AND IMAGE PROCESSING							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge on different components of machine vision systems and image processing techniques.	
Unit – I	**Processing of Information in the Human Visual System:**	**9**
Design and structure of eye– Adaptation to different light level– Rod and Cone Responses. Introduction to Building a Machine Vision Inspection: Specification– Part presentation– Performance requirement– Information interfaces– Installation space– Environment.		
Unit – II	**Designing a Machine Vision System:**	**9**
Camera types– Field view– Resolution: camera sensor resolution, Spatial resolution, Measurement of accuracy, Calculation of resolution, Resolution for a Line Scan Camera - Choice of camera, Frame grabber and hardware platform– Pixel rate– Lens design - digital and smart cameras.		
Unit – III	**Lighting System & Camera Computer Interface:**	**9**
Demands on machine vision lighting – Light and light perception – Light sources for machine vision – Light Color and Part Color: Monochromatic light, white light, UV, IR and Polarized light – Light filters. Analog camera buses – Analog video signal - Parallel digital camera buses– Standard PC buses – Computer buses – Digital video transmission – Camera link – Driver software: Application programming interface- Features of machine vision system.		
Unit – IV	**Image Processing Algorithms:**	**9**
Introduction to Digital Image Processing - Image sampling and quantization - Image enhancement: Gray Value Transformations, Radiometric Calibration, Image Smoothing– Geometric transformation– Image segmentation– Object Recognition and Image Understanding. Feature extraction: Region Features, Gray Value Features, Contour Features–Morphology–Edge extraction– Fitting. Template matching: Grey value based, Image pyramid matching. Optical Character recognition - Integration of vision sensors, Compact systems and vision controllers.		
Unit – V	**Applications and Case Studies:**	**9**
Diameter inspection of rivets – Tubing inspection – Glue check under UV Light – Completeness check of automotive control component – Multiple position and completeness- Check of small hybrid circuit – Pin-type verification – Type and result data management of spark plugs – Robot guidance.		
		Total:45

TEXT BOOK:

1.	Alexander Hornberg, "Handbook of Machine Vision", Wiley-VCH, Germany, 2006.

REFERENCES:

1.	Davies E.K, "Machine Vision: Theory, Algorithms, Practicalities", 3rd Edition, Elsevier, India, 2005.
2.	Milan Sonka, "Image Processing Analysis and Machine Vision", 2007 Edition, Vikas Publishing House, India, 2007.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	interpret the fundamental concepts of vision system	Understanding (K2)
CO2	identify the suitable components for designing the machine vision system	Applying (K3)
CO3	illustrate the function of various lighting system and computer interfaces	Understanding (K2)
CO4	infer the concept of image processing techniques	Applying (K3)
CO5	design the machine vision system for real time manufacturing applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	2	2	2	2							3	2	2
CO2	3	2	2	2	2							3	2	2
CO3	3	2	2	2	2							3	2	2
CO4	3	2	2	2	2							3	2	2
CO5	3	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	15	50	35				100
CAT2	15	50	35				100
CAT3	15	50	35				100
ESE	5	45	50				100

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

22MTE29- MEMS AND NEMS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Physics for Mechatronics Engineering, Chemistry for Mechatronics Engineering**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides introduction to the basic concepts of MEMS and NEMS. It familiarizes the concept of fabrication, manufacturing and packaging of Micro System and applications of Micro and Nano product for various applications.	
Unit – I	**Microsystems, Microsensors and Actuators:**	**9**
Overview-Microsystems - Working principle of Microsystems - Micro sensors - Micro actuation techniques - Micropump – Micromotors – Microvalves – Microgrippers.		
Unit – II	**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 – III	**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- Micro System Applications		
Unit – IV	**Introduction and Overview: Nanoscale**	**9**
Mendeleyev's Periodic Table of Elements and Electronic Configurations - Nanoengineering and Nanoscience - Carbon Nanoelectronics: Carbon Nanotubes - Analysis of Carbon Nanotubes - Classification of Carbon Nanotubes		
Unit – V	**Modeling of Nanoelectromechanical Systems**	**9**
Introduction to Modeling, Analysis, and Simulation of NEMS - Newtonian Mechanics - Functional Nano-Electro-mechanical Systems - Piezoactuators: Steady-state models and Characteristics.		
		Total:45

TEXT BOOK:

1.	Tai-Ran Hsu, "MEMS And Microsystems: Design And Manufacture", 1st Edition, McGraw-Hill Education Pvt. Ltd, New Delhi, 2002. (Units – I, II & III)
2.	Lyshevski, S.E, "Nano- and Micro-Electromechanical Systems: Fundamentals of Nano- and Microengineering", 2nd Edition, CRC Press, 2005. (Units – IV & V)

REFERENCES:

1.	Marc Madou, "Fundamentals of Microfabrication", 2nd Edition, CRC Press, New York, 2002.
2.	Zhang, Dan, Wei, Bin, "Advanced Mechatronics and MEMS Devices II", 1st Edition, Springer International Publishing, Singapore, 2017.
3.	Takahata, K, "Advances in Micro/Nano Electromechanical Systems and Fabrication Technologies" 1st Edition, InTech, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the basics of micro sensors and micro actuators	Understanding (K2)
CO2	identify the suitable fabrication process of microsystem	Understanding (K2)
CO3	develop the micro systems for various applications	Applying (K3)
CO4	elucidate the function of nanoscale materials	Understanding (K2)
CO5	Infer the concept of Nano-electronic devices	Applying (K3)

Mapping of COs with POs and PSOs

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

CO3	3	2	2	2								2	3	3
CO4	3	2	2	2								2	3	3
CO5	3	2	2	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	15	50	35				100
CAT2	15	50	35				100
CAT3	15	50	35				100
ESE	5	60	35				100

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

22MTE30 - MOBILE ROBOTICS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Problem Solving and Programming in C, Theory of Machines**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course enables to grasp the knowledge on different kinds of mobile robots and their design, architecture and path planning algorithms.	
Unit – I	**Introduction to Mobile Robots:**	**9**
Types of mobile robots: Automated Guided vehicles (AGVs)- Service robots - Cleaning robots – Social robots – Field robots – Inspection and exploration robots - Humanoid robots – Nuclear robots – Underwater robots - Autonomous surface vessels - Applications of mobile robots.		
Unit – II	**Mobile Robot Engineering:**	**9**
Mobile robot subsystems – Fundamentals of wheeled and legged mobile robot - Kinematics models of mobile robots: Kinematic models and constraints – Hilare mobile robots – Car-like mobile robots – Mobile robot maneuverability - Mobile robot workspace-Motion control.		
Unit – III	**Locomotion:**	**9**
Introduction - Legged mobile robots - Leg configurations and stability - Examples of legged robot locomotion - Wheeled mobile robots - Wheeled locomotion: Design space-Case studies.		
Unit – IV	**Perception and Localization:**	**9**
Sensors for mobile robots – Representing uncertainty - Feature extraction - Mobile robot localization - Challenge of localization: Noise and Aliasing - Map representation - Probabilistic map-based localization.		
Unit – V	**Planning and Navigation:**	**9**
Introduction- Competences for navigation- Planning and Reacting- Navigation architectures- Modularity for code reuse and sharing- Control localization- Techniques for decomposition- Case studies: Tiered robot architectures.		
		Total:45

TEXT BOOK:

1.	Roland Siegwart, Illah Reza Nourbakhsh & Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", 2nd Edition, MIT Press, United Kingdom, 2011.

REFERENCES:

1.	Farbed Fahimi, "Autonomous Robots – Modeling, Path Planning and Control", Springer, Switzerland, 2009.
2.	Alonzo Kelly, "Mobile Robotics: Mathematics, Models and Methods", Cambridge University Press, United Kingdom, 2013.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	identify various domains for robotic systems applications	Understanding (K2)
CO2	develop kinematic model of mobile robots	Applying (K3)
CO3	analyze different concepts of locomotion	Applying (K3)
CO4	select the sensory devices for localization	Understanding (K2)
CO5	apply the concepts of planning and navigation	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	70	15				100
CAT2	10	40	50				100
CAT3	10	60	30				100
ESE	10	50	40				100

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

22MTE31 - PRODUCT DESIGN AND DEVELOPMENT							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides a set of product development methods that can be put into immediate practice and focus on current innovation trends	
Unit - I	**Development Processes and Organizations:**	**9**
Introduction to New Product and Product design- Characteristics of successful product development – The challenges in product development -Product development process – Adapting generic product development process- Product development process flows –product development organizations.		
Unit - II	**Opportunity Identification and Product Planning:**	**9**
Types of opportunities- Structure of Opportunity Identification – Opportunity identification process; Product Planning Process - Four types of product development projects – Steps in Product Planning- - Identifying Customer needs.		
Unit - III	**Product specifications and Concept development:**	**9**
Product Specifications – Target and final specifications. Concept generation: Five step method- Concept selection- Concept screening – Concept scoring – concept testing.		
Unit - IV	**Product architecture and Industrial Design:**	**9**
Implications of the architecture – Establishing the architecture – Delayed differentiation – Platform Planning – System level design issues. Industrial Design – Assessing the Need for Industrial Design and its impact - Industrial design process and management – Assessing the quality of Industrial Design.		
Unit - V	**Design considerations and prototyping:**	**9**
Design for environment – Design for manufacturing and supply chain; Prototyping – Principles – Technologies – planning for prototypes -Robust design – Process flow.		
		Total:45

TEXT BOOK:

1.	Ulrich, Karl T., Eppinger, Steve D., and Yang, Maria C., “Product Design and Development”, 7th Edition, McGraw-Hill Education, 2020.

REFERENCES:

1.	Devdas Shetty, "Product Design For Engineers", Cengage Learning, Boston, 2016.
2.	Maddock M. & Uriarte L., "Brand New: Solving the Innovation Paradox – How Great Brands Invent and Launch New Products, Services and Business Models", John Wiley & Sons, Inc., New Jersey, 2011.
3.	Roozenburg N. F. & Eekels J., "Product design: fundamentals and methods", John Wiley & Sons Inc., New Jersey, 1995.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	infer the basic need for new product design and development process	Understanding (K2)
CO2	identify opportunities and customer needs for new product development	Applying (K3)
CO3	arrive at product specification and develop concepts for new product	Analyzing (K4)
CO4	establish the overall product architecture and assess its industrial design	Analyzing (K4)
CO5	assess the design from environmental, manufacturing and supply chain perspective and develop prototypes	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	2	2	2	2								3	2	2
CO2	3	3	3			2			2			3	2	2

CO3	3	3	3	3	2	2				2	2	3	2	2
CO4	3	3	3	3	2	2						3	2	2
CO5	3	3	3	3	2	2	2	2	3	2	2	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	30	30	30			100
CAT2	10	30	30	30			100
CAT3	10	30	30	30			100
ESE	10	30	30	30			100

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

22MTE32 - BATTERY MANAGEMENT SYSTEM							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course is to impart fundamental knowledge on electrochemical energy storage systems considering the operation and design of various battery technologies. This course also enables the students to understand the requirement of batteries.	
Unit – I	**Introduction:**	**9**
Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging.		
Unit – II	**Major Battery Chemistries Development and Testing:**	**9**
Battery performance evaluation- Primary battery - Service time- Voltage data- Service life – ohmic load curve- Effect of operating temperature on service life. Secondary batteries- Discharge curves- Terminal voltages- Plateau voltage –Lead acid Batteries – Construction and application.		
Unit – III	**Recent Technologies:**	**9**
Recent development of electrode materials in lithium ion batteries- Recent development of solid electrolytes and their application to solid state batteries-Polymer solid electrolytes for lithium ion conduction– Thin Film solid state Batteries: Fundamentals, Constriction and application – Super Capacitors: Fundamental, Construction and application.		
Unit – IV	**Design of Battery Management System (BMS):**	**9**
Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, Energy balancing with multi-battery system.		
Unit – V	**Batteries for Automotives – Future prospects:**	**9**
Degrees of vehicle electrification – Battery size vs. application -USABC and DOE targets for vehicular energy storage systems – Analysis and simulation of batteries - Equivalent circuit and life modeling – Environmental concerns in battery production – Recycling of batteries. Advanced Fire Proof Batteries – Lithium ion Phosphate battery.		
		Total:45

TEXT BOOK:

1.	Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series, New York, 2008.

REFERENCES:

1.	Minami, T., Tatsumisago, M., Wakihara, M., Iwakura, C., Kohijiya, S., "Solid state ionics for batteries", Springer Publication, New York, 2009.
2.	Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes publication, United Kingdom, 2001.
3.	Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, United Kingdom, 2010.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	interpret the role of battery management system	Understanding (K2)
CO2	demonstrate the various types of batteries and their performance	Understanding (K2)
CO3	describe the recent developments in battery systems	Understanding (K2)
CO4	design the battery pack for the required applications	Applying (K3)
CO5	Select the batteries based on the prospectives of automotives	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	1						1	2	2	2

CO2	3	2	2	2	1						2	2	3	3
CO3	3	2	2	2	1						1	2	2	2
CO4	3	2	2	2	1						1	2	2	2
CO5	3	2	3	3	2						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	60	20				100
ESE	20	55	25				100

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

22MTE33- PRODUCTION MANAGEMENT							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Manufacturing Processes, Engineering Economics and Management, Numerical Methods for Engineers**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	To impart knowledge about product/process design & demand forecasting and identify plant location & layout, material handling systems and implement aggregate planning, supply chain management, lean and agile systems in industries.	
Unit - I	**Concept of PM and Demand Forecasting:**	**9**
Objectives of Production Management – Production systems – Concept – Types - Productivity. Product Design and analysis: Process planning and design- Economic Analysis- Designing for customer- Designing for manufacture and assembly. Demand forecasting: Time series - Moving Average – Exponential Smoothing – Trend Projections – Regression and Correlation Analysis - Forecast errors.		
Unit - II	**Facility Design:**	**9**
Plant location - Factors affecting plant location – Center of Gravity Method – Factor Rating Method – Breakeven Analysis Method. Plant layout: classification – layout design procedures- Assembly Line Balancing. Material handling systems: unit load concept – Material handling principles- classification of material handling equipment.		
Unit - III	**Aggregate Planning and ERP:**	**9**
Aggregate planning strategies-Methods-Master Production Schedule. Material requirement planning (MRP)-BOM- Lot sizing in MRP- Capacity Requirement Planning- MRP II. Enterprise Resource Planning (ERP)-Modules-steps in ERP implementation- ERP products and software's		
Unit - IV	**Supply Chain Management (SCM):**	**9**
Elements of SCM - Supply chain performance- Drivers and metrics- Planning demand and supply- Planning inventory- Supply chain coordination - Bullwhip effect – Transportation networks- Inbound & outbound logistics – Reverse logistics – Warehouse management.		
Unit - V	**Lean and Agile Systems:**	**9**
Toyota production systems – Types of wastes - Lean principles –Lean tools. Value stream mapping – Current state map - Future state map, 5S, Kanban, TPM, SMED, Visual management, Kaizen. Agile manufacturing – Fundamental structure – Agility through Management - Technology, Manufacturing strategy, Competitive driver.		
		Total:45

TEXT BOOK:

1.	William J.Stevenson, "Operations Management", 13th Edition, McGraw-Hill Education, New York, 2018.

REFERENCES:

1.	Robert Jacobs, Ravi Shankar & Richard B Chase, "Operations and supply chain Management", 17th Edition, McGraw-Hill Education, New York, 2024.
2.	Sunil Chopra & Peter Meindl, "Supply Chain Management – Strategy, Planning and Operation", 7th Edition, Pearson Education, New Delhi, 2021.
3.	Devadhasan S.R, Mohansivakumar V, Murugesh R & Shalij P.R, "Lean and Agile Manufacturing- Theoretical, Practical and Research Futurities", PHI Learning, New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	forecast the demand and plan for a product / service	Applying (K3)
CO2	select proper location for a plant and design the layout / material handling systems	Analyzing (K4)
CO3	develop aggregate and facility requirement plan for a manufacturing company	Applying (K3)

CO4	utilize the concept of supply chain management	Understanding (K2)
CO5	apply various lean and agile principles in a manufacturing/service enterprise	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	3	2						2	2	1	2
CO2	3	2	2	2	2						2	2	1	2
CO3	3	2	2	3	2						2	2	1	2
CO4	2	2	2	2	2						2	2	1	2
CO5	2	2	2	2	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	13	56	31				100
CAT2	5	40	30	25			100
CAT3	13	56	31				100
ESE	10	40	40	10			100

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

22MTE34 - CYBER PHYSICAL SYSTEMS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Sensors and Signal Conditioning, Microcontroller Programming and Applications**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	To acquire knowledge and skills on various hardware and software design aspects of Cyber-Physical Systems (CPS) on modelling and analysis of secured network system.	
Unit – I	**Introduction**	**9**
Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, CPS HW platforms: Processors, Sensors, Actuators, CPS network, CPS SW stack RTOS, Scheduling real time control tasks.		
Unit - II	**Design of Embedded Systems**	**9**
Types of Processors – Parallelism. Memory architectures - Memory technologies - Memory hierarchy - Memory models. Input and Output - I/O Hardware - Sequential software in a concurrent world - Analog/Digital interface.		
Unit - III	**Multitasking and Scheduling**	**9**
Imperative Programs - Threads - Processes and message passing. Scheduling with fixed timing parameters- Memory effects, Multiprocessor/ Multicore scheduling- Accommodating variability and uncertainty- Managing other resources- Rhythmic tasks scheduling.		
Unit – IV	**Security of Cyber-Physical Systems**	**9**
Cyber security requirements- Defining security and privacy -Attack model -Counter measures -System theoretic approaches- Examples of security and privacy in action- Approaches to secure cyber-physical systems- Ongoing security and privacy challenges for CPSs- Ethical hacking.		
Unit – V	**Design of Mechatronics system and CPS**	**9**
V Model and its variants - System boundary definition- Multi-view and multi-level modeling- Topological modeling- Semantic interoperability modeling- Multi-agent modeling- Collaboration modeling- internal block diagrams- multi-agent development platform – Software tools- Java, Modelica. Case Study: Suspension control, Healthcare: Artificial Pancreas/Infusion Pump/Pacemaker, Green buildings: Automated lighting, AC control, Digital twin system.		
		Total:45

TEXT BOOK:

1.	Edward A. Lee & Sanjit A. Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", 2nd Edition, MIT press, United Kingdom, 2017.

REFERENCES:

1.	Rajeev Alu, "Principles of Cyber-Physical Systems", MIT Press, United Kingdom, 2016.
2.	Song H., Rawat D. B., Jeschke S. & Brecher C., "Cyber-physical systems: foundations, principles and applications", Morgan Kaufmann, United States, 2016.
3.	Rodrigues, Joel Jose PC, Ivan Stojmenovic, & Danda B. Rawat, "Cyber-physical systems: from theory to practice", CRC Press, Florida, 2015.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the fundamentals of cyber physical systems in real-time control tasks	Understanding (K2)
CO2	infer the different components and architecture of CPS using embedded system	Understanding (K2)
CO3	interpret the functions of CPS multitasking and scheduling	Understanding (K2)
CO4	classify the concepts of CPS in security and privacy aspects	Understanding (K2)
CO5	design the mechatronics system with integration of CPS for real-time applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1								2	3	3
CO2	3	2	2	1								1	1	1
CO3	3	2	3	1								1	1	1
CO4	3	2	3	1								1	1	1
CO5	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	30	70					100
CAT2	30	70					100
CAT3	20	60	20				100
ESE	10	70	20				100

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

22MTE35 - AGRICULTURAL ROBOTICS AND AUTOMATION							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Mechanics of Serial Manipulator**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course imparts knowledge on machinery for farming, global positioning system and information system and to familiarize the concepts of weed management and machinery selection.

Unit – I	**Introduction**	**9**
History of Mechanized Agriculture - Farming Operations and Related Machines – Tillage- Planting Cultivation and Harvesting- Agricultural Automation - Agricultural Vehicle Robot.		
Unit – II	**Precision Agriculture**	**9**
Sensors – types and agricultural applications- Global Positioning System (GPS) - GPS for civilian use- Differential GPS- Carrier-phase GPS- Real-time kinematic GPS- Military GPS- Geographic Information System- Variable Rate Applications and Controller Area Networks.		
Unit – III	**Traction and Testing**	**9**
Hitching- Principles of hitching- Types of hitches- Hitching and weight transfer- Control of hitches- Tires and Traction models- Traction predictor spread sheet- Soil Compaction- Traction Aids- Tractor Testing.		
Unit – IV	**Soil Tillage and Weed Management**	**9**
Tillage Methods and Equipment - Mechanics of Tillage Tools - Performance of Tillage Implements- Hitching of Tillage Implements- Weed Management - Conventional Cropping Systems- Tools- Crop Rotation- Mechanical Cultivation.		
Unit – V	**Machinery Selection**	**9**
Screw Conveyors, Pneumatic Conveyors- Bucket Elevators- Forage Blowers and Miscellaneous Conveyors- Machinery Selection - Field Capacity and Efficiency- Draft and Power Requirements- Machinery Costs.		
		Total:45

TEXT BOOK:

1.	Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster, "Engineering Principles of Agricultural Machines", ASABE Publication, 2012.

REFERENCES:

1.	Qin Zhang, Francis J. Pierce, "Agricultural Automation Fundamentals and Practices", CRC Press, 2016.
2.	Stephen L Young, Francis J. Pierce, "Automation: The Future of Weed Control in Cropping Systems", Springer, Dordrecht Heidelberg New York London, 2014.
3.	R.A. Kepner, Roy Bainer, E.L. Barger, "Principles of Farm Machinery", 3rd Edition, CBS Publishers, New Delhi, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the areas in agricultural process where robotics can be applied	Understanding (K2)
CO2	integrate sensor and robotic system for specific process in agricultural applications	Applying (K3)
CO3	infer knowledge on traction and testing in robot mechanics	Understanding (K2)
CO4	Interpret the importance of tillage and weed management	Understanding (K2)
CO5	develop suitable machinery selection for specific agricultural tasks	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	1	2							2	2	2
CO2	2	2	3	1	2							2	2	2
CO3	2	2	3	1	2							2	2	2
CO4	2	2	3	1	2							2	2	2
CO5	2	2	3	1	2							2	2	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	55	30				100
CAT2	15	55	30				100
CAT3	15	55	30				100
ESE	5	65	30				100

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

22MTE36 - AIRCRAFT MECHATRONICS							
Programme & Branch	**B.E. & Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Sensors and Signal processing, Systems and Control Engineering, Microcontroller Programming and Applications**	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	To impart basic knowledge about the avionic architecture, various avionics data buses, displays and gain more knowledge on various avionics subsystems

Unit – I	**Introduction to Avionics**	**9**

Basics of Avionics, the cockpit environment – a historical overview-evolution and crew tasks, Need for Avionics in civil-military aircraft and space systems – Integrated Modular Avionics Architecture.

Unit – II	**Digital Avionics Bus Architecture:**	**9**

Preliminary Architecture Consideration-Comparison of hierarchical and parallel avionics bus architecture–Topologies- Review of Protocols-Data bus Characteristics- MIL STD 1553B–ARINC 429–Avionics Standard Communication Bus (ASCB)-Boeing DATAC Bus- Bus Performance Characteristics-Failure modes and Effects.

Unit – III	**Flight Deck and Cockpits:**	**9**

Control and display technologies: Tactile control panel (TCP), Direct voice input (DVI) –-Civil cockpit and military cockpit: MFDS, PFDS-HUD, HMD, HMI

Unit – IV	**Navigation Systems:**	**9**

ADF, VOR, DME, NDB, ILS, marker beacon, RNAV architecture, INS, GPS and GNSS characteristics, Airborne surveillance systems- ACAS and TAWS.

Unit – V	**Fly-By-Wire & Auto Pilot:**	**9**

Fly-by-wire: Basic principles and A320 detailed case study. Auto pilot – Basic principles, Longitudinal and lateral auto pilot

Total:45

TEXT BOOK:

1.	R.P.G. Collinson, "Introduction to Avionics", 3rd Edition, Chapman & Hall Publications, New York, 2011.

REFERENCES:

1.	Albert Helfrick.D, "Principles of Avionics", 3rd Edition, Avionics Communications Inc, USA, 2004.
2.	Cary R .Spitzer, "The Avionics Handbook", 1st Edition, Springer science+Business media LLC , USA, 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	built digital avionics architecture	Applying (K3)
CO2	integrate avionics system using digital data buses	Applying (K3)
CO3	apply various cockpit display technologies for avionics	Applying (K3)
CO4	design and build navigation systems	Applying (K3)
CO5	design fly-by-wire and auto pilot 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	3	2	2	3							1	3	3
CO2	3	3	2	1	1							1	3	3
CO3	3	3	2	1	1		2					1	3	3
CO4	3	3	2	3	2		2					1	3	3

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	10	45	45				100
CAT3	10	40	50				100
ESE	5	55	40				100

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

22MTO01 - DESIGN OF MECHATRONICS SYSTEMS							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course provides knowledge on system design, devices and products in achieving an optimal balance between basic mechanical structure and its control.	
Unit - I	**Fundamentals of Mechatronics Systems:**	**9+3**
Introduction - Key elements – Mechatronics design process –Types of Design: Traditional and Mechatronics design - Integrated product design - Advanced approaches in Mechatronics - Industrial design and ergonomics, Safety. Case study: Study of Mechatronics systems.		
Unit - II	**System Modelling:**	**9+3**
Introduction - Model categories - Fields of application - Model development - Model verification - Model validation - Simulators and Simulation – Design of mixed system: Electro mechanical system design – Model transformation – Domain independent description forms: Bond graph and Block Diagram - Simulator coupling. Response study: Mathematical modelling of open loop systems.		
Unit - III	**System Interfacing:**	**9+3**
Introduction – Elements of data acquisition and control system – Overview of I/O process - Installation of I/O card and software – TIA/EIA serial interface standards (RS232/422/485) – General Purpose Interface Bus (IEEE 488) - GUI card – Ethernet switch - Man Machine Interfaces. Response study: Real time data acquisition system.		
Unit - IV	**Case Study on Mechatronics Systems:**	**9+3**
Semi-active Wheel Suspension - Internal Combustion Engine with Drive Train - Camera Winder - Auto focus Camera - Disk Drive – Transducer calibration system - Strain gauge weighing system - Controlling temperature of a hot/cold reservoir using PID – pH Control system. Response study: Simulation of closed loop control of systems.		
Unit - V	**Case Study on Advanced Systems:**	**9+3**
Machine tool control system - Electronics engine management system - Pick and place industrial manipulator – Autonomous mobile robot - Artificial Intelligence in Mechatronics - Fuzzy controlled washing machine.		
Lecture: 45, Tutorial: 15, Total: 60		

TEXT BOOK:

1.	Devdas Shetty & Richard A. Kolk, "Mechatronics System Design", 2nd Edition, CT Cengage Learning, Stamford, 2011.

REFERENCES:

1.	Bolton W., "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering", 6th Edition, Pearson Education Limited, New York, 2015.
2.	Robert H. Bishop, "The Mechatronics handbook. Fundamentals and modeling", 2nd Edition, CRC Press, London, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the necessary components for mechatronics system design	Understanding (K2)
CO2	model the Mechatronics system	Understanding (K2)
CO3	select the suitable interface for mechatronics system	Understanding (K2)
CO4	develop the physical system based on mechatronics design process	Applying (K3)
CO5	build the mechatronics systems for real time 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	2	1										3		
CO2	2	1			2							3		

CO3	3	1			2							3		
CO4	3	2	1	1	3							3		
CO5	3	2	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	15	85					100
CAT2	15	85					100
CAT3	15	55	30				100
ESE	5	60	35				100

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

22MTX01 - DATA ACQUISITION AND VIRTUAL INSTRUMENTATION							
(Offered by Department of Mechatronics Engineering)							
Programme& Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course provides the fundamental knowledge on Graphical System Design programming, data acquisition and interfacing techniques of Virtual Instrumentation (VI)\.	
Unit - I	**Basics of Virtual Instrumentation:**	**9**
Architecture of a Graphical System Design based virtual instrument - Data Flow programming - Graphical user interface platform - G programming and modular programming - Graphical programming palettes: Control, Functions and tool palettes – Data Types: Numeric, String, and Boolean.		
Unit - II	**VI Programming Techniques:**	**9**
Structures: Loops, Shift Registers, Case, Event, Timed, Flat sequence - Expression node - Formula nodes - Arrays/Clusters - Waveform Generation - File I/O: Read/ Write - Variables: Local/Global - Sub-VI.		
Unit - III	**Data Acquisition Hardware Interface:**	**9**
Basics of DAQ hardware and software - Concepts of data acquisition and terminology - Installing hardware and drivers - NI-MAX Configuring and addressing the hardware - Communicating between the Real-time Target and Host PC		
Unit - IV	**Data Logging, Control, and Monitoring**	**9**
Measuring/Generating the Analog Input/Output: Simulating the Hardware and Validating the Measurement - Generating and Reading Digital Signal - Triggering - Timing and Synchronization Methods - Programming with the NI-DAQmx		
Unit - V	**Real time Applications:**	**9**
Instrument control: Signal processing tools - Measuring Temperature, Strain, Force, Pressure, Sound, Vibration, and Acceleration, Edges, Frequency, and Duty Cycle. Vision and Motion, Vision Acquisition and Vision Assistant tool.		

Experiments:	
1.	Data acquisition using LabVIEW for temperature measurement with thermocouple.
2.	Data acquisition using LabVIEW for temperature measurement with RTD/ Thermistor.
3.	Creation of a CRO using LabVIEW and measurement of frequency and amplitude from external source.
4.	Create function generator using LabVIEW and display the amplitude and frequency on CRO (externally connected)
5.	Demonstrate amplitude modulation considering modulating and carrier wave from external source.
6.	Interface LEDs to DAQ output and implement the counter operation.
7.	Data acquisition using LabVIEW for load / strain measurement using suitable transducers.
8.	Demonstrate binary to grey code converter (& vice versa) using DAQ card.
9.	Data acquisition using LabVIEW for distance/humidity measurement using suitable transducers.
10.	Reading audio input with Microphones and output using DAQ card.

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Jeffery Travis & Jim Kring, "LabVIEW for Everyone: Graphical programming made easy and Fun", 3rd Edition, Pearson Education, India, 2009.

REFERENCES:

1.	Gupta, Joseph & John, "Virtual Instrumentation using LabVIEW", 2nd Edition, Tata McGraw Hill, India, 2010.
2.	Rick Bitter, Taqi Mohiuddin & Matt Nawrocki, "LabVIEW Advanced Programming Techniques", 2nd Edition, Taylor & Francis Group, New York, 2007.

COURSE OUTCOMES: **On completion of the course, the students will be able to**	**BT Mapped (Highest Level)**

CO1	demonstrate the basic concepts of Virtual Instrumentation	Understanding (K2) Imitation (S1)
CO2	interpret the different software tools in Virtual Instrumentation	Applying (K3) Manipulation (S2)
CO3	interface data acquisition hardware with software	Applying (K3) Manipulation (S2)
CO4	develop programming concepts with data logging and control	Applying (K3) Precision (S3)
CO5	design graphical programming solutions to real world problems	Applying (K3) Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2							2		
CO2	3	3	3	3	2							2		
CO3	3	3	3	3	2							2		
CO4	3	3	3	3	2							2		
CO5	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	15	35	50				100
CAT2	10	35	55				100
CAT3	10	35	55				100
ESE	5	40	55				100

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

22MTX02 - FACTORY AUTOMATION							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course provides the fundamental knowledge about automation in the field of production and assembly lines.	
Unit – I	**Overview:**	**9**
Automation overview, Requirement of automation systems, Architecture of factory automation system, Basic components of automation – Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, Process control valves.		
Unit – II	**Programmable Automation Controllers:**	**9**
Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, PLC selection, PLC installation, Basic discrete I/o programming and maintenance of PLC using timer/counter functions.		
Unit – III	**Communication and Control Systems:**	**9**
Man-machine interface, Computer aided process control hardware and software, Process related interfaces, Communication and networking, Data transfer techniques, Computer based data acquisition system, Internet of things (IoT) for plant automation.		
Unit – IV	**SCADA:**	**9**
Definition – Elements of SCADA – SCADA control – Remote terminal units – Master station – Interfacing PLC with SCADA – Data logging and trending.		
Unit – V	**Robots for Factory Automation:**	**9**
Basic construction and configuration of robot, Pick and place robot, Welding robot, Robots in Sorting, Mobile robots, Cobots and Humanoid robots.		

LIST OF EXPERIMENTS / EXERCISES:	
1.	Introduction to programming /simulation/communication software for PLC programming
2.	Logical testing of I/O's and its interfacing with PLC for a given case study
3.	Level control using PLC
4.	Interfacing Pneumatic cylinders with PLC
5.	Introduction to HMI programming using software
6.	Interfacing PLC and HMI
7.	Data logging and trending using PLC & HMI for a given case study
8.	Studies on ABB robot functions and programming

Lecture:45, Practical:30, Total:75

TEXT BOOK:	
1.	Bolton W., "Mechatronics", 6th Edition, Pearson Education, New Delhi, 2019.

REFERENCES/ MANUAL / SOFTWARE:	
1.	Petruzella Frank D., "Programmable Logic Controllers", 5th Edition, McGraw-Hill, New York, 2019.
2.	Stuart Boyer A., "SCADA Supervisory Control and Data Acquisition", 4th Edition, ISA, USA, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify the different types of sensors, actuators and PLC used in automation system	Understanding (K2) Imitation (S1)
CO2	infer the knowledge about communication and control system in real time interfacing	Understanding (K2) Imitation (S1)
CO3	adapt the concepts of SCADA for factory automation	Applying (K3) Manipulation (S2)
CO4	interpret the basic configuration and application of robot in factory automation	Applying (K3) Precision (S3)
CO5	develop plant level automation for real process plant using PLC/SCADA/ robotics	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											
CO2	3	3	3											
CO3	3	3	3		2									
CO4	3	3	3		3									
CO5	3	3	3	3	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	5	95					100
CAT2	5	50	45				100
CAT3	5	55	40				100
ESE	10	50	40				100

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

22GEO04 - INNOVATION AND BUSINESS MODEL DEVELOPMENT							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course will inspire the students to think innovation concepts and ideas for business model developments.	
Unit - I	**Innovation and Design Thinking:**	**9+3**
Innovation and Creativity– Types of innovation – challenges in innovation- steps in innovation management- 7 concerns of design. Design Thinking and Entrepreneurship – Design Thinking Stages: Empathize – Define – Ideate – Prototype – Test. Design thinking tools: Analogies – Brainstorming – Mind mapping		
Unit - II	**User Study and Contextual Enquiry:**	**9+3**
Explanatory research – primary and secondary data – classification of secondary data – sources of secondary data – qualitative research – focus groups – depth interviews – analysis of qualitative data – survey methods – observations- Process of identifying customer needs –organize needs into a hierarchy –establish relative importance of the needs- Establish target specifications		
Unit - III	**Product Design:**	**9+3**
Techniques and tools for concept generation, concept evaluation – Product architecture –Minimum Viable Product (MVP)- Product prototyping – tools and techniques– overview of processes and materials – evaluation tools and techniques for user-product interaction		
Unit - IV	**Business Model Canvas (BMC):**	**9+3**
Lean Canvas and BMC - difference and building blocks- BMC: Patterns – Design – Strategy – Process–Business model failures: Reasons and remedies		
Unit - V	**IPR and Commercialization:**	**9+3**
Need for Intellectual Property- Basic concepts - Different Types of IPs: Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design– Patent Licensing - Technology Commercialization – Innovation Marketing		
Lecture:45, Tutorial:15, Total:60		

TEXT BOOK:

1. Rishikesha T.Krishnan, “8 Steps To Innovation: Going From Jugaad To Excellence”, Collins India, 2013.

REFERENCES:

1. Peter Drucker, “Innovation and Entrepreneurship”, Routledge CRC Press, London, 2014.
2. Eppinger, S.D. and Ulrich, K.T. “Product design and development”, 7th edition, McGraw-Hill Higher Education, 2020.
3. Alexander Osterwalder, “Business model generation: A handbook for visionaries, game changers, and challengers”, 1st edition, John Wiley and Sons; 2010
4. Indian Innovators Association, “Patent IPR Licensing – Technology Commercialization – Innovation Marketing: Guide Book for Researchers, Innovators”, Notion Press, Chennai, 2017

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand innovation need and design thinking phases	Understanding (K2)
CO2	identify, screen and analyse ideas for new products based on customer needs	Analysing (K4)
CO3	develop and analyse the product concepts based on the customer needs and presents the overall architecture of the product.	Analysing (K4)
CO4	predict a structured business model for MVP	Applying (K3)
CO5	practice the procedures for protection of their ideas’ IPR	Applying (K3)

Mapping of COs with POs and PSOs

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

CO2	3	3	3	3	2	2	2	2	3	3	3	3		
CO3	2	2	3	3	3	3	3	3	3	3	3	3		
CO4				3	2	2	2	3	3	3	3	3		
CO5				3	2	2		3	2	3	3	3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

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

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

22MTO02 - ROBOTICS							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course provides the basic knowledge about industrial manipulator, its control, design and applications	
Unit – I	**Introduction to Robotics:**	**9+3**
Types and components of a robot- Classification of robots - Closed loop and open loop control systems. Kinematics systems: Definition of mechanisms and manipulators- Social issues and safety.		
Unit – II	**Robot Kinematics and Dynamics:**	**9+3**
Kinematic Modelling: Translation and rotation representation- Coordinate transformation- DH parameters- Jacobian-Singularity and Statics. Dynamic Modelling: Equations of motion- Euler-Lagrange formulation.		
Unit – III	**Sensors and Vision System:**	**9+3**
Sensor - Contact and Proximity, Position, Velocity, Force, Tactile. Introduction to Cameras- Camera calibration- Geometry of image formation - Vision applications in robotics.		
Unit – IV	**Robot Control and Actuation Systems:**	**9+3**
Basics of control: Transfer functions, Control laws: P, PD, PID - Non-linear and advanced controls. Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings - Parameters for selection of actuators.		
Unit – V	**Control Hardware and Interfacing:**	**9+3**
Embedded systems: Architecture and integration with sensors, Actuators, Programming for robot applications.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Saha S.K., "Introduction to Robotics", 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.

REFERENCES:

1.	Niku Saeed B., "Introduction to Robotics: Analysis", PHI Learning, New Delhi, 2011.
2.	Ghosal A., "Robotics: Fundamental Concepts and Analysis", Oxford, New Delhi, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the features of an industrial robots with end effector	Understanding (K2)
CO2	perform kinematic and dynamic analyses with simulation	Applying (K3)
CO3	select various sensors for robotics	Understanding (K2)
CO4	identify different control and actuation systems for robots	Understanding (K2)
CO5	Integrate mechanical and electrical hardware for robot programming and applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1							2		
CO2	3	3	2	2	1							2		
CO3	3	3	2	2	1							2		
CO4	3	3	2	2	1							2		
CO5	3	3	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	15	65	20				100
CAT2	15	65	20				100
CAT3	10	60	30				100
ESE	10	55	35				100

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

22MTO03 - 3D PRINTING AND DESIGN							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	The course is designed to impart knowledge and skills related to 3D printing technologies, selection of materials and equipments to develop a product.	
Unit – I	**3D Printing & CAD for Additive Manufacturing:**	**9+3**
Introduction: Process - Classification, Additive v/s Conventional Manufacturing processes. Application Domains: Aerospace- Electronics- Health Care- Defense – Automotive – Construction - Food Processing - Machine Tools. CAD Data formats- Data translation- Data loss- STL format.		
Unit – II	**Additive Manufacturing Techniques:**	**9+3**
Stereo-Lithography- LOM- FDM- SLS- SLM- Binder Jet technology; Process parameter- Process Selection for various applications. Reverse engineering – Steps for 3d printing technology.		
Unit – III	**Materials:**	**9+3**
Metals, Non-Metals, Ceramics; Various forms of raw material-Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties; Support Materials		
Unit – IV	**Additive Manufacturing Equipment:**	**9+3**
Process Equipment-Design and process parameters; Governing Bonding Mechanism; Common faults and troubleshooting; Process Design		
Unit – V	**Post Processing & Product Quality:**	**9+3**
Post Processing- Requirement and Techniques. Product Quality- Inspection and testing - Defects and their causes.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Chee Kai Chua and Kah Fai Leong, “3D Printing and Additive Manufacturing - Principles and Applications”, World Scientific, Singapore, 2017.

REFERENCES:

1.	Sabrie Soloman, "3D Printing and Design", Khanna Publishing House, New Delhi, 2021.
2.	Gibson I., Rosen D. W. & Stucker B., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, USA, 2010.
3.	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, Germany, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the need of additive manufacturing in real world applications	Understanding (K2)
CO2	choose appropriate technique for AM applications	Applying (K3)
CO3	select a specific material for the given application	Applying (K3)
CO4	identify the process parameters of different AM process	Applying (K3)
CO5	ensure the quality of the AM 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	2	1										3		

CO2	2	1			2							3		
CO3	2	1			2							3		
CO4	2	3	1	2	2						2	2		
CO5	2	3	1	2	2						2	2		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	33	67					100
CAT2	10	52	38				100
CAT3	10	52	38				100
ESE	6	60	34				100

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

22GEO05 - ENTREPRENEURSHIP DEVELOPMENT							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Economics & Management**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	The purpose of this course to create entrepreneurial awareness among engineering students.	
Unit – I	**Entrepreneurship Concepts:**	**9**
Entrepreneurship & Entrepreneur- Role in Economic Development - Factors affecting Entrepreneurship- Creativity and Innovation - Entrepreneurship vs Intrapreneurship- Entrepreneurial Motivation factors – Types of Entrepreneurship & Entrepreneurs - Characteristics of Entrepreneurs - Entrepreneurship Development in India		
Unit – II	**Entrepreneurial Ventures and opportunity assessment:**	**9**
New venture creation – Bootstrapping, Minipreneurship, Start-ups, Acquiring, Franchising & Social venturing - Venture development stages - Models of market opportunity- Opportunity assessment: Critical Factors In Opportunity Assessment, Idea vs Opportunity, Evaluation process, Global opportunities for entrepreneurs.		
Unit – III	**Business Plan:**	**9**
Designing Business Model- Business Model Canvas- Objectives of a Business Plan - Business Planning Process – Structure of a Business Plan – Technical, Marketing, Financial Feasibility assessment - Competitive analysis - Common errors in Business Plan formulation - Presentation of the Business Plan: The 'Pitch'- case studies		
Unit – IV	**Financing and accounting:**	**9**
Forms of entrepreneurial capital – Sources of Financial capital: debt financing- Commercial banks and other sources, equity financing: Initial Public offering (IPO), Private placement - Venture capitalists - Angel investors-New forms of financing: Impact investors, Micro-financing, Peer-to-Peer Lending, Crowd funding - Natural capital. Preparing Financial Budget, Break even analysis, Taxation-Direct and indirect taxes, Insolvency and Bankruptcy- Case Study		
Unit – V	**Small Business Management:**	**9**
Definition of Small Scale Industries: Strengths and Weaknesses, Sickness in Small Enterprises: Symptoms -Causes and remedies- Indian Startup Ecosystem – Institutions supporting small business enterprises, Business Incubators – Government Policy for Small Scale Enterprises - Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger, FDI and Sub-Contracting		
		Total:45

TEXT BOOK:

1.	Donald F. Kuratko,"Entrepreneurship: Theory, Process, Practice", 11th Edition, Cengage Learning, Boston, 2020.

REFERENCES:

1.	Robert D. Hisrich, Michael P. Peters & Dean A. Shepherd, Sabyasachi Sinha "Entrepreneurship", 11th Edition, McGraw Hill, Noida, 2020.
2.	Charantimath Poornima .M, "Entrepreneurship Development and Small Business Enterprises", 3rd Edition, Pearson Education, Noida, 2018.
3.	Gordon E & Natarajan K, "Entrepreneurship Development", 6th Edition, Himalaya Publishing House, Mumbai, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the importance of entrepreneurship and demonstrate the traits of an entrepreneur	Applying (K3)
CO2	identify suitable entrepreneurial ventures and business opportunity	Applying (K3)
CO3	assess the components of business plan	Analyzing (K4)
CO4	appraise the sources of finance and interpret accounting statements	Applying (K3)
CO5	interpret the causes of sickness of small scale enterprises and its remedies	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

22MTO04-DRONE SYSTEM TECHNOLOGY							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course strives to identify and introduce Drones or UAVs (Unmanned Aerial Vehicles) as piloted by remote control or on board computers through computer vision and artificial intelligence technologies.	
Unit – I	**Unit Title: Introduction to Unmanned Aerial Vehicles (UAV):**	**9**
Overview and background: history of UAVs, classifications of UAVs, lift generation method. Contemporary applications like military, government and civil areas.		
Unit – II	**Unit Title: Unmanned Aerial System (UAS) components:**	**9**
Platforms - configurations - characteristics – applications. Propulsion: internal combustion engines, turbine engines, electric systems. On-board flight control – Payloads: sensing/surveillance, weaponized UAS and delivery. Communications: command/control, telemetry. Launch/recovery systems - Ground control stations		
Unit – III	**Unit Title: Basic Concepts of Flight:**	**9**
Aerodynamics: lift, weight, thrust, and drag. Flight performance: climbing vs. gliding flight, range / endurance - Stability and control: flight axes, flight controls, autopilots. Emergency identification and handling - Fixed wing operations: Types of fixed wing drones, make, parts, terminology and operation.		
Unit – IV	**Unit Title: Drone Equipment Maintenance:**	**9**
Maintenance of drone, flight control box - Maintenance of ground equipment- batteries - Scheduled servicing - Repair of equipment - Fault finding and rectification - Weather and meteorology.		
Unit – V	**Unit Title: Regulatories and Regulations:**	**9**
Homeland regulatory: FCC, FAA. Regulations: FCC compliance, UAS registration, Federal Aircraft Regulations (FARs) - Safety considerations. Operational considerations like liability / legal issues, ethical implications.		
		Total:45

TEXT BOOK:

1.	Paul Fahlstrom, Thomas Gleason, "Introduction to UAV Systems", 5th Edition, John Wiley & Sons, New York, 2022

REFERENCES:

1.	Randal W. Beard & Timothy W. McLain, "Small Unmanned Aircraft: Theory and Practice", 1st Edition, Princeton University Press, Newjersy, 2012.
2.	Jha, "Theory, Design, and Applications of Unmanned Aerial Vehicles", 1st Edition, CRC press, Florida, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer knowledge on the development and potential of UAV in professional activities	Understanding (K2)
CO2	interpret the features and characteristics of an unmanned aerial system	Applying (K3)
CO3	infer on flight operation and control using drone	Applying (K3)
CO4	realize the drone equipment maintenance and repair	Understanding (K2)
CO5	interpret the regulatory measures and regulations in UAV operation	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	3	2	3	1							2		
CO2	2	3	2	3	1							2		
CO3	2	3	2	3	1							2		
CO4	2	3	2	3	1							2		

CO5	2	3	2	3	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	15	65	20				100
CAT2	15	65	20				100
CAT3	30	70	-				100
ESE	5	65	30				100

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

22MTO05 - MICRO AND NANO ELECTROMECHANICAL SYSTEMS							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All B.E./B.Tech. Branches Except Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Physics for Mechatronics Engineering, Chemistry for Mechatronics Engineering**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides introduction to the basic concepts of MEMS and NEMS. It familiarizes the concept of fabrication, manufacturing and packaging of Micro System and applications of Micro and Nano product for various applications.	
Unit – I	**Microsystems, Microsensors and Actuators**	**9**
Overview-Microsystems - Working principle of Microsystems - Micro sensors - Micro actuation techniques - Micropump – Micromotors – Microvalves – Microgrippers.		
Unit – II	**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 – III	**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- Micro System Applications		
Unit – IV	**Introduction and Overview: Nanoscale Materials**	**9**
Mendeleyev's Periodic Table of Elements and Electronic Configurations - Nanoengineering and Nanoscience - Carbon Nanoelectronics: Carbon Nanotubes - Analysis of Carbon Nanotubes - Classification of Carbon Nanotubes		
Unit – V	**Modeling of Nanoelectromechanical Systems**	**9**
Introduction to Modeling, Analysis, and Simulation of NEMS - Newtonian Mechanics - Functional Nano-Electro-mechanical Systems - Piezoactuators: Steady-state models and Characteristics.		
		Total:45

TEXT BOOK:

1.	Tai-Ran Hsu, "MEMS And Microsystems: Design And Manufacture", 1st Edition, McGraw-Hill Education Pvt. Ltd, New Delhi, 2002. (Units-I, II & III)
2.	Lyshevski, S.E, "Nano- and Micro-Electromechanical Systems: Fundamentals of Nano- and Microengineering", 2nd Edition, CRC Press, 2005. (Units – IV & V)

REFERENCES:

1.	Marc Madou, "Fundamentals of Microfabrication", 2nd Edition, CRC Press, New York, 2002.
2.	Zhang, Dan, Wei, Bin, "Advanced Mechatronics and MEMS Devices II", 1st Edition, Springer International Publishing, Singapore, 2017.
3.	Takahata, K, "Advances in Micro/Nano Electromechanical Systems and Fabrication Technologies" 1st Edition, InTech, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the basics of micro sensors and micro actuators	Understanding (K2)
CO2	identify the suitable fabrication process of microsystem	Understanding (K2)
CO3	develop the micro systems for various applications	Applying (K3)
CO4	elucidate the function of nanoscale materials	Understanding (K2)
CO5	Infer the concept of Nano-electronic devices	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		
CO2	3	2	2	2								2		

CO3	3	2	2	2								2		
CO4	3	2	2	2								2		
CO5	3	2	2	2								2		

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	50	35				100
CAT2	15	50	35				100
CAT3	15	50	35				100
ESE	5	60	35				100

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

22MTJ01 - DATA MODELING AND MACHINE INTELLIGENCE							
Programme & Branch	**B.E. Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Numerical Methods for Engineers**	**5/6/7**	**HN**	**3**	**0**	**2**	**4**

Preamble	To know the underlying structure behind data modelling and machine learning concepts and apply the same for real world applications.	
Unit – I	**Data Modelling**	**9**
Data - Big Data Analytics and Types of Analytics – Big Data Analysis Framework – Descriptive Statistics- Univariate Data Analysis and visualization – Bivariate Data and Multivariate Data – Multivariate Statistics – Essential Mathematics for Multivariate Data.		
Unit – II	**Similarity Learning and Regression Analysis**	**9**
Introduction to Similarity or Instance based Learning – Nearest Neighbor Learning – Weighted K Nearest-Neighbor Algorithm – Nearest Centroid Classifier – Locally Weighted Regression (LWR) – Introduction to Regression – Introduction to Linearity, Correlation and Causation – Introduction to Linear Regression – Validation of Regression Methods – Multiple Linear Regression – Polynomial Regression – Logistic Regression.		
Unit – III	**Bayesian Learning**	**9**
Introduction to Probability based Learning – Fundamentals of Bayes Theorem – Classification Using Bayes Model – Naive Bayes Algorithm for Continuous Attributes – Types of Naive Bayes Classifiers – Introduction to Probabilistic Graphical Models – Bayesian Belief Network – Markov Chain.		
Unit – IV	**Support Vector Machines**	**9**
Introduction to Support Vector Machine – Optimal Hyperplane – Functional and Geometric Margin – Hard Margin SVM as an Optimization Problem – Soft Margin Support Vector Machines – Introduction to Kernels and Non-linear SVM – Kernal-based Non-Linear Classifier – Support Vector Regression.		
Unit – V	**Reinforcement Learning**	**9**
Overview of Reinforcement Learning – Scope of Reinforcement Learning – Reinforcement Learning as Machine Learning – Components of Reinforcement Learning – Markov Decision Process – Multi arm Bandit Problem and Reinforcement Problem Types – Model based Learning (Passive Learning) – Model Free Methods – Q Learning – SARSA Learning.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Explore the given dataset and create sample database in python programming platform
2.	Create Univariate and Bivariate Graphs in python programming platform
3.	Create a sample dataset and explore statistical operations using Pandas
4.	Sample dataset creation using Pandas visualize the results through plots
5.	Create a sample dataset and apply preprocessing techniques
6.	Implement K-Nearest Neighbor algorithm for a sample dataset
7.	Implement Linear Regression algorithm for a sample dataset
8.	Implement and demonstrate the working of Naïve Bayesian classifier for a sample dataset
9.	Implement and demonstrate Hidden Markov Model for a sample dataset
10.	Implement Support Vector Machine algorithm for a sample dataset

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	S.Sridhar, M.Vijayalakshmi, “Machine Learning”, 1st Edition, Oxford University Press, 2021.

REFERENCES/ MANUAL / SOFTWARE:

1.	David Forsyth, “Applied Machine Learning “, Springer, 2019.
2.	M.Gopal, “Applied Machine Learning”, McGraw-Hill Education, 1st Edition, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Interpret the concepts behind data modelling and visualization	Understanding (K2) Imitation (S1)
CO2	Interpret similarity learning techniques and regression for solving uncertainty problems	Understanding (K2) Manipulation (S2)
CO3	Interpret probability-based learning and apply for real time applications	Understanding (K2) Manipulation (S2)
CO4	Apply support vector machines for solving optimization-based problems	Applying (K3) Precision (S3)
CO5	Develop programming for regression algorithms for decision-making functions	Applying (K3) Precision (S3)
CO6	Develop data modelling the given sample dataset using machine learning programming platform	Applying (K3) Precision (S3)
CO7	Develop sample dataset using Pandas	Applying (K3) Manipulation (S2)
CO8	Develop programming for supervised machine learning algorithm for the given sample dataset	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	3	3	3							2	2	2
CO2	3	3	3	3	3							2	2	2
CO3	3	3	3	3	3							2	2	2
CO4	3	3	3	3	3							2	2	2
CO5	3	3	3	3	3							2	2	2
CO6	3	3	3	3	3							2	2	2
CO7	3	3	3	3	3							2	2	2
CO8	3	3	3	3	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	50	30				100
CAT2		50	50				100
CAT3		50	50				100
ESE	10	40	50				100

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

22MTH01 - DEEP LEARNING							
Programme & Branch	**B.E. Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Numerical Methods for Engineers**	**5/6/7**	**HN**	**3**	**0**	**0**	**3**

Preamble	This course provides introduction to deep learning with focus on both theory and practice to develop models for various real-time applications.	
Unit – I	**Machine Learning Fundamentals:**	**9**
Introduction – Machine Learning – Challenges with Machine Learning – Overfitting – Confronting Overfitting – Types of Machine Learning: Classification and Regression.		
Unit – II	**Neural Networks:**	**9**
Nodes and Layers of a Neural Network – Supervised Learning of a Neural Network – Training a single-layer using Delta Rule – Stochastic Gradient Descent – Implementation of SGD and Batch Method – Comparison – Limitation of Single-layer neural network.		
Unit – III	**Training of Multi-Layer Neural Network:**	**9**
Back Propagation Algorithm – XOR Problem and Momentum - Cost Function and Learning Rule - Cross Entropy Function – Comparison of Cost Functions.		
Unit – IV	**Neural Network and Classification:**	**9**
Binary Classification – Multiclass Classification – Improvement of the Deep Neural Network: Vanishing Gradient – Overfitting-Computational Load – ReLU function – Dropout. Architecture of ConvNet – Convolution and Pooling Layers		
Unit – V	**Applications of Deep Learning:**	**9**
Detection in chest X-ray images -Object detection and classification -RGB and depth image fusion -NLP tasks - Dimensionality estimation - Time series forecasting -Building electric power grid for controllable energy resources - Robotic control in industrial environments.		
		Total:45

TEXT BOOK:

1.	Phil Kim, "MATLAB Deep Learning with Machine Learning, Neural Networks and Artificial Intelligence", The APress, Springer Science, Volume-130, Issue-21, New York, 1st Edition, 2017.

REFERENCES:

1.	Russell S. and Norvig N., "Artificial Intelligence: A Modern Approach", Prentice Hall Series in Artificial Intelligence, 2003.
2.	Satish Kumar., "Neural Networks: A Classroom Approach", Tata McGraw-Hill Education, 2004.
3.	Josh Patterson & Adam Gibson, "Deep Learning: A Practioner's Approach", 1st Edition, O'Reilley Media,Inc, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the concepts behind machine learning	Understanding (K2)
CO2	apply appropriate neural networks functions to resolve uncertainty problems	Applying (K3)
CO3	infer the basic concepts of training multi-layer neural network using various cost functions	Understanding (K2)
CO4	select a suitable convolution neural network for the real-time data sets	Applying (K3)
CO5	design and analyze real-world industrial problems by applying appropriate deep learning 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	2	2	3	3							2	3	3
CO2	3	3	3	3	3							3	2	2
CO3	3	2	2	3	2							2	3	3

CO4	3	3	3	3	2							2	3	3
CO5	3	3	3	3	3							2	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														
ASSESSMENT PATTERN - THEORY														
Test / Bloom's Category*	**Remembering (K1) %**		**Understanding (K2) %**		**Applying (K3) %**		**Analyzing (K4) %**		**Evaluating (K5) %**		**Creating (K6) %**		**Total %**	
CAT1	20		50		30								100	
CAT2	20		50		30								100	
CAT3	20		50		30								100	
ESE	20		50		30								100	
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)														

22MTH02 - ADVANCED CONTROL AND SYSTEM IDENTIFICATION							
Programme & Branch	**B.E. Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Systems and Control Engineering**	**5/6/7**	**HN**	**3**	**1**	**0**	**4**

Preamble	This course various methods in system identification and state estimation and also promotes an understanding different adaptive control schemes and its applications	
Unit – I	**System Identification**	**9+3**
Introduction: Dynamic systems, Models for Linear Time-invariant Systems, Time varying systems and nonlinear systems, The system identification procedure. Non-parametric methods- Transient analysis, Frequency analysis, Correlation analysis and Spectral analysis. Parametric methods: Least Square- Prediction error method -Maximum Likelihood – Instrumental Variable methods		
Unit – II	**Recursive methods and Closed Loop Identification**	**9+3**
Recursive methods: Recursive least squares method- The recursive prediction error method - Recursive instrumental variable method- Input signal design for identification. Identification of systems operating in closed loop: Identifiability considerations – Direct and indirect identification – Joint input / output identification		
Unit – III	**State Estimation**	**9+3**
Linear Optimal State Estimation: Kalman filter - Stability Analysis. Non-Linear State Estimation: Extended Kalman filter – Bucy filter. Adaptive State Estimation: Parameter Identification via Extended Kalman filter		
Unit – IV	**Adaptive Control Schemes**	**9+3**
Internal Model Control (IMC) schemes: Known parameters -Adaptive Internal Model Control schemes – Stability and robustness analysis. Robust adaptive control: Problem formulation - Ordinary direct adaptive control with dead zone – New robust direct adaptive control - Robust adaptive control with least prior knowledge. Indirect adaptive periodic control: Problem formulation – Adaptive control scheme and control law.		
Unit – V	**Applications of Adaptive Control**	**9+3**
Optimal adaptive tracking for nonlinear systems: Problem statement – Adaptive tracking – adaptive back stepping – Inverse concepts – Design of strict feedback system. Adaptive inverse for actuator compensation: Plants with actuator non-linearities – Parameterized inverses – State feedback designs– Output feedback inverse control and designs.		
Lecture:45, Tutorial:15, Total:60		

TEXT BOOK:

1.	Torsten Soderstrom T and PetreStoica, “System Identification”, Prentice Hall International, Second Edition, London, 2001. (Unit- 1,2 &3)
2.	Gang Feng and Rogelio Lozano, “Adaptive Control Systems”, Newness publisher, First Edition, Jordan Hill, 1999 (Unit-4 & 5)

REFERENCES:

1.	Lennart Ljung, “System Identification: Theory for the User”, Prentice-Hall, Second Edition, New Jersey, USA, 1999.
2.	Karl J.Astrom and Bjorn Witten mark, “Adaptive Control”, Pearson Education, Second Edition, New Delhi, 2003.
3.	Eveleigh,V.W. “Adaptive Control and optimization Techniques”, Tata McGraw Hill Newyork,1967.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the parametric and non-parametric methods of system identification	Applying (K3)
CO2	apply recursive methods for identification of system models	Applying (K3)
CO3	implement state estimation techniques for parameter identification	Applying (K3)
CO4	elaborate different adaptive control methods for advanced control of processes	Applying (K3)
CO5	describe the applications of various adaptive control schemes for advanced control of system	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1	3							2	3	3
CO2	3	2	1	1	3							2	3	3
CO3	3	2	1	1	3							2	3	3
CO4	3	2	1	1	3							2	3	3
CO5	3	2	1	1	3							2	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	60				100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	10	30	60				100
* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)							

22MTH03 - MULTI SENSOR AND DECISION SYSTEMS							
Programme & Branch	**B.E. Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Electron Devices and Digital Circuits, Sensors and Signal Conditioning**	**5/6/7**	**HN**	**3**	**1**	**0**	**4**

Preamble	Multi-Sensor Data Fusion (MSDF) is a broad interdisciplinary field with a wide range of applications from defense to healthcare to e-commerce.	
Unit – I	**MULTISENSOR DATA FUSION INTRODUCTION**	**9+3**
Sensors and sensor data, Use of multiple sensors, Fusion applications. The inference hierarchy: output data. Data fusion model. Architectural concepts and issues. Benefits of data - Limitation of Data Fusion.		
Unit – II	**ALGORITHMS FOR DATA FUSION**	**9+3**
Mathematical tools used: Algorithms, co-ordinate transformations, rigid body motion. Dependability and Markov chains. Taxonomy of algorithms for multi sensor data fusion. Data association. Identity declaration		
Unit – III	**ESTIMATION**	**9+3**
Kalman filtering, practical aspects of Kalman filtering, extended Kalmal filters. Decision level identify fusion. Knowledge based approaches.		
Unit – IV	**ADVANCED FILTERING**	**9+3**
Data information filter, extended information filter. Decentralized and scalable decentralized estimation. Sensor fusion and approximate agreement. Optimal sensor fusion using range trees recursively. Distributed dynamic sensor fusion		
Unit – V	**HIGH PERFORMANCE DATA STRUCTURES**	**9+3**
Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems within dependability bounds. Implementing data fusion system.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	David L. Hall, Mathematical techniques in Multisensor data fusion, Artech House, Boston, 1992. (Unit-1,2,3 &4)
2.	R.R. Brooks and S.S. Iyengar, Multisensor Fusion: Fundamentals and Applications with Software, Prentice Hall Inc., New Jersey, 1998. (Unit-5)

REFERENCES:

1.	Sensor and Data Fusion, Lawrence A. Klein, 2nd Edition, SPIE Press, 2012.
2.	Multi Sensor Data Fusion, H. B. Mitchell, Springer, 2007.
3.	Handbook of Multi Sensor Data Fusion: Theory and Practice, Martin Liggins, David Hall, James Llinas, 2nd Edition, CRC Press, 2008.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the concept of sensor fusion.	Understanding (K2)
CO2	apply algorithms for multisensor data fusion.	Applying (K3)
CO3	develop mathematical models and algorithms for multi sensor data fusion	Applying (K3)
CO4	understand the variety of methods available for data fusion and sensor fusion	Applying (K2)
CO5	interpret high performance data structures	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	3	3	3	2							2		2
CO2	2	3	3	3	2							2		3

CO3	3	3	3	3	2							2		2
CO4	2	3	3	3	2							2		2
CO5	1	3	3	3	2							2		3

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

ASSESSMENT PATTERN - THEORY

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

22MTH04 - INTELLIGENT NAVIGATION AND MAPPING							
Programme & Branch	**B.E. Mechatronics Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Kinematics of Machines, Machine Dynamics**	**5/6/7**	**HN**	**3**	**0**	**0**	**3**

Preamble	This course covers the principles of robot motion, forward and inverse kinematics, perception, localization and simultaneous mapping and localization. It also provides a logical, computationally efficient algorithm which serves as a basis to map and navigate static and dynamic environments.	
Unit – I	**Locomotion and Perception**	**9**
Introduction– Ground Robot Locomotion: Legged and Wheeled- Forward and Inverse Kinematics - Sensors using Light and Sound – Inertia based Sensors – Beacon based Sensors - Vision – Feature Extraction.		
Unit – II	**Localization**	**9**
Introduction to localization – challenges in localization – localization and navigation – belief representation – map representation – probabilistic map-based localization – Markov localization – EKF localization – UKF localization – Grid localization – Monte Carlo localization – localization in dynamic environments.		
Unit – III	**Simultaneous Localization and Mapping (SLAM)**	**9**
SLAM in Landmark World – Taxonomy of the SLAM Problem - Autonomous Map Building – Occupancy Grid Mapping – SLAM Paradigms: Extended Kalman Filter SLAM – Graph-based SLAM – Particle Filter SLAM – Sparse Extended Information Filter – fastSLAM algorithm – Visual and RGB SLAM.		
Unit – IV	**Path Planning and Navigation**	**9**
Map representations – Path planning Algorithms – Sampling based Path Planning – Path Smoothing – Planning at different length-scales – Obstacle Avoidance Techniques.		
Unit – V	**Case Studies**	**9**
Wheel Drive Mode - Normal Vehicle Drive Mode - Differential Drive Kinematics - Forward and Inverse Kinematics - Odometric Localization and Dead Reckoning - Occupancy Grid Mapping - Particle Filtering – Path planning.		
		Total:45

TEXT BOOK:

1.	Nikolaus Correll, "Introduction to Autonomous Mobile Robots", Magellan Scientific, 2016.

REFERENCES:

1.	Roland Siegwart, Illah Reza Nourbakhsh & Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", 2nd Edition, MIT Press, United Kingdom, 2011.
2.	Juan-Antonio Fernández-Madrigal, José Luis Blanco Claraco, “Simultaneous Localization and Mapping for Mobile Robots - Introduction and Methods”, Information Science Reference, 2013.
3.	Alonzo Kelly, "Mobile Robotics: Mathematics, Models and Methods", Cambridge University Press, United Kingdom, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the different kind of locomotion and develop kinematic model of autonomous system	Understanding (K2)
CO2	apply the different localization techniques for autonomous system	Applying (K3)
CO3	implement SLAM Paradigms for autonomous system	Applying (K3)
CO4	realize the path planning techniques for autonomous system	Applying (K3)
CO5	demonstrate the simultaneous mapping and localization concept using autonomous robot	Applying (K3)

Mapping of COs with POs and PSOs

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

CO2	3	3	3	3	2							2	3	3
CO3	3	3	3	3	2							2	3	3
CO4	3	3	3	3	2							2	3	3
CO5	3	3	3	3	2							2	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY

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