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KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

REGULATIONS, CURRICULUM & SYLLABI - 2020

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

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

BACHELOR OF ENGINEERING DEGREE
IN
MECHATRONICS ENGINEERING

DEPARTMENT OF MECHATRONICS ENGINEERING

KONGU
Assuring the Best

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KONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 060
(Autonomous)

INSTITUTE VISION

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

INSTITUTE MISSION

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

QUALITY POLICY

We are committed to

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

DEPARTMENT OF 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 quality Mechatronics professionals to meet the global challenges

MS2: Foster continuous learning and research by nurturing innovation and providing state-of-the art facilities

MS3: Collaborate with industries and R&D organizations to promote training and consultancy services

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 Engineering based 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	2
MS2	3	3	3
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 system by synergistic combination of precision mechanical engineering, electronic controls and systems
PSO2	Adapt multidisciplinary approach to solve real world 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 2020

CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION

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

These regulations are applicable to all candidates admitted into BE/BTech Degree programmes from the academic year 2020 – 2021 onwards.

1. DEFINITIONS AND NOMENCLATURE

In these Regulations, unless otherwise specified:

i. "University" means ANNA UNIVERSITY, Chennai.

ii. "College" means KONGU ENGINEERING COLLEGE.

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

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

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

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

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

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

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

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

xi. "Head of the Department" means Head of the Department concerned of the College.

2. PROGRAMMES AND BRANCHES OF STUDY

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

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

3. ADMISSION REQUIREMENTS

3.1 First Semester Admission

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

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

(OR)

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

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

3.2 Lateral Entry Admission

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

(OR)

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

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

4. STRUCTURE OF PROGRAMMES

4.1 Categorisation of Courses

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

i. Humanities and Social Sciences (HS) including Management Courses

ii. Basic Science (BS) Courses

iii. Engineering Science (ES) Courses

iv. Professional Core (PC) Courses

v. Professional Elective (PE) Courses

vi. Open Elective (OE) Courses

vii. Employability Enhancement Courses (EC) like Project work, Professional Skills Training, Industrial Training, Comprehensive Test & Viva, Entrepreneurships/Start ups and Internship in Industry or elsewhere

viii. Audit Courses (AC)

ix. Mandatory Courses (MC) like Student Induction Program and Environmental Science.

x. Honours Degree Courses (HC)

4.2 Credit Assignment and Honours Degree

4.2.1. Credit Assignment

Each course is assigned certain number of credits as follows:

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

The minimum number of credits to complete the BE/BTech programme is 169.

4.2.2. Honours Degree

If a candidate earns 18 to 20 additional credits in an emerging area, then he/she can be awarded with Honours degree mentioning that emerging area as his/her specialization. The respective board of studies shall recommend the specializations for honours degree and appropriate additional courses to be studied by the candidate which shall get approval from Academic Council of the institution. A candidate shall have not less than 8.0 CGPA and no history of arrears during the entire programme to opt for the honours degree.

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

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

*Title by KEC

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

4.3 Employability Enhancement Courses

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

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

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

(or)

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

(or)

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

4.3.2 Comprehensive Test & Viva

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

4.3.3 Internships

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

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

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

eighth semester. Such candidate shall earn the minimum number of credits required to complete eighth semester other than project through either approved Value Added Courses /Online courses / Self Study Courses or Add/Drop courses as per clause 4.4 and clause 4.5 respectively.

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

4.4 Value Added Courses / Online Courses / Self Study Courses

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

4.4.1 Value Added Courses: Value Added courses each with One / Two credits shall be offered by the college with the prior approval from the respective Board of Studies. A candidate can earn a maximum of six credits through value added courses during the entire duration of the programme.

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

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

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

4.4.5 A candidate can earn a maximum of 30 credits through all value added courses, online courses and self study courses.

4.5 Flexibility to Add or Drop Courses

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

4.5.2 From the first to eighth semesters the candidates have the option of registering for additional elective/Honours courses or dropping of already registered additional elective/Honours courses within two weeks from the start of the semester. Add / Drop is only an option given to the candidates. Total number of credits of such courses during the entire programme of study cannot exceed eight.

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

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

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

5. DURATION OF THE PROGRAMME

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

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

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

6. COURSE REGISTRATION FOR THE EXAMINATION

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

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

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

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

7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS

7.1 The BE/BTech programmes consist of Theory Courses, Theory cum Practical courses, Practical courses, Project Work, Professional Skills Training / Industrial Training, Internship and Entrepreneurships/ Start ups. Performance in each course of study shall be evaluated based on (i) Continuous Assessments (CA) throughout the semester and (ii) End Semester Examination (ESE) at the end of the semester except for the courses which

are evaluated based on continuous assessment only. Each course shall be evaluated for a maximum of 100 marks as shown below:

Sl. No.	Category of Course	Continuous Assessment Marks	End Semester Examination Marks
1.	Theory / Practical	50	50
2.	Theory cum Practical	The distribution of marks shall be decided based on the credit weightage assigned to theory and practical components.	
3.	Professional Skills Training / / Comprehensive Test & Viva / Entrepreneurships / Start ups / Project Work - I / Industrial Training / Mandatory Course	100	---
4.	Project Work-II Phase-I / Project Work-II Phase-II / Internships	50	50
5.	Value Added Course	The distribution of marks shall be decided based on the credit weightage assigned	---
6.	All other Courses		

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

7.3 Theory Courses

For all theory courses out of 100 marks, the continuous assessment shall be 50 marks and the end semester examination shall be for 50 marks. However, the end semester examinations shall be conducted for 100 marks and the marks obtained shall be reduced to 50. The continuous assessment tests shall be conducted as per the schedule laid down in the academic schedule. Three tests shall be conducted for 50 marks each and reduced to 30 marks each. The total of the continuous assessment marks and the end semester examination marks shall be rounded off to the nearest integer.

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

Sl. No.	Type	Max. Marks	Remarks
1.	Test - I	30	Average of best two
	Test - II	30	
	Test - III	30	
2.	Tutorial	15	Should be of Open Book/Objective Type. Average of best 4 (or more, depending on the nature of the course, as may be approved by Principal)
3.	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	50	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 every year.

7.4 Theory cum Practical Courses

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

7.5 Practical Courses

For all practical courses out of 100 marks, the continuous assessment shall be for 50 marks and the end semester examination shall be for 50 marks. Every exercise / experiment shall be evaluated based on the candidate’s performance during the practical class and the candidate's records shall be maintained.

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

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

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

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

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

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	Guide	Review Committee (excluding guide)	Guide	Review Committee (excluding guide)	Guide	Ext. Exr.	Guide	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 project work shall be evaluated based on the project report submitted by the candidate in the respective semester and viva-voce examination by a committee consisting of two examiners and guide of the project work.

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

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

7.7 Project Work-I Phase-I / Industrial Training

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

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

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

7.8 Professional Skills Training

Phase-I training shall be conducted for minimum of 80 hours in 4^{th} semester vacation and during 5^{th} semester. Phase-II training shall be conducted for minimum of 80 hours in 5^{th} semester vacation and during 6^{th} semester. The evaluation procedure shall be approved by Principal.

7.9 Comprehensive Test and Viva

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

7.10 Entrepreneurships/ Start ups

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

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

7.11 Projects through Internships

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

7.12 Value Added Course

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

7.13 Online Course

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

7.14 Self Study Course

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

7.15 Audit Course

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

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

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

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

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

7.16 Mandatory Course

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

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

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

8. REQUIREMENTS FOR COMPLETION OF A SEMESTER

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

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

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

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

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

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

8.1.5 Candidate’s progress is satisfactory.

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

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

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

9. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION

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

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

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

10. PROVISION FOR WITHDRAWAL FROM EXAMINATIONS

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

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

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

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

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

11. PROVISION FOR BREAK OF STUDY

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

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

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

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

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

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

12. PASSING REQUIREMENTS

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

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

12.3 For a candidate who does not satisfy the clause 12.1, the continuous assessment marks secured by the candidate in the first attempt shall be retained and considered valid for

subsequent attempts. However, from the fourth attempt onwards the marks scored in the end semester examinations alone shall be considered, in which case the candidate shall secure minimum 50 % marks in the end semester examinations to satisfy the passing requirements.

13. REVALUATION OF ANSWER SCRIPTS

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

14. SUPPLEMENTARY EXAMINATION

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

15. AWARD OF LETTER GRADES

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

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

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

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

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

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

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

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

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

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

16. ELIGIBILITY FOR THE AWARD OF DEGREE

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

i. Successfully completed all the courses under the different categories, as specified in the regulations.

ii. Successfully gained the required number of total credits as specified in the curriculum corresponding to the candidate's programme within the stipulated time (vide clause 5).

iii. Successfully passed any additional courses prescribed by the respective Board of Studies whenever readmitted under regulations other than R-2020 (vide clause 11.3)

iv. No disciplinary action pending against him / her.

17. CLASSIFICATION OF THE DEGREE AWARDED

17.1 First Class with Distinction:

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

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

(OR)

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

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

17.2 First Class:

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

- Should have passed the examination in all the courses of all eight semesters (six semesters for lateral entry candidates) within ten consecutive semesters (eight consecutive semesters for lateral entry candidates) excluding authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from the examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 7.00

17.3 Second Class:

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

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

17.5 Honours Degree:

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

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 8.00

18. MALPRACTICES IN TESTS AND EXAMINATIONS

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

19. AMENDMENTS

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

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B.E. DEGREE IN MECHATRONICS ENGINEERING CURRICULUM UNDER REGULATIONS 2020

(For the candidates admitted from academic year 2020-21 onwards)

CURRICULUM BREAKDOWN STRUCTURE (for 2020-21 batches of students)										
Summary of Credit Distribution										
Category	**Semester**								**Total number of credits**	**Curriculum Content (% of total number of credits of the program)**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
HS	4	3		3			3		**13**	**7.69**
BS	11	11	4	4					**30**	**17.75**
ES	4	4	8	4/0					**20**	**11.83**
PC	4	4	11	9/13	13	12	3		**56**	**33.14**
PE					3		12	3	**18**	**10.65**
OE				4	4	3		3	**14**	**8.28**
EC					2	6	6	4	**18**	**10.65**
MC										
Semesterwise Total	**23**	**22**	**23**	**24**	**22**	**21**	**24**	**10**	**169**	**100.00**

CATEGORISATION OF COURSES

HUMANITIES AND SOCIAL SCIENCE INCLUDING MANAGEMENT (HS)

Sl.No.	Course Code	Course Name	L	T	P	C	Sem
1.	20EGT11	English Language Skills	3	0	0	3	I
2.	20VEC11	Yoga and Values for Holistic Development	--	--	--	1	I
3.	20EGT21	Advanced Communication Skills	3	0	0	3	II
4.	20EGL31	English for work place communication Laboratory	0	0	2	1	IV
5.	20GET31	Universal Human Values	2	0	0	2	IV
6.	20GET71	Economics and Management for Engineers	3	0	0	3	VII
Total Credits to be earned						13	

BASIC SCIENCE (BS)

Sl.No.	Course Code	Course Name	L	T	P	C	Sem
1.	20MAC11	Matrices and Differential Equations	3	1*	2*	4	I
2.	20PHT11	Applied Physics	3	0	0	3	I
3.	20CYT11	Applied Chemistry	3	0	0	3	I
4.	20PHL11	Physical Sciences Laboratory I	0	0	2	1	I
5.	20MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	II
6.	20PHT22	Materials Science and Metallurgy	3	0	0	3	II
7.	20CYT22	Chemistry for Mechanical Systems	3	0	0	3	II
8.	20PHL22	Physical Scieneces Laboratory II	0	0	2	1	II
9.	20MAT31	Probability and Partial Differential Equations	3	1	0	4	III
10.	20MAT41	Statistics and Numerical Methods	3	1	0	4	IV
Total Credits to be earned						30	

ENGINEERING SCIENCE (ES)

Sl.No.	Course Code	Course Name	L	T	P	C	Sem
1.	20MEC11	Engineering Drawing	2	0	2	3	I
2.	20MEL11	Engineering Practices Laboratory	0	0	2	1	I
3.	20MTT22	Electron Devices and Digital Circuits	3	0	0	3	II
4.	20MTL21	Electron Devices and Digital Circuits Laboratory	0	0	2	1	II
5.	20CSC31	Programming in C	3	0	2	4	III
6.	20MTT31	Kinematics of Machines	3	1	0	4	III
7.	20CSC41	Pyhton Programming	3	0	2	4	IV
Total Credits to be earned						20	

PROFESSIONAL CORE (PC)

Sl.No.	Course Code	Course Name	L	T	P	C	Sem	Domain/ Stream
1.	20MTT11	Engineering Mechanics	3	1	0	4	I	PD
2.	20MTT21	Fluid Mechanics and Thermodynamics	3	1	0	4	II	PS
3.	20MTT32	Systems and Control Engineering	3	0	0	3	III	AE
4.	20MTT33	Electrical Machines	3	0	0	3	III	PD
5.	20MTT34	Manufacturing Processes	3	0	0	3	III	PS
6.	20MTL31	Electrical Machines and Control Laboratory	0	0	2	1	III	AE
7.	20MTL32	Manufacturing Processes Laboratory	0	0	2	1	III	PS
8.	20MTT41	Machine Dynamics	3	1	0	4	IV	PD
9.	20MTT42	Sensors and Signal Conditioning	3	0	0	3	IV	AE
10.	20MTL41	Sensors and Signal Conditioning Laboratory	0	0	2	1	IV	AE
11.	20MTL42	Computer Aided Drafting Laboratory	0	0	2	1	IV	PD
12.	20MTT51	CNC and Metrology	3	0	0	3	V	AE
13.	20MTT52	Microcontroller Programming and Applications	3	0	0	3	V	AE
14.	20MTT53	Strength of Materials	3	1	0	4	V	PD
15.	20MTL51	CNC and Metrology Laboratory	0	0	2	1	V	AE
16.	20MTL52	Microcontroller Programming and Applications Laboratory	0	0	2	1	V	AE
17.	20MTL53	Computer Aided Engineering Laboratory	0	0	2	1	V	PD
18.	20MTT61	Programmable Automation Controllers	3	0	0	3	VI	AE

19.	20MTT62	Mechanics of Serial Manipulator	3	0	0	3	VI	AS
20.	20MTT63	Fluid Power Systems	3	0	0	3	VI	PS
21.	20MTL61	Programmable Automation Controllers Laboratory	0	0	2	1	VI	AE
22.	20MTL62	Robotics and Control Laboratory	0	0	2	1	VI	AS
23.	20MTL63	Fluid Power Systems Laboratory	0	0	2	1	VI	AE
Total Credits to be earned						56		

PROFESSIONAL ELECTIVE (PE)

Sl.No.	Course Code	Course Name	L	T	P	C	Sem	Domain/ Stream
		Semester V						
1.	20MTE01	Design of Mechanical Elements	3	0	0	3	V	PD
2.	20MTE02	Graphical System Design	3	0	0	3	V	AE
3.	20MTE03	Power Electronics and Drives	3	0	0	3	V	AE
4.	20MTE04	Introduction to Industrial Internet of Things	3	0	0	3	V	AE
5.	20MTE05	Operations Research	3	0	0	3	V	PE
6.	20MTE06	Advanced Control Theory	3	0	0	3	V	AS
		Semester VII						
7.	20MTE07	Heat and Mass Transfer	3	0	0	3	VII	PD
8.	20MTE08	Machine Drawing	3	0	0	3	VII	PD
9.	20MTE09	Precision Equipment Design	3	0	0	3	VII	PD
10.	20MTE10	Embedded Programming for Mechatronics	3	0	0	3	VII	AE
11.	20MTE11	Machine Learning	3	0	0	3	VII	AS
12.	20MTE12	Automotive Engineering	3	0	0	3	VII	AE
		Semester VII						
13.	20MTE13	Fundamentals of Research	3	0	0	3	VII	GE
14.	20MTE14	Computer Integrated Manufacturing	3	0	0	3	VII	PE
15.	20MTE15	Precision Manufacturing	3	0	0	3	VII	PE
16.	20MTE16	Process Control and Instrumentation	3	0	0	3	VII	AE
17.	20MTE17	Cyber Physical Systems	3	0	0	3	VII	AE
18.	20MTE18	Optimal and Adaptive Control	3	0	0	3	VII	AS
		Semester VII						
19.	20MTE19	Machine Tool Control and Condition Monitoring	3	0	0	3	VII	PE
20.	20MTE20	Applied Finite Element Method	3	0	0	3	VII	PD
21.	20MTE21	Additive Manufacturing	3	0	0	3	VII	PE
22.	20MTE22	Industrial Automation Protocols	3	0	0	3	VII	AE
23.	20MTE23	Robot Programming	3	0	0	3	VII	AS
24.	20MTE24	Battery Management System	3	0	0	3	VII	PS
		Semester VII						
25.	20MTE25	Maintenance Engineering	3	0	0	3	VII	PE
26.	20MTE26	Automotive Electronics	3	0	0	3	VII	AE
27.	20MTE27	Micro Electro Mechanical Systems	3	0	0	3	VII	PD
28.	20MTE28	Mobile Robotics	3	0	0	3	VII	AS
29.	20MTE29	Drone Technology	3	0	0	3	VII	AS
30.	20MTE30	Total Quality Management	3	0	0	3	VII	GE
		Semester VIII						
31.	20MTE31	Avionics	3	0	0	3	VIII	

32.	20MTE32	Product Design and Development	3	0	0	3	VIII	PD
33.	20MTE33	Production Management	3	0	0	3	VIII	PE
34.	20MTE34	Nanoscience and Technology	3	0	0	3	VIII	PD
35.	20MTE35	Principles of Farm Machineries	3	0	0	3	VIII	PS
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	20MTO01	Design of Mechatronics Systems	3	1	0	4	IV
2	20MTO02	Factory Automation	3	0	2	4	V
3	20MTO03	Data Acquisition and Virtual Instrumentation	3	0	2	4	V
4	20GEO04	Innovation and Business Model Development	3	1	0	4	V
5	20MTO04	3D Printing and Design	3	0	0	3	VI
6	20MTO05	Drone System Technology	3	0	0	3	VI
7	20GEO11	Entrepreneurship Development	3	0	0	3	VI
8	20MTO06	Robotics	3	0	0	3	VIII
9	20MTO07	Virtual and Augment Reality in Industry 4.0	3	0	0	3	VIII

OPEN ELECTIVE COURSES OFFERED BY OTHER DEPARTMENTS (OE)

S.No.	Course Code	Course Title	L	T	P	C	Offering Dept.
		SEMESTER - IV					
1	20CEO01	Remote Sensing and its Applications	3	0	2	4	CIVIL
2	20MEO01	Renewable Energy Sources	3	0	2	4	MECH
3	20AUO01	Automotive Engineering	3	0	2	4	AUTO
4	20ECO01	Wearable Technology	3	1	0	4	ECE
5	20ECO02	Basics of Electronics in Automation Appliances	3	1	0	4	ECE
6	20ECO03	Principles of Quantum Computing	3	0	2	4	ECE
7	20EEO01	Solar and Wind Energy Systems	3	1	0	4	EEE
8	20EEO02	Electrical Wiring and Lighting	3	1	0	4	EEE
9	20EEO03	Electrical Safety	3	1	0	4	EEE
10	20EIO01	Digital Image Processing and Its Applications	3	1	0	4	EIE
11	20CSO01	Fundamentals of Databases	3	0	2	4	CSE
12	20CSO02	Python Programming and Frameworks	3	0	2	4	CSE
13	20ITO01	Artificial Intelligence	3	1	0	4	IT
14	20ITO02	Web Technologies	3	1	0	4	IT

15	20ITO03	Introduction to Operating Systems	3	1	0	4	IT
16	20ITO04	Programming in Python	3	1	0	4	IT
17	20CHO01	Drugs and Pharmaceuticals Technology	3	1	0	4	CHEM
18	20CHO02	Process Automation	3	1	0	4	CHEM
19	20FTO01	Baking Technology	3	0	2	4	FT
20	20FTO02	Food Processing Technology	3	1	0	4	FT
21	20CDO01	Fundamentals of User Experience Design	3	1	0	4	CSD
22	20ADO01	Data Warehousing and Data Mining	3	0	2	4	AIDS
23	20ALO01	Business Intelligence	3	1	0	4	AIML
24	20PHO01	Thin Film Technology	3	1	0	4	PHY
25	20CYO01	Instrumental Methods of Analysis	3	1	0	4	CHEMIS
		SEMESTER - V					
26	20CEO02	Disaster Management	3	1	0	4	CIVIL
27	20MEO02	Design of Experiments	3	0	2	4	MECH
28	20AUO02	Automotive Electronics	3	0	2	4	AUTO
29	20ECO04	PCB Design and Fabrication	3	0	2	4	ECE
30	20EEO04	Energy Conservation and Management	3	1	0	4	EEE
31	20EIO02	Industrial Automation	3	1	0	4	EIE
32	20EIO03	Measurements and Instrumentation	3	1	0	4	EIE
33	20CSO03	Computational Science for Engineers	3	1	0	4	CSE
34	20CSO04	Formal Languages and Automata	3	1	0	4	CSE
35	20ITO05	Data Science	3	1	0	4	IT
36	20ITO06	Advanced Java Programming	3	1	0	4	IT
37	20CHO03	Renewable Bioenergy Resources	3	1	0	4	CHEM
38	20CHO04	Intelligent Controllers	3	1	0	4	CHEM
39	20FTO03	Processing of Milk and Milk Products	3	0	2	4	FT
40	20FTO04	Processing of Fruits and Vegetables	3	0	2	4	FT
41	20CDO02	Fundamentals of User Interactive Design	3	0	2	4	CSD
42	20ADO02	Computer Vision	3	0	2	4	AIDS
43	20ALO02	Data Exploration and Visualization Techniques	3	0	2	4	AIML
44	20PHO02	High Energy Storage Devices	3	0	0	3	PHY
45	20CYO02	Corrosion Science and Engineering	3	1	0	4	CHEMIS
46	20CYO03	Chemistry of Cosmetics in Daily Life	3	1	0	4	CHEMIS
47	20CYO04	Chemistry of Nutrition for Women Health	3	1	0	4	CHEMIS
48	20MAO01	Mathematical Foundations for Machine Learning	3	1	0	4	MATHS
49	20MAO02	Graph Theory and its Applications	3	1	0	4	MATHS
		SEMESTER - VI					
50	20CEO03	Introduction to Smart Cities	3	0	0	3	CIVIL

51	20CEO04	Environmental Health and Safety	3	0	0	3	CIVIL
52	20MEO03	Fundamentals of Ergonomics	3	0	0	3	MECH
53	20MEO04	Principles of Management and Industrial Psychology	3	0	0	3	MECH
54	20AUO03	Vehicle Maintenance	3	0	0	3	AUTO
55	20ECO05	Electronic Hardware and Troubleshooting	2	0	2	3	ECE
56	20ECO06	Bioinspired Computing Technologies	2	0	2	3	ECE
57	20EEO05	Micro Grid and Smart Grid	3	0	0	3	EEE
58	20EEO06	E-Waste Management	3	0	0	3	EEE
59	20EIO04	Biomedical Instrumentation and Applications	3	0	0	3	EIE
60	20EIO05	PLC Programming and Its Applications	3	0	0	3	EIE
61	20EIO06	Instrumentation for Industry 4.0	3	0	0	3	EIE
62	20CSO05	Java Programming	2	0	2	3	CSE
63	20CSO06	Web Engineering	2	0	2	3	CSE
64	20CSO07	Nature Inspired Optimization Techniques	3	0	0	3	CSE
65	20ITO07	Bio Natural Language Processing	3	0	0	3	IT
66	20ITO08	Disaster Management for Information Technology	3	0	0	3	IT
67	20CHO05	Food as Medicine	3	0	0	3	CHEM
68	20CHO06	Organic Farming	3	0	0	3	CHEM
69	20FTO05	Principles of Food Safety	3	0	0	3	FT
70	20FTO06	Fundamentals of Food Packaging and Storage	3	0	0	3	FT
71	20CDO03	Introduction to Mobile Game Design	3	0	0	3	CSD
72	20ADO03	Neural Networks and Deep Learning	3	0	0	3	AIDS
73	20ALO03	Industrial Machine Learning	3	0	0	3	AIML
74	20PHO03	Structural and Optical Characterization of Materials	3	0	0	3	PHY
75	20CYO05	Chemistry Concepts for Competitive Examinations	3	0	0	3	CHEMIS
76	20CYO06	Waste and Hazardous Waste Management	3	0	0	3	CHEMIS
77	20MAO03	Data Analytics using R Programming	3	0	2	4	MATHS
78	20MAO04	Number Theory and Cryptography	3	1	0	4	MATHS
		SEMESTER - VIII					
79	20CEO05	Infrastructure Planning and Management	3	0	0	3	CIVIL
80	20CEO06	Environmental Laws and Policy	3	0	0	3	CIVIL
81	20MEO05	Safety Measures for Engineers	3	0	0	3	MECH
82	20MEO06	Energy Conservation in Thermal Equipments	3	0	0	3	MECH
83	20AUO04	Public Transport Management	3	0	0	3	AUTO
84	20AUO05	Autonomous Vehicles	3	0	0	3	AUTO
85	20ECO07	Optical Engineering	3	0	0	3	ECE
86	20EEO07	Electric Vehicle	3	0	0	3	EEE
87	20EIO07	Graphical Programming using Virtual Instrumentation	3	0	0	3	EIE

88	20EIO08	Testing of Materials	3	0	0	3	EIE
89	20CSO08	Fundamentals of Internet of Things	3	0	0	3	CSE
90	20CSO09	Machine Translation	3	0	0	3	CSE
91	20CSO10	Fundamentals of Blockchain	3	0	0	3	CSE
92	20ITO09	Modern Application Development	3	0	0	3	IT
93	20ITO10	Object Oriented System Development using UML	3	0	0	3	IT
94	20ITO11	Reinforcement Learning	3	0	0	3	IT
95	20CHO07	Cosmetics and Personal Health Care Products	3	0	0	3	CHEM
96	20CHO08	Brewing and Alcohol Technology	3	0	0	3	CHEM
97	20FTO07	Food Ingredients	3	0	0	3	FT
98	20FTO08	Food and Nutrition	3	0	0	3	FT
99	20CDO04	Introduction to Graphics Design	3	0	0	3	CSD
100	20ADO04	Business Analytics	3	0	0	3	AIDS
101	20ALO04	Machine Learning for Smart Cities	3	0	0	3	AIML
102	20MAO05	Advanced Linear Algebra	3	0	0	3	MATHS
103	20MAO06	Optimization Techniques	3	0	0	3	MATHS

GENERAL OPEN ELECTIVE

(Common to All BE/BTech branches)

S.No.	Course Code	Course Title	L	T	P	C	Offering Dept.	Semester
1	20GEO01	German Language Level 1	4	0	0	4	IV/V/VII/VIII	ECE
2	20GEO02	Japanese Language Level 1	4	0	0	4	IV/V/VII/VIII	ECE
3	20GEO03	Design Thinking for Engineers	3	1	0	4	V	CSE
4	20GEO04	Innovation and Business Model Development	3	1	0	4	V	MTS
5	20GEO05	German Language Level 2	4	0	0	4	IV/V/VII/VIII	ECE
6	20GEO06	German Language Level 3	3	0	0	3	IV/V/VII/VIII	ECE
7	20GEO07	German Language Level 4	3	0	0	3	IV/V/VII/VIII	ECE
8	20GEO08	Japanese Language Level 2	4	0	0	4	IV/V/VII/VIII	ECE
9	20GEO09	Japanese Language Level 3	3	0	0	3	IV/V/VII/VIII	ECE
10	20GEO10	Japanese Language Level 4	3	0	0	3	IV/V/VII/VIII	ECE
11	20GEO11	NCC Studies (Army Wing) - I	3	0	2	4	V/VI	EEE
12	20GEO12	NCC Studies (Air Wing) - I	3	0	2	4	V/VI	IT
13	20GEO13	French Language Level 1	4	0	0	4	IV/V/VII/VIII	ECE
14	20GEO14	French Language Level 2	4	0	0	4	IV/V/VII/VIII	ECE
15	20GEO15	French Language Level 3	3	0	0	3	IV/V/VII/VIII	ECE
16	20GEO16	Spanish Language Level 1	4	0	0	4	IV/V/VII/VIII	ECE
17	20GEO17	Spanish Language Level 2	4	0	0	4	IV/V/VII/VIII	ECE
18	20GEO18	Spanish Language Level 3	3	0	0	3	IV/V/VII/VIII	ECE
19	20GEO19	Entrepreneurship Development	3	0	0	3	VIII	MTS

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

Sem.	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	Course11	Credits
I	20EGT11 English Language Skills (3-0-0-3)	20MAC11 Matrices & Differential Equations (3-1*-2*-4)	20PHT11 Applied Physics (3-0-2*-3.5)	20CYT11 Applied Chemistry (3-0-2*-3.5)	20MEC11 Engineering Drawing (3-0-2-3)	20MTT11 Engineering Mechanics (3-1-0-4)	20MEL11 Engineering Practices Laboratory (0-0-2-1)	20PHL11 Physical Sciences Laboratory I (0-0-2-1)	20VEC11 Yoga and Values for Holistic Development (1-0-1-1)			23
II	20EGT21 Advanced Communication Skills (3-0-0-3)	20MAC21 Multivariable Calculus & Complex Analysis (3-1*-2*-4)	20PHT22 Materials Science and Metallurgy (3-0-0-3)	20CYT22 Chemistry for Mechanical Systems (3-0-0-3)	20MTT21/20CSC31 Fluid Mechanics & Thermodynamics/ Programming in C (3-1-0-4)/(3-0-2-4)	20MTT22 Electron Devices &Digital Circuits (3-0-0-3)	20MTL21 Electron Devices &Digital Circuits Laboratory (0-0-2-1)	20PHL22 Physical Sciences Laboratory I (0-0-2-1)				22
III	20MAT31 Probability &Partial Differential Equations (3-1*-0-4)	20CSC31/20CSC41 Programming in C/Python Programming (3-0-2-4)	20MTT31 Kinematics of Machines (3-1-0-4)	20MTT32 Systems &Control Engineering (3-0-0-3)	20MTT33 Electrical Machines (3-0-0-3)	20MTT34 Manufacturing Processes (3-0-0-3)	20MTL31 Electrical Machines & Control Laboratory (0-0-2-1)	20MTL32 Manufacturing Processes Laboratory (0-0-2-1)	20MNT31 Environmental Science (2-0-0-0)			23
IV	20CSC41/20MTT21 Python Programming/ Fluid Mechanics & Thermodynamics (3-0-2-4)/(3-1-0-4)	20MAT41 Statistics & Numerical Methods (3-1-0-4)	20MTT41 Machine Dynamics (3-1-0-4)	20MTT42 Sensors & Signal Conditioning (3-0-0-3)	20MTT43 Sensors & Signal Conditioning Laboratory (0-0-2-1)	Open Elective I (3-1-0-4)/ (3-0-2-4)	20MTL42 Computer Aided Drafting Laboratory (0-0-2-1)	20MTL32 English for Work Place Communication Laboratory (0-0-2-1)	20GET41 Universal Human Values (2-0-0-2)			21
V	20MTT51 CNC and Metrology (3-0-0-3)	20MTT52 Micro controller Programming and Applications (3-0-0-3)	20MTT53 Strength of Materials (3-1-0-4)	Professional Elective I (3-0-0-3)	Open Elective II (3-1-0-4)/ (3-0-2-4)	20MTL51 CNC and Metrology Laboratory (0-0-2-1)	20MTL52 Micro controller Programming and Applications Lab (0-0-2-1)	20MTL53 Computer Aided Engineering Laboratory (0-0-2-1)	20GEL51/20GEI51 Professional Skills I / Industrial Training I (0-0-0-2)			21
VI	20MTT61 Programmable Automation Controllers (3-0-0-3)	20MTT62 Mechanics of Serial Manipulator (3-0-0-3)	20MTT63 Fluid Power System (3-0-0-3)	Open Elective III (3-0-0-3)	20MTL61 Programmable Automation Controllers Lab (0-0-2-1)	20MTL62 Robotics and Control Lab (0-0-2-1)	20MTL63 Fluid Power Systems Laboratory (0-0-2-1)	18MTL63 Graphical System Design Laboratory (0-0-2-1)	20GEL61/20GEI61 Professional Skills II / Industrial Training II (0-0-2-1)	20MTP61 Project Work I (0-0-4-2)	20GEP61 Comprehensive Test/Viva (0-0-0-2)	21
VII	20GET71 Economics and Management for Engineers (3-0-0-3)	20MTT71 Machine Vision& Image Processing (3-0-0-3)	Professional Elective II (3-0-0-3)	Professional Elective III (3-0-0-3)	Professional Elective IV (3-0-0-3)	Professional Elective V (3-0-0-3)	20MTP71 Project Work 2 Phase II (0-0-12-6)					24
VIII	Open Elective IV (3-0-0-3)	Professional Elective VI (3-0-0-3)	20MTP81 Project Work 2 Phase II (0-0-8-4)									20

COURSE MAPPING WITH PO & PSO

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	20EGT11	English Language Skills						✓			✓	✓	✓	✓		
1	20MAC11	Matrices and Differential Equations	✓	✓	✓	✓	✓									
1	20PHT11	Applied Physics	✓	✓	✓											
1	20CYT11	Applied Chemistry	✓	✓	✓	✓										
1	20MEC11	Engineering Drawing	✓	✓	✓	✓						✓	✓	✓	✓	✓
1	20MTT11	Engineering Mechanics	✓	✓	✓	✓								✓		✓
1	20MEL11	Engineering Practices Laboratory	✓		✓	✓	✓	✓			✓	✓		✓		
1	20PHL11	Physical Sciences Laboratory I				✓										
1	20VEC11	Yoga and Values for Holistic Development						✓		✓	✓			✓		
2	20EGT21	Advanced Communication Skills						✓			✓	✓	✓	✓		
2	20MAC21	Multivariable Calculus and Complex Analysis	✓	✓	✓		✓									
2	20PHT22	Materials Science and Metallurgy	✓	✓	✓											
2	20CYT22	Chemistry for Mechanical Systems	✓	✓	✓	✓										
2	20MTT21	Fluid Mechanics and Thermodynamics	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓
2	20MTT22	Electron Devices and Digital Circuits	✓	✓	✓		✓							✓	✓	✓
2	20PHL22	Physical Sciences Laboratory II			✓											
2	20MTL21	Electron Devices and Digital Circuits Laboratory	✓	✓	✓		✓				✓	✓		✓	✓	✓
3	20MAT31	Probaility and Partial Differential Equations	✓	✓	✓											
3	20CSC31	Programming in C	✓	✓	✓	✓	✓				✓	✓		✓		
3	20MTT31	Kinematics of Machines	✓	✓	✓	✓								✓	✓	✓
3	20MTT32	Systems and Control Engineering	✓	✓	✓	✓	✓							✓	✓	✓
3	20MTT33	Electrical Machines	✓	✓	✓	✓	✓							✓	✓	✓
3	20MTT34	Manufacturing Processes	✓	✓	✓	✓								✓	✓	✓
3	20MTL31	Electrical Machines and Control Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
3	20MTL32	Manufacturing Processes Laboratory	✓	✓	✓	✓					✓	✓		✓	✓	✓
3	20MNT31	Environmental Science	✓	✓	✓				✓					✓	✓	✓
4	20MAT41	Statistics and Numerical Methods	✓	✓	✓	✓										
4	20CSC41	Python Programming	✓	✓	✓	✓										
4	20MTT41	Machine Dynamics	✓	✓	✓	✓	✓							✓	✓	✓
4	20MTT42	Sensors and Signal Conditioning	✓	✓		✓								✓	✓	✓
4	20MTL41	Sensors and Signal Conditioning Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
4	20MTL42	Computer Aided Drafting Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
4	20EGL31	English for work place communication									✓	✓		✓		
4	20GET41	Universal Human Values						✓	✓	✓	✓	✓				
5	20MTT51	CNC and Metrology	✓	✓	✓	✓	✓							✓	✓	✓
5	20MTT52	Microcontroller Programming and Applications	✓	✓	✓	✓	✓						✓		✓	✓
5	20MTT53	Strength of Materials	✓	✓	✓	✓	✓							✓		✓
5	20MTL51	CNC and Metrology Laboratory	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓
5	20MTL52	Microcontroller Programming and Applications Laboratory	✓	✓	✓	✓	✓				✓			✓	✓	✓
Sem.	**Course Code**	**Course Title**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**

5	20MTL53	Computer Aided Engineering Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
5	20GEL51/ 20GEI51	Professional Skills Training 1 / Industrial Training 1	✓	✓				✓	✓		✓	✓	✓	✓		
6	20MTT61	Programmable Automation Controllers	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓
6	20MTT62	Mechanics of Serial Manipulator	✓	✓	✓	✓	✓							✓	✓	✓
6	20MTT63	Fluid Power Systems	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓
6	20MTL61	Programmable Automation Controllers Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
6	20MTL62	Robotics and Control Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
6	20MTL63	Fluid Power Systems Laboratory	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓
6	20GEL61/ 20GEI61	Professional Skills Training II / Industrial Training II	✓	✓				✓	✓		✓	✓	✓	✓		
6	20MTP61	Project Work I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	20GEP61	Comprehensive Test / Viva	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	20GET71	Engineering Economics and Management	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
7	20MTT71	Machine Vision and Image Processing	✓	✓	✓	✓	✓							✓	✓	✓
7	20MTP71	Project Work 2 Phase I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	20MTP81	Project work 2 Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO 2
Professional Elective																
5	20MTE01	Design of Mechanical Elements	✓	✓	✓	✓	✓							✓	✓	✓
5	20MTE02	Graphical System Design	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
5	20MTE03	Power Electronics Drives	✓	✓	✓		✓							✓	✓	✓
5	20MTE04	Introduction to Industrial Internet of Things	✓	✓	✓	✓	✓							✓	✓	✓
5	20MTE05	Operations Research	✓	✓	✓	✓	✓						✓	✓	✓	✓
5	20MTE06	Advanced Control Theory	✓	✓	✓	✓	✓					✓		✓	✓	✓
6	20MTE07	Heat and Mass Transfer	✓	✓		✓		✓					✓		✓	✓
6	20MTE08	Machine Drawing	✓	✓	✓	✓								✓	✓	✓
6	20MTE09	Precision Equipment Design	✓	✓	✓	✓	✓							✓	✓	✓
6	20MTE10	Embedded Programming for Mechatronics	✓	✓	✓	✓	✓							✓	✓	✓
6	20MTE11	Machine Learning	✓	✓	✓	✓	✓							✓	✓	✓
6	20MTE12	Automotive Engineering	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓
7	20MTE13	Fundamentals of Research	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	20MTE14	Computer Integrated Manufacturing	✓	✓	✓	✓	✓							✓	✓	✓
7	20MTE15	Precision Manufacturing	✓	✓	✓	✓	✓		✓				✓	✓	✓	✓
7	20MTE16	Process Control and Instrumentation	✓	✓	✓	✓	✓						✓		✓	✓
7	20MTE17	Cyber Physical Systems	✓	✓	✓	✓	✓							✓	✓	✓
7	20MTE18	Optimal and Adaptive Control	✓	✓	✓	✓	✓							✓	✓	✓
7	20MTE19	Machine Tool Control and Condition Monitoring	✓	✓	✓	✓	✓	✓						✓	✓	✓
7	20MTE20	Applied Finite Element Method	✓	✓	✓	✓	✓							✓	✓	✓
7	20MTE21	Additive Manufacturing	✓	✓	✓	✓	✓						✓	✓	✓	✓
7	20MTE22	Industrial Automation Protocols	✓	✓	✓	✓	✓							✓	✓	✓
7	20MTE23	Robot Programming	✓	✓	✓	✓	✓							✓	✓	✓

7	20MTE24	Battery Management System	✓	✓	✓	✓	✓						✓	✓	✓	✓
7	20MTE25	Maintenance Engineering	✓	✓	✓			✓					✓	✓	✓	✓
7	20MTE26	Automotive Electronics	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓
7	20MTE27	Micro Electro Mechanical Systems	✓	✓	✓	✓	✓							✓	✓	✓
7	20MTE28	Mobile Robotics	✓	✓	✓	✓	✓							✓	✓	✓
7	20MTE29	Drone Technology	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
7	20MTE30	Total Quality Management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	20MTE31	Avionics	✓	✓	✓	✓	✓	✓						✓	✓	✓
8	20MTE32	Product Design and Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	20MTE33	Production Management	✓	✓	✓	✓	✓						✓	✓	✓	✓
8	20MTE34	Nanoscience and Technology	✓	✓	✓	✓	✓							✓	✓	✓
8	20MTE35	Principles of Farm Machineries	✓	✓	✓							✓		✓	✓	✓
Open Elective																
4	20MTO01	Design of Mechatronics Systems	✓	✓	✓	✓	✓							✓	✓	✓
5	20MTO02	Factory Automation	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓
5	20MTO03	Data Acquisition and Virtual Instrumentation	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
5	20GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	20MTO04	3d Printing and Design	✓	✓	✓	✓	✓						✓	✓	✓	✓
6	20MTO05	Drone System Technology	✓	✓	✓	✓	✓						✓	✓	✓	✓
6	20GEO05	Entrepreneurship Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	20MTO06	Robotics	✓	✓	✓	✓	✓							✓	✓	✓
8	20MTO07	Augmented and Virtual Reality	✓	✓	✓	✓	✓	✓						✓	✓	✓

Sem.	**Course Code**	**Course Title**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		OPEN ELECTIVE														
4	20CEO01	Remote Sensing and its Applications	✓	✓	✓	✓		✓			✓			✓		
4	20MEO01	Renewable Energy Sources	✓	✓		✓			✓		✓	✓				
4	20MTO01	Design of Mechatronics Systems	✓	✓	✓	✓	✓							✓		
4	20AUO01	Automotive Engineering	✓	✓	✓		✓				✓	✓				
4	20ECO01	Wearable Technology	✓	✓	✓	✓		✓		✓				✓		
4	20ECO02	Basics of Electronics in Automation Appliances	✓	✓	✓	✓		✓	✓	✓			✓	✓		
4	20ECO03	Principles of Quantum Computing	✓	✓	✓	✓	✓				✓	✓		✓		
4	20EEO01	Solar and Wind Energy Systems	✓	✓	✓				✓							
4	20EEO02	Electrical Wiring and Lighting	✓	✓	✓	✓	✓									
4	20EEO03	Electrical Safety	✓	✓	✓											
4	20EIO01	Digital Image Processing and Its Applications	✓	✓	✓	✓	✓									

4	20CSO01	Fundamentals of Databases	✓	✓	✓	✓	✓									
4	20CSO02	Python Programming and Frameworks														
4	20ITO01	Artificial Intelligence	✓	✓	✓	✓										
4	20ITO02	Web Technologies	✓	✓	✓											
4	20ITO03	Introduction to Operating Systems	✓	✓	✓	✓										
4	20ITO04	Programming in Python			✓		✓							✓		
4	20CHO01	Drugs and Pharmaceuticals Technology	✓	✓	✓	✓	✓									
4	20CHO02	Process Automation	✓	✓	✓		✓									
4	20FTO01	Baking Technology	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		
4	20FTO02	Food Processing Technology	✓	✓	✓	✓								✓		
4	20CDO01	Fundamentals of User Experience Design	✓	✓	✓	✓					✓	✓	✓			
4	20ADO01	Data Warehousing and Data Mining	✓	✓	✓											
4	20ALO01	Business Intelligence	✓	✓	✓											
4	20PHO01	Thin Film Technology	✓	✓	✓											
4	20CYO01	Instrumental Methods of Analysis	✓	✓	✓	✓										

Sem.	**Course Code**	**Course Title**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
5	20CEO02	Disaster Management	✓	✓	✓			✓	✓					✓		
5	20MEO02	Design of Experiments	✓	✓	✓	✓	✓						✓			
5	20MTO02	Factory Automation	✓	✓	✓	✓	✓	✓			✓	✓		✓		
5	20MTO03	Data Acquisition and Virtual Instrumentation	✓	✓	✓	✓	✓				✓	✓		✓		
5	20AUO02	Automotive Electronics	✓	✓	✓	✓	✓				✓	✓		✓		
5	20ECO04	PCB Design and Fabrication	✓	✓	✓		✓			✓	✓	✓		✓		
5	20EEO04	Energy Conservation and Management	✓	✓	✓		✓									
5	20EIO02	Industrial Automation	✓	✓	✓	✓	✓									
5	20EIO03	Measurements and Instrumentation	✓	✓	✓	✓	✓									
5	20CSO03	Computational Science for Engineers	✓	✓	✓											
5	20CSO04	Formal Languages and Automata	✓	✓	✓											
5	20ITO05	Data Science	✓	✓	✓	✓										
5	20ITO06	Advanced Java Programming	✓	✓	✓											
5	20CHO03	Renewable Bioenergy Resources	✓	✓	✓	✓			✓							
5	20CHO04	Intelligent Controllers	✓		✓	✓		✓								
5	20FTO03	Processing of Milk and Milk Products	✓	✓	✓		✓	✓		✓	✓	✓		✓		

5	20FTO04	Processing of Fruits and Vegetables	✓	✓	✓		✓	✓		✓	✓	✓		✓		
5	20CDO02	Fundamentals of User Interactive Design	✓	✓	✓											
5	20ADO02	Computer Vision	✓	✓	✓	✓	✓									
5	20ALO02	Data Exploration and Visualization Techniques	✓	✓	✓	✓	✓									
5	20PHO02	High Energy Storage Devices	✓	✓	✓											
5	20CYO02	Corrosion Science and Engineering	✓	✓	✓	✓										
5	20CYO03	Chemistry of Cosmetics in Daily Life	✓	✓	✓											
5	20CYO04	Chemistry of Nutrition for Women Health	✓	✓	✓											
5	20MAO01	Mathematical Foundations for Machine Learning	✓	✓		✓	✓									
5	20MAO02	Graph Theory and its Applications	✓	✓	✓											

Sem.	**Course Code**	**Course Title**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
6	20CEO03	Introduction to Smart Cities	✓	✓	✓											
6	20CEO04	Environmental Health and Safety	✓	✓	✓	✓										
6	20MEO03	Fundamentals of Ergonomics	✓	✓	✓	✓	✓	✓	✓					✓		
6	20MEO04	Principles of Management and Industrial Psychology						✓		✓	✓	✓	✓			
6	20MTO04	3D Printing and Design	✓	✓	✓	✓	✓						✓	✓		
6	20MTO05	Drone System Technology	✓	✓	✓	✓	✓						✓	✓		
6	20MTO06	Virtual and Augument Reality in Industry 4.0														
6	20AUO03	Vehicle Maintenance	✓	✓	✓	✓								✓		
6	20ECO05	Electronic Hardware and Troubleshooting	✓	✓	✓	✓	✓	✓								
6	20ECO06	Bioinspired Computing Technologies	✓	✓	✓		✓				✓					
6	20EEO05	Micro Grid and Smart Grid	✓	✓	✓	✓										
6	20EEO06	E-Waste Management	✓	✓	✓	✓										
6	20EIO04	Biomedical Instrumentation and Applications	✓	✓	✓	✓	✓	✓								
6	20EIO05	PLC Programming and Its Applications	✓	✓	✓	✓	✓									
6	20EIO06	Instrumentation for Industry 4.0	✓	✓	✓	✓	✓									
6	20CSO05	Java Programming	✓	✓	✓	✓	✓									
6	20CSO06	Web Engineering	✓	✓	✓	✓	✓									
6	20CSO07	Nature Inspired Optimization Techniques	✓	✓	✓											
6	20ITO07	Bio Natural Language Processing	✓	✓	✓	✓										
6	20ITO08	Disaster Management for Information Technology	✓	✓	✓	✓										
6	20CHO05	Food as Medicine	✓	✓	✓	✓		✓						✓		

6	20CHO06	Organic Farming	✓		✓			✓	✓	✓	✓		✓	✓		
6	20FTO05	Principles of Food Safety	✓	✓	✓		✓	✓	✓	✓				✓		
6	20FTO06	Fundamentals of Food Packaging and Storage	✓	✓	✓		✓	✓		✓				✓		
6	20CDO03	Introduction to Mobile Game Design	✓	✓	✓											
6	20ADO03	Neural Networks and Deep Learning	✓	✓	✓											
6	20ALO03	Industrial Machine Learning	✓	✓	✓											
Sem.	**Course Code**	**Course Title**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
6	20PHO03	Structural and Optical Characterization of Materials	✓	✓	✓											
6	20CYO05	Chemistry Concepts for Competitive Examinations	✓	✓	✓											
6	20CYO06	Waste and Hazardous Waste Management	✓	✓	✓	✓			✓							
6	20MAO03	Data Analytics using R Programming	✓	✓	✓	✓	✓									
6	20MAO04	Number Theory and Cryptography	✓	✓	✓		✓									
8	20CEO05	Infrastructure Planning and Management	✓	✓	✓											
8	20CEO06	Environmental Laws and Policy	✓	✓	✓	✓										
8	20MEO05	Safety Measures for Engineers	✓			✓		✓	✓	✓						
8	20MEO06	Energy Conservation in Thermal Equipments	✓	✓												
8	20MTO06	Robotics	✓	✓	✓	✓	✓							✓		
8	20MTO07	Virtual and Augment Reality in Industry 4.0	✓	✓	✓	✓	✓	✓						✓		
8	20AUO04	Public Transport Management	✓	✓				✓	✓	✓	✓	✓	✓	✓		
8	20AUO05	Autonomous Vehicles	✓	✓	✓											
8	20ECO07	Optical Engineering	✓	✓	✓	✓		✓		✓	✓			✓		
8	20EEO07	Electric Vehicle	✓	✓	✓	✓										
8	20EIO07	Graphical Programming using Virtual Instrumentation	✓	✓	✓	✓	✓									
8	20EIO08	Testing of Materials	✓	✓	✓	✓	✓									
8	20CSO08	Fundamentals of Internet of Things	✓	✓	✓		✓									
8	20CSO09	Machine Translation	✓	✓	✓											
8	20CSO10	Fundamentals of Blockchain	✓	✓	✓											
8	20ITO09	Modern Application Development	✓	✓	✓	✓										
8	20ITO10	Object Oriented System Development using UML	✓	✓	✓	✓										
8	20ITO11	Reinforcement Learning	✓	✓	✓	✓										

8	20CHO07	Cosmetics and Personal Health Care Products	✓		✓			✓		✓				✓		
8	20CHO08	Brewing and Alcohol Technology	✓	✓												
8	20FTO07	Food Ingredients	✓	✓	✓			✓						✓		
Sem.	**Course Code**	**Course Title**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
8	20FTO08	Food and Nutrition	✓	✓	✓			✓						✓		
8	20CDO04	Introduction to Graphics Design	✓	✓	✓											
8	20ADO04	Business Analytics	✓	✓	✓											
8	20ALO04	Machine Learning for Smart Cities	✓	✓	✓											
8	20MAO05	Advanced Linear Algebra	✓	✓	✓											
8	20MAO06	Optimization Techniques	✓	✓	✓											
		GENERAL OPEN ELECTIVE														
4,5,6, 8	20GEO01	German Language Level 1								✓	✓	✓		✓		
4,5,6, 8	20GEO02	Japanese Language Level 1								✓	✓	✓		✓		
5	20GEO03	Design Thinking for Engineers	✓	✓	✓											
6	20GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
4,5,6, 8	20GEO05	German Language Level 2								✓	✓	✓		✓		
4,5,6, 8	20GEO06	German Language Level 3								✓	✓	✓		✓		
4,5,6, 8	20GEO07	German Language Level 4								✓	✓	✓		✓		
4,5,6, 8	20GEO08	Japanese Language Level 2								✓	✓	✓		✓		
4,5,6, 8	20GEO09	Japanese Language Level 3								✓	✓	✓		✓		
4,5,6, 8	20GEO10	Japanese Language Level 4								✓	✓	✓		✓		
4,5,6, 8	20GEO11	NCC Studies (Army Wing) - I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
4,5,6, 8	20GEO12	NCC Studies (Air Wing) - I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
4,5,6, 8	20GEO13	French Language Level 1								✓	✓	✓		✓		
4,5,6, 8	20GEO14	French Language Level 2								✓	✓	✓		✓		
4,5,6, 8	20GEO15	French Language Level 3								✓	✓	✓		✓		
4,5,6, 8	20GEO16	Spanish Language Level 1								✓	✓	✓		✓		
4,5,6, 8	20GEO17	Spanish Language Level 2								✓	✓	✓		✓		

4,5,6, 8	20GEO18	Spanish Language Level 3								✓	✓	✓		✓		
8	20GEO19	Entrepreneurship Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

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

SEMESTER – I									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20EGT11	English Language Skills	3	0	0	3	50	50	100	HS
20MAC11	Matrices and Differential Equations	3	1	2	4	50	50	100	BS
20PHT11	Applied Physics	3	0	0	3	50	50	100	BS
20CYT11	Applied Chemistry	3	0	0	3	50	50	100	BS
20MTT11	Engineering Mechanics	3	1	0	4	50	50	100	PC
20MEC11	Engineering Drawing	2	0	2	3	50	50	100	ES
Practical / Employability Enhancement									
20MEL11	Engineering Practices Laboratory	0	0	2	1	50	50	100	ES
20PHL11	Physical Sciences Laboratory I	0	0	2	1	50	50	100	BS
20VEC11	Yoga and Values for Holistic Development	--	--	--	1	100	0	100	HS
20MNT11	Student Induction Program				0	100	0	100	MC
Total Credits to be earned					23				

SEMESTER – II									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20EGT21	Advanced Communication Skills	3	0	0	3	50	50	100	HS
20MAC21	Multivariable Calculus and Complex Analysis	3	1	2	4	50	50	100	BS
20PHT22	Materials Science and Metallurgy	3	0	0	3	50	50	100	BS
20CYT22	Chemistry for Mechanical Systems	3	0	0	3	50	50	100	BS
20MTT21	Fluid Mechanics and Thermodynamics	3	1	0	4	50	50	100	PC
20MTT22	Electron Devices and Digital Circuits	3	0	0	3	50	50	100	ES
Practical / Employability Enhancement									
20MTL21	Electron Devices and Digital Circuits Laboratory	0	0	2	1	50	50	100	ES
20PHL22	Physical Sciences Laboratory II	0	0	2	1	50	50	100	BS
Total Credits to be earned					22				

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

SEMESTER – III									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20CSC31	Programming in C	3	0	2	4	50	50	100	ES
20MAT31	Probability and Partial Differential Equations	3	1	0	4	50	50	100	BS
20MTT31	Kinematics of Machines	3	1	0	4	50	50	100	ES
20MTT32	Systems and Control Engineering	3	0	0	3	50	50	100	PC
20MTT33	Electrical Machines	3	0	0	3	50	50	100	PC
20MTT34	Manufacturing Processes	3	0	0	3	50	50	100	PC
Practical / Employability Enhancement									
20MTL31	Electrical Machines and Control Laboratory	0	0	2	1	50	50	100	PC
20MTL32	Manufacturing Processes Laboratory	0	0	2	1	50	50	100	PC
20MNT31	Environmental Science	2	0	0	0	100	0	100	MC
Total Credits to be earned					23				

SEMESTER – IV									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20CSC41	Python Programming	3	0	2	4	50	50	100	ES
20MAT41	Statistics and Numerical Methods	3	1	0	4	50	50	100	BS
20MTT41	Machine Dynamics	3	1	0	4	50	50	100	PC
20MTT42	Sensors and Signal Conditioning	3	0	0	3	50	50	100	PC
	Open Elective 1	3	1/0	0/2	4	50	50	100	OE
Practical / Employability Enhancement									
20MTL41	Sensors and Signal Conditioning Laboratory	0	0	2	1	50	50	100	PC
20MTL42	Computer Aided Drafting Laboratory	0	0	2	1	50	50	100	PC
20EGL31	English for work place communication	0	0	2	1	50	50	100	HS
20GET41	Universal Human Values	2	0	0	2	50	50	100	HS
Total Credits to be earned					24				

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

SEMESTER – V									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MTT51	CNC and Metrology	3	0	0	3	50	50	100	PC
20MTT52	Microcontroller Programming and Applications	3	0	0	3	50	50	100	PC
20MTT53	Strength of Materials	3	1	0	4	50	50	100	PC
	Professional Elective 1	3	0	0	3	50	50	100	PE
	Open Elective 2	3	1/0	0/2	4	50	50	100	OE
Practical / Employability Enhancement									
20MTL51	CNC and Metrology Laboratory	0	0	2	1	50	50	100	PC
20MTL52	Microcontroller Programming and Applications Laboratory	0	0	2	1	50	50	100	PC
20MTL53	Computer Aided Engineering Laboratory	0	0	2	1	50	50	100	PC
20GEL51	Professional Skills Training 1 / Industrial Training 1*	--	--	--	2	50	50	100	EC
Total Credits to be earned					22				

*80 hours of training

SEMESTER – VI									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MTT61	Programmable Automation Controllers	3	0	0	3	50	50	100	PC
20MTT62	Mechanics of Serial Manipulator	3	0	0	3	50	50	100	PC
20MTT63	Fluid Power Systems	3	0	0	3	50	50	100	PC
	Open Elective 3	3	0	0	3	50	50	100	OE
Practical / Employability Enhancement									
20MTL61	Programmable Automation Controllers Laboratory	0	0	2	1	50	50	100	PC
20MTL62	Robotics and Control Laboratory	0	0	2	1	50	50	100	PC
20MTL63	Fluid Power Systems Laboratory	0	0	2	1	50	50	100	PC
20GEL61/ 20GEI61	Professional Skills Training 2 / Industrial Training 2 *	--	--	--	2	100	0	100	EC
20MTP61	Project Work I	0	0	4	2	50	50	100	EC
20GEP61	Comprehensive Test and Viva	--	--	--	2	100	0	100	EC
Total Credits to be earned					21				

*80 hours of training

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

SEMESTER – VII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20GET71	Engineering Economics and Management	3	0	0	3	50	50	100	HS
20MTT71	Machine Vision and Image Processing	3	0	0	3	50	50	100	PC
	Professional Elective-II	3	0	0	3	50	50	100	PE
	Professional Elective-III	3	0	0	3	50	50	100	PE
	Professional Elective-IV	3	0	0	3	50	50	100	PE
	Professional Elective-V	3	0	0	3	50	50	100	PE
Practical / Employability Enhancement									
20MTP71	Project Work-II Phase-I	0	0	12	6	50	50	100	EC
Total Credits to be earned					24				

SEMESTER – VIII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
	Professional Elective 6	3	0	0	3	50	50	100	PE
	Open Elective 4	3	0	0	3	50	50	100	OE
Practical / Employability Enhancement									
20MTP81	Project work 2 Phase II $	0	0	8	4	50	50	100	EC
Total Credits to be earned					10				

Total Credits : 169

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

SEMESTER – I									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20EGT11	English Language Skills	3	0	0	3	40	60	100	HS
20MAC11	Matrices and Differential Equations	3	1*	2*	4	50	50	100	BS
20PHT11	Applied Physics	3	0	0	3	40	60	100	BS
20CYT11	Applied Chemistry	3	0	0	3	40	60	100	BS
20MTT11	Engineering Mechanics	3	1	0	4	40	60	100	PC
20MEC11	Engineering Drawing	2	0	2	3	40	60	100	ES
Practical / Employability Enhancement									
20MEL11	Engineering Practices Laboratory	0	0	2	1	60	40	100	ES
20PHL11	Physical Sciences Laboratory I	0	0	2	1	60	40	100	BS
20VEC11	Yoga and Values for Holistic Development	--	--	--	1	100	0	100	HS
20MNT11	Student Induction Program				0	100	0	100	MC
Total Credits to be earned					23				

*****Alternate weeks

SEMESTER – II									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20EGT21	Advanced Communication Skills	3	0	0	3	40	60	100	HS
20MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	50	50	100	BS
20PHT22	Materials Science and Metallurgy	3	0	0	3	40	60	100	BS
20CYT22	Chemistry for Mechanical Systems	3	0	0	3	40	60	100	BS
20CSC31	Programming in C	3	1	0	4	50	50	100	ES
20MTT22	Electron Devices and Digital Circuits	3	0	0	3	40	60	100	ES
Practical / Employability Enhancement									
20MTL21	Electron Devices and Digital Circuits Laboratory	0	0	2	1	60	40	100	ES
20PHL22	Physical Sciences Laboratory II	0	0	2	1	60	40	100	BS
Total Credits to be earned					22				

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

SEMESTER – III									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20CSC34	Data Structures using C	3	0	2	4	50	50	100	ES
20MAT31	Probability and Partial Differential Equations	3	1	0	4	40	60	100	BS
20MTT31	Kinematics of Machines	3	1	0	4	40	60	100	ES
20MTT32	Systems and Control Engineering	3	0	0	3	40	60	100	PC
20MTT33	Electrical Machines	3	0	0	3	40	60	100	PC
20MTT34	Manufacturing Processes	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
20MTL31	Electrical Machines and Control Laboratory	0	0	2	1	60	40	100	PC
20MTL32	Manufacturing Processes Laboratory	0	0	2	1	60	40	100	PC
20MNT31	Environmental Science	2	0	0	0	100	0	100	MC
Total Credits to be earned					23				

SEMESTER – IV									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MTT21	Fluid Mechanics and Thermodynamics	3	1	0	4	40	60	100	PC
20MAT41	Statistics and Numerical Methods	3	1	0	4	40	60	100	BS
20MTT41	Machine Dynamics	3	1	0	4	40	60	100	PC
20MTT42	Sensors and Signal Conditioning	3	0	0	3	40	60	100	PC
	Open Elective I	3	1/0	0/2	4	40/ 50	60/ 50	100	OE
Practical / Employability Enhancement									
20MTL41	Sensors and Signal Conditioning Laboratory	0	0	2	1	60	40	100	PC
20MTL42	Computer Aided Drafting Laboratory	0	0	2	1	60	40	100	PC
20EGL31	English for work place communication	0	0	2	1	60	40	100	HS
20GEL51	Professional Skills Training I / Industrial Training I$	--	--	--	2	100	0	100	EC
Total Credits to be earned					24				

$80 hours of training

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

SEMESTER – V									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MTT51	CNC and Metrology	3	0	0	3	40	60	100	PC
20MTT52	Microcontroller Programming and Applications	3	0	0	3	40	60	100	PC
20MTT53	Strength of Materials	3	1	0	4	40	60	100	PC
	Professional Elective I	3	0	0	3	40	60	100	PE
	Open Elective II	3	1/0	0/2	4	40/ 50	60/ 50	100	OE
Practical / Employability Enhancement									
20MTL51	CNC and Metrology Laboratory	0	0	2	1	60	40	100	PC
20MTL52	Microcontroller Programming and Applications Laboratory	0	0	2	1	60	40	100	PC
20MTL53	Computer Aided Engineering Laboratory	0	0	2	1	60	40	100	PC
20GEL61	Professional Skills Training II / Industrial Training II #	--	--	--	2	100	0	100	EC
Total Credits to be earned					22				

#80 hours of training

SEMESTER – VI									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MTT61	Programmable Automation Controllers	3	0	0	3	40	60	100	PC
20MTT62	Mechanics of Serial Manipulator	3	0	0	3	40	60	100	PC
20MTT63	Fluid Power Systems	3	0	0	3	40	60	100	PC
	Open Elective III	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
20MTL61	Programmable Automation Controllers Laboratory	0	0	2	1	60	40	100	PC
20MTL62	Robotics and Control Laboratory	0	0	2	1	60	40	100	PC
20MTL63	Fluid Power Systems Laboratory	0	0	2	1	60	40	100	PC
20GET41	Universal Human Values	2	0	0	2	100	0	100	HS
20MTP61	Project Work I	0	0	4	2	100	0	100	EC
20GEP61	Comprehensive Test and Viva	-	-	-	2	100	0	100	EC
Total Credits to be earned					21				

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

SEMESTER – VII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20GET71	Economics and Management for Engineers	3	0	0	3	40	60	100	HS
20MTT71	Machine Vision and Image Processing	3	0	0	3	40	60	100	PC
	Professional Elective II	3	0	0	3	40	60	100	PE
	Professional Elective III	3	0	0	3	40	60	100	PE
	Professional Elective IV	3	0	0	3	40	60	100	PE
	Professional Elective V	3	0	0	3	40	60	100	PE
Practical / Employability Enhancement									
20MTP71	Project Work II Phase I	0	0	12	6	50	50	100	EC
Total Credits to be earned					24				

SEMESTER – VIII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
	Professional Elective VI	3	0	0	3	40	60	100	PE
	Open Elective IV	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
20MTP81	Project work II Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					10				

Total Credits : 169

LIST OF PROFESSIONAL ELECTIVE (PE)

Course Code	Course Name	L	T	P	C	Sem	Domain/ Stream
	Semester V						
	Elective I						
20MTE01	Design of Mechanical Elements	3	0	0	3	V	PD
20MTE02	Graphical System Design	3	0	0	3	V	AE
20MTE03	Power Electronics and Drives	3	0	0	3	V	AE
20MTE04	Introduction to Industrial Internet of Things	3	0	0	3	V	AE
20MTE05	Operations Research	3	0	0	3	V	PE
20MTE06	Advanced Control Theory	3	0	0	3	V	AS
	Semester VII						
	Elective II						
20MTE07	Heat and Mass Transfer	3	0	0	3	VII	PD
20MTE08	Machine Drawing	3	0	0	3	VII	PD
20MTE09	Precision Equipment Design	3	0	0	3	VII	PD
20MTE10	Embedded Programming for Mechatronics	3	0	0	3	VII	AE
20MTE11	Machine Learning	3	0	0	3	VII	AS
20MTE12	Automotive Engineering	3	0	0	3	VII	AE
	Elective III						
20GEE01	Fundamentals of Research	3	0	0	3	VII	GE
20MTE13	Optimal and Adaptive Control	3	0	0	3	VII	AS
20MTE14	Computer Integrated Manufacturing	3	0	0	3	VII	PE
20MTE15	Precision Manufacturing	3	0	0	3	VII	PE
20MTE16	Process Control and Instrumentation	3	0	0	3	VII	AE
20MTE17	Cyber Physical Systems	3	0	0	3	VII	AE
	Elective IV						
20MTE18	Battery Management System	3	0	0	3	VII	PS
20MTE19	Machine Tool Control and Condition Monitoring	3	0	0	3	VII	PE
20MTE20	Applied Finite Element Method	3	0	0	3	VII	PD
20MTE21	Additive Manufacturing	3	0	0	3	VII	PE
20MTE22	Industrial Automation Protocols	3	0	0	3	VII	AE
20MTE23	Robot Programming	3	0	0	3	VII	AS
	Elective V						
20MTE24	Total Quality Management	3	0	0	3	VII	GE
20MTE25	Maintenance Engineering	3	0	0	3	VII	PE
20MTE26	Automotive Electronics	3	0	0	3	VII	AE
20MTE27	Micro Electro Mechanical Systems	3	0	0	3	VII	PD
20MTE28	Mobile Robotics	3	0	0	3	VII	AS
20MTE29	Drone Technology	3	0	0	3	VII	AS
	Semester VIII						
	Elective VI						
20MTE30	Principles of Farm Machineries	3	0	0	3	VIII	PS
20MTE31	Avionics	3	0	0	3	VIII	AS
20MTE32	Product Design and Development	3	0	0	3	VIII	PD
20MTE33	Production Management	3	0	0	3	VIII	PE
20MTE34	Nanoscience and Technology	3	0	0	3	VIII	PD

***** 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)

(Offered by Department of Mechatronics)

Course Code	Course Title	Hours/Week			Credit	Sem
		L	T	P		
20MTO01	Design of Mechatronics Systems	3	1	0	4	IV
20MTO02	Factory Automation	3	0	2	4	V
20MTO03	Data Acquisition and Virtual Instrumentation	3	0	2	4	V
20GEO04	Innovation and Business Model Development	3	1	0	4	V
20MTO04	3D Printing and Design	3	0	0	3	VI
20MTO05	Drone System Technology	3	0	0	3	VI
20GEO19	Entrepreneurship Development	3	0	0	3	VI
20MTO06	Robotics	3	0	0	3	VIII
20MTO07	Virtual and Augment Reality in Industry 4.0	3	0	0	3	VIII

20EGT11 ENGLISH LANGUAGE SKILLS

(Common to all Engineering and Technology Branches)

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

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

Total: 45

TEXT BOOK:

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

REFERENCES:

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

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

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

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		16	30	37		17	100
CAT2		17	30	37		16	100
CAT3		13	33	37		17	100
ESE		7	21	37		35	100

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

20MAC11 - MATRICES AND DIFFERENTIAL EQUATIONS
(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	BS	3	1*	2*	4

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

List of Exercises / Experiments:

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

*Alternate week Lecture: 45, Tutorial and Practical:15, Total:60

TEXT BOOK:

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

REFERENCES:

1. Kreyszig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley Sons, 2011.
2. Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi.
3. Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics – I", 2nd Edition, Pearson India Education, New Delhi, 2018.
4. MATLAB Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve engineering problems which needs matrix computations.	Applying (K3)
CO2	identify the appropriate method for solving first order ordinary differential equations.	Applying (K3)
CO3	solve higher order linear differential equations with constant and variable coefficients.	Applying (K3)
CO4	apply the concept of ordinary differential equations for modeling and finding solutions to engineering problems.	Applying (K3)
CO5	apply Laplace Transform to find solutions of Linear Ordinary Differential Equations	Applying (K3)
CO6	know the basics of MATLAB and computing eigen values and eigen vectors of real matrix by MATLAB.	Understanding (K2), Manipulation (S2)
CO7	solve ordinary differential equations with constant and variable coefficients and simultaneous first order ordinary differential equations using MATLAB.	Applying (K3), Manipulation (S2)
CO8	compute Laplace and inverse Laplace Transform of basic functions and solve Second Order ODE by using Laplace Transform with MATLAB.	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	1										
CO2	3	3	2	1										
CO3	3	3	2	1										
CO4	3	3	2											
CO5	3	3	2	1										
CO6					3									
CO7					3									
CO8					3									
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

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

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

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

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

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

Total: 45

TEXT BOOK:

1. Avadhanulu M.N., Kshirsagar P.G. and Arun Murthy T.V.S., "A Textbook of Engineering Physics",11th Edition, S. Chand & Company Pvt. Ltd., New Delhi, 2019.

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	35	45				100
CAT3	25	35	40				100
ESE	20	40	40				100

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

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

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

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

Total: 45

TEXT BOOK:

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

REFERENCES:

1. Palanisamy P.N., Manikandan P., Geetha A.& Manjula Rani K., “Applied Chemistry”, 6th Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2019.
2. Payal B. Joshi, Shashank Deep, “Engineering Chemistry”, Oxford University Press, New Delhi, 2019.
3. Palanna O., “Engineering Chemistry”, McGraw Hill Education, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the suitable water softening methods to avoid boiler troubles.	Applying (K3)
CO2	apply the principle of electrochemistry for various applications.	Applying (K3)
CO3	make use of corrosion control methods to solve corrosion related problems.	Applying (K3)
CO4	illustrate the quality of fuels from its characteristics.	Understanding (K2)
CO5	explain the types of polymers, plastics and fabrication methods.	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

20MTT11 - ENGINEERING MECHANICS

Programme & Branch	BE - Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	3	1	0	4

Preamble	This course provides introduction to the basic concepts of forces, inertia, centroid and moments of area along with their effects on motion. It introduces the phenomenon of friction and its effects. It familiarizes students to cognitive learning in applied mechanics and develops problem-solving skills in both theoretical and engineering oriented problems.	
Unit - I	**Statics of Particles:**	**9+3**
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 representation of forces–Equilibrium of a particle in space.		
Unit - II	**Statics of Rigid Bodies:**	**9 + 3**
Moments: Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar component of moments – 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 – Equilibrium of Rigid bodies in three dimensions. Trusses: Method of joints- Method of sections. Principle of virtual work.		
Unit - III	**Properties of Surfaces and Solids:**	**9 + 3**
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 + 3**
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 + 3**
Dynamics of Particles: Newton's law, Work - Energy and Impulse - Momentum equations of particles – Impact of elastic bodies. Kinematics of Rigid body: Translation - Rotation about a fixed axis–General plane motion. Kinetics of rigid body.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Dubey N.H, "Engineering Mechanics: Statics and Dynamics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

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.

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

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

ASSESSMENT PATTERN - THEORY

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

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

20MEC11 – ENGINEERING DRAWING
(Common to Civil, Mechanical, Mechatronics, Automobile Engineering, Chemical & Food Technology Branches)

Programme & Branch	BE(Civil, Mech, MTS, Auto) &BTech(Chem, FT)	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	ES	2	0	2	3

Preamble	To impart knowledge on orthographic, isometric projections, sectional views and development of surfaces by solving different application oriented problems.	
Unit - I	**General Principles of Orthographic Projection:**	**9**
Importance of graphics in engineering applications - Use of drafting instruments - BIS conventions and specifications - Size, layout and folding of drawing sheets - Lettering and dimensioning - Projections of Points, Lines and Planes - General principles of orthographic projection - First angle projection - Layout of views - Projection of points located in all quadrant and straight lines located in the first quadrant - Determination of true lengths and true inclinations and location of traces - Projection of polygonal surface and circular lamina inclined to both reference planes.		
Unit - II	**Projections of Solid:**	**9**
Projections of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method.		
Unit - III	**Sectioning of Solids:**	**9**
Sectioning of solids - prisms, pyramids, cylinder and cone in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other - Obtaining true shape of section.		
Unit - IV	**Development of Surfaces:**	**9**
Development of lateral surfaces of simple solids like prisms, pyramids, cylinders and cones – development of simple truncated solids involving prisms, pyramids, cylinders and cones.		
Unit - V	**Isometric Projection and Introduction to AutoCAD:**	**9**
Principles of isometric projection - Isometric scale - Isometric projections of simple and truncated solids like prisms, pyramids, cylinders and cones - Conversion of isometric projection into orthographic projection - Introduction to AutoCAD.		

Lecture:30, Practical:30, Total:60

TEXT BOOK:

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

REFERENCES:

1. Basant Agrawal, Agrawal C.M., "Engineering Drawing", 2nd Edition, McGraw Hill Education, 2019.
2. Gopalakrishnana K.R. "Engineering Drawing", Volume. I & II, Subhas Publications, Bengaluru, 2014.
3. Parthasarathy N.S., Vela Murali. "Engineering Drawing", 1st Edition, Oxford University Press, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret international standards of drawings and sketch the projections of points, lines and planes.	Understanding (K2)
CO2	draw the projections of 3D primitive objects like prisms, pyramids, cylinders and cones.	Applying (K3)
CO3	construct the various sectional views of solids like prisms, pyramids, cylinders and cones.	Applying (K3)
CO4	develop the lateral surfaces of simple and truncated solids.	Applying (K3)
CO5	sketch the isometric projections of simple and truncated solids and convert isometric drawing in to orthographic projection.	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	25	35	40				100

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

20PHL11 – PHYSICAL SCIENCES LABORATORY I
(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1	BS	0	0	2	1

Preamble	This course aims to impart hands on training in the determination of the physical parameters such as Young's modulus, rigidity modulus, frequency of vibration, velocity of ultrasonic waves, compressibility of water, wavelength of laser, acceptance angle and the numerical aperture of an optical fiber, and to develop the skills in handling different basic instruments and also aims to impart the basic concepts of volumetric, conductometric and pH meter experiments and thereby, to improve the analytical capability.

List of Exercises / Experiments:

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

Total: 30

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

20MEL11 – ENGINEERING PRACTICES LABORATORY
(Common to Civil, Mechanical, Mechatronics, Automobile Engineering, Chemical & Food Technology Branches)

Programme & Branch	BE (Civil, Mech, MTS, Auto) & BTech (Chem, FT)	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	ES	0	0	2	1

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

List of Exercises / Experiments:

	PART A – MECHANICAL ENGINEERING
1.	To prepare square or rectangular shaped MS plates using power tools for cutting, polishing and shaping to the required dimensions.
2.	To carryout drilling, tapping and assembly on the given MS plates.
3.	To carryout thread forming on a GI/PVC pipes and prepare water leak proof water line from overhead tank.
4.	To prepare a wood or plywood box/tray/any innovative models using modern power tools like cutting machine, router, jigsaw, power screw driver etc.
5.	Welding practice through arc welding / simulator
	PART B – ELECTRICAL AND ELECTRONICS ENGINEERING
1.	Safety Aspects of Electrical Engineering, Electrical Symbols, Components Identification, Fuse selection and installation, Circuit Breakers selection
2.	Wiring circuit for fluorescent lamp and Stair case wiring
3.	Measurement of Earth resistance
4.	Soldering of Simple Circuits and trouble shooting
5.	Implementation of half wave and full wave Rectifier using diodes

Total: 30

REFERENCES /MANUAL / SOFTWARE:

1.	Engineering Practices Laboratory Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	plan the sequence of operations for effective completion of the planned models/ innovative articles	Creating (K6), Precision (S3)
CO2	identify and use appropriate modern power tools and complete the exercises/models accurately	Applying (K3), Precision (S3)
CO3	select fuses and Circuit breakers	Understanding (K2), Manipulation (S2)
CO4	perform house wiring and realize the importance of earthing	Applying (K3), Manipulation (S2)
CO5	trouble shoot the electrical and electronic circuits	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

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

20VEC11 – YOGA AND VALUES FOR HOLISTIC DEVELOPMENT

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

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

Lecture:10, Practical:10, Total:20

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN

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

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

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

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

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

Total: 45

TEXT BOOK:

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

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	use functional grammar for improving communication skills	Applying (K3)
CO2	listen and comprehend different spoken excerpts critically and infer Unspoken and impliedmeanings.	Applying (K3)
CO3	read different genres of texts, infer implied meanings and critically analyze and evaluate themfor ideas as well as for method of presentation.	Analyzing (K5)
CO4	write effectively and persuasively and produce different types of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluativewriting.	Creating (K6)
CO5	speak effectively, to express opinions clearly, initiate and sustain a discussion and alsonegotiate using appropriate communicative strategies.	Creating (K6)

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

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		13	30	33	-	17	100
CAT2		13	33	37	-	17	100
CAT3		20	30	33	-	17	100
ESE		6	40	36	-	18	100

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

20MAC21 - MULTIVARIABLE CALCULUS AND COMPLEX ANALYSIS

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	BS	3	1*	2*	4

Preamble	To impart the knowledge of partial derivatives, evaluation of real and complex integrals, vector calculus and analytic functions to the students for solving the problems related to various engineering disciplines.	
Unit - I	**Functions of Several Variables:**	**9**
Functions of two or more variables – Partial derivatives – Total differential – Taylor's series for functions of two variables – Maxima and minima – Constrained maxima and minima – Lagrange's multiplier method		
Unit - II	**Multiple Integrals:**	**9**
Double integration in cartesian coordinates – Change of order of integration – Application: Area between two curves – Triple integration in cartesian coordinates –Volume as triple integrals		
Unit - III	**Vector Calculus:**	**9**
Directional derivative – Gradient of a scalar point function – Divergence of a vector point function – Curl of a vector – Solenoidal and Irrotational vectors – Green's, Stoke's and Gauss divergence theorems (without proof) – Verification of the above theorems and evaluation of integrals using them.		
Unit - IV	**Analytic Functions:**	**9**
Functions of a complex variable – Analytic functions – Necessary and sufficient conditions (excluding proof) – Cauchy-Riemann equations (Statement only) – Properties of analytic function (Statement only) – Harmonic function – Construction of analytic function – Conformal mapping: w = z + a, az, 1/z – Bilinear transformation.		
Unit - V	**Complex Integration:**	**9**
Introduction – Cauchy's theorem (without proof) – Cauchy's integral formula – Taylor's and Laurent series – Singularities – Classification – Cauchy's residue theorem (without proof) – Applications: Evaluation of definite integrals involving sine and cosine functions over the circular contour.		

List of Exercises / Experiments:

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

***Alternate week**

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

TEXT BOOK:

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

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	compute extremal values which arise in function of several variables.	Applying (K3)
CO2	solve Problems involving Double and Triple integrals.	Understanding (K2)
CO3	apply the concept of vectors in engineering problems.	Applying (K3)
CO4	identify, construct and apply analytic functions in electrostatics and fluid flow problems.	Applying (K3)
CO5	evaluate complex integrals which are extensively applied in engineering.	Applying (K3)
CO6	compute maxima and minima of a single variable function, gradient, curl and divergence of a vector function using MATLAB.	Understanding (K2), Manipulation (S2)
CO7	evaluate Double, Triple integrals and determine area between two curves using MATLAB	Applying (K3), Manipulation (S2)
CO8	construct analytic function, find bilinear transformation and compute poles and residues using MATLAB.	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3												
CO2	3	3	2											
CO3	3	3												
CO4	3	3												
CO5	3	3	2											
CO6					3									
CO7					3									
CO8					3									

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

ASSESSMENT PATTERN - THEORY

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

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

20PHT22 - MATERIALS SCIENCE AND METALLURGY

(Common to Mechatronics Engineering & Automobile Engineering Branches)

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

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

Total: 45

TEXT BOOK:

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

REFERENCES:

1. Donald K. Askeland, Pradeep P. Fulay and Wendelin J. Wright, ¯The Science and Engineering of Materials‖, 6th Edition, Centage Learning, Singapore, 2011.
2. Sam Zhang, Lin Li and Ashok Kumar, ¯Materials Characterization Techniques‖, 1st Edition, CRC Press, Boca Raton, 2008.
3. Tamilarasan K. and Prabu K., ¯Materials Science and Metallurgy‖, 1st Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2019.

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	30	30	40				100
CAT3	25	35	40				100
ESE	20	40	40				100

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

20CYT22 - CHEMISTRY FOR MECHANICAL SYSTEMS

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

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

Total: 45

TEXT BOOK:

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

REFERENCES:

1.	Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K. & Kowshalya V.N., "Environmental Science". Revised Edition, Pearson Education, New Delhi, 2019.
2.	Palanna O., "Engineering Chemistry", McGraw Hill Education, New Delhi, 2017.
3.	Payal B.Joshi & Shashank Deep, "Engineering Chemistry", Oxford University Press, New Delhi, 2019.

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

20MTT21 - FLUID MECHANICS AND THERMODYNAMICS

Programme & Branch	BE-Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics, Mathematics I	2/4	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		**9+3**
Fluid Properties and Fluid Statics: 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		**9+3**
Fluid Kinematics and Fluid Dynamics: 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		**9+3**
Viscous Flow, Flow through Pipes and Dimensional analysis: 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. Dimensional analysis: Buckingham's theorem		
Unit - IV		**9+3**
Basics of Thermodynamics and First Law of Thermodynamics: 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 to closed and open systems – Steady Flow Energy Equation (SFEE) – Simple problems.		
Unit - V		**9+3**
Second Law of Thermodynamics and Entropy: 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.		

Leture: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								1	1	2	2
CO2	3	3	2								1	1	2	2
CO3	2	2	3	2	1	3	3				1	1	3	3
CO4	2	2	3	2	1	2	2				1	1	3	3
CO5	3	3	2	2	1	2	2				1	1	2	2

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

ASSESSMENT PATTERN - THEORY

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

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

20MTT22 - ELECTRON DEVICES AND DIGITAL CIRCUITS

Programme & Branch	BE-Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	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 introduces 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- Ohms Law- Kirchhoff's Current Law- Kirchhoff's Voltage Law- Star –Delta Transformation- Mesh Analysis- Nodal Analysis – Super Position Theorem- Thevenin's Theorem- Norton's 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- Construction and characteristics of FET		
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, Tabulation Method – 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 – Analysis and design of sequential circuits with state diagram and State table - Design of Synchronous and asynchronous counters – shift register.		

Total:45

TEXT BOOK:

1. Ravish R.Singh, ¯Network Analysis and Synthesis‖ 4th Reprint 2016, McGraw Hill Education (India) Private Limited, New Delhi.
2. Floyd, ¯Electronic Devices‖, 10th Edition, Pearson Education, New Delhi, 2018.

REFERENCES:

1. Anandkumar A., ¯Fundamentals of Digital Circuits‖, 4nd Edition, Prentice Hall of India, New Delhi, 2016.
2. Morris Mano M., ¯Digital Design‖, 5th Edition, Prentice Hall of India, New Delhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the basic laws and theorems of Circuit Network.	Analysing (K4)
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	Analysing (K4)
CO5	design the sequential circuits	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	1		2							3	3	3
CO2	2	1	1		2							3	2	2
CO3	3	2	1		2							3	3	3
CO4	3	3	1		2							3	3	3
CO5	3	3	1		2							3	3	3

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

ASSESMENT PATTERN - THEORY

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

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

20PHL22 - PHYSICAL SCIENCES LABORATORY II

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

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

List of Exercises / Experiments:

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

Total: 30

REFERENCES:

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

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

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

20MTL21 - ELECTRON DEVICES AND DIGITAL CIRCUITS LABORATORY

Prog. & Branch	BE – Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Pre requisite	Nil	2	ES	0	0	2	1

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

List of Exercises / Experiments:

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.	Drain characteristics of FET
6.	Half wave and Full wave rectifier
7.	Verification of Boolean theorems using digital logic gates
8.	Design and implementation of binary adder and subtractor
9.	Design and implementation of multiplexer and de-multiplexer
10.	Design and implementation of encoder and decoder
11.	Design of Counters
12.	Design of Shift Register

Total: 30

REFERENCES:

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	Analyzing (K4), Precision (S3)

Mapping of COs with POs and PSOs

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

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

20MAT31 - PROBABILITY AND PARTIAL DIFFERENTIAL EQUATIONS

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

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

Preamble	To provide the skills for solving the real time engineering problems involving partial differential equations and impart knowledge in applying probability concepts in their respective fields and express functions in terms of Fourier series.	
Unit - I	**Random Variables:**	**9+3**
Introduction to Probability - Definition of random variable - Discrete and Continuous random variables - Probability Mass and Probability density functions - Mathematical expectation and Variance - Moments - Moment generating functions.		
Unit - II	**Standard Probability Distributions:**	**9+3**
Discrete Distributions: Binomial distribution - Poisson distribution - Geometric distribution - Continuous Distributions: Uniform distribution – Exponential distribution – Normal distribution.		
Unit - III	**Fourier Series:**	**9+3**
Dirichlet's conditions - General Fourier series - Change of interval - Odd and even functions - Half range Sine series - Half range Cosine series – Harmonic analysis.		
Unit - IV	**Partial Differential Equations:**	**9+3**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Lagrange's linear equation - Solution of homogeneous linear partial differential equations of higher order with constant coefficients.		
Unit - V	**Applications of Partial Differential Equations:**	**9+3**
Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two dimensional heat equation (excluding insulated edges).		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

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

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the concept of random variables.	Applying (K3)
CO2	implement the exact distribution for solving engineering problems.	Applying (K3)
CO3	express the given function or data in terms of Fourier series.	Applying (K3)
CO4	formulate and solve higher order partial differential equations	Applying (K3)
CO5	apply Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.	Applying (K3)

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

ASSESSMENT PATTERN - THEORY

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

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

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

20CSC31 – PROGRAMMING IN C

Programme & Branch	All BE/BTech Engineering & Technology branches except CSE, IT	Sem.	Category	L	T	P	Credit
Prerequisities	NIL	2/3	ES	3	0	2	4

Preamble	The course is designed for use by freshmen students taking their first course in programming. It deals with the techniques needed to practice computational thinking, the art of using computers to solve problems and the ways the computers can be used to solve problems. This course also focuses on developing programming skills using C language.	
Unit - I	**Introduction to Computer and Problem Solving:**	**9**
Overview of computers : Types, Generations, Characteristics, Basic computer Organization – Problem solving techniques: Algorithms - Flowcharts – Pseudo codes – Structuring the logic: Sequential, selection and repetitive structure		
Unit - II	**Introduction to C and Control Statements:**	**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 - decision making and looping statements		
Unit - III	**Arrays and Functions:**	**9**
Declaring, initializing and accessing arrays – operations on arrays – Two dimensional arrays and their operations. 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, passing arguments to function using pointers -pointers and 1D arrays –arrays vs pointers , 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 Exercises:

1.	Writing algorithms and drawing flowcharts using Raptor Tool for problems involving sequential, Selection and repetition structures
2.	Programs for demonstrating the use of different types of operators like arithmetic, logical, relational and ternary operators
3.	Programs using decision making and repetitive statements
4.	Programs for demonstrating one-dimensional and two-dimensional numeric array
5.	Programs to demonstrate modular programming concepts using functions and strings (Using built-in and user-defined functions)
6.	Programs to illustrate the use of structures and pointers
7.	Programs to implement file operations

Lecture:45, Practical : 30, Total:75

TEXT BOOK:

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

REFERENCES:

1.	Yashavant Kanetkar, "Let us C", 16th Edition, BPB Publications, 2018.
2.	Sumitabha Das, ―Computer Fundamentals and C Programmingǁ, 1st Edition, McGraw Hill, 2018.
3.	Balagurusamy E., "Programming in ANSI C", 7th Edition, McGraw Hill Education, 2017.

	COURSE OUTCOMES: On completion of the course, the students will be able to	**BT Mapped (Highest Level)**
CO1:	outline the basics of computers and apply problem solving techniques to express the solutionfor the given problem	Applying (K3)
CO2:	identify the appropriate looping and control statements in C and develop applications usingthese statements	Applying (K3)
CO3:	develop simple C programs using the concepts of arrays and modular programming	Applying (K3)
CO4:	apply the concepts of pointers and develop C programs using strings and pointers	Applying (K3)
CO5:	make use of user defined data types and file concept to solve given problems	Applying (K3)
CO6:	demonstrate the execution of flowcharts for the given problem using Raptor	Applying (K3), Precision (S3)
CO7:	demonstrate the application of sequential, selective and repetitive control structures	Applying (K3), Precision (S3)
CO8:	develop solutions to the given problem using derived /user defined data types and functionsand also using file concepts	Applying (K3), Precision (S3)

*

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

Mapping 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	2	2											
CO4	3	2	2											
CO5	3	2	2											
CO6	3	2	2	2	1					1				
CO7	3	2	2	2	1					1				
CO8	3	2	2	2	1					1				
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom‘s Taxonomy														

ASSESSMENT PATTERN - THEORY

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

20CSC34 – DATA STRUCTURES USING C

Common to ECE, EEE, E & I, MTS Branches

Programme & Branch	Common to ECE, EEE, E & I , MTS Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Programming in C	3	PC	3	0	2	4

Preamble	This course is indented to introduce the concept of elementary data structures and notion of algorithms to novice learner from cross disciplines in Engineering and Technology.	
Unit – I	**List:**	**9**
Data Structures - Abstract Data Types (ADT) - List ADT and Array Implementation - Linked List - 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) Precision (S3)
CO2	make use of arrays and linked lists to create Stack and Queue ADTs.	Applying (K3) Precision (S3)
CO3	utilize Tree ADT to develop simple application	Applying (K3) Precision (S3)
CO4	make use of Graph ADT for standard problems	Applying (K3) Precision (S3)
CO5	illustrate the use of standard sorting and Hashing Techniques	Applying (K3) Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**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
ESE	5	35	60				100

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

20MTT31 KINEMATICS OF MACHINES

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	20MTT11 - Engineering Mechanics, 20MEC11 - Engineering Graphics	3	PC	3	1	0	4

Preamble	This course deals with analysis of velocity, acceleration and synthesis of various simple mechanisms. It provides insight on generation of cam profile, design of gears & gear trains and stability control using gyroscope mechanisms.	
Unit - I	**Basics and 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 - Mechanical advantage - Transmission angle - Description of common Mechanisms - Single, double and offset slider mechanisms - Quick return mechanism. Straight line generators - Design of crank-rocker Mechanism.		
Unit - II	**Velocity and acceleration of mechanisms:**	**9+3**
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 – Coriolis Acceleration component.		
Unit - III	**Kinematics of Cam and Follower:**	**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 and flat faced followers.		
Unit - IV	**Kinematics of Gears and Gear Trains:**	**9+3**
Theory of Gearing – gear nomenclature, law of gearing, tooth forms, minimum number of teeth, length of arc of contact, contact ratio and interference. Gear trains – types, velocity and torque calculation- Parallel axis and epicyclic gear trains.		
Unit - V	**Gyroscopic stability control mechanisms:**	**9+3**
Gyroscopes –Gyroscopic couples – Gyroscopic effects in automobiles, ships and air planes.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Khurmi R.S & Gupta K, "Theory of Machines", 14th Revised Edition, S. Chand & Co. Ltd, New Delhi, 2005.

REFERENCES:

1. Rattan S.S, "Theory of Machines", 4th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2019.
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	Applying (K3)
CO2	apply the concepts of kinematics to compute the velocity and acceleration for simple mechanisms	Applying (K3)

CO3	design and analyze the profile of various cam mechanisms for different applications	Applying (K3)
CO4	solve and evaluate the kinematic aspects of gears and gear trains	Applying (K3)
CO5	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	3	2	2	2								2	3	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	10	40	50				100
CAT2	10	40	50				100
CAT3	10	40	50				100
ESE	10	40	50				100

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

20MTT32 SYSTEMS AND CONTROL ENGINEERING

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	20MTT11 - Engineering Mechanics, 20MAC21 - Calculus and Complex Analysis and 20MTT22 - Electron Devices and Digital Circuits	3	PC	3	0	0	3

Preamble	This course introduces the fundamental concepts of signals and systems and also promotes an understanding of the control systems concepts in 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 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 - Step response of second order underdamped System - 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", 6th Edition, New Age International Publishers, New Delhi, 2018.
3. Norman S. Nise, "Control Systems Engineering", 7th Edition, Wiley India Private Ltd, New Delhi, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	classify various types of continuous time signals and systems and analyze using Laplace transform	Applying (K3)
CO2	develop the mathematical model of electrical, mechanical and electromechanical systems	Applying (K3)
CO3	analyze the time domain response of first and second order systems	Applying (K3)
CO4	assess the stability of systems in time domain and frequency domain	Applying (K3)
CO5	analyze the frequency response of systems and design the 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	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	20	20	60				100
CAT2	20	20	60				100
CAT3	20	20	60				100
ESE	20	20	60				100

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

20MTT33 ELECTRICAL MACHINES

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	20MTT22 Electronics Devices and Digital Circuits	3	PC	3	0	0	3

Preamble	This course provides the knowledge about construction, working principle, starting and speed control techniques of various electrical machines used in real time application.	
Unit - I	**DC Machines:**	**9**
Introduction- Electromagnetism- Classification of electrical machines– Static and Dynamic induced EMF – Construction and Principle of operation of DC machines – Types - EMF equation and Back EMF- Torque equation, Characteristics of series and shunt motor – Starters: 3-point starter – Speed control: Armature and Field control-electric braking.		
Unit - II	**Transformer and Synchronous Machines:**	**9**
Construction and Principle of operation of single-phase transformer-EMF equation- Transformer losses - OC and SC test - Autotransformer. Alternator: Construction and Principle of operation- EMF equation. Synchronous motor: Construction and Principle of operation - Starting methods– Applications.		
Unit - III	**Three phase Induction Motor:**	**9**
Construction and Principle of operation- Torque equation-Starters: DOL and Star/Delta starter. Speed control: Voltage, Frequency, V/f – Applications. Induction generator.		
Unit - IV	**Single Phase Induction Motor and Stepper Motor**:	**9**
Single phase Induction motor: Construction and Principle of operation - Double field revolving theory -Types-Applications. Stepper motor: Classifications- Construction and Principle of operation –Types - Applications.		
Unit - V	**Special Machines:**	**9**
Servo mechanism – DC Servo motor - AC Servo motor – Applications. Construction, Operation and Applications of: Brushless permanent magnet DC motor –Universal motor– Switched reluctance motor-Linear induction motor.		

Total:45

TEXT BOOK:

1. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2018.

REFERENCES:

1. Theraja B.L. & Theraja A.K., "A Text Book of Electrical Technology – Volume 2", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2017.
2. Takashi Kenjo, "Stepping Motors and their Microprocessor Controls", 2nd Edition, Oxford University Press, USA, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the construction and operation of DC Machines	Understanding (K2)
CO2	assess the performance characteristics of transformer and demonstrate the operation of synchronous machines	Applying (K3)
CO3	elaborate the functions of synchronous machines and its applications	Understanding (K2)
CO4	summarize the working principle and operation of single phase induction motor and stepper motor	Understanding (K2)
CO5	select the appropriate special machine 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		2
CO2	3	3	2	2	1							2	1	3
CO3	3	3	2	2	1							2	1	3
CO4	3	2										2		2
CO5	3	2	1	1	1							2	1	3

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	50	40				100
CAT2	20	50	30				100
CAT3	15	50	35				100
ESE	20	50	30				100

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

20MTT34 MANUFACTURING PROCESSES

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	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 to fabricate various machine element parts.	
Unit – I	**Foundry Technology:**	**9**
Introduction to Molding and Casting - Molding sand: types, properties - Preparation of green sand molding - Pattern making: Pattern materials, types and allowances - Core making: types of core, core materials, making of cores - Casting methods: Die casting, Centrifugal Castings, Investment Casting and Shell mold Casting - Defects in casting.		
Unit - II	**Metal Forming Processes:**	**9**
Rolling: Introduction, Rolling mills, Rolling operations - Extrusion: Forward and Backward extrusion - Production of seamless tubing and pipes - Cold and Hydrostatic Extrusion - Drawing: Hot and Cold drawing - Deep drawing - Tube and wire drawing - Sheet metal and forging operations		
Unit - III	**Metal Removal Processes:**	**9**
Lathe: types, main parts and operations - single point cutting tool nomenclature - Drilling Machine: Types, operations, types of drills - Twist drill nomenclature - Reaming and tapping - Milling Machine: Types, operations - types of milling cutters - Shaper and Planer: types, main parts, operations. (Numerical problems in Lathe, Drilling and Milling operations)		
Unit - IV	**Metal Joining Processes:**	**9**
Classification of Welding Process - Fusion Welding Processes: Arc Welding - Gas Tungsten Arc welding - Gas Metal Arc Welding - Electron Beam Welding - Laser Beam Welding - Solid State Welding: Cold Welding - Ultrasonic Welding - Friction Welding - Resistance Welding - Explosive Welding - Gas welding: Oxy – Acetylene welding process - Weld defects: types, causes and cure - Brazing and soldering: Concepts and applications.		
Unit – V	**Metal Finishing Processes:**	**9**
Grinding Machine: Methods of grinding - Types of grinding machines - Grinding wheel and its selection – Lapping – Honing - Super finishing - Broaching Machine: pull type and push type broachers - broaching 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. & Schmid R., "Manufacturing Engineering and Technology", 7th Edition, Pearson Education, India, 2018.
2. Rao P.N., "Manufacturing Technology, Volume I & II", 3rd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the various foundry techniques like pattern making, molding, casting, melting furnaces and inspection	Understanding (K2)
CO2	categorize various forming processes involving bulk forming and sheet metal operations	Understanding (K2)
CO3	choose the metal removal 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	3								2	2	2
CO3	3	3	2	2								2	1	1
CO4	3	3	1	1								2	2	2
CO5	3	1	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	25	75					100
CAT2	15	55	30				100
CAT3	25	75					100
ESE	20	60	20				100

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

20MTL31 ELECTRICAL MACHINES AND CONTROL LABORATORY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	20MTL21 Electronics Devices and Digital Circuits Laboratory	3	PC	0	0	2	1
Preamble	This course aided to understand the characteristics behaviour of electrical machines through practical realization. It also intended to design, develop and analyze the open loop and closed loop control systems.						

List of Exercises / Experiments:

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.	Development and analysis of mechanical translational system
8.	Development and analysis of mechanical rotational system
9.	Development and analysis of electrical system using op-amp
10.	Development and analysis of electromechanical system using gears
11.	Closed loop analysis of PID controller for position control system
12.	Design of compensators for first order systems

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2018.
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	2	2	2	2	1							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

20MTL32 MANUFACTURING PROCESSES LABORATORY

Programme &	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit

Branch							
Prerequisites	**NIL**	**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 Exercises / Experiments :

1.	Lathe operations: Step turning, Taper turning and Knurling
2.	Lathe operation: Thread Cutting
3.	Lathe operation: Eccentric turning
4.	Milling machine operation: Spur gear milling / Contour / Key way milling
5.	Shaper / planner machine operation: Key way / Dove tail shape Cutting
6.	Drilling machine operations: Drilling, Reaming and Tapping
7.	Grinding machine operations: Surface grinding and Cylindrical grinding
8.	Preparation of 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 / Spot welding

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	develop the various mechanical components using centre lathe through single point and multi point cutting tool	Applying (K3), Precision (S3)
CO2	develop the various mechanical components using special machines like milling machine, Shaper and drilling machine	Applying (K3), Precision (S3)
CO3	develop the surfaces of machining parts with high finishing using surface and cylindrical grinder	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

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

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

20MAT41 – STATISTICS AND NUMERICAL METHODS
(Common to all Engineering and Technology Branches except ECE, CSE and IT)

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

Preamble	To impart knowledge in testing of samples, ANOVA and interpolation. Also develop skills to apply numerical algorithms to identify roots of algebraic and transcendental equations and solve linear and ordinary differential equations.	
Unit - I	**Testing of Hypothesis:**	**9+3**
Introduction – Critical region and level of significance – Types of Errors – Large sample tests: Z-test for single proportion and difference of two sample proportions – Z-test for single mean and difference of means – Small sample tests: Student's t-test fortesting significance of single mean and difference of means – F-test for comparison of variances – Chi-square test: Test of goodness of fit – Test of independence of attributes.		
Unit - II	**Design of Experiments:**	**9+3**
Introduction – Analysis of variance – One way classification: Completely Randomized Design – Two way classification: Randomized Block Design – Three way classification: Latin Square Design.		
Unit - III	**Solution to Algebraic and Transcendental Equations:**	**9+3**
Method of false position – Newton-Raphson method – Solution of linear system of equations – Direct methods: Gauss eliminationmethod and Gauss - Jordan method – Iterative methods: Gauss Jacobi and Gauss-Seidel methods.		
Unit - IV	**Interpolation, Numerical Differentiation and Integration:**	**9+3**
Interpolation: Interpolation with equal intervals: Newton s forward and backward difference formulae — Interpolation with unequal intervals: Lagrange's interpolation formula – Newton's divided difference formula. Numerical Differentiation and Integration: Differentiation using Newton s forward, backward and divided difference formulae — Numerical integration: Trapezoidal rule — Simpsons 1/3rd rule.		
Unit - V	**Numerical Solution of First order Ordinary Differential Equations:**	**9+3**
Single step methods: Taylor series method – Euler method – Modified Euler method – Fourth order Runge-Kutta method – Multistep methods: Milne's predictor corrector method – Adam's Bashforth method.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1. Veerarajan T, Ramachandran T., ―Statistics and Numerical Methods‖, 1st Edition, Tata McGraw Hill Publishing Company, NewDelhi, 2018.

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply statistical tests for solving engineering problems involving small and large sample tests.	Applying (K3)
CO2	handle experimental data with the knowledge of ANOVA.	Applying (K3)
CO3	apply various numerical techniques to solve algebraic and transcendental equations	Applying (K3)
CO4	compute intermediate values of given data, numerical derivatives and integral values	Applying (K3)
CO5	obtain the solution of first ordinary differential equations by numerical methods.	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

(Common to all BE/BTech Engineering & Technology branches except CSE, IT)

Programme & Branch	All BE/BTech Engineering & Technology branches except CSE, IT	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3/4	ES	3	0	2	4

Preamble	This course introduces the core python programming. It emphasizes on developing python programs with all datatypes, functions, classes, objects and numpy	
Unit - I	**Introduction:**	**9**
Introduction: 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,Tuples and Dictionary: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 and Regular Expressions:Strings:Concatenation , append, multiply on strings – Immutable – formatting operator – Built-instring 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 and Modules: 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, NumPy and Matplotlib:**	**9**
Object Orientation: 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 Exercises / Experiments :

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

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Reema Thareja, "Python Programming using Problem Solving Approach", 3rd Edition, Oxford University Press, 2017.

REFERENCES:

1.	Nageswara Rao, "Core Python Programming", 2nd Edition, DreamTech Press, New Delhi, 2018.
2.	Jake Vander Plas , "Python Data Science Handbook Essential Tools for Working with Data", 1st Edition, O'Reilly Media, , 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of basic python constructs to write 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 in a string.	Applying (K3)
CO4	solve the problems using functions and modules.	Applying (K3)
CO5	understand the class and object and apply inheritance in programming.	Applying (K3)
CO6	implement the basic data types and control statements.	Applying (K3), Manipulation (S2)
CO7	demonstrate functions, regular expressions and object oriented concepts.	Applying (K3), Manipulation (S2)
CO8	perform numpy operations and analyse results using matplotlib	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										
CO6	3	2	1	1										
CO7	3	2	1	1										
CO8	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	25	50				100
CAT2	20	20	60				100
CAT3	20	20	60				100
ESE	25	25	50				100

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

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	20MEC11 - Engineering Mechanics, 20MTT32 –Systems and Control Engineering, 20MTT31 - Kinematics of Machines	4	PC	3	1	0	4

Preamble	This course aims to impart knowledge on force analysis of various static & dynamic members, balancing of rotating & reciprocating masses in various types of engines and impact of free and forced vibration in various systems. It also emphasis on compensator design based on governors and automatic control of dynamic systems.	
Unit - I	**Force Analysis:**	**9**
Inertia forces and D'Alembert's principle–Inertia force analysis in reciprocating engines – Gas forces – Equivalent masses –Bearing loads – Crank shaft torque – Fly wheels–turning moment diagrams and fluctuation of energy in reciprocating engine mechanisms, coefficient of fluctuation of energy and speed, weight of flywheel.		
Unit - II	**Balancing of Masses:**	**9**
Static and dynamic balancing –Balancing of rotating masses –Balancing of single cylinder Engine –Balancing of Multi-cylinder Engine –Partial balancing of locomotive Engines – Balancing of radial engine – Direct and reverse crank method		
Unit - III	**Free and Damped Vibrations:**	**9**
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 - IV	**Forced and Torsional Vibrations:**	**9**
Response to periodic forcing –Harmonic Forcing –Forcing caused by unbalance – Support motion-Logarithmic decrement-magnification factor – Force transmissibility and amplitude transmissibility – Vibration isolation. Torsional systems- Natural frequency of single, two and three rotor systems, Torsionally Equivalent System – Stepped shaft and Geared shaft		
Unit - V	**Control Mechanisms and Goverenor:**	**9**
Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling Force. Automatic control of mechanical systems- Transfer function- viscous damped output		

Total:45

TEXT BOOK:

1. Rattan S.S, "Theory of Machines", 4th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2019.

REFERENCES:

1. Khurmi R.S & Gupta K, "Theory of Machines", 14th Revised Edition, S. Chand & Co. Ltd, New Delhi, 2005.
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	assess inertia force, torque for reciprocating mechanisms and parameters of flywheel	Applying (K3)
CO2	analyze the static and dynamic unbalance of revolving and reciprocating masses	Analyzing (K4)
CO3	evaluate, analyze and demonstrate the frequencies of free and damped vibrations	Analyzing (K4)
CO4	evaluate the frequencies of forced and torsional vibration systems	Analyzing (K4)
CO5	estimate the characteristics of different types of centrifugal governors	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		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	20	50	20			100
CAT2		30	40	30			100
CAT3	10	20	50	20			100
ESE	10	20	40	30			100

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

20MTT42 SENSORS AND SIGNAL CONDITIONING

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	20PHT11 - Applied Physics	4	PC	3	0	0	3

Preamble	To make students familiar about 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 – Measurement system errors - Error analysis – Static and dynamic characteristics of transducers – Classification of transducers – Selection of transducers – Calibration of instruments.		
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**
Ideal operational amplifier — General operational amplifier stages – Pin diagram & internal circuit diagrams of IC 741, 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 Electronic Measurement and Instrumentation, Dhanpat Rai & Co, New Delhi, 2015.
2.	D Choudhury Roy., "Linear Integrated Circuits ", 2nd Edition, New Academic Science, New Delhi, 2017.

REFERENCES:

1.	John G. Webster, "Measurement, Instrumentation, and Sensors Handbook", 2nd Edition, CRC Press, United States, 2018.
2.	Ramon Pallas. Arney, and John G.Webster., Sensors and Signal Conditioning, Second Edition, John Wiley & Sons, 2001.

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	20	70	10				100
CAT2	20	80	-				100
CAT3	20	60	20				100
ESE	20	60	20				100

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

20MTL41 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 the concept behind working of various types of Sensors used in Industries to measure various physical parameters.						

List of Exercises / 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.	Design of two stage Instrumentation amplifier
10.	Measurement of unknown Resistance using Wheatstone Bridge
11.	Measurement of unknown Inductance using Maxwell Bridge
12.	Measurement of unknown Capacitance using Schering Bridge

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	measure physical parameters using sensors for industrial measurement applications.	Applying (K3), Imitation (S1)
CO2	conduct and analyze the influence of dynamic factors that affect the characteristics of measurement system.	Applying (K3), Imitation (S1)
CO3	demonstrate use of measurement bridges for signal conditioning 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	3	2	1	3	1				2	2		2	3	3
CO2	3	2	1	3	1				2	2		2	3	3
CO3	3	2	1	3	1				2	2		2	3	3

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

20MTL42 COMPUTER AIDED DRAFTING LABORATORY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	20MEC11 Engineering Drawing	4	PC	0	0	2	1
Preamble	This course aids to design the mechanical and electrical components drawing using computer-aided tool.						

List of Exercises / Experiments:

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 / Robotic Manipulators using AUTOCAD.
6.	Study of electrical and electronic symbols.
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 assembly drawings of machine parts conforming IS conventions	Applying (K3), Manipulation (S2)
CO2	design the technical drawings for mechatronics related components with exact dimensions through appropriate views	Applying (K3), Manipulation (S2)
CO3	create 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	1	3				2	2		2	2	2
CO2	2	1	2	1	3				2	2		2	2	2
CO3	2	1	2	1	3				2	2		2	2	2

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

20EGL31 ENGLISH FOR WORKPLACE COMMUNICATION

(Common to All Engineering and Technology Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	4	HS	0	0	2	1
Preamble	This course is designed to impart required levels of fluency in using the English Language at B2 level in the CEFR through activities, hands-on training and application.						

List of Exercises / Experiments:

1.	Mock Interviews
2.	Presentation
3.	Group Discussion
4.	Reading Aloud
5.	Soft Skills
6.	Listening Test

Total:30

REFERENCES/MANUAL/SOFTWARE:

1. Sanjay Kumar & Pushp Lata, "Communication Skills", 2nd Edition, Oxford University Press, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	acquire effective listening and reading skills	Understanding (K2), Imitation (S1)
CO2	acquire and demonstrate appropriate professional skills for the workplace	Applying (K3), Naturalization (S5)
CO3	speak fluently and write meaningfully in English in the given context	Applying (K3), Articulation (S4)

Mapping of COs with POs and PSOs

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

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

20GET41 - UNIVERSAL HUMAN VALUES

(Common to All BE/BTech branches)

Programme & Branch	All BE/BTech Engineeirng & Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3 / 4	HS	2	0	0	2

Preamble	To make the student to know what they ‗really want to be' in their life and profession, understand the meaning of happiness and prosperity for a human being. Also to facilitate the students to understanding of harmony at all the levels of human living, and live accordingly	
Unit - I	**Introduction:**	**6**
Need and Basic Guidelines of Value Education – Content and Process of Value Education – Self Exploration – purpose of self-Exploration – Content and Process of Self exploration – Natural Acceptance – Realization and Understanding – Basic Human Aspirations – Continuous Happiness and Prosperity – Exploring Happiness and Prosperity – Basic Requirement for Fulfillment ofHuman 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 inthe Self and Body, Self (‗I') as the Conscious Entity, the Body as the Material Entity – Exercise – Body as an Instrument– Harmonyin 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 – Identificationof 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, ExcellBooks 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 matteredǁ, 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 scenarioin the society	Applying (K3)
CO2	distinguish between the Self and the Body, understand the meaning of Harmony in the Self, the Co–existence of Self and Body	Applying (K3)
CO3	infer the value of harmonious relationship based on trust, respect and other naturally acceptable feelings in human–human relationships and explore their role in ensuring a harmonious society	Applying (K3)
CO4	transform themselves to co-exist with nature by realising interconnectedness and four order of nature	Applying (K3)
CO5	distinguish between ethical and unethical practices, and extend ethical and moral practices for a better living	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test /Bloom’s Category*	Rememberin g(K1) %	Understandin g(K2) %	Applying (K3) %	Analyzing (K4) %	Evaluatin g(K5) %	Creating (K6) %	Total %
CAT1	25	75					100
CAT2	25	75					100
CAT3	NA						
ESE	NA						

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

20MTT51 - 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 part programming and various measurement techniques	
Unit – I	**Basic Concepts of Metal Cutting and CNC Machines:**	**9**
Introduction – Mechanics of chip formation -Mechanics of oblique cutting - Cutting forces and power- Tool life –Surface finish- Machinability. CNC machines: Classification – Construction details: Structure, Configuration of CNC system – Compensations for Machine accuracy – DNC – Adaptive control CNC systems, Drives and Controls - Drive Mechanism, gearbox, Spindle Drives, Axes drives - Magnetic Levitation and Linear motors. Timing belts and pulleys, Spindle bearing – Arrangement and installation. Slide ways. Re-circulating ball screws – Backlash measurement and compensation, linear motion guide ways.		
Unit – II	**Tooling for CNC Machines:**	**9**
Interchangeable tooling system – Preset and qualified tools – coolant 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, Angular and 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. Screw thread metrology: Terminology- Errors in thread, Gears Terminology- Measurement of various terminology in gears. Surface Finish and Form Measurement: Measurement of surface finish: Terminology – Geometrical irregularities – Roughness – Waviness. Surface roughness measurement methods.		
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 for Units I,II,III.
2. Jain R.K, "Engineering Metrology", Khanna Publishers, New Delhi, 2018, for Units IV, V.

REFERENCES:

1. HMT Limited, "Mechatronics", McGraw-Hill, New Delhi, 2017.
2. Raghavendra N.V. & Krishnamurthy L, "Engineering Metrology and Measurements", Oxford University Press, India, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	estimate the parameters of metal cutting and comprehend the basic components, drives and controls involved in a CNC system	Applying (K3)
CO2	select various tooling systems and fixtures for CNC and identify the 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	40	40	20				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)**

20MTT52 - MICROCONTROLLER PROGRAMMING AND APPLICATIONS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Electron Devices and Digital Circuits Problem Solving and Programming	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	**8085 Microprocessor:**	**9**
8085 Architecture – Pin configuration – Memory organization – Addressing modes – Instruction sets – Interrupts – Memory and I/O Interfacing – Assembly Language Programming.		
Unit – II	**8051 Microcontroller:**	**9**
Selection of Microcontrollers - 8051 Microcontroller Architecture – Pin configuration – Memory organization –Special function registers – Program Counter – PSW register – Stack and stack pointer.		
Unit - III	**8051 Assembly language / Embedded C Programming:**	**9**
Compiler C - Programming Structure, Data types, memory models, Infinite loops and handling interrupts in C - Intel Hex file format. Instruction sets – Addressing modes – 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.
2. Mazidi Muhammad Ali, Mazidi Janice Gillispie and McKinlay Rolin, "The 8051 Microcontroller and Embedded Systems", 2nd Edition, Pearson Education, New Delhi, 2014.

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	infer the basic concepts of 8085 microprocessor and 8051 Microcontroller	Understanding (K2)
CO2	develop Embedded C assembly language programming for 8051 Microcontroller	Applying (K3)
CO3	solve assembly/Embedded C programming using 8051 Microcontroller for a given case study	Applying (K3)
CO4	interface analog/digital I/Os with 8051 Microcontroller	Applying (K3)
CO5	design a Microcontroller based system for Mechatronics applications	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1										2	2
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	30	30	40				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	20	20	60				100

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

20MTT53 - STRENGTH OF MATERIALS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics, Matrices and Differential Equations	5	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 – 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 Lab

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	Analyzing (K4)
CO2	analyze the biaxial state of stresses at a point in a body, thin cylinders and spherical shells	Analyzing (K4)
CO3	construct the shear force and bending moment diagrams and analyze the bending stresses of beams	Analyzing (K4)
CO4	estimate the slope and the deflection of beams and strengths of the columns	Analyzing (K4)
CO5	analyze the torsion behavior of shafts and coil springs	Analyzing (K4)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1								3		3
CO2	3	3	2	2	1							3		3
CO3	3	2	1	1								3		3
CO4	3	2	1	1								3		3
CO5	3	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	15	15	35	35			100
CAT2	15	15	35	35			100
CAT3	15	15	35	35			100
ESE	15	15	35	35			100

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

20MTL51 - 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 emphasis on the development of CNC part programming. It also gives practical knowledge on various measurement techniques used in industrial practice.						

List of Exercises / Experiments:

1.	Study of G codes and M codes for machining centre and turning centre
2.	Programming and machining of given component using MTAB trainer machine
3.	Programming and machining of given component using CNC turning centre
4.	Programming and machining of given component using CNC turning centre
5.	CNC code generation of given component using MASTER CAM (Lathe) and interfacing it to CNC turning centre
6.	Programming and machining of given component using CNC machining centre
7.	Programming and machining of given component 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
10.	Calibration of Dial Gauge; static characteristic study; Use of dial gauge as measuring device and Comparator
11.	Calibration of profile projector and measurement of micro components
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, 2018.
3.	Laboratory manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	develop part program and execute using CNC machines and draw, simulate a profile using MASTERCAM	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

20MTL52 - 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 practical course emphasis on the practical aspects of Microcontroller Assembly/Embedded C programming, simulation and interfacing of hardware used in real time applications						

List of Exercises / Experiments :

1.	Arithmetic functions using 8085 Microprocessor
2.	Arithmetic functions using 8051 Microcontroller
3.	Interfacing of switch, LED and seven segment LED
4.	Interfacing of LCD with 89c51 Microcontroller
5.	DC motor programming for the given case study
6.	Stepper motor programming for the given case study
7.	Servo motor programming for the given case study
8.	Actuation of pneumatic cylinders for the given case study
9.	Interfacing of high power devices for the given case study
10.	Study on Interfacing sensors, Microcontroller with IoT module

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	build programming for 8085 microprocessor and 89C51 microcontroller	Applying (K3), Manipulation (S2)
CO2	verify 89c51 programming logic and interfacing circuits using simulation software	Applying (K3), Precision (S3)
CO3	develop Microcontroller based system for Mechatronics applications	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					3			1	3	
CO2	2	3	2	2	1				2			2	2	1
CO3	3	3	2	2	1				3			2	3	1

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

20MTL53 - COMPUTER AIDED ENGINEERING LABORATORY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Graphics, Strength of Materials	5	PC	0	0	2	1
Preamble	This practical course is intended to model and analyze different components using CAD packages and CAE tools.						

List of Exercises / Experiments :

1.	Part and Assembly drawing of Couplings using Pro-E/ SOLIDWORKS
2.	Part and Assembly drawing of Bearings using Pro-E/ SOLIDWORKS
3.	Part and Assembly drawing of Valves using Pro-E/ SOLIDWORKS
4.	Modeling and Drafting of Machine Elements i.e. Tail Stock/ Screw Jack / Connecting Rod using Pro-E/ SOLIDWORKS
5.	Structural analysis of a given component using ANSYS
6.	Non-linear analysis of a given component using ANSYS
7.	Thermal analysis of a given component using ANSYS
8.	Contact analysis of a model using ANSYS
9.	Modal analysis of an object using ANSYS
10.	Vibration analysis of an object using ANSYS
11.	Modeling and analyzing of any part models using CAD and CAE packages
12.	Stress Analysis of a given model using HYPERMESH

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Mary Kathryn Thompson & John Martin Thompson, "ANSYS Mechanical APDL for Finite Element Analysis", 1st Edition, Butterworth-Heinemann , Elsevier, 2017.
2.	Modeling and Analysis lab Manual.
3.	CATIA / SOLIDWORKS / ANSYS / HYPERMESH

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret drawings and develop machine components using standard CAD packages	Applying (K3), Manipulation (S2)
CO2	solve the structural, contact and vibration problems with different loadings using analysis tools	Analyzing (K4), Precision (S3)
CO3	explore various CAD and CAE packages	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	1	2	2	3				2	3		2	2	2
CO2	2	1	3	2	3				2	3		2	2	2
CO3	2	1	3	2	3				2	2		2	2	2

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

20GEL51 PROFESSIONAL SKILLS TRAINING – I
(For all BE/ BTech / MSc /MCA /BSc Branches)

Programme & Branch	(Common to all 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 – I**

Soft skills and its importance: Pleasure and pains of transition from an academic environment to work environment-Need for change- Fear, stress and competition in the professional world-Importance of positive attitude- Self motivation and continuous knowledge upgradation-Self-confidence. Professional grooming and practices: Basics of corporate culture-Key pillars of business etiquette- Basics of etiquette-Introductions and greetings-Rules of the handshake, earning respect, business manners-Telephone etiquette- Body Language.

Unit - II	**Quantitative Aptitude & Logical Reasoning - I**

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**

Writing Skills: Writing strategies and formats – Importance of Résumés – Writing a Cover letter – Writing a fresher's CV / Résumés – Responding to Job Advertisements – Professional e-mail Writing – Responding to e-mails and business letters – Technical Report writing – Interpretation of Technical Data (Transcoding) – Writing One-page Essays. Verbal Aptitude – Synonyms – Antonyms – Homonyms – One word substitution – Idioms and Phrases – Paired words – Analogies – Spelling test – Cloze test – using suitable verb forms – using appropriate articles and prepositions; Spotting Errors – Sentence Correction and Formation – Grammar Based questions (Transformation : Active-Passive & Direct-Indirect); Rearranging Jumbled Sentences & Jumbled paragraphs, Identifying Facts, Inferences and Judgements statements.

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

20MTT61 - 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**
Introduction – Input Devices: Discrete: Pushbuttons –Proximity Sensors – Reed Switches – Encoders - Float switch-Temperature switch – Pressure switch – Analog: Temperature –Flow–Pressure sensors. Output Devices: Discrete- Relays – Contactors – DOL Starter - Solenoid valves- Analog: Control valve – VFD – Stepper motor drive – Servo drive.		
Unit - II	**Programmable Logic Controller:**	**9**
Introduction – Architecture of PLC – Principles of operation – Types of 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 – Programming devices- Application case studies.		
Unit - IV	**Advanced PLC programming and Communication Protocols:**	**9**
Program control instructions- Analog PLC operation – PLC - PID functions – Motion control instructions- HMI interface – Data communications: 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 – IoT based data acquisition using 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	1	1					2	3	3
CO2	3	3	3	3	3	1	1					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	30	30	40				100
CAT2	20	30	50				100
CAT3	10	30	60				100
ESE	20	30	50				100

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

20MTT62 – MECHANICS OF SERIAL MANIPULATOR

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics, Kinematics of Machines, Machine Dynamics	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.
2. Craig John J., "Introduction to Robotics: Mechanics and Control", 3rd Edition, Pearson Education, New Delhi, 2017.

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)**

20MTT63 - FLUID POWER SYSTEMS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Fluid Mechanics and Thermodynamics	6	PC	3	0	0	3

Preamble	This course provides knowledge and skill to generate, control and transmission of power using pressurized fluids	
Unit - I	**Fundamentals of Hydraulic System:**	**9**
Basics of fluid power system – Advantages and applications of Fluid power systems – Fluid properties – Pascal's Law and its application – Losses in pipes, valves and fittings – Fluid power symbols – Hydraulic pumps: Gear, Vane and Piston pumps, Pump performance, Characteristics and Selection - Sizing of 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**
Properties of Air - Perfect Gas laws – 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.		
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) – Introduction to Fluid logic devices and applications – 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 –Safety aspects in Fluid Power System, Installation, Maintenance and trouble shooting of Fluid Power systems.		

Total:45

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 pump for hydraulic power pack	Understanding (K2)
CO2	choose appropriate control valves for fluid power applications	Applying (K3)
CO3	select pneumatic components and fluid power actuators for low cost automation	Applying (K3)
CO4	design and construct a fluid power circuits real time applications	Applying (K3)
CO5	design, construct, test, install, maintain and trouble shoot fluid power circuits for engineering applications	Analyzing (K4)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	50	30				100
CAT3	10	40	50				100
ESE	20	45	35				100

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

20MTL61 - 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 Exercises / Experiments:

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

20MTL62 - 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 Exercises / Experiments:

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

20MTL63 - FLUID POWER SYSTEMS LABORATORY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Fluid Mechanics and Thermodynamics	6	PC	0	0	2	1
Preamble	This course provides knowledge and skill to generate, control and transmission of power using pressurized fluids						

List of Exercises / Experiments:

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

Total:30

REFERENCES/MANUAL/SOFTWARE:

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

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

Mapping of COs with POs and PSOs

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

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

20GEL61 PROFESSIONAL SKILLS TRAINING – II
(For all BE/ BTech / MSc /MCA /BSc Branches)

Programme & Branch	(Common to all Engineering and Technology branches)	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	EC	0	0	80	2

Preamble	This subject is to enhance the employability skills and to develop career competency
Unit - I	**Soft Skills – II**

Group discussions: Advantages of group discussions-Structured GD- Team work: Value of team work in organizations- Definition of a team, why team-Elements of leadership, disadvantages of a team, stages of team formation- Group development activities. Facing an interview: Foundation in core subject- industry orientation / knowledge about the company- professional personality-Communication skills-Activities before Interview, upon entering interview room, during the interview and at the end Mock interviews.

Unit - II	**Quantitative Aptitude & Logical Reasoning – II**

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**

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.

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

20MTP61 - PROJECT WORK I

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

Total : 60

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	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	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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

20GET71 - ENGINEERING ECONOMICS AND MANAGEMENT

(Common to All Engineering and Technology Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	HS	3	0	0	3

Preamble	The aim of the course is to create fundamental knowledge on management by introducing concepts like economics, national income, marketing, operations management, accounting principles etc.	
Unit - I	**Micro Economics:**	**9**
Economics – Basics Concepts and Principles – Demand and Supply – Law of demand and Supply – Determinants – Market Equilibrium – Circular Flow of Economic activities and Income.		
Unit - II	**Macro Economics, Business Ownership and Management concepts:**	**9**
National Income and its measurement techniques. Inflation - Causes of Inflation – Controlling Inflation – Business Cycle. Forms of business – Ownership types. Management concepts: Taylor and Fayol's Principles – Functions of Management - Managerial Skills - Levels of Management - Roles of manager.		
Unit - III	**Marketing Management:**	**9**
Marketing - Core Concepts of Marketing - Four P's of Marketing - New product development – Intellectual Property rights (IPR), Product Life Cycle - Pricing Strategies and Decisions.		
Unit - IV	**Operations Management:**	**9**
Operations Management - Resources - Types of Production system - Site selection, Plant Layout, Steps in Production Planning and Control - Inventory - EOQ Determination.		
Unit - V	**Financial Management:**	**9**
Accounting Principles – Financial Statements and its uses – Depreciation: Straight Line and Diminishing Balance Method – Break Even Analysis – Capital Budgeting: Significance –Traditional and discounted cash flow methods.		

Total:45

TEXT BOOK:

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

REFERENCES:

1. Geetika, Piyali Ghosh and Purba Roy Choudhury, "Managerial Economics", 3rd Edition, McGraw-Hill, New Delhi, 2018.
2. William J Stevenson, "Operations Management", 14th Edition, McGraw-Hill Education, 2021.
3. William G. Nickels, James M. McHugh, Susan M. McHugh, "Understanding Business", 12th Edition, McGraw-Hill Education, New York, 2019.
4. Philip Kotler, "Marketing Management", Pearson India, 15th edition, 2017.
5. Harold Koontz And Heinz Weihrich, "Essentials of Management: An International, Innovation, And Leadership Perspective", 11th Edition, McGraw-Hill Education (India), New Delhi, 2020.

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

20MTT71 - 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 the practical knowledge about various components of machine vision systems and image processing techniques.	
Unit – I	**Processing of Information in the Human Visual System:**	**9**
Design and structure of eye– Adaptation to different light level– Rod and Cone Responses. Introduction to Building a Machine Vision Inspection: Specification– Part presentation– Performance requirement– Information interfaces– Installation space– Environment.		
Unit – II	**Designing a Machine Vision System:**	**9**
Camera types– Field view– Resolution: camera sensor resolution, Spatial resolution, Measurement of accuracy, Calculation of resolution, Resolution for a Line Scan Camera - Choice of camera, Frame grabber and hardware platform– Pixel rate– Lens design - digital and smart cameras.		
Unit – III	**Lighting System & Camera Computer Interface:**	**9**
Demands on machine vision lighting – Light and light perception – Light sources for machine vision – Light Color and Part Color: Monochromatic light, white light, UV, IR and Polarized light – Light filters. Analog camera buses – Analog video signal - Parallel digital camera buses– Standard PC buses – Computer buses – Digital video transmission – Camera link – Driver software: Application programming interface- Features of machine vision system.		
Unit – IV	**Image Processing Algorithms:**	**9**
Introduction to Digital Image Processing - Image sampling and quantization - Image enhancement: Gray Value Transformations, Radiometric Calibration, Image Smoothing– Geometric transformation– Image segmentation– Object Recognition and Image Understanding. Feature extraction: Region Features, Gray Value Features, Contour Features–Morphology–Edge extraction–Fitting. Template matching: Grey value based, Image pyramid matching. Optical Character recognition - Integration of vision sensors, Compact systems and vision controllers.		
Unit – V	**Applications and Case Studies:**	**9**
Diameter inspection of rivets– Tubing inspection – Glue check under UV Light– Completeness check of automotive control component– Multiple position and completeness- Check of small hybrid circuit– Pin type verification– Typeand 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	explain the concept of lighting system and various computer interfaces	Understanding(K2)
CO4	infer the concept of image processing techniques	Understanding(K2)
CO5	design the machine vision system for real time manufacturing applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	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	20	60	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	50	30				100

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

20MTP71 PROJECT WORK 2 PHASE I

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	EC	0	0	12	6

Total : 180

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	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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

20MTP81 PROJECT WORK 2 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

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20MTE01 - DESIGN OF MECHANICAL ELEMENTS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Strength of Materials	5	PE	3	1	0	4

Preamble	This course provides systematic knowledge about design and analysis of machine elements and transmission elements for suitable product/process development.	
Unit – I	**Design Fundamentals:**	**9+3**
Fundamental principles of mechanical design – Occam's Razor, Simplicity vs. Complexity, Laws of Nature, St. Venant's Theory, Golden Rectangle, Independent Functions, Abbe's Principle, Maxwell & Reciprocity, Self-principles, stability, Symmetry, Parallel Axis theorem, Accuracy, Repeatability and Resolution, Sensitive directions and Reference Features, Triangulate for stiffness, Load Paths, Free body diagrams & Superposition, Centers of Action, Exact Constraint Design, Elasticity Averaged Design, Stick Figures. Types of loads –Stresses – Static, varying, thermal, impact and residual. Factors of safety – Theories of failure – Stress concentration factors – S-N curves		
Unit – II	**Design of Shafts, Keys and Couplings:**	**9+3**
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+3**
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+3**
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	**Conveyors and Accessories Design:**	**9+3**
Conveyors – Types – Design of Belt conveyors –Design considerations- Design Parameters – Belt Dimension, Capacity and Speed Dimension, capacity and speed –Roller diameter – Belt power and tension-Idler spacing – Pulley diameter – Motor – Type of drive unit – Location and arrangement of pulley – Control mode – Intended application – Maximum loading capacity		

Lecture:45, Tutorial:15, Total:60

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 conveyors and their accessories	Applying (K3)

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	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*	Rememberin g (K1) %	Understandin g (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	To tal %
CAT1	10	30	60				100
CAT2		20	80				100
CAT3		20	80				100
ESE	10	20	70				100

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

20MTE02 GRAPHICAL SYSTEM DESIGN

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Problem Solving and Programming, Sensors and Transducers	5	PE	3	0	0	3

Preamble	This course provides systematic knowledge about the principles in programming technique with different instrument interfaces and virtual instruments and the basics of graphical system introduced in real time systems.	
Unit – I	**Introduction to GSD:**	**9**
Historical perspectives, advantages, block diagram and architecture of a virtual instrument, data -flow techniques, graphical programming in Graphical System Design (GSD) - Graphical user interfaces – Controls and Indicators – 'G' programming/ modular programming - Data flow programming.		
Unit – II	**GSD Programming Techniques:**	**9**
Data types - Editing, Debugging and Running a Virtual Instrument – Graphical programming palettes and tools – Function and Libraries in GSD platform – String and File I/O: High level and Low-level file I/O's- Sub-VI programming.		
Unit – III	**GSD Software Tools:**	**9**
Arrays and Clusters – Bundle/Unbundle and Bundle/Unbundle – Plotting data: graphs and charts – Attribute nodes – Local and global variables - Structures: FOR Loops, WHILE loops, Shift Registers, CASE structure, Formula nodes, Sequence structures, Timed looped structures.		
Unit – IV	**GSD Data Acquisition Hardware:**	**9**
Basics of DAQ Hardware and Software – Concepts of Data Acquisition – Configuring and addressing the hardware – Real time Data Acquisition using hardware: USB based DAQ with programming.		
Unit – V	**GSD tools applications:**	**9**
Advantages and Applications: Introduction to TCP/IP VI's and Instrument Control – Machine vision and acquisition tools– Signal processing/ analysis tools – Control design and simulation tools		

Total:45

TEXT BOOK:

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

REFERENCES:

1. Gupta, Joseph and John, "Virtual Instrumentation using LabVIEW", 2nd Edition, Tata McGraw Hill, 2010.
2. Rick Bitter, "LabVIEW Advanced Programming Techniques", 2nd Edition, Taylor & Francis Group, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the basic concepts about virtual instrumentation	Applying (K3)
CO2	interpret the software tools in virtual instrumentation	Applying (K3)
CO3	develop programming through LabVIEW graphical programming environment	Applying (K3)
CO4	experiment with data acquisition hardware and LabVIEW software	Applying (K3)
CO5	select the hardware and software concept of data acquisition system for advanced 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	2
CO2	3	3	3		2							2	3	3
CO3	3	3	3		2							2	3	3
CO4	3	3	3		3							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*	**Rememberin g (K1) %**	**Understandin g (K2) %**	**Applyin g (K3) %**	**Analyzing (K4) %**	**Evaluatin g (K5) %**	**Creatin g (K6) %**	**Total %**
CAT1	40	40	20				100
CAT2	10	30	30	30			100
CAT3	10	30	30	30			100
ESE	15	25	40	20			100

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

20MTE03 - POWER ELECTRONICS AND DRIVES

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Electron Devices & Digital Circuits Electrical Machines	5	PE	3	0	0	3

Preamble	This course discusses power processing electronic circuits apart from introducing the basics of power semiconductor devices.	
Unit - I	**Power Electronics Devices:**	**9**
Concept of power electronics – Power semiconductor devices - Principle of operation – Steady state and switching characteristics of power diodes, power BJT, power MOSFET, IGBT – Firing circuit for thyristor- Steady state and switching characteristics of SCR –Two transistor model of SCR – DIAC – TRIAC – GTO.		
Unit - II	**AC-DC and DC-AC Converter:**	**9**
Principle of phase controlled converter with R and RL load - Freewheeling diode- Single phase full wave converter – Single phase semi converter – Three phase semi converter – Three phase fully controlled converter – Applications of AC-DC converter. Introduction to inverter –Single phase and Three phase voltage source inverters –PWM inverters – Applications of DC-AC converter.		
Unit - III	**DC - DC and AC - AC Converter:**	**9**
DC Chopper – Control strategies – Principle of operation – Step up and step down chopper – Applications of DC-DC converter – Single phase AC voltage controller – On - off control and phase control – Sequence control of AC voltage controller – Single phase: Step up and step down cycloconverters - – Applications of AC-AC converter.		
Unit - IV	**DC Drives:**	**9**
DC Drives - Introduction to DC drives – Basic performance equations of DC motor – Single phase DC drives – Three phase DC drives – Chopper Drives – Two quadrant chopper drive – Four quadrant chopper drive.		
Unit - V	**AC Drives:**	**9**
Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Simulation of power converters using software.		

Total:45

TEXT BOOK:

1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2014.
2. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2012.

REFERENCES:

1. Singh M.D. & Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2013.
2. Muhammad H. Rashid, "Power Electronics: Devices, Circuits & Applications", 4th Edition, Pearson, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the operation and switching characteristics of power solid state devices	Understanding (K2)
CO2	describe the working principle of AC – DC and DC – AC converters	Understanding (K2)
CO3	express the construction and working of DC – DC and AC – AC converters	Applying (K3)
CO4	select a suitable power converter for a given DC drive	Understanding (K2)
CO5	choose an appropriate power converter for a given AC drive	Applying (K3)

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

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	30				100
CAT2	25	40	35				100
CAT3	30	30	40				100
ESE	25	45	30				100

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

20MTE04 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	Industrial Internet of Things (IIoT) is an application of IoT in industries to modify the various existing industrial systems. IIoT links the automation system with enterprise, planning and product lifecycle.	
Unit - I	**Introduction:**	**9**
Introduction-IoT Architecture-Application-based IoT Protocols-Infrastructure-based protocols-Data protocols-Transport protocols. Cloud Computing: Types of cloud-Business aspects of cloud-Virtualization- Key aspect of cloud computing-Mobile cloud computing- Fog Computing: Applications of Fog computing. Sensor Cloud: Applications of Sensor Cloud- Big Data.		
Unit - II	**IIoT Architectures:**	**9**
Overview of IOT components - Various architectures of IOT and IIOT, Advantages and disadvantages, Industrial internet - Reference architecture; IIOT system components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IOT.		
Unit - III	**Sensor and Interfacing:**	**9**
Introduction to sensors, Transducers, Classification, Roles of sensors in IIoT, Various types of sensors, Design of sensors, sensor architecture, special requirements for IIoT sensors, Role of actuators, Types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial and Parallel, Ethernet, BACNet and M2M.		
Unit - IV	**Protocols and Cloud:**	**9**
Introduction to Industrial data transmission, Features & Components of : Fieldbus, Profibus, HART, Interbus, Bitbus, CC-link, Modbus, Batibus,DigitalSTROM, Controller area network, DeviceNet, LonWorks, ISA 100.11a, Wireless HART, LoRa & LoRaWAN, NB-IoT, IEEE 802.11AH. Clouds : Types of clouds		
Unit - V	**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:	BT Mapped

On completion of the course, the students will be able to		**(Highest Level)**
CO1	comprehend the fundamentals of IIoT and its potential, challenges	Understanding (K2)
CO2	infer the various components and architecture of IIoT	Understanding (K2)
CO3	design the sensors based IIoT architecture with interface standards	Applying (K3)
CO4	realize and choose the Protocols and Cloud platforms for different IIoT solutions	Applying (K3)
CO5	build the concepts of Design Thinking for industrial 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	15	65	20				100

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

20MTE05 OPERATIONS RESEARCH

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Matrices and Differential Equations, Calculus and Complex Analysis, Statistics and Numerical Methods	6	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		

Lecture:45, Tutorial:15, Total:60

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)**

20MTE06 - 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 analyse 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 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**
Behaviour of non-linear 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 non-linearities 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.	I & II
2	Slotine and Li , "Applied Nonlinear Control", 2nd Edition, Prentice Hall Publishers, USA, 1991.	III, IV & V

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyse the time domain characterisitcs of continuos systems in state space domain	Analyzing (K4)
CO2	design state feedback controllers and observers	Applying (K3)
CO3	apply the concepts in the design of state feedback controllers and observers	Analyzing (K4)
CO4	analyse the behaviour of nonlinear systems using describing function method	Analyzing (K4)
CO5	analyse the stability of linear and nonlinear systems using Lyapunov stability method	Analyzing (K4)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	2	2					1		2	3	3
CO2	3	2	1	1	1					1		2	3	3
CO3	3	3	2	2	2					1		2	3	3
CO4	3	3	2	2	2					1		2	3	3
CO5	3	3	2	2	2					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	20	40	30			100
CAT2	10	20	40	30			100
CAT3	10	20	40	30			100
ESE	10	20	40	30			100

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

20MTE07 HEAT AND MASS TRANSFER

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Fluid Mechanics and Thermodynamics	7	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 Correlations.		

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	40	30	30				100
CAT2	20	40	40				100
CAT3	20	30	50				100
ESE	20	40	40				100

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

20MTE08 MACHINE DRAWING

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Graphics Design of Mechanical Elements	7	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", 45th 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:	BT Mapped

On completion of the course, the students will be able to		**(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	Applying (K3)
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		40	60				100
CAT2		20	80				100
CAT3		20	80				100
ESE		20	80				100

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

20MTE09 PRECISION EQUIPMENT DESIGN

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Kinematics of Machines Machine Dynamics Systems and Control Engineering	7	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, The 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:	BT Mapped

On completion of the course, the students will be able to		**(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	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)**

20MTE10 EMBEDDED PROGRAMMING FOR MECHATRONICS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Microcontroller Programming and Applications	7	PE	3	0	0	3

Preamble	This course provides knowledge and skill on advanced Microcontrollers and Embedded programming for Mechatronics applications.	
Unit - I	**PIC18 Microcontroller:**	**9**
Architecture of PIC 18 – Pin Description – Memory organization: Program memory – Data Memory – I/O Ports – Timers – Counters – Capture/ Compare /PWM mode – External hardware interrupts– USART – ADC.		
Unit - II	**PIC 18 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	**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 - IV	**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 - 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 – Applications.		

Total:45

TEXT BOOK:

1. Mazidi, Muhammad Ali, Mckinlay, Rolin D. & Causey Danny, "PIC Microcontroller and Embedded Systems using Assembly and C for PIC 18", Second Edition, Pearson Education Asia, Noida, 2021.
2. Misra S., Mukherjee A., and Roy A., “Introduction to IoT”, Cambridge University Press, First Edition, 2021.

REFERENCES:

1. Valvano Jonathan W, "Embedded Microcomputer Systems: Real Time Interfacing", 3rd Edition, Thomson Asia, Singapore, 2011.
2. Data sheet – ATMEGA 8.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret architecture and interfacing concepts of PIC18 microcontroller	Understanding (K2)
CO2	develop embedded programming using PIC18 microcontrollers	Applying (K3)
CO3	interpret architecture and interfacing concepts of ATMEGA 8 microcontroller	Understanding (K2)
CO4	build embedded programming using ATMEGA 8 microcontroller	Applying (K3)
CO5	interface microcontroller with IOT module 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	30	30	40				100
CAT2	20	20	60				100
CAT3	20	30	50				100
ESE	20	30	50				100

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

20MTE11 MACHINE LEARNING

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Matrices and Differential Equations Multivariable Calculus and Complex Analysis Problem Solving and Programming	7	PE	3	0	0	3

Preamble	Machine Learning focuses on developing algorithms to find patterns or make predictions from empirical data. This course gives an introduction about supervised, unsupervised and reinforcement learning algorithms.	
Unit - I	**Introduction:**	**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, 2013.

REFERENCES:

1. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", 2nd Edition, Chapman and Hall/CRC Press, NA, 2014.
2. Jiawei Han, Micheline Kamber, "Data Mining Concepts and Techniques", 3rd Edition, Elsevier, NA, 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	1	3	3							2	3	1
CO2	3	2	1	3	3							2	3	1
CO3	3	2	1	3	3							2	3	1
CO4	3	2	1	3	3							2	3	1
CO5	2	1		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	20	50	30				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	20	40	40				100

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

20MTE12 - AUTOMOTIVE ENGINEERING

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 on working principle of automotive components and various alternative fuel resources recommended for automotive engines.	
Unit - I	**Engines and Exhaust systems:**	**9**
Engine components: Cylinder block - Cylinder head - Sump - Manifolds - Gaskets - Cylinder - Piston - Rings - Connecting rod - Piston pins - Crank shaft - Bearings - Valves - Mufflers. Simple Carburetor - Port and Valve Timing diagram - Engine cooling and Lubrication systems - MPFI and CRDI - Exhaust systems - SCR - EGR - Catalytic converter - DeNox Trap - Emission standards in India.		
Unit - II	**Transmission Systems:**	**9**
Clutch - Types and Construction - Clutch operation - Electromagnetic - Mechanical - Hydraulic - Vacuum. Gear Boxes: Manual and Automatic - Simple Floor Mounted Shift Mechanism - CVT - Dual Clutch transmission - Over Drives - Transfer Box - Fluid flywheel - Torque converter - Propeller shaft - Slip Joint - Universal Joints - Differential and Rear Axle.		
Unit - III	**Steering, Brakes and Suspension:**	**9**
Wheels and Tyres - Wheel Alignment Parameters. Steering: Steering Geometry - Types of steering gear box - Davis and Ackermann steering mechanism - Power Steering - Electronic Steering - Types of Front Axle. Suspension systems: Types of suspension springs - Shock absorbers. Braking Systems: Types and Construction - Hydraulic brakes - Air brakes - Antilock Braking System.		
Unit - IV	**Chassis Frame, Battery and Lighting System:**	**9**
Chassis construction - Truck chassis - Four-wheel drive chassis - Body on frame - Semi integral and integral type - Loads acting on frame. Types of batteries - Construction, Operation and Maintenance. Electrical systems: Lighting - Wiring circuit.		
Unit - V	**Automotive accessories and Alternate Energy Sources:**	**9**
Head lights - Switches - Indicating lights. Accessories: Direction indicators - Windscreen wiper - Horn - Speedometer - Heaters - Air conditioner. Use of Natural Gas, LPG, CNG, LPG, Bio diesel, Shale gas, Liquid nitrogen, Ethanol and Hydrogen in Automobiles - Fuel Cells.		

Total:45

TEXT BOOK:

1. Kirpal Singh, "Automobile Engineering Volume I & II", 13th Edition, Standard Publishers, New Delhi, 2017.

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	summarize suspension, brake and steering systems of automobile	Understanding (K2)
CO4	illustrate the types of chassis and circuit for automotive electrical systems	Understanding (K2)
CO5	explain automotive accessories and alternate fuel sources for automobiles	Understanding (K2)

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	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	40	60					100

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

20GEE01 FUNDAMENTALS OF RESEARCH
(Common to All BE/BTech branches)

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

Preamble	This course familiarize the fundamental concepts/techniques adopted in research, problem formulation and also disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.	
Unit – I	**Introduction to Research:**	**9**
Introduction to Research: Types and Process of Research - 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.	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	Analyzing (K4)
CO2	formulate a research problem from published literature/journal papers	Evaluating (K5)
CO3	write, present a journal paper/ project report in proper format	Creating (K6)
CO4	select suitable journal and submit a research paper	Applying (K3)
CO5	compile a research report and the presentation	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

20MTE13 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 – Thefunctionals of a single function- Optimal Control Formulation: The Performance measure: Performance measures for optimal control problems, selecting a performance measure. Constraints – Variational approach to optimal control problems: Necessary conditions for optimal control.		
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.		

Lecture: 45, Total:45

TEXT BOOK:

1	Kirk, Donald E. "Optimal Control Theory: An Introduction" 1st Edition, Dover publications, USA, 2004.	I,II & III
2	Karl J Astrom and Bjorn Wittenmark, " Adaptive Control", 2nd Edition, Addison Wesley, USA, 2008.	IV & V

REFERENCES:

1	Desineni Subburam 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	formulate optimal control problem	Understand(K2)
CO2	apply the concepts in the design of optimal controller using LQR concepts	Applying (K3)
CO3	determine optimal control solution for discrete systems using dynamic programming	Applying (K3)
CO4	gain knowledge about the model reference adaptive control and self-tuning control systems	Understand(K2)
CO5	know the Implementation aspects of adaptive control 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	1										2	3	3
CO2	3	2	1	1	1							2	3	3
CO3	3	2	1	1	1							2	3	3
CO4	3	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	20	30	50	-			100
CAT2	10	40	30	20			100
CAT3	20	30	40	10			100
ESE	20	20	40	20			100

*** ±3% may be varied**

20MTE14 COMPUTER INTEGRATED MANUFACTURING

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Processes, CNC and Metrology	7	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	25	65	10				100
CAT2	20	60	20				100
CAT3	25	65	10				100
ESE	20	60	20				100

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

20MTE15 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 – Applications.		
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, 2011.

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, 2007.

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				1	2	3	2
CO2	3	2	2	2	1		1				1	2	3	2
CO3	3	2	2	2	1		1				1	2	3	2
CO4	3	2	2	2	1		1				1	2	3	2
CO5	3	2	2	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	50	30				100
CAT2	20	50	30				100
CAT3	20	40	40				100
ESE	20	50	30				100

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

20MTE16 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	7	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 regulator 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	Analyzing (K4)
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	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1										2	2
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	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)**

20MTE17 CYBER PHYSICAL SYSTEMS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Sensors and Signal Conditioning, Microcontroller Programming and Applications	7	PE	3	0	0	3

Preamble	To acquire knowledge and skills on various hardware and software design aspects of Cyber-Physical Systems (CPS) - modeling, analysis, and design	
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	explain the fundamentals of cyber physical systems, its potential and challenges	Understanding (K2)
CO2	infer the various components and architecture of CPS	Understanding (K2)
CO3	interpret the functions of CPS multitasking and scheduling	Understanding (K2)
CO4	explain the concepts of CPS in security and privacy aspects	Understanding (K2)
CO5	design the mechatronics system with integration of CPS 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	2	2	1								2	3	3
CO2	3	2	2	1								1	1	1
CO3	3	2	2	1								1	1	1
CO4	3	2	2	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	40	60					100
CAT2	40	60					100
CAT3	20	50	30				100
ESE	25	60	15				100

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

20MTE18 BATTERY MANAGEMENT SYSTEM

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	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	**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		
Unit - V	**Design of battery BMS:**	**9**
Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, Energy balancing with multi-battery system.		

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	select the appropriate battery system with respect to application	Applying (K3)
CO3	describe the recent developments in battery systems	Understanding (K2)
CO4	understand the requirements of battery systems for automotive applications and understand the modelling of battery systems	Understanding (K2)
CO5	design the model of battery pack	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	50	30				100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	55	25				100

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

20MTE19 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 control-Supervisory 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	2	1		1						2	1	2
CO2	3	2	2	1		1						2	1	2
CO3	3	2	2	3	2	1						2	1	2
CO4	3	2	2	3	2	1						2	1	2
CO5	3	2	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	20	60	20				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)**

20MTE20 APPLIED FINITE ELEMENT METHOD

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Strength of Materials	7	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 a finite element.	
Unit – I	**Introduction to FEA:**	**9**
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.

COURSE OUTCOMES:	BT Mapped

On completion of the course, the students will be able to		**(Highest Level)**
CO1	apply the finite element concepts used for designing engineering components	Applying (K3)
CO2	derive the element matrix equation for solving one dimensional structural problems and solve for different applications	Analyzing (K4)
CO3	estimate the results for a 3D domain using simple two dimensional assumptions for different applications	Evaluating (K5)
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	10	30	30	30			100
CAT2		20	40	40			100
CAT3		20	40	40			100
ESE	15	35	25	25			100

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

20MTE21 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	select the suitable solid based rapid prototyping system for a specific application	Applying (K3)
CO4	select 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	40	40	20				100
CAT2	30	40	30				100
CAT3	30	45	25				100
ESE	30	40	30				100

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

20MTE22 INDUSTRIAL AUTOMATION PROTOCOLS

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

Preamble	To impart basic concepts of data networks and different industrial automation protocols standards and its functions.	
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:	BT Mapped

On completion of the course, the students will be able to		**(Highest Level)**
CO1	demonstrate the basic network requirements for Industrial automation	Understanding (K2)
CO2	infer the data network fundamentals	Understanding (K2)
CO3	explain the HART and MODBUS Protocol for Networked Industrial Automation	Understanding (K2)
CO4	infer the FIELDBUS and PROFIBUS for industrial automation network	Understanding (K2)
CO5	demonstrate the functions of AS-I, Device net and Ethernet in industrial network	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	2								2	2	2
CO2	3	2	2	2								1	2	2
CO3	3	2	2	2	1							2	3	3
CO4	3	2	2	2	1							2	3	3
CO5	3	2	2	2	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	30	70					100
ESE	40	60					100

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

20MTE23 ROBOT PROGRAMMING

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Problem Solving and Programming, 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: RAPID – An overview.

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	Applying (K3)
CO2	operate and simple maintenance functions	Applying (K3)
CO3	analyse the application constraints while using industrial robot	Applying (K3)
CO4	perform cycle time and cost analysis	Applying (K3)
CO5	design a simple work cell layout	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)**

20MTE24 - TOTAL QUALITY MANAGEMENT

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Statistics and Numerical Methods	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 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	25	45	30				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)**

20MTE25 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 machines.	
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 Between Failures (MTBF), Mean Time To Repair (MTTR) and Mean To Down Time (MTDT).		
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 – Data 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 techniques	Understanding (K2)
CO3	plan and implement the maintenance management systems	Understanding (K2)
CO4	synthesize the functional concepts of reliability and safety engineering	Understanding (K2)
CO5	apply the 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	25	65	10				100
CAT3	25	60	15				100
ESE	20	60	20				100

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

20MTE26 AUTOMOTIVE ELECTRONICS

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 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 V 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.
2. Ribbens William B, "Understanding Automotive Electronics", 8th Edition, Butterworth- Heinemann, Burlington, 2017.

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:	BT Mapped

On completion of the course, the students will be able to		**(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	Understanding (K2)
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	40	60					100
CAT2	40	60					100
CAT3	40	50	10				100
ESE	40	50	10				100

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

20MTE27 MICRO ELECTRO MECHANICAL SYSTEMS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics, Engineering Mechanics, Sensors and Signal Conditioning	7	PE	3	0	0	3

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

Total:45

TEXT BOOK:

1. Tai-Ran Hsu, "MEMS And Microsystems: Design And Manufacture", 1st Edition, McGraw-Hill Education Pvt. Ltd, New Delhi, 2002.

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, NA, 2017.

COURSE OUTCOMES:	BT Mapped

On completion of the course, the students will be able to		**(Highest Level)**
CO1	examine Scaling laws of micro system	Applying (K3)
CO2	interpret the concepts of micro sensors and micro actuators	Understanding (K2)
CO3	identify the suitable fabrication process of microsystem	Applying (K3)
CO4	identify the micro machining process and packaging	Applying (K3)
CO5	design and develop the micro system for various applications	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	3
CO2	3	3	2									2	3	3
CO3	3	3	3	2	3							2	3	3
CO4	3	3	3	2	3							2	3	3
CO5	3	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	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)**

20MTE28 MOBILE ROBOTICS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Problem Solving and Programming, Kinematics of Machines, Machine Dynamics	7	PE	3	0	0	3

Preamble	This course enables to grasp the knowledge on different kinds of mobile robots and their design, architecture, manufacture and structural disposition.	
Unit - I	**Introduction to Mobile Robots:**	**9**
Types of mobile robots: Automated Guided vehicles (AGVs)- Service robots - Cleaning robots – Social robots – Field robots – Inspection and exploration robots - Humanoid robots – Nuclear robots – Underwater robots - Autonomous surface vessels - Applications of mobile robots.		
Unit - II	**Mobile Robot Engineering:**	**9**
Mobile robot subsystems – Fundamentals of wheeled and legged mobile robot - Kinematics models of mobile robots: Kinematic models and constraints – Hilare mobile robots – Car-like mobile robots – Mobile robot maneuverability - Mobile robot workspace-Motion control.		
Unit - III	**Locomotion:**	**9**
Introduction - Legged mobile robots - Leg configurations and stability - Examples of legged robot locomotion - Wheeled mobile robots - Wheeled locomotion: Design space-Case studies.		
Unit - IV	**Perception and Localization:**	**9**
Sensors for mobile robots – Representing uncertainty - Feature extraction - Mobile robot localization - Challenge of localization: Noise and Aliasing - Map representation - Probabilistic map-based localization - Probabilistic map-based localization.		
Unit - V	**Planning and Navigation:**	**9**
Introduction- Competences for navigation- Planning and Reacting- Navigation architectures- Modularity for code reuse and sharing- Control localization- Techniques for decomposition- Case studies: Tiered robot architectures.		

Total:45

TEXT BOOK:

1.	Roland Siegwart, Illah Reza Nourbakhsh & Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", 2nd Edition, MIT Press, United Kingdom, 2011.

REFERENCES:

1.	Farbed Fahimi, "Autonomous Robots – Modeling, Path Planning and Control", Springer, Switzerland, 2009.
2.	Alonzo Kelly, "Mobile Robotics: Mathematics, Models and Methods", Cambridge University Press, United Kingdom, 2013.

COURSE OUTCOMES:	BT Mapped

On completion of the course, the students will be able to		**(Highest Level)**
CO1	identify various domains for robotic systems applications	Understanding (K2)
CO2	develop kinematic model of mobile robots	Applying (K3)
CO3	analyze different concepts of locomotion	Applying (K3)
CO4	select the sensory devices for localization	Understanding (K2)
CO5	apply the concepts of planning and navigation	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

20MTE29 DRONE TECHNOLOGY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Problem Solving and Programming, Kinematics of Machines, Machine Dynamics	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	**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. Operational considerations like liability / legal issues, ethical implications LOS / BLOS.		
Unit - II	**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	**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	**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	**Regulatories and Regulations:**	**9**
Homeland regulatories: FCC, FAA and foreign regulatory. Regulations: FCC compliance, UAS registration, Federal Aircraft Regulations (FARs) - Safety considerations		

Total:45

TEXT BOOK:

1. Paul Fahlstrom, Thomas Gleason, "Introduction to UAV Systems", 4th Edition, John Wiley & Sons, NA, 2016.

REFERENCES:

1. Randal W. Beard & Timothy W. McLain, "Small Unmanned Aircraft: Theory and Practice", Princeton University Press, Newjersy, 2010.
2. Jha, "Theory, Design, and Applications of Unmanned Aerial Vehicles", 1st Edition, CRC press, Florida, 2017.

COURSE OUTCOMES:	BT Mapped

On completion of the course, the students will be able to		**(Highest Level)**
CO1	acquire the basic knowledge about the development and potential of UAV in professional activities	Understanding (K2)
CO2	interpret the features and characteristics of an Unmanned Aerial System	Understanding (K2)
CO3	infer the basic concepts and features of flight	Applying (K3)
CO4	realize the drone equipment maintenance and repair	Applying (K3)
CO5	follow the regulatory measures and regulations	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	3						2	3	3	3
CO2	2	3	2	3	3						2	3	3	3
CO3	2	3	2	3	3						2	3	3	3
CO4	2	3	2	3	3						2	3	3	3
CO5	2	3	2	3	3	2	2	2			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	60	20				100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	60	20				100

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

20MTE30 PRINCIPLES OF FARM MACHINERIES

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	0	0	3

Preamble	This course explores the nature of soil conditions and principles of farm equipment.	
Unit - I	**Introduction to Farm Machines and Soil**	**9**
Introduction to farm machines: Objectives of farm mechanisms - Classification of farm machines - Materials for construction of farm machines - Principles of operation and selection of machines for production of crops - Soil: Nature and Origin of soil- Soil forming rocks and minerals - Soil classification and composition - Soil forming processes.		
Unit - II	**Tillage**	**9**
Tillage: Primary and Secondary tillage equipment - Forces acting on tillage tools - Field operation patterns - Draft measurement of tillage equipment - Earth moving equipment - Construction & working principles of bulldozer - Trencher - Excavators - Sowing - Planting and transplanting equipment their calibration and adjustments.		
Unit - III	**Fertilizer Application Equipment**	**9**
Fertilizer application equipment: Selection - Calibration - Construction features - Different components and adjustment of weed control - Plant protection equipment - Sprayers and Dusters - Work physiology of men and women.		
Unit - IV	**Principles and Types of Cutting Mechanisms**	**9**
Principles and types of cutting mechanisms: Construction and adjustments of shear and impact type cutting mechanisms - Crop harvesting machinery: Mowers - Windrowers - Reapers - Reaper binders and forage harvesters - Forage chopping and handling equipment - Root crop harvesting equipment - Cotton picking and sugarcane harvesting equipment.		
Unit – V	**Principles of Harvesting Tools and Machines**	**9**
Principles of harvesting tools and machines: Horticultural tools and gadgets - Testing of farm machine - Test codes and procedure - Interpretation of test results - Selection and management of farm machines for optimum performance - Workplace layout for men and women.		

Total: 45

TEXT BOOK:

1. Kepner R. A., Bainer Roy and Barger E. L, "Principals of Farm Machinery", 3rd Edition, CBS Publishers and Distributors, New Delhi, 2017.

REFERENCES:

1. Bosoi E.S., "Theory, Construction and Calculation of Agricultural Machines", 1st Edition, Oxonion Press Pvt. Ltd., New Delhi, 1990.
2. Ghosh P.K. and Swain S., "Practical Agricultural Engineering", 1st Edition, NayaProkash, Calcutta, 1993.
3. Donnel Hunt, "Farm Machinery and Management", 10th Edition, Iowa State University Press, Ames, USA, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the nature of soil condition and different types of farming equipment	Understanding (K2)
CO2	illustrate the working of tillage equipment	Understanding (K2)
CO3	identify the fertilizer application equipment and explain its working construction	Understanding (K2)
CO4	explain the cutting mechanisms for various crops	Understanding (K2)
CO5	illustrate the principle of harvesting equipment for various crop	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
CO2	3	2	1							1		1	2	3
CO3	3	2	1							1		1	2	3
CO4	3	2	1							1		1	2	3
CO5	3	2	1							1		1	2	3

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

ASSESSMENT PATTERN - THEORY

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

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

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**
Avionics Bus architecture-Data buses AFDX/ARINC-664-MIL STD 1553B-ARINC 429-ARINC 629-ARINC 818		
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.

REFERE

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	1					1	3	3
CO2	3	3	2	1	1							1	3	3
CO3	3	3	2	1	1		1					1	3	3
CO4	3	3	2	3	2							1	3	3
CO5	3	3	2	3	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	40	40				100
CAT2	10	40	50				100
CAT3	10	40	50				100
ESE	15	40	45				100

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

20MTE32 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	34	30			104

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

20MTE33 PRODUCTION MANAGEMENT

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Processes, Economics and Management for Engineers, Statistics and Numerical Methods	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 equipments		
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", 15th Edition, McGraw-Hill Education, New York, 2018.
2. Sunil Chopra & Peter Meindl, "Supply Chain Management – Strategy, Planning and Operation", 7th Edition, Pearson Education, New Delhi, 2019.
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	30	40	30				100
CAT2	20	20	40	20			100
CAT3	20	40	40				100
ESE	25	30	35	10			100

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

20MTE34 NANOSCIENCE AND TECHNOLOGY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics Applied Chemistry Materials Science and Metallurgy Chemistry for Mechanical Systems	8	PE	3	0	0	3

Preamble	This course impart the knowledge on the basics of nanoscience and nanotechnology. To describe the different types of nanostructured materials and its synthesis process. It helps to understand the applications of nanomaterials for transistors, energy conversion and energy storage.	
Unit - I	**Nanoscience and Technology:**	**9**
Emerging trends in nanoscience and technology, Periodic table, Atomic structure, Molecules and phases, Molecular and atomic size, Surfaces and dimensions, Prospects at the nanoscale, Bulk to nano transition, Scope of nano science and technology.		
Unit - II	**Nanomaterials:**	**9**
Size dependent properties, Optical, electrical, mechanical, magnetic properties, Quantum confinement, 0D, 1D, 2D, 3D nanostructures, Quantum dot, Quantum wire, Quantum well, Bulk materials, Length and time scale in nanostructures.		
Unit - III	**Nanomaterial Synthesis:**	**9**
Top-Down approach, Bottom-up approach, Chemical precipitation and co-precipitation, Sol-gel synthesis, Self-assembly, Microwave heating synthesis, Electrochemical synthesis, Inert gas condensation, Ball Milling, Molecular beam epitaxy, Chemical vapour deposition method and Electro deposition.		
Unit - IV	**Semiconductor Nanoparticles:**	**9**
Size dependant physical properties like melting point, Solid state phase transformations, Excitons, Band-gap variations. P-N junction, Metal-semiconductor, Metal-insulator, FET, MOSFETs. Types of nanocomposite -. Metal oxide, Ceramic, Glass and Polymer.		
Unit - V	**Applications of Nanomaterials:**	**9**
Solar cells and batteries, Fuel cells, PEM fuel cell. Acid/ alkaline fuel cells, Design of fuel cells, Carbon nanotubes for energy storage, Energy and Environment, Hydrogen storage in carbon nanotubes.		

Total:45

TEXT BOOK:

1. Charles P., Poole JR. & Franks. J. Qwens, "Introduction to Nanotechnology", Wiley India Pvt. Ltd., Noida, 2012.

REFERENCES:

1. Mick Wilson & Kamali Kannagara, "Nanotechnology - Basics Science and Emerging Technologies", Overseas Press, New Delhi, 2005.
2. Pradeep T., "Nano the Essential Nanoscience and Nanotechnology", 1st Edition, McGraw Hill, New Delhi, 2012.
3. Linden, "Hand book of Batteries and fuel cells", 4th Edition, McGraw Hill, New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the fundamental principles of nanoscience and nanotechnology	Understanding (K2)
CO2	infer optical, electrical, mechanical and magnetic properties of nanomaterials	Understanding (K2)
CO3	apply engineering concepts for the synthesis of nanomaterials	Applying (K3)
CO4	analyze the properties of semiconducting nanoparticles	Analyzing (K4)
CO5	apply the concepts of nanostructured materials for energy storage	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	2	2
CO2	2	1										2	2	2
CO3	2	2	1	1								2	2	2
CO4	3	3	2	2	1							2	2	2
CO5	3	3	2	2	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	40	60					100
CAT2	20	40	40				100
CAT3	20	20	40	20			100
ESE	20	30	40	10			100

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

20MTO01 - DESIGN OF MECHATRONICS SYSTEMS

(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches except Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	4	OE	3	1	0	4

Preamble	This course relates the design of systems, devices and products aimed at achieving an optimal balance between basic mechanical structure and its overall 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	3	3
CO2	2	1			2							3	3	3
CO3	3	1			2							3	3	3
CO4	3	2	1	1	3							3	3	3
CO5	3	2	1	1	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	60	20				100
CAT2	20	60	20				100
CAT3	10	30	60				100
ESE	20	40	40				100

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

20MTO02 - FACTORY AUTOMATION

(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Engineering and Technology 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	**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 - III	**Programmable Automation Controllers:**	**9**
Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC communication and networking, PLC selection, PLC installation, Advantage of using PLC for industrial automation, Application of PLC to process control industries.		
Unit - IV	**SCADA:**	**9**
Definition – Elements of SCADA – SCADA control – Remote terminal units – Master station – Communications protocols in SCADA – Applications of SCADA.		
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 Exercises / Experiments:

1.	Study on Embedded C Programming development in software platform
2.	Study on Microcontroller Simulator
3.	Development of Embedded C Programming and Interfacing sensors and relays with Microcontroller
4.	Interfacing sensors with Microcontroller and IoT module
5.	Introduction to programming /simulation/communication software for PLC programming
6.	Logical testing of I/Os and its interfacing with PLC
7.	Speed control of motor using PLC
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:

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 power electronics devices used in automation system	Understanding (K2)
CO2	infer the knowledge about communication and control system in real time interfacing	Understanding (K2)

CO3	analyze the functions of programmable logic controllers in automation industries	Applying (K3)
CO4	adapt the concepts of SCADA for factory automation	Applying (K3)
CO5	interpret the basic configuration and application of robot in factory automation	Applying (K3)
CO6	develop a microcontroller based system for automation	Applying (K3), Precision (S3)
CO7	build and simulate PLC programming for discrete and analog I/Os	Applying (K3), Precision (S3)
CO8	develop plant level automation for real process plant using PLC and SCADA	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2										2	2
CO2	3	3	3		2								3	3
CO3	3	3	3		2	1							3	3
CO4	3	3	3		3								3	3
CO5	3	3	3	3	3								3	3
CO6	3	2	1	2	2				2	2		2	3	3
CO7	3	2	1	2	2				2	2		2	3	3
CO8	3	2	1	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	40	40	20				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	15	35	50				100

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

20MTO03 - DATA ACQUISITION AND VIRTUAL INSTRUMENTATION

(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches except Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	OE	3	0	2	4

Preamble	This course provides the basics, programming techniques, data acquisition and interfacing techniques of Virtual Instrumentation (VI) and its applications.	
Unit - I	**Virtual Instrumentation:**	**9**
Historical perspectives, Advantages, Block diagram and architecture of a virtual instrument, Data -flow techniques, Graphical programming in data flow, Comparison with conventional programming– Graphical user interfaces – Controls and Indicators – 'G' programming/ modular programming.		
Unit - II	**VI Software Tools:**	**9**
Data types – Data flow programming – Editing, Debugging and Running a Virtual Instrument – Graphical programming palettes and tools – Function and Libraries – Structures: FOR Loops, WHILE loops, Shift Registers, CASE structure, Formula nodes, Sequence structures, Timed looped structures.		
Unit - III	**VI Programming Techniques:**	**9**
Arrays and Clusters – Bundle/ Unbundle and Bundle /Unbundle by name – Plotting data: graphs and charts – String and File I/O: High level and Low level file I/O's – Attribute nodes – Local and global variables - Sub-VI.		
Unit - IV	**Data Acquisition Hardware:**	**9**
Basics of DAQ hardware and software – Concepts of data acquisition and terminology – Installing hardware and drivers – Configuring and addressing the hardware – Digital and Analog I/O function – Real time data acquisition – USB based DAQ.		
Unit - V	**VI applications:**	**9**
Advantages and Applications: TCP/IP VI's – PXI – Instrument control – Image acquisition – Motion control – Signal processing/ analysis – Control design and simulation.		

List of Exercises / Experiments :

1.	GSD using For loops, While loops with shift registers / feedback nodes
2.	GSD using Local variables and Global variables
3.	GSD using Case structures and Sequence structures
4.	GSD using Timed structures, Formula nodes and Event structures
5.	GSD using Waveform graph, Waveform chart and XY graph
6.	GSD using String functions, editing, formatting and parsing string
7.	GSD using Arrays functions and Multi-dimensional arrays
8.	GSD using Clusters operations: Assembling clusters and disassembling clusters
9.	GSD using File Input / File Output function, Read / Write a file
10.	GSD for real time measurement using Thermistor / Piezo-electric sensor

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, NA, 2007.

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

CO1	demonstrate the basic concepts about virtual instrumentation	Understanding (K2)
CO2	explain the different programming palettes	Understanding (K2)
CO3	interpret the aspects of palettes in real time measurement	Understanding (K2)
CO4	experiment with modular hardware and compatible LabVIEW software	Understanding (K2)
CO5	select the hardware and software concept of data acquisition system for advanced applications	Understanding (K2)
CO6	interpret the software tools in virtual instrumentation	Applying (K3), Manipulation (S2)
CO7	develop programming through LabVIEW graphical environment	Applying (K3), Manipulation (S2)
CO8	perform interface of data acquisition hardware with LabVIEW software	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	2									2	2	2
CO2	3	3	3		2							2	3	3
CO3	3	3	3		2							2	3	3
CO4	3	3	3		3							2	3	3
CO5	3	3	3	3	3							2	3	3
CO6	3	2	1	2	2							2	3	3
CO7	3	2	1	2	2				2	2		2	3	3
CO8	3	2	1	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	50	50					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)**

20MTO04 - 3D PRINTING AND DESIGN

(Offered by Department of Mechatronics Engineering)

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

Preamble	The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product.	
Unit - I	**3D Printing & CAD for Additive Manufacturing:**	**9**
Introduction, Process, Classification, Advantages, Additive v/s Conventional Manufacturing processes, Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools. CAD Data formats, Data translation, Data loss, STL format.		
Unit - II	**Additive Manufacturing Techniques:**	**9**
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**
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**
Process Equipment-Design and process parameters; Governing Bonding Mechanism; Common faults and troubleshooting; Process Design		
Unit - V	**Post Processing & Product Quality:**	**9**
Post Processing- Requirement and Techniques; Product Quality- Inspection and testing - Defects and their causes.		

Total:45

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.
	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	3	3
CO2	2	1			2							3	3	3
CO3	2	1			2							3	3	3
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	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)**

20MTO05 - DRONE SYSTEM TECHNOLOGY

(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches except Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	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	**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	**Unmanned Aerial System (UAS) components:**	**9**
Platforms - configurations - characteristics – applications. Propulsion: Payloads: sensing / surveillance, weaponized UAS and delivery. Communications: command/control, telemetry. Launch/recovery systems - Ground control stations.		
Unit - III	**Basic Concepts of Flight:**	**9**
Aerodynamics: lift, weight, thrust, and drag. Flight performance: climbing vs. gliding flight, range / endurance - Stability and control: Fixed wing operations: Types of fixed wing drones, make, parts, terminology and operation.		
Unit - IV	**Drone Equipment Maintenance:**	**9**
Maintenance of drone, flight control box - Maintenance of ground equipment- batteries - Scheduled servicing - Fault finding and rectification - Weather and meteorology.		
Unit - V	**Regulatories and Regulations:**	**9**
Homeland regulatories: FCC, FAA and foreign regulatory. Regulations: FCC compliance, UAS registration, Federal Aircraft Regulations (FARs) - Safety considerations		

Total:45

TEXT BOOK:

1. Paul Fahlstrom, Thomas Gleason, "Introduction to UAV Systems", 4th Edition, John Wiley & Sons, USA, 2012.

REFERENCES:

1. Randal W. Beard and Timothy W. McLain, "Small Unmanned Aircraft: Theory and Practice", Princeton University Press, New Jersey, 2010.
2. Jha, "Theory, Design, and Applications of Unmanned Aerial Vehicles", CRC Press, Florida, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	acquire the basic knowledge about the development and potential of UAV in professional activities	Understanding (K2)

CO2	interpret the features and characteristics of an Unmanned Aerial System	Understanding (K2)
CO3	infer the basic concepts and features of flight	Applying (K3)
CO4	realize the drone equipment maintenance and repair	Applying (K3)
CO5	follow the Regulatory measures and regulations	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	3						2	3	3	3
CO2	2	3	2	3	3						2	3	3	3
CO3	2	3	2	3	3						2	3	3	3
CO4	2	3	2	3	3						2	3	3	3
CO5	2	3	2	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	20	60	20				100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	60	20				100

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

20MTO06 - ROBOTICS

(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches except Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	8	OE	3	0	0	3

Preamble	This course provides the knowledge about industrial robots and their control and design.	
Unit - I	**Introduction to Robotics:**	**9**
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**
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**
Sensor: Contact and Proximity, Position, Velocity, Force, Tactile. Introduction to Cameras- Camera calibration- Geometry of image formation- Euclidean/Similarity/Affine/Projective transformations- Vision applications in robotics.		
Unit - IV	**Robot Control and Actuation Systems:**	**9**
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**
Embedded systems: Architecture and integration with sensors, Actuators, Components, Programming for robot applications.		

Total:45

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", 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	design control laws for a robot	Applying (K3)
CO4	integrate mechanical and electrical hardware for a real prototype of robotic device	Applying (K3)
CO5	select a robotic system for given application	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)**

20MTO07 - VIRTUAL AND AUGMENT REALITY IN INDUSTRY 4.0

(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches except Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	8	OE	3	0	0	3

Preamble	This course familiarizes the basics concept of virtual reality and also analyses the kinematics and dynamics behaviors of VR Environment through software.	
Unit - I	**Introduction to Augmented Reality:**	**9**
System structure of augmented reality; Key technology in AR; General solution for calculating geometric & illumination consistency in the augmented environment.		
Unit - II	**Virtual Reality and Virtual Environments:**	**9**
The historical development of VR: Classic components of a VR system, Virtual environments, Requirements for VR, Benefits of virtual reality. Hardware technologies for 3D user interfaces: Visual displays, Auditory displays, Haptic displays, Choosing output devices for 3D user interfaces.		
Unit - III	**Geometric Modelling:**	**9**
Geometric modelling: Introduction – From 2D to 3D – 3D space curves – 3D boundary representation - Geometrical Transformations: Introduction – Frames of reference – Modelling transformations – Instances –Picking – Flying – Scaling the VE – Collision detection. A Generic VR system: Introduction –Virtual environment –Computer environment – VR Technology – Model of interaction – VR systems.		
Unit - IV	**VR Hardwares & Softwares:**	**9**
Human factors: Introduction –Eye - Ear- Somatic senses – VR Hardware: Introduction – Sensor hardware – Head-coupled displays – Acoustic hardware – Integrated VR systems-VR Software: Introduction –Modelling virtual world –Physical simulation – VR toolkits – Introduction to VRML.		
Unit - V	**VR Applications in Manufacturing:**	**9**
Introduction to Productivity Enhancement Platforms: Virtual prototyping spaces, Virtual collaborative working spaces, Augmented and virtual assistance, Telepresence - Applications of VR in Robotics: Robot teleoperation.		

Total:45

TEXT BOOK:

1. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", 1st Edition, Morgan Kaufmann, USA, 2009.

REFERENCES:

1. John Vince., "Virtual Reality Systems ", 1st Edition, Pearson Education Asia, US, 2002.

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

CO1	explain the basic concept and framework of Augmented & virtual reality	Understanding (K2)
CO2	establish an insight to virtual environment	Understanding (K2)
CO3	realize the multimodal user interaction and perception in VR using geometric modelling and control mechanisms	Applying (K3)
CO4	apply computing tools for the development of VR environment	Applying (K3)
CO5	develop virtual reality for 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	1	2	1	1	1	1						3	1	3
CO2	1	2	1	1	1	2						3	1	3
CO3	3	2	3	2	3	3						3	1	3
CO4	3	2	3	3	3	3						3	2	3
CO5	3	2	3	3	3	3						3	2	3

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

ASSESSMENT PATTERN - THEORY

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

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

20GEO04 - INNOVATION AND BUSINESS MODEL DEVELOPMENT
(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	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**
Innovation and Creativity– Types of innovation – challenges in innovation- steps in innovation management- 7 concerns of design. Design Thinking and Entrepreneurship – Design Thinking Stages: Empathize – Define – Ideate – Prototype – Test. Design thinking tools: Analogies – Brainstorming – Mind mapping		
Unit - II	**User Study and Contextual Enquiry:**	**9**
Explanatory research – primary and secondary data – classification of secondary data – sources of secondary data – qualitative research – focus groups – depth interviews – analysis of qualitative data – survey methods – observations- Process of identifying customer needs – organize needs into a hierarchy –establish relative importance of the needs- Establish target specifications		
Unit - III	**Product Design:**	**9**
Techniques and tools for concept generation, concept evaluation – Product architecture –Minimum Viable Product (MVP)- Product prototyping – tools and techniques– overview of processes and materials – evaluation tools and techniques for user-product interaction		
Unit - IV	**Business Model Canvas (BMC):**	**9**
Lean Canvas and BMC - difference and building blocks- BMC: Patterns – Design – Strategy – Process–Business model failures: Reasons and remedies		
Unit - V	**IPR and Commercialization:**	**9**
Need for Intellectual Property- Basic concepts - Different Types of IPs: Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design– Patent Licensing - Technology Commercialization – Innovation Marketing		

Total:45

TEXT BOOK:

1.	Rishikesha T.Krishnan, “8 Steps To Innovation: Going From Jugaad To Excellence”, Collins India, 2013.

REFERENCES:

1.	Peter Drucker, “Innovation and Entrepreneurship”, Routledge CRC Press, London, 2014.
2.	Eppinger, S.D. and Ulrich, K.T. “Product design and development”, 7th edition, McGraw-Hill Higher Education, 2020.
3.	Alexander Osterwalder, “Business model generation: A handbook for visionaries, game changers, and challengers”, 1st edition, John Wiley and Sons; 2010
4.	Indian Innovators Association, “Patent IPR Licensing – Technology Commercialization – Innovation Marketing: Guide Book for Researchers, Innovators”, Notion Press, Chennai, 2017

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand innovation need and design thinking phases	Understanding (K2)
CO2	identify, screen and analyse ideas for new products based on customer needs	Analysing (K4)
CO3	develop and analyse the product concepts based on the customer needs and presents the overall architecture of the product.	Analysing (K4)
CO4	predict a structured business model for MVP	Applying (K3)
CO5	practice the procedures for protection of their ideas' IPR	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

20GEO19 - ENTREPRENEURSHIP DEVELOPMENT
(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Economics & Management	6	EC	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.		
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		1
CO2	1	2	2	2		2	2	1	1		3	2		2
CO3	2	2	2	2	2	2	2	2	2	2	3	2		1
CO4	1	1	2	1		2	1	1	1	2	3	2		1
CO5	1	1	2	1		2	1	1	1	2	3	2		1

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

ASSESSMENT PATTERN - THEORY

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

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

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE-638060

(AUTONOMOUS)

BOARD OF MECHATRONICS ENGINEERING

DEGREE & PROGRAMME: **B.E. & MECHATRONICS ENGINEERING**

HONOURS DEGREE TITLE: **INTELLIGENT AUTONOMOUS SYSTEMS**

The following courses are identified to earn additional 18 credits to get an Honors degree with specialization in Intelligent Autonomous Systems

S.No	Course Code	Course Title	Credits	Prerequisites	Semester
1.	20MTJ01	Data Modeling and Machine Intelligence	4	Numerical Methods for Engineers	5
2.	20MTH01	Deep Learning	3	Numerical Methods for Engineers	5
3.	20MTH02	Advanced Control and System Identification	4	Systems and Control Engineering	6
4.	20MTH03	Multi Sensor and Decision Systems	4	Electron Devices and Digital Circuits, Sensors and Signal Conditioning	6
5.	20MTH04	Intelligent Navigation and Mapping	3	Kinematics of Machines, Machine Dynamics	7
		TOTAL	**18**		

20MTJ01 - 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)
CO2	interpret similarity learning techniques and regression for solving uncertainty problems	Understanding (K2)
CO3	interpret probability-based learning and apply for real time applications	Understanding (K2)
CO4	apply support vector machines for solving optimization-based problems	Applying (K3)
CO5	develop programming for regression algorithms for decision-making functions	Applying (K3)
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), Precision (S3)
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)

20MTH01 - 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	**Introduction to Deep Learning:**	**9**
Introduction - Linear Algebra: Scalars -Vectors -Matrices and tensors; Probability Distributions - Feature Descriptor I & II, Bayesian Learning I & II, Machine Learning Basics: Capacity - Overfitting and underfitting - Hyperparameters and validation sets - Estimators - Bias and variance - Decision Surfaces - Discriminant Function I, II & III.		
Unit – II	**Machine Learning Fundamentals:**	**9**
Linear Classifier - Support Vector Machine - Multiclass Support Vector Machine - Linear Machines with Hinge Loss – Regularization - Optimization Techniques in Machine Learning - Stochastic gradient descent - Nonlinear Functions - Batch Optimization.		
Unit – III	**Neural Networks:**	**9**
Introduction to Neural Network - Linear Associative Networks - Perceptron's - Multilayer Perceptron - Back Propagation Learning - Deep Backprop Networks - Hopfield Nets - Boltzmann Machines - Loss Function - Autoencoder - Autoencoder Vs. PCA I - Autoencoder Vs. PCA II - Variational Autoencoders.		
Unit – IV	**Convolutional Neural Network:**	**9**
Convolutional Neural Network - Building blocks of CNN - Transfer Learning - Convolution Operation - Sparse Interactions - Parameter Sharing - Equivariance - Pooling - Convolution Variants: Strided - Tiled - Transposed and dilated convolutions - Optimizers - Gradient Computation - Revisiting Gradient Descent - Momentum Optimizer – RMSProp – Adam.		
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 - Guiding charities in maximizing donations and Robotic control in industrial environments.		
		Total:45

TEXT BOOK:

1.	Ian Godfellow, YoshuaBengio, & Aaron Courvillie, "Deep Learning",The MIT Press, Cambridge Massachusetts, 2nd Edition, 2016.

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'ReilleyMedia,Inc, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	interpret the concepts behind deep learning	Understanding (K2)
CO2	apply appropriate machine learning functions to resolve uncertainty problems	Applying (K3)
CO3	infer the basic concepts of neural network using various loss 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	80					100
CAT2		70	30				100
CAT3	20	80					100
ESE	20	40	40				100

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

20MTH02 - 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)

20MTH03 - 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)

20MTH04 - 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)