KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

REGULATIONS, CURRICULUM & SYLLABI - 2018

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

(For the students admitted during 2018 - 2019 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 2018
(Revision: 4)

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 2018 – 2019 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
BTech	Chemical Engineering
	Information Technology
	Food Technology

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/Industrial Training, Comprehensive Test & Viva, Entrepreneurships/Start ups and Internship in Industry or elsewhere

viii. Audit Courses (AC)

ix. Mandatory Courses (MC)

4.2 Credit Assignment

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 programme shall vary from 168 to 173 as per the chosen programme of study.

4.3 Employability Enhancement Courses

A candidate shall be offered with the employability enhancement courses like project work, professional skills training/industrial training, comprehensive test & viva, industrial training, 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 course 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 or Professional Skills Training II. The area in which the candidate wants to initiate a start up may be interdisciplinary or multidisciplinary. The progress of the startup shall be evaluated by a panel of members constituted by the Principal through periodic reviews.

4.3.2 Comprehensive Test and Viva

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

4.3.3 Internships

The curriculum enables a candidate to go for full time projects 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 approval from 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 courses or dropping of already registered additional elective 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) and earn continuous assessment marks. This will be considered as an attempt for the purpose of classification.

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

7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS

7.1 The BE/BTech programmes consist of Theory Courses, Theory cum Practical courses, Practical courses, Comprehensive Test and Viva, Project Work, Professional Skills 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	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.	Practical / Professional Skills Training / Comprehensive Test & Viva / Entrepreneurships / Start ups / Project Work I Phase I / Mandatory Course/ Industrial Training/Universal Human Values	100	---
4.	Project Work I Phase II / Project Work 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 the continuous assessment shall be for 100 marks. Every exercise / experiment shall be evaluated based on the candidate's performance during the practical class and the candidates' records maintained.

7.5.1 The apportionment of continuous assessment marks for each course shall be decided by the course coordinator based on rubrics of that particular course.

Type	Max. Marks	Remarks
Assessment based on rubrics for each experiment	50	Absolute Mark System
Assessment Test	50	
Total	100	Rounded off to one decimal place

7.6 Project Work II / Project Work I 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/ Project Work I Phase II and the Viva-Voce Examination shall be distributed as below:

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

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

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

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

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

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

7.7 Project Work I 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	Supervisor	Review Committee (excluding supervisor)	Supervisor	Review Committee (excluding supervisor)	Supervisor	Review Committee	Supervisor	Review Committee
0	0	10	10	15	15	20	10	20

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

7.8 Professional Skills Training

Phase I training shall be conducted for minimum of 80 hours in 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 the 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 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 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 Universal Human Values

The course imparting the human values shall be taught for all candidates who have joined in various branches of all BE/BTech programmes. This course shall carry a maximum of 100 marks and shall be evaluated through continuous assessment tests only vide clause 7.1. The candidate(s) can earn 2 credits by successfully completing this course. Two continuous assessment tests will be conducted and the average marks will be taken for the GPA and CGPA calculations.

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 and satisfy the attendance requirements.

9. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION

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

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

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

10. PROVISION FOR WITHDRAWAL FROM EXAMINATIONS

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

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

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

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

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

11. PROVISION FOR BREAK OF STUDY

11.1 A candidate is normally permitted to avail the authorised break of study under valid reasons (such as accident or hospitalization due to prolonged ill health or any other valid reasons) and to rejoin the programme in a later semester. He/She shall apply in advance to the Principal, through the Head of the Department, stating the reasons therefore, in any case, not later than the last date for registering for that semester examination.

A candidate is permitted to avail the authorised break of study only once during the entire period of study for a maximum period of one year. However, in extraordinary situation the candidate may apply for additional break of study not exceeding another one year by paying prescribed fee for the break of study.

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

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

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

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

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

12. PASSING REQUIREMENTS

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

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

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

13. REVALUATION OF ANSWER SCRIPTS

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

14. SUPPLEMENTARY EXAMINATION

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

15. AWARD OF LETTER GRADES

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

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

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

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

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

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

The GPA and CGPA indicate the academic performance of a candidate at the end of a semester

and at the end of successive semesters respectively.

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

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

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

16. ELIGIBILITY FOR THE AWARD OF DEGREE

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

i. Successfully completed all the courses under the different categories, as specified in the regulations.
ii. Successfully gained the required number of total credits as specified in the curriculum corresponding to the candidate's programme within the stipulated time (vide clause 5).
iii. Successfully passed any additional courses prescribed by the respective Board of Studies whenever readmitted under regulations other than R-2018 (vide clause 11.3)
iv. No disciplinary action pending against him / her.

17. CLASSIFICATION OF THE DEGREE AWARDED

17.1 First Class with Distinction:

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

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

(OR)

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

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the First Appearance within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.

- Submission of equivalent course list approved by the respective Board of studies.

- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.

- Should have secured a CGPA of not less than 9.00

17.2 First Class:

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

- Should have passed the examination in all the courses of all eight semesters (six semesters for lateral entry candidates) within ten consecutive semesters (eight consecutive semesters for lateral entry candidates) excluding authorized break of study (vide clause 11) after the commencement of his / her study.

- Withdrawal from the examination (vide clause 10) shall not be considered as an appearance.

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.

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.

All amendments until the 16th Academic council meeting have been incorporated.

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CURRICULUM BREAKDOWN STRUCTURE										
Summary of Credit Distribution										
Category	**Semester**								**Total number of credits**	**Curriculum Content (% of total number of credits of the program)**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
HS	**3**	**4**		**1**	**2**		**3**		**13**	**7.52**
BS	**11**	**11**	**4**	**4**					**30**	**17.34**
ES	**7**	**3**	**4**						**14**	**8.09**
PC		**3**	**15**	**21**	**17**	**13**			**69**	**39.88**
PE						**3**	**9**	**3**	**15**	**8.67**
OE					**4**	**4**	**3**	**3**	**14**	**8.09**
EC					**2**	**4**	**6**	**6**	**18**	**10.41**
Semesterwise Total	**21**	**21**	**23**	**26**	**25**	**24**	**21**	**12**	**173**	**100.00**

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

CATEGORISATION OF COURSES							
HUMANITIES AND SOCIAL SCIENCE INCLUDING MANAGEMENT (HS)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18EGT11	English for Communication I	3	0	0	3	I
2.	18EGT21	English for Communication II	3	0	0	3	II
3.	18VEC11	Value Education	2	0	1	1	II
4.	18EGL31	English for Workplace Communication	0	0	2	1	IV
5.	18GET51	Universal Human Values	2	0	0	2	V
6.	18MBT71	Engineering Economics and Management	3	0	0	3	VII
Total Credits to be earned						**13**	

BASIC SCIENCE (BS)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18MAC11	Mathematics I	3	1*	2*	4	I
2.	18PHC11	Applied Physics	3	0	2*	3.5	I
3.	18CYC11	Applied Chemistry	3	0	2*	3.5	I
4.	18MAC21	Mathematics II	3	1*	2*	4	II
5.	18PHC23	Materials Science and Metallurgy	3	0	2*	3.5	II
6.	18CYC22	Environmental Chemistry in Mechanical Systems	3	0	2*	3.5	II
7.	18MAC31	Mathematics III	3	1*	2*	4	III
8.	18MAC41	Statistics and Numerical Methods	3	1*	2*	4	IV
Total Credits to be earned						**30**	

ENGINEERING SCIENCE (ES)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18GET11	Introduction to Engineering	3	0	0	3	I
2.	18MEC11	Engineering Drawing	2	0	2	3	I
3.	18MEL11	Engineering Practices Laboratory	0	0	2	1	I
4.	18CSC11	Problem Solving and Programming	2	0	2	3	II
5.	18MET31	Engineering Mechanics	3	1	0	4	III
Total Credits to be earned						**14**	

PROFESSIONAL CORE (PC)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream**
1.	18ECT21	Circuit Analysis and Network Synthesis	3	0	0	3	II	PD
2.	18MET33	Fluid Mechanics and Hydraulic Machines	3	0	0	3	III	PS
3.	18MTT31	Analog Devices and Digital Circuits	3	0	0	3	III	PD
4.	18MTT32	Manufacturing Processes	3	0	0	3	III	PS
5.	18MTT33	Sensors and Transducers	3	0	0	3	III	AE
6.	18MTL31	Analog Devices and Digital Circuits Laboratory	0	0	2	1	III	PD
7.	18MTL32	Manufacturing Processes Laboratory	0	0	2	1	III	PS

8.	18MTL33	Sensors and Transducers Laboratory	0	0	2	1	III	AE
9.	18MET41	Strength of Materials	3	1	0	4	IV	PD
10.	18EIT43	DC and AC machines	3	0	0	3	IV	PD
11.	18MTT41	Kinematics of Machines	3	1	0	4	IV	PD
12.	18MTT42	Thermodynamics and Heat Transfer	3	1	0	4	IV	PD
13.	18MTT43	Power Electronics and Drives	3	0	0	3	IV	PD
14.	18EEL43	DC and AC machines Laboratory	0	0	2	1	IV	PD
15.	18MTL41	Power Electronics and Drives Laboratory	0	0	2	1	IV	PD
16.	18MTL42	Computer Aided Drafting Laboratory	0	0	2	1	IV	PD
17.	18MTT51	CNC and Metrology	3	0	0	3	V	AE
18.	18MTT52	Microcontroller Programming and Applications	3	0	0	3	V	AE
19.	18MTT53	Machine Dynamics	3	1	0	4	V	PD
20.	18MTT54	Systems and Control Engineering	3	1	0	4	V	AE
21.	18MTL51	CNC and Metrology Laboratory	0	0	2	1	V	AE
22.	18MTL52	Microcontroller Programming and Applications Laboratory	0	0	2	1	V	AE
23.	18MTL53	Computer Aided Engineering Laboratory	0	0	2	1	V	PD
24.	18MTT61	Programmable Automation Controllers	3	0	0	3	VI	AE
25.	18MTT62	Kinematics and Dynamics of Serial Manipulator	3	0	0	3	VI	AS
26.	18MTC61	Fluid Power System	3	0	2	4	VI	PS
27.	18MTL61	Programmable Automation Controllers Laboratory	0	0	2	1	VI	AE
28.	18MTL62	Robotics and Control Laboratory	0	0	2	1	VI	AS
29.	18MTL63	Graphical System Design Laboratory	0	0	2	1	VI	AE
Total Credits to be earned						69		

PROFESSIONAL ELECTIVE (PE)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream**
		Elective – I						
1.	18MTE01	Design of Mechanical Elements	3	0	0	3	VI	PD
2.	18MTE02	Machine Drawing	3	0	0	3	VI	PD
3.	18MTE03	Operations Research	3	0	0	3	VI	PS
4.	18MTE04	Machine Learning	3	0	0	3	VI	AS

5.	18MTE05	Embedded Programming for Mechatronics	3	0	0	3	VI	AE
6.	18MTE06	Process Control and Instrumentation	3	0	0	3	VI	AE
		Elective – II						
7.	18GEE01	Fundamentals of Research	3	0	0	3	VII	GE
8.	18MTE07	Precision Equipment Design	3	0	0	3	VII	PD
9.	18MTE08	Precision Manufacturing	3	0	0	3	VII	PS
10.	18MTE09	Machine Vision and Image Processing	3	0	0	3	VII	AS
11.	18MTE10	Introduction to Industrial Internet of Things	3	0	0	3	VII	AE
12.	18MTE11	Bio Mechatronics	3	0	0	3	VII	AS
		Elective – III						
13.	18MTE12	Machine Tool Control and Condition Monitoring	3	0	0	3	VII	PS
14.	18MTE13	Applied Finite Element Method	3	0	0	3	VII	PD
15.	18MTE14	Additive Manufacturing	3	0	0	3	VII	PS
16.	18MTE15	Cyber Physical Systems	3	0	0	3	VII	AE
17.	18MTE16	Industrial Automation Protocols	3	0	0	3	VII	AE
18.	18MTE17	Robot Programming	3	0	0	3	VII	AS
		Elective – IV						
19.	18MTE18	Maintenance Engineering	3	0	0	3	VII	PS
20.	18MTE19	Computer Integrated Manufacturing	3	0	0	3	VII	PS
21.	18MTE20	Automotive Electronics	3	0	0	3	VII	AE
22.	18MTE21	Micro Electro Mechanical Systems	3	0	0	3	VII	PD
23.	18MTE22	Mobile Robotics	3	0	0	3	VII	AS
24.	18MTE23	Drone Technology	3	0	0	3	VII	AS
		Elective – V						
25.	18MBE49	Entrepreneurship Development	3	0	0	3	VIII	GE
26.	18MTE24	Product Design and Development	3	0	0	3	VIII	PD
27.	18MTE25	Production Management	3	0	0	3	VIII	PS
28.	18MTE26	Nanoscience and Technology	3	0	0	3	VIII	PD
29.	18MTE27	Avionics	3	0	0	3	VIII	AS
30.	18MTE28	Principles of Farm Machineries	3	0	0	3	VIII	PS
Total Credits to be earned						**15**		

EMPLOYABILITY ENHANCEMENT COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18GEL51/ 18GEI51	Professional Skills Training I / Industrial Training I	0	0	0	2	V
2.	18GEL61/ 18GEI61	Professional Skills Training II / Industrial Training II	0	0	0	2	VI
3.	18GEP71	Comprehensive Test and Viva	0	0	0	2	VII
4.	18MTP61	Project Work I Phase I	0	0	4	2	VI
5.	18MTP71	Project Work I Phase II	0	0	8	4	VII
6.	18MTP81	Project Work II	0	0	12	6	VIII
Total Credits to be earned						**18**	

***** Domain/Stream Abbreviations: AE – AUTOMATION ENGINEERING, AS – AUTONOMOUS SYSTEMS, PD – PRODUCT DESIGN, PS – PRODUCTION SYSTEMS, GE – GENERAL ENGINEERING

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18MTO01	Design of Mechatronics Systems	3	1	0	4	V
2.	18MTO02	Factory Automation	3	0	2	4	VI
3.	18MTO03	Data Acquisition and Virtual Instrumentation	3	0	2	4	VI
4.	18MTO04	3D Printing and Design	3	0	0	3	VII
5.	18MTO05	Drone System Technology	3	0	0	3	VII
6.	18MTO06	Robotics	3	0	0	3	VIII
7.	18MTO07	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 Name**	**L**	**T**	**P**	**C**	**OFFERED BY**
		SEMESTER V					
8.	18MAO01	Mathematical Foundations of Machine Learning	3	1	0	4	MATHS
9.	18PHO01	Thin film Technology	3	1	0	4	PHYSICS
10.	18CYO01	Corrosion Science and Engineering	3	1	0	4	CHEMISTRY
11.	18CEO01	Remote Sensing and its Applications	3	0	2	4	CIVIL
12.	18MEO01	Renewable Energy Sources	3	0	2	4	MECH
13.	18AUO01	Automotive Engineering	3	0	2	4	AUTO
14.	18ECO01	PCB Design and Fabrication	3	0	2	4	ECE

15.	18ECO02	Neural Networks and Fuzzy Logic for Engineering Applications	3	0	2	4	ECE
16.	18EEO01	Electrical Wiring and Lighting	3	1	0	4	EEE
17.	18EEO02	Solar and Wind Energy Systems	3	1	0	4	EEE
18.	18EIO01	Neural Networks and Deep Learning	3	1	0	4	EIE
19.	18CSO01	Data Structures and its Applications	3	0	2	4	CSE
20.	18CSO02	Formal Languages and Automata Theory	3	1	0	4	CSE
21.	18CSO03	Computational Science for Engineers	3	1	0	4	CSE
22.	18ITO01	Python Programming	3	0	2	4	IT
23.	18ITO02	Advanced Java Programming	3	0	2	4	IT
24.	18CHO01	Polymer Technology	3	1	0	4	CHEM
25.	18CHO02	Introduction to Drugs and Pharmaceuticals Technology	3	1	0	4	CHEM
26.	18FTO01	Food Processing Technology	3	1	0	4	FT
27.	18FTO02	Baking Technology	3	0	2	4	FT
		SEMESTER VI					
28.	18MAO02	Graph Theory and its Applications	3	1	0	4	MATHS
29.	18MAO03	Number Theory and Cryptography	3	1	0	4	MATHS
30.	18CYO02	Instrumental Methods of Analysis	3	1	0	4	CHEMISTRY
31.	18CEO02	Disaster Management	3	1	0	4	CIVIL
32.	18MEO02	Design of Experiments	3	0	2	4	MECH
33.	18AUO02	Autonomous Vehicles	3	1	0	4	AUTO
34.	18ECO03	Principles of Quantum Computing	3	0	2	4	ECE
35.	18EEO03	Energy Conservation and Management	3	1	0	4	EEE
36.	18EIO02	Digital Image Processing and Its Applications	3	1	0	4	EIE
37.	18EIO03	Industrial Automation	3	1	0	4	EIE
38.	18CSO04	Web Engineering	3	0	2	4	CSE
39.	18CSO05	Foundations of Data Analytics	3	1	0	4	CSE
40.	18CSO06	Nature Inspired Optimization Techniques	3	1	0	4	CSE
41.	18CSO07	Introducing Data Science	3	1	0	4	CSE
42.	18ITO03	Java Programming	3	1	0	4	IT
43.	18ITO04	Next Generation Databases	3	1	0	4	IT
44.	18CHO03	Bio Energy Resources	3	1	0	4	CHEM

45.	18CHO04	Fundamentals of Nanoscience and Nanotechnology	3	1	0	4	CHEM
46.	18FTO03	Processing of milk and milk products	3	0	2	4	FT
47.	18FTO04	Processing of Fruits and Vegetables	3	0	2	4	FT
		SEMESTER VII					
48.	18MAO04	Advanced Linear Algebra	3	0	0	3	MATHS
49.	18MAO05	Optimization Techniques	3	0	0	3	MATHS
50.	18PHO02	Structural and Optical Characterization of Materials	3	0	0	3	PHYSICS
51.	18CYO03	Waste and Hazardous Waste Management	3	0	0	3	CHEMISTRY
52.	18CEO03	Introduction to Smart Cities	3	0	0	3	CIVIL
53.	18CEO04	Environmental Health and Safety	3	0	0	3	CIVIL
54.	18MEO03	Fundamentals of Ergonomics	3	0	0	3	MECH
55.	18MEO04	Principles of Management and Industrial Psychology	3	0	0	3	MECH
56.	18AUO03	Alternate Fuels for Automobile	3	0	0	3	AUTO
57.	18ECO04	Electronic Hardware and Troubleshooting	2	0	2	3	ECE
58.	18ECO05	Principles of Communication Techniques	3	0	0	3	ECE
59.	18EEO04	Micro Grid and Smart Grid	3	0	0	3	EEE
60.	18EEO05	Electrical Safety	3	0	0	3	EEE
61.	18EIO04	Biomedical Instrumentation and Applications	3	0	0	3	EIE
62.	18EIO05	PLC Programming and Its Applications	3	0	0	3	EIE
63.	18CSO08	Artificial Intelligence and its applications	3	0	0	3	CSE
64.	18ITO05	Business Continuity Planning	3	0	0	3	IT
65.	18ITO06	Mobile Application Development	3	0	0	3	IT
66.	18CHO05	Enzyme Engineering	3	0	0	3	CHEM
67.	18CHO06	Nuclear Engineering	3	0	0	3	CHEM
68.	18FTO05	Principles of Food Safety	3	0	0	3	FT
69.	18FTO06	Food and Nutrition	3	0	0	3	FT
		SEMESTER VIII					
70.	18CEO05	Infrastructure Planning and Management	3	0	0	3	CIVIL
71.	18CEO06	Environmental Laws and Policy	3	0	0	3	CIVIL
72.	18MEO05	Safety Measures for Engineers	3	0	0	3	MECH
73.	18MEO06	Energy Conservation in Thermal Equipments	3	0	0	3	MECH

74.	18AUO04	Automotive Electronics	3	0	0	3	AUTO
75.	18AUO05	Vehicle Maintenance	3	0	0	3	AUTO
76.	18ECO06	Bioinspired Computing Technologies	2	0	2	3	ECE
77.	18EEO06	Electric Vehicle	3	0	0	3	EEE
78.	18EIO06	Measurements and Instrumentation	3	0	0	3	EIE
79.	18EIO07	Graphical Programming using Virtual Instrumentation	3	0	0	3	EIE
80.	18CSO09	Applied Machine Learning	3	0	0	3	CSE
81.	18CSO10	Fundamentals of Blockchain	3	0	0	3	CSE
82.	18CSO11	Fundamentals of Internet of Things	3	0	0	3	CSE
83.	18ITO07	Essentials of Information Technology	3	0	0	3	IT
84.	18ITO08	Virtual and Augmented Reality Frameworks	3	0	0	3	IT
85.	18CHO07	Fertilizer Technology	3	0	0	3	CHEM
86.	18FTO07	Food Ingredients	3	0	0	3	FT
87.	18FTO08	Fundamentals of Food Packaging and Storage	3	0	0	3	FT

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

S. No.	Course Code	Course Title	L	T	P	C	Offering Department	Semester
88.	18GEO01	German Language Level 1	4	0	0	4	ECE	V/ VI/ VII/ VIII
89.	18GEO02	Japanese Language Level 1	4	0	0	4	ECE	V/ VI/ VII/ VIII
90.	18GEO03	Design Thinking for Engineers	3	0	0	3	CSE	VI
91.	18GEO04	Innovation and Business Model Development	3	0	0	3	MTS	VIII
92.	18GEO05	German Language Level 2	4	0	0	4	ECE	V/ VI/ VII/ VIII
93.	18GEO06	German Language Level 3	3	0	0	3	ECE	V/ VI/ VII/ VIII
94.	18GEO07	German Language Level 4	3	0	0	3	ECE	V/ VI/ VII/ VIII
95.	18GEO08	Japanese Language Level 2	4	0	0	4	ECE	V/ VI/ VII / VIII
96.	18GEO09	Japanese Language Level 3	3	0	0	3	ECE	V/ VI/ VII / VIII
97.	18GEO10	Japanese Language Level 4	3	0	0	3	ECE	V/ VI/ VII / VIII
98.	18GEO11	NCC Studies (Army Wing) – I	3	0	2	4	EEE	V/ VI
99.	18GEO12	NCC Studies (Air Wing) – I	3	0	2	4	IT	V / VI

KEC R2018: SCHEDULING OF COURSES – BE (Mechatronics Engineering) Total Credits: 173

Sem.	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	Credits
I	18EGT11 English for Communi-cation I (3-0-0-3)	18MAC11 Mathematics I (3-1*-2*-4)	18PHC11 Applied Physics (3-0-2*-3.5)	18CYC11 Applied Chemistry (3-0-2*-3.5)	18GET11 Introduction to Engineering (3-0-0-3)	18MEC11 Engineering Drawing (2-0-2-3)	18MEL11 Engineering Practices Laboratory (0-0-2-1)				21
II	18EGT21 English for Communi-cation II (3-0-0-3)	18MAC21 Mathematics II (3-1*-2*-4)	18PHC23 Materials Science and Metallurgy (3-0-2*-3.5)	18CYC22 Environmental Chemistry in Mechanical Systems (3-0-2*-3.5)	18CSC11 Problem Solving and Programming (2-0-2-3)	18ECT21 Circuit Analysis and Network Synthesis (3-0-0-3)	18VEC11 Value Education (2-0-1-1)				21
III	18MAC31 Mathematics III (3-1*-2*-4)	18MET31 Engineering Mechanics (3-1-0-4)	18MET33 Fluid Mechanics and Hydraulic Machines (3-0-0-3)	18MTT31 Analog Devices and Digital Circuits (3-0-0-3)	18MTT32 Manufacturing Processes (3-0-0-3)	18MTT33 Sensors and Transducers (3-0-0-3)	18MTL31 Analog Devices and Digital Circuits Lab (0-0-2-1)	18MTL32 Manufacturing Processes Laboratory (0-0-2-1)	18MTL33 Sensors and Transducers Laboratory (0-0-2-1)		23
IV	18MAC41 Statistics and Numerical Methods (3-1*-2*-4)	18MET41 Strength of Materials (3-1-0-4)	18EIT43 DC and AC Machines (3-0-0-3)	18MTT41 Kinematics of Machines (3-1-0-4)	18MTT42 Thermo dynamics and Heat Transfer (3-1-0-4)	18MTT43 Power Electronics and Drives (3-0-0-3)	18EEL43 DC and AC Machines Lab (0-0-2-1)	18MTL41 Power Electronics and Drives Lab (0-0-2-1)	18MTL42 Computer Aided Drafting Lab (0-0-2-1)	18EGL31 English for Workplace Communica-tion (0-0-2-1)	26
V	18MTT51 CNC and Metrology (3-0-0-3)	18MTT52 Micro controller Programming and Applications (3-0-0-3)	18MTT53 Machine Dynamics (3-1-0-4)	18MTT54 Systems and Control Engineering (3-1-0-4)	Open Elective I (3-1/0-0/2-4)	18MTL51 CNC and Metrology Laboratory (0-0-2-1)	18MTL52 Micro controller Programming and Applications Lab (0-0-2-1)	18MTL53 Computer Aided Engineering Laboratory (0-0-2-1)	18GEL51/ 18GEI51 Professional Skills Training I / Industrial Training I* (0-0-0-2)	18GET51 Universal Human Values (2-0-0-2)	25
VI	18MTT61 Programmable Automation Controllers (3-0-0-3)	18MTT62 Kinematics and Dynamics of Serial Manipulator (3-0-0-3)	18MTC61 Fluid Power System (3-0-2-4)	Professional Elective I (3-0-0-3)	Open Elective II (3-1/0-0/2-4)	18MTL61 Programmable Automation Controllers Lab (0-0-2-1)	18MTL62 Robotics and Control Lab (0-0-2-1)	18MTL63 Graphical System Design Laboratory (0-0-2-1)	18GEL61/ 18GEI 61 Professional Skills Training II / Industrial Training II* (0-0-0-2)	18MTP61 Project Work I Phase I (0-0-4-2)	24
VII	18MBT71 Engineering Economics and Management (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)	Open Elective III (3-0-0-3)	18GEP71 Comprehen-sive Test / Viva (0-0-0-2)	18MTP71 Project Work I Phase II (0-0-8-4)				21
VIII	Professional Elective V (3-0-0-3)	Open Elective IV (3-0-0-3)	18MTP81 Project Work II (0-0-12-6)								12

MAPPING OF COURSES WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	18EGT11	English for Communication I						✓			✓	✓	✓	✓		
1	18MAC11	Mathematics I	✓	✓	✓	✓	✓									
1	18PHC11	Applied Physics	✓	✓	✓	✓										
1	18CYC11	Applied Chemistry	✓	✓	✓	✓										
1	18GET11	Introduction to Engineering	✓	✓	✓	✓		✓	✓					✓	✓	✓
1	18MEC11	Engineering Drawing	✓	✓	✓	✓						✓	✓	✓	✓	✓
1	18MEL11	Engineering Practices Laboratory	✓	✓	✓	✓	✓				✓	✓	✓	✓		
2	18EGT21	English for Communication II					✓			✓	✓	✓	✓			
2	18MAC21	Mathematics II	✓	✓	✓		✓									
2	18PHC23	Materials Science and Metallurgy	✓	✓	✓	✓										
2	18CYC22	Environmental Chemistry in Mechanical Systems	✓	✓	✓	✓			✓							
2	18CSC11	Problem Solving and Programming	✓	✓	✓	✓	✓					✓				
2	18ECT21	Circuit Analysis and Network Synthesis	✓	✓	✓		✓								✓	✓
2	18VEC11	Value Education						✓		✓				✓		
3	18MAC31	Mathematics III	✓	✓	✓	✓										
3	18MET31	Engineering Mechanics	✓	✓	✓	✓								✓		✓
3	18MET33	Fluid Mechanics and Hydraulic Machines	✓	✓	✓			✓	✓			✓		✓	✓	✓
3	18MTT31	Analog Devices and Digital Circuits	✓	✓	✓		✓							✓	✓	✓
3	18MTT32	Manufacturing Processes	✓	✓	✓	✓								✓	✓	✓
3	18MTT33	Sensors and Transducers	✓	✓		✓								✓	✓	✓
3	18MTL31	Analog Devices and Digital Circuits Laboratory	✓	✓	✓		✓				✓	✓		✓	✓	✓
3	18MTL32	Manufacturing Processes Laboratory	✓	✓	✓	✓					✓	✓		✓	✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
3	18MTL33	Sensors and Transducers Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
4	18MAC41	Statistics and Numerical Methods	✓	✓	✓	✓	✓									
4	18MET41	Strength of Materials	✓	✓	✓	✓	✓							✓		✓
4	18EIT43	DC and AC machines	✓	✓	✓	✓	✓								✓	✓
4	18MTT41	Kinematics of Machines	✓	✓	✓	✓								✓	✓	✓
4	18MTT42	Thermodynamics and Heat Transfer	✓	✓	✓	✓			✓					✓	✓	✓
4	18MTT43	Power Electronics and Drives	✓	✓	✓		✓							✓	✓	✓
4	18EEL43	DC and AC machines Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
4	18MTL41	Power Electronics and Drives Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
4	18MTL42	Computer Aided Drafting Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
4	18EGL31	English for Work Place Communication									✓	✓		✓		
5	18MTT51	CNC and Metrology	✓	✓	✓	✓	✓							✓	✓	✓
5	18MTT52	Microcontroller Programming and Applications	✓	✓	✓	✓	✓						✓		✓	✓
5	18MTT53	Machine Dynamics	✓	✓	✓	✓	✓							✓	✓	✓
5	18MTT54	Systems and Control Engineering	✓	✓	✓	✓	✓							✓	✓	✓
5	18MTL51	CNC and Metrology Laboratory	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓
5	18MTL52	Microcontroller Programming and Applications Laboratory	✓	✓	✓	✓	✓				✓			✓	✓	✓
5	18MTL53	Computer Aided Engineering Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
5	18GEL51/ 18GEI51	Professional Skills Training I / Industrial Training I	✓	✓				✓	✓		✓	✓	✓	✓		
5	18GET51	Universal Human Values						✓	✓	✓	✓	✓				
6	18MTT61	Programmable Automation Controllers	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓
6	18MTT62	Kinematics and Dynamics of Serial Manipulator	✓	✓	✓	✓	✓							✓	✓	✓
5	18MTC61	Fluid Power System	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓
6	18MTL61	Programmable Automation Controllers Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
6	18MTL62	Robotics and Control Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
6	18MTL63	Graphical System Design Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓
6	18GEL61/ 18GEI61	Professional Skills Training II / Industrial Training II	✓	✓				✓	✓		✓	✓	✓	✓		
6	18MTP61	Project Work I Phase I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	18MBT71	Engineering Economics and Management	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
7	18GEP71	Comprehensive Test / Viva	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓
7	18MTP71	Project Work I Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	18MTP81	Project Work II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Professional Elective Courses														
6	18MTE01	Design of Mechanical Elements	✓	✓	✓	✓	✓							✓	✓	✓
6	18MTE02	Machine Drawing	✓	✓	✓	✓								✓	✓	✓
6	18MTE03	Operations Research	✓	✓	✓	✓	✓						✓	✓	✓	✓
6	18MTE04	Machine Learning	✓	✓	✓	✓									✓	✓
6	18MTE05	Embedded Programming for Mechatronics	✓	✓	✓	✓	✓							✓	✓	✓
6	18MTE06	Process Control and Instrumentation	✓	✓	✓	✓	✓						✓		✓	✓
7	18GEE01	Fundamentals of Research	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	18MTE07	Precision Equipment Design	✓	✓	✓	✓	✓							✓	✓	✓
7	18MTE08	Precision Manufacturing	✓	✓	✓	✓	✓		✓				✓	✓	✓	✓
7	18MTE09	Machine Vision and Image Processing	✓	✓	✓	✓								✓	✓	✓
7	18MTE10	Introduction to Industrial Internet of Things	✓	✓	✓	✓	✓							✓	✓	✓
7	18MTE11	Bio Mechatronics	✓	✓	✓	✓		✓							✓	✓
7	18MTE12	Machine Tool Control and Condition Monitoring	✓	✓	✓			✓						✓	✓	✓
7	18MTE13	Applied Finite Element Method	✓	✓	✓	✓	✓							✓	✓	✓
7	18MTE14	Additive Manufacturing	✓	✓	✓	✓	✓						✓	✓	✓	✓
7	18MTE15	Cyber Physical Systems	✓	✓	✓		✓		✓						✓	✓
7	18MTE16	Industrial Automation Protocols	✓	✓	✓	✓	✓							✓	✓	✓
7	18MTE17	Robot Programming	✓	✓	✓	✓	✓							✓	✓	✓
7	18MTE18	Maintenance Engineering	✓	✓	✓			✓					✓	✓	✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	18MTE19	Computer Integrated Manufacturing	✓	✓	✓	✓	✓							✓	✓	✓
7	18MTE20	Automotive Electronics	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓
7	18MTE21	Micro Electro Mechanical Systems	✓	✓	✓	✓	✓							✓	✓	✓
7	18MTE22	Mobile Robotics	✓	✓	✓	✓	✓							✓	✓	✓
7	18MTE23	Drone Technology	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓
8	18MBE49	Entrepreneurship Development		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	18MTE24	Product Design and Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	18MTE25	Production Management	✓	✓	✓	✓	✓						✓	✓	✓	✓
8	18MTE26	Nanoscience and Technology	✓	✓	✓	✓	✓							✓	✓	✓
8	18MTE27	Avionics	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓
8	18MTE28	Principles of Farm Machineries	✓	✓	✓							✓		✓	✓	✓

		Open Elective Courses														
5	18MAO01	Mathematical Foundations of Machine Learning	✓	✓	✓	✓	✓									
5	18PHO01	Thin film Technology	✓	✓	✓											
5	18CYO01	Corrosion Science and Engineering	✓	✓	✓	✓										
5	18CEO01	Remote Sensing and its Applications	✓	✓	✓	✓	✓									
5	18MEO01	Renewable Energy Sources	✓	✓	✓	✓			✓			✓		✓		
5	18MTO01	Design of Mechatronics Systems	✓	✓	✓	✓	✓							✓		
5	18AUO01	Automotive Engineering	✓	✓	✓		✓									
5	18ECO01	PCB Design and Fabrication	✓	✓	✓	✓	✓				✓					
5	18ECO02	Neural Networks and Fuzzy Logic for Engineering Applications	✓	✓	✓	✓	✓				✓					
5	18EEO01	Electrical Wiring and Lighting	✓	✓	✓	✓	✓	✓								
5	18EEO02	Solar and Wind Energy Systems	✓	✓	✓	✓										
5	18EIO01	Neural Networks and Deep Learning	✓	✓	✓	✓	✓									
5	18CSO01	Data Structures and its Applications	✓	✓	✓	✓	✓									
5	18CSO02	Formal Languages and Automata Theory	✓	✓	✓	✓										

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
5	18CSO03	Computational Science for Engineers	✓	✓	✓	✓	✓									
5	18ITO01	Python Programming			✓		✓									
5	18ITO02	Advanced Java Programming			✓		✓									
5	18CHO01	Polymer Technology	✓	✓												
5	18CHO02	Introduction to Drugs and Pharmaceuticals Technology	✓	✓	✓	✓	✓									
5	18FTO01	Food Processing Technology	✓	✓	✓	✓										
5	18FTO02	Baking Technology	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		
6	18MAO02	Graph Theory and its Applications	✓	✓	✓											
6	18MAO03	Number Theory and Cryptography	✓	✓	✓		✓									
6	18CYO02	Instrumental Methods of Analysis	✓	✓	✓	✓										
6	18CEO02	Disaster Management	✓	✓	✓			✓	✓					✓		
6	18MEO02	Design of Experiments	✓	✓	✓	✓	✓						✓	✓		
6	18MTO02	Factory Automation	✓	✓	✓	✓	✓	✓			✓	✓		✓		
6	18MTO03	Data Acquisition and Virtual Instrumentation	✓	✓	✓	✓	✓				✓	✓		✓		
6	18AUO02	Autonomous Vehicles	✓	✓	✓											
6	18ECO03	Principles of Quantum Computing	✓	✓	✓	✓	✓									
6	18EEO03	Energy Conservation and Management	✓	✓	✓		✓									
6	18EIO02	Digital Image Processing and Its Applications	✓	✓	✓	✓	✓									
6	18EIO03	Industrial Automation	✓	✓	✓	✓	✓									
6	18CSO04	Web Engineering	✓	✓	✓	✓										
6	18CSO05	Foundations of Data Analytics	✓	✓	✓											
6	18CSO06	Nature Inspired Optimization Techniques	✓	✓	✓	✓										
6	18CSO07	Introducing Data Science	✓	✓	✓											
6	18ITO03	Java Programming	✓	✓	✓	✓	✓	✓						✓		
6	18ITO04	Next Generation Databases	✓	✓	✓	✓										
6	18CHO03	Bio Energy Resources	✓	✓	✓	✓	✓									
6	18CHO04	Fundamentals of Nanoscience and Nanotechnology	✓	✓	✓	✓	✓									

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
6	18FTO03	Processing of Milk and Milk Products	✓	✓	✓		✓	✓		✓	✓	✓		✓		
6	18FTO04	Processing of Fruits and Vegetables	✓	✓	✓		✓	✓		✓	✓	✓		✓		
7	18MAO04	Advanced Linear Algebra	✓	✓	✓											
7	18MAO05	Optimization Techniques	✓	✓	✓											
7	18PHO02	Structural and Optical Characterization of Materials	✓	✓	✓											
7	18CYO03	Waste and Hazardous Waste Management	✓	✓	✓	✓			✓							
7	18CEO03	Introduction to Smart Cities	✓	✓	✓				✓							
7	18CEO04	Environmental Health and Safety	✓	✓	✓	✓										
7	18MEO03	Fundamentals of Ergonomics	✓	✓	✓	✓		✓	✓			✓		✓		
7	18MEO04	Principles of Management and Industrial Psychology			✓			✓	✓	✓	✓	✓				
7	18MTO04	3D Printing and Design	✓	✓	✓	✓	✓						✓	✓		
7	18MTO05	Drone System Technology	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		
7	18AUO03	Alternate Fuels for Automobile	✓	✓												
7	18ECO04	Electronic Hardware and Troubleshooting	✓	✓	✓	✓	✓	✓								
7	18ECO05	Principles of Communication Techniques	✓	✓	✓	✓	✓									
7	18EEO04	Micro Grid and Smart Grid	✓	✓	✓	✓	✓									
7	18EEO05	Electrical Safety	✓	✓	✓											
7	18EIO04	Biomedical Instrumentation and Applications	✓	✓	✓	✓	✓									
7	18EIO05	PLC Programming and Its Applications	✓	✓	✓	✓	✓									
7	18CSO08	Artificial intelligence and its applications	✓	✓	✓											
7	18ITO05	Business Continuity Planning	✓	✓	✓	✓										
7	18ITO06	Mobile Application Development	✓	✓	✓	✓										
7	18CHO05	Enzyme Engineering	✓	✓	✓	✓	✓									
7	18CHO06	Nuclear Engineering	✓	✓												
7	18FTO05	Principles of Food safety	✓	✓	✓		✓	✓	✓	✓				✓		
7	18FTO06	Food and Nutrition	✓	✓	✓	✓								✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	18CEO05	Infrastructure Planning and Management	✓	✓	✓											
8	18CEO06	Environmental Laws and Policy	✓	✓	✓	✓										
8	18MEO05	Safety Measures for Engineers		✓		✓	✓	✓	✓	✓	✓			✓		
8	18MEO06	Energy Conservation in Thermal Equipments	✓	✓	✓			✓	✓			✓	✓	✓		
8	18MTO06	Robotics	✓	✓	✓	✓	✓							✓		
8	18MTO07	Virtual and Augment Reality in Industry 4.0	✓	✓	✓	✓	✓	✓						✓		
8	18AUO04	Automotive Electronics	✓	✓	✓											
8	18AUO05	Vehicle Maintenance	✓		✓			✓								
8	18ECO06	Bioinspired Computing Technologies	✓	✓	✓	✓										
8	18EEO06	Electric Vehicle	✓	✓	✓	✓	✓									
8	18EIO06	Measurements and Instrumentation	✓	✓	✓	✓	✓									
8	18EIO07	Graphical Programming using Virtual Instrumentation	✓	✓	✓	✓	✓									
8	18CSO09	Applied Machine Learning	✓	✓	✓											
8	18CSO10	Fundamentals of Blockchain	✓	✓	✓	✓										
8	18CSO11	Fundamentals of Internet of Things	✓	✓	✓	✓	✓									
8	18ITO07	Essentials of Information Technology	✓	✓	✓	✓										
8	18ITO08	Virtual and Augmented Reality Frameworks	✓	✓	✓	✓										
8	18CHO07	Fertilizer Technology	✓	✓												
8	18FTO07	Food Ingredients	✓	✓	✓			✓						✓		
8	18FTO08	Fundamentals of Food Packaging and Storage	✓	✓	✓		✓	✓		✓				✓		
		General Open Elective														
5,6,7,8	18GEO01	German Language Level 1								✓	✓	✓		✓		
5,6,7,8	18GEO02	Japanese Language Level 1								✓	✓	✓		✓		
7	18GEO03	Design Thinking for Engineers	✓	✓	✓	✓										
8	18GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5,6,7,8	18GEO05	German Language Level 2								✓	✓	✓		✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
5,6,7,8	18GEO06	German Language Level 3								✓	✓	✓		✓		
5,6,7,8	18GEO07	German Language Level 4								✓	✓	✓		✓		
5,6,7,8	18GEO08	Japanese Language Level 2								✓	✓	✓		✓		
5,6,7,8	18GEO09	Japanese Language Level 3								✓	✓	✓		✓		
5,6,7,8	18GEO10	Japanese Language Level 4								✓	✓	✓		✓		
5,6	18GEO11	NCC Studies (Army Wing) – I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
5,6	18GEO12	NCC Studies (Air Wing) – I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				

B.E. MECHATRONICS ENGINEERING CURRICULUM – R2018

SEMESTER – I									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
18EGT11	English for Communication I	3	0	0	3	50	50	100	HS
18MAC11	Mathematics I	3	1*	2*	4	50	50	100	BS
18PHC11	Applied Physics	3	0	2*	3.5	50	50	100	BS
18CYC11	Applied Chemistry	3	0	2*	3.5	50	50	100	BS
18GET11	Introduction to Engineering	3	0	0	3	50	50	100	ES
18MEC11	Engineering Drawing	2	0	2	3	50	50	100	ES
Practical / Employability Enhancement									
18MEL11	Engineering Practices Laboratory	0	0	2	1	100	0	100	ES
Total Credits to be earned					**21**				

***Alternate Weeks**

SEMESTER – II									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
18EGT21	English for Communication II	3	0	0	3	50	50	100	HS
18MAC21	Mathematics II	3	1*	2*	4	50	50	100	BS
18PHC23	Materials Science and Metallurgy	3	0	2*	3.5	50	50	100	BS
18CYC22	Environmental Chemistry in Mechanical Systems	3	0	2*	3.5	50	50	100	BS
18CSC11	Problem Solving and Programming	2	0	2	3	50	50	100	ES
18ECT21	Circuit Analysis and Network Synthesis	3	0	0	3	50	50	100	PC
Practical / Employability Enhancement									
18VEC11	Value Education	2	0	1	1	100	0	100	HS
Total Credits to be earned					**21**				

***Alternate Weeks**

B.E. MECHATRONICS ENGINEERING CURRICULUM – R2018

SEMESTER – III									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
18MAC31	Mathematics III	3	1*	2*	4	50	50	100	BS
18MET31	Engineering Mechanics	3	1	0	4	50	50	100	ES
18MET33	Fluid Mechanics and Hydraulic Machines	3	0	0	3	50	50	100	PC
18MTT31	Analog Devices and Digital Circuits	3	0	0	3	50	50	100	PC
18MTT32	Manufacturing Processes	3	0	0	3	50	50	100	PC
18MTT33	Sensors and Transducers	3	0	0	3	50	50	100	PC
Practical / Employability Enhancement									
18MTL31	Analog Devices and Digital Circuits Laboratory	0	0	2	1	100	0	100	PC
18MTL32	Manufacturing Processes Laboratory	0	0	2	1	100	0	100	PC
18MTL33	Sensors and Transducers Laboratory	0	0	2	1	100	0	100	PC
Total Credits to be earned					**23**				

***Alternate Weeks**

SEMESTER – IV									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
18MAC41	Statistics and Numerical Methods	3	1*	2*	4	50	50	100	BS
18MET41	Strength of Materials	3	1	0	4	50	50	100	PC
18EIT43	DC and AC Machines	3	0	0	3	50	50	100	PC
18MTT41	Kinematics of Machines	3	1	0	4	50	50	100	PC
18MTT42	Thermodynamics and Heat Transfer	3	1	0	4	50	50	100	PC
18MTT43	Power Electronics and Drives	3	0	0	3	50	50	100	PC
Practical / Employability Enhancement									
18EEL43	DC and AC Machines Laboratory	0	0	2	1	100	0	100	PC
18MTL41	Power Electronics and Drives Laboratory	0	0	2	1	100	0	100	PC
18MTL42	Computer Aided Drafting Laboratory	0	0	2	1	100	0	100	PC
18EGL31	English for Workplace Communication	0	0	2	1	100	0	100	HS
Total Credits to be earned					**26**				

***Alternate Weeks**

B.E. MECHATRONICS ENGINEERING CURRICULUM – R2018

SEMESTER – V									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
18MTT51	CNC and Metrology	3	0	0	3	50	50	100	PC
18MTT52	Microcontroller Programming and Applications	3	0	0	3	50	50	100	PC
18MTT53	Machine Dynamics	3	1	0	4	50	50	100	PC
18MTT54	Systems and Control Engineering	3	1	0	4	50	50	100	PC
	Open Elective I	3	0	2	4	50	50	100	OE
Practical / Employability Enhancement									
18MTL51	CNC and Metrology Laboratory	0	0	2	1	100	0	100	PC
18MTL52	Microcontroller Programming and Applications Laboratory	0	0	2	1	100	0	100	PC
18MTL53	Computer Aided Engineering Laboratory	0	0	2	1	100	0	100	PC
18GEL51/ 18GEI51	Professional Skills Training I / Industrial Training I*	--	--	--	2	100	0	100	EC
18GET51	Universal Human Values	2	0	0	2	100	0	100	HS
Total Credits to be earned					**25**				

***80 hours of Training**

SEMESTER – VI									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
18MTT61	Programmable Automation Controllers	3	0	0	3	50	50	100	PC
18MTT62	Robot Kinematics and Dynamics	3	0	0	3	50	50	100	PC
18MTC61	Fluid Power System	3	0	2	4	50	50	100	PC
	Professional Elective I	3	0	0	3	50	50	100	PE
	Open Elective II	3	0	2	4	50	50	100	OE
Practical / Employability Enhancement									
18MTL61	Programmable Automation Controllers Laboratory	0	0	2	1	100	0	100	PC
18MTL62	Robotics and Control Laboratory	0	0	2	1	100	0	100	PC
18MTL63	Graphical System Design Laboratory	0	0	2	1	100	0	100	PC
18GEL61/ 18GEI61	Professional Skills Training II / Industrial Training II*	---	---	---	2	100	0	100	EC
18MTP61	Project Work I Phase I	0	0	4	2	100	0	100	EC
Total Credits to be earned					**24**				

***80 hours of Training**

B.E. MECHATRONICS ENGINEERING CURRICULUM – R2018

SEMESTER – VII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
18MBT71	Engineering Economics and Management	3	0	0	3	50	50	100	HS
	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
	Open Elective III	3	0	0	3	50	50	100	OE
Practical / Employability Enhancement									
18GEP71	Comprehensive Test and Viva	---	---	---	2	100	0	100	EC
18MTP71	Project Work I Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					**21**				

SEMESTER – VIII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
	Professional Elective V	3	0	0	3	50	50	100	PE
	Open Elective IV	3	0	0	3	50	50	100	OE
Practical / Employability Enhancement									
18MTP81	Project Work II	---	---	12	6	50	50	100	EC
Total Credits to be earned					**12**				

Total Credits: 173

S. No.	Course Code	Course Name	L	T	P	C	Domain/ Stream
		Semester VI					
		Elective – I					
1.	18MTE01	Design of Mechanical Elements	3	0	0	3	PD
2.	18MTE02	Machine Drawing	3	0	0	3	PD
3.	18MTE03	Operations Research	3	0	0	3	PS
4.	18MTE04	Machine Learning	3	0	0	3	AS
5.	18MTE05	Embedded Programming for Mechatronics	3	0	0	3	AE
6.	18MTE06	Process Control and Instrumentation	3	0	0	3	AE
		Semester VII					
		Elective – II					
7.	18GEE01	Fundamentals of Research	3	0	0	3	GE
8.	18MTE07	Precision Equipment Design	3	0	0	3	PD
9.	18MTE08	Precision Manufacturing	3	0	0	3	PS
10.	18MTE09	Machine Vision and Image Processing	3	0	0	3	AS
11.	18MTE10	Introduction to Industrial Internet of Things	3	0	0	3	AE
12.	18MTE11	Bio Mechatronics	3	0	0	3	AS
		Elective – III					
13.	18MTE12	Machine Tool Control and Condition Monitoring	3	0	0	3	PS
14.	18MTE13	Applied Finite Element Method	3	0	0	3	PD
15.	18MTE14	Additive Manufacturing	3	0	0	3	PS
16.	18MTE15	Cyber Physical Systems	3	0	0	3	AE
17.	18MTE16	Industrial Automation Protocols	3	0	0	3	AE
18.	18MTE17	Robot Programming	3	0	0	3	AS
		Elective – IV					
19.	18MTE18	Maintenance Engineering	3	0	0	3	PS
20.	18MTE19	Computer Integrated Manufacturing	3	0	0	3	PS
21.	18MTE20	Automotive Electronics	3	0	0	3	AE
22.	18MTE21	Micro Electro Mechanical Systems	3	0	0	3	PD
23.	18MTE22	Mobile Robotics	3	0	0	3	AS
24.	18MTE23	Drone Technology	3	0	0	3	AS

		Semester VIII						
		Elective – V						
25.	18MBE49	Entrepreneurship Development	3	0	0	3	VIII	GE
26.	18MTE24	Product Design and Development	3	0	0	3	VIII	PD
27.	18MTE25	Production Management	3	0	0	3	VIII	PS
28.	18MTE26	Nanoscience and Technology	3	0	0	3	VIII	PD
29.	18MTE27	Avionics	3	0	0	3	VIII	AS
30.	18MTE28	Principles of Farm Machineries	3	0	0	3	VIII	PS
Total Credits to be earned						**15**		

***** Domain/Stream Abbreviations: AE – AUTOMATION ENGINEERING, AS – AUTONOMOUS SYSTEMS, PD – PRODUCT DESIGN, PS – PRODUCTION SYSTEMS, GE – GENERAL ENGINEERING

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18MTO01	Design of Mechatronics Systems	3	1	0	4	V
2.	18MTO02	Factory Automation	3	0	2	4	VI
3.	18MTO03	Data Acquisition and Virtual Instrumentation	3	0	2	4	VI
4.	18MTO04	3D Printing and Design	3	0	0	3	VII
5.	18MTO05	Drone System Technology	3	0	0	3	VII
6.	18MTO06	Robotics	3	0	0	3	VIII
7.	18MTO07	Virtual and Augment Reality in Industry 4.0	3	0	0	3	VIII
8.	18GEO04	Innovation and Business Model Development	3	0	0	3	VIII

18EGT11 - ENGLISH FOR COMMUNICATION I

(Common to all Engineering and Technology Branches)

Programme & Branch	B.E. & Mechatronics Engineering	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 B1 level in the Common European Framework (CEFR).	
Unit - I	**Listening, Speaking, Reading and Writing. Activity Based Learning – Phase – I:**	**9**
Listening - People talking about their 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.		
Unit - II	**Listening, Speaking, Reading and Writing. 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.		
Unit - III	**Listening, Speaking, Reading and Writing. 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.		
Unit - IV	**Listening, Speaking, Reading and Writing. 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.		
Unit - V	**Listening, Speaking, Reading and Writing. 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.		

Total: 45

TEXT BOOK:

1. Jack C. Richards, "Interchange, Student's Book 2", 4th Edition, Cambridge University Press, New York, 2017.

REFERENCES:

1. Jack C. Richards & Theodore Rodgers, "Approaches and Methods in Language Teaching", 3rd Edition, Cambridge University Press, New York, 2014.
2. Penny Ur, "A Course in English Language Teaching", 2nd Edition, Cambridge University Press, New York, 2012.

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		3	47	17		33	100
CAT2			37	23		40	100
CAT3		3	47	33		17	100
ESE		2	42	27		29	100

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

18MAC11 - MATHEMATICS I

(Common to All Engineering and Technology Branches)

Programme & Branch	B.E. & Mechatronics Engineering	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, multivariable functions and differential equations.	
Unit - I	**Matrices:**	**9**
Introduction to Matrices in Engineering – Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors (without proof) – Cayley – Hamilton theorem (Statement and applications only) - Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Nature of Quadratic forms - Reduction of quadratic form to canonical form by orthogonal transformation – Applications of Eigen values and Eigen vectors: Electric circuit – Mass string problems.		
Unit - II	**Multivariable Calculus:**	**9**
Functions of two 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 - III	**First Order Ordinary Differential Equations:**	**9**
Solutions of differential equations in variables separable form – Exact differential equations – Linear first order differential equations – Bernoulli's equation – Clairaut's equation.		
Unit - IV	**Ordinary Differential Equations of Higher Order:**	**9**
Linear differential equations of second and higher order with constant coefficients - Particular Integrals for the types: e^{ax} – cosax, sinax – x^n – e^{ax} x^n , e^{ax} sinbx and e^{ax} cosbx – x^n sinax and x^n cosax – Differential Equations with variable coefficients: Euler-Cauchy's equation – Legendre' s equation.		
Unit - V	**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).		

List of Exercises / Experiments:

1.	Introduction to MATLAB
2.	Matrix operations : Addition, Multiplication, Transpose and Inverse
3.	Computation of eigen values and eigen vectors
4.	Finding ordinary and partial derivatives
5.	Computing extremes of a single variable function
6.	Plotting and visualizing single variable functions
7.	Solving first and second order ordinary differential equations
8.	Solution of Simultaneous first order ODEs

***Alternate Weeks**

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

TEXT BOOK:

1. Grewal B. S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, New Delhi, 2011.

REFERENCES:

1. Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics - I", 2nd Edition, Pearson India Education, New Delhi, 2018.
2. Won Y. Yang, Young K. Choi, Jaekwon Kim, Man Cheol Kim, Jin Kim H. and Taeho Im, "Engineering Mathematics with MATLAB", 1st Edition, CRC Press, London, 2018.

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	compute extremal values which arise in function of several	Understanding (K2)
CO3	identify the appropriate method for solving first order ordinary differential equations	Applying (K3)
CO4	solve higher order linear differential equations with constant and variable coefficients	Applying (K3)
CO5	apply the concept of ordinary differential equations for modeling and finding solutions to engineering problems	Applying (K3)
CO6	determine eigen values and eigen vectors of a given matrix using MATLAB	Applying (K3), Manipulation (S2)
CO7	compute maxima and minima of a single variable function, plot and visualize single variable function using MATLAB	Applying (K3), Manipulation (S2)
CO8	solve first and second order ordinary differential equations and simultaneous first order ordinary differential equations using MATLAB	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

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

18PHC11 - APPLIED PHYSICS

(Common to All Engineering and Technology Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1	BS	3	0	2*	3.5

Preamble	This course aims to impart the essential concepts of properties of matter, acoustics, ultrasonics, quantum physics, laser and fibre optics, 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	**Properties of Matter:**	**9**
Elasticity: Stress – Strain – Hooke's law – Stress-strain diagram – Poisson's ratio - Modulus of elasticity - Beams – Bending of beams – Expression for bending moment - Cantilever – Depression of the loaded end of a cantilever - Young's modulus by uniform and non-uniform bending methods - I-shaped girders. Viscosity: Viscous force – Viscosity – Co-efficient of viscosity – Importance of viscosity of liquids (qualitative).		
Unit - II	**Acoustics and Ultrasonics:**	**9**
Acoustics: Sound - Reverberation and reverberation time – Growth and decay of sound and Sabine's formula (qualitative) - Absorption coefficient - Factors affecting acoustics of buildings and their remedies. Ultrasonics: Properties of ultrasonic waves - Production of ultrasonic waves - Magnetostrictive generator - Piezoelectric generator - Applications of ultrasonic waves in non destructive testing.		
Unit - III	**Thermal and Quantum Physics:**	**9**
Thermal Physics: Modes of heat transfer - Thermal conductivity - Radial and cylindrical heat flow - Conduction through compound media (series and parallel). Quantum Physics: Matter waves - Schrodinger's time independent and time dependent wave equations – Physical significance of wave function - Particle in a one dimensional box.		
Unit - IV	**Laser, Fibre Optics and Applications:**	**9**
Laser and Applications: Spontaneous emission and stimulated emission - Population inversion - Pumping methods - Einstein's coefficients - Nd:YAG laser - Holography. Fiber Optics and Applications: Principle of propagation of light through optical fibers - Numerical aperture and acceptance angle - Classification of optical fibers based on refractive index, modes and materials - Fiber optical communication links (block diagram).		
Unit - V	**Crystal Physics:**	**9**
Crystal systems - Bravais lattice - Lattice planes - Miller indices - Interplanar spacing in cubic lattice - Atomic radius, Coordination number and Packing factor for SC, BCC and FCC crystal structures - Crystal imperfections: line and surface imperfections.		

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 viscosity of a given liquid using Poiseuilles' method.
3.	Determination of the velocity of ultrasonic waves in a liquid and the compressibility of a liquid using ultrasonic interferometer.
4.	Determination of the wavelength and the angle of divergence of a semiconductor laser.
5.	Determination of the acceptance angle and the numerical aperture of a given optical fiber.

***Alternate Weeks**

Lecture:45, Practical:15, Total:60

TEXT BOOK:

1. Tamilarasan K. and Prabu K., "Engineering Physics - I", 3rd Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2014.

REFERENCES:

1. Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai and Sons, New Delhi, 2009.
2. Mehta and Neeraj, "Applied Physics for Engineers", 1st Edition, Prentice-Hall of India Pvt. Ltd., New Delhi, 2011.
3. Tamilarasan K. and Prabu K., "Physics Laboratory Manual", 3rd Edition, SCM Publishers, Erode, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of the concepts of elasticity and bending moment of a beam to a simple structure under simple loading to compute the Young\'s modulus of a material, and to explain the concepts of viscosity of liquids.	Applying (K3)
CO2	apply the concepts of growth and decay of sound energy in a hall to recognize the requirements of acoustically good buildings, and to describe the production of ultrasonic waves and non-destructive testing using ultrasonic waves.	Applying (K3)
CO3	use the concepts of heat flow to explain heat conduction through materials, and to describe the behavior of electrons in a metal by means of quantum physics.	Applying (K3)
CO4	apply the concepts of laser 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 fiber optic communication link.	Applying (K3)
CO5	explain seven crystal systems, atomic packing factor of the select crystal systems and the types of crystal defects.	Understanding (K2)
CO6	determine the Young\'s modulus of a material using the concepts of elasticity and bending moment of a beam, and to determine the viscosity of a liquid using the concepts of viscosity.	Applying (K3), Precision (S3)
CO7	compute the velocity of ultrasonic waves in a liquid and the compressibility of a liquid using the concepts of propagation of sound through a medium.	Applying (K3), Precision (S3)
CO8	determine the wavelength and the angle of divergence of a semiconductor laser beam using the concepts of propagation of light through a medium, and to compute the acceptance angle and the numerical aperture of an optical fiber using the concept of total internal reflection.	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											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	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	20	40	40				100
CAT2	20	45	35				100
CAT3	20	50	30				100
ESE	20	40	40				100

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

18CYC11 - 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	2*	3.5

Preamble	Applied Chemistry course imparts the basic principles and concepts of chemistry in the field of Engineering and Technology. It also imparts knowledge on Water Technology, Electrochemistry, Corrosion and its control, Fuels & Combustion and Polymers.	
Unit - I	**Water Technology:**	**9**
Introduction - Sources of water - Impurities in water - Types of water – Water Quality Standards - Hardness of water - Expression of hardness - Units of hardness - Estimation of hardness of water by EDTA method - Determination of alkalinity - Disadvantages of using hard water - Boiler troubles - Scale and sludge - Softening of water - External treatment method - Demineralization process - Internal treatment process - Carbonate and Calgon conditioning - Desalination by reverse osmosis method.		
Unit - II	**Electrochemistry:**	**9**
Introduction - Cells - Representation of a galvanic cell - Reversible and irreversible cells - Electrode potential - Nernst equation - Reference electrode - Standard hydrogen electrode - Glass electrode - Electrochemical series and its applications - Conductometric titrations - Mixture of weak and strong acid vs strong base.		
Unit - III	**Corrosion and its Control:**	**9**
Introduction - Chemical corrosion - Electrochemical corrosion - Galvanic corrosion - Concentration cell corrosion - Galvanic series - Factors influencing rate of corrosion - Corrosion control methods - Sacrificial anodic method - Protective coatings - Pretreatment of metal surface - Metallic coating - Electroplating - Nonmetallic coating - Phosphate coating - Organic coating - Paints - Constituents and their functions - Special paints - water repellant and luminescent paints.		
Unit - IV	**Fuels and Combustion:**	**9**
Introduction - Classification of fuels - Requirements of a good fuel - Combustion - Principle of combustion - Calorific value - Gross and net calorific values - Explosive range - Spontaneous ignition temperature - Calorific intensity - Solid fuels - Coal and its varieties - Proximate analysis - Significance - Metallurgical coke - Otto-Hoffman byproduct method - Liquid fuel - Refining of petroleum - Manufacture of synthetic petrol - Hydrogenation of coal - Bergius method - Knocking - Octane number - Cetane number - Gaseous fuel - LPG.		
Unit - V	**Polymers:**	**9**
Introduction - Classification of polymers - Functionality - Polymerization - Plastics - Types - Thermo and thermosetting plastics - Individual polymers - Polypropylene, PVC, PET and epoxy resin - Preparation, properties and uses - Compounding of plastics - Fabrication of plastics - Compression, injection, extrusion and blow moulding methods - Foamed plastics.		

List of Exercises / Experiments:

1.	Estimation of total, temporary and permanent hardness of water by EDTA method.
2.	Estimation of Ca2+ and Mg2+ hardness separately by EDTA method.
3.	Estimation of alkalinity of the given water sample.
4.	Conductometric titration - Mixture of acids.
5.	Estimation of hydrochloric acid using pH meter.

***Alternate Weeks**

Lecture:45, Practical:15, Total:60

TEXT BOOK:

1. Palanisamy P.N., Manikandan P., Geetha A. & Manjula Rani K., "Applied Chemistry", 5th Edition, Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2018.

REFERENCES:

1. Jain & Jain, "Engineering Chemistry", 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2016.
2. Sharma B.K., "Industrial Chemistry", Krishna Prakasan Media Pvt. Ltd, Meerut, 2014.
3. Palanisamy P.N., Manikandan P., Geetha A & Manjula Rani K., "Chemistry Laboratory Manual", Rajaganapathy Publishers, Erode, 2018.

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 to construct cells and measure the electrode potential	Applying (K3)
CO3	adopt the suitable corrosion control methods for the given practical 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)
CO6	estimate the amount of hardness for the given water sample by EDTA method	Applying (K3), Precision (S3)
CO7	estimate the amount of alkalinity for the given water sample	Applying (K3), Precision (S3)
CO8	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	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2												
CO5	3	2												
CO6	3	2	1	3										
CO7	3	2	1	3										
CO8	3	2	1	3										

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

ASSESSMENT PATTERN - THEORY

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

18GET11 - INTRODUCTION TO ENGINEERING

(Common to All Engineering and Technology Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1	ES	3	0	0	3

Preamble	The objective of this course is to realize the importance of engineering, measurements and the fundamental concepts of common engineering disciplines like Civil, Mechanical, Electrical and Electronics Engineering.	
Unit - I	**Engineering and Measurements:**	**9**
Engineering and Measurements: Engineering - Engineer and Engineering Graduate - Graduate attributes - Role of engineer - Professional bodies and their role. Physical Quantities - Dimensions - SI Units, Symbols and Conversions - Mechanical Measuring Instruments - Electrical Measuring Instruments - Accuracy and Precision - Data Acquisition System.		
Unit - II	**Mechanical Engineering:**	**9**
Mechanical Engineering: IC Engines - Power Plants - Boilers and Furnaces - Pumps - Refrigeration and Air Conditioner - CAD/CAM - Additive Manufacturing. Hybrid Electric Vehicles, Industry 4.0.		
Unit - III	**Civil Engineering:**	**9**
Civil Engineering: Selection of the site for Building - Building approval process - Contract and tenders - Building Materials - Components of Building - Sequence of works for building construction - Prefabricated Structures - Water Management - Rainwater harvesting - Infrastructure - Bridges, Dams and Roads.		
Unit - IV	**Electrical Engineering:**	**9**
Electrical Engineering: Terminologies - Current, voltage, potential difference, power, energy - Supply: DC, AC - single phase and three phase - Energy conversion - Utility structure - Single line diagram of power system - Apparatus - Tariff - House wiring. Alternator - Induction motor - Solar and wind energy.		
Unit - V	**Electronics Engineering:**	**9**
Electronics Engineering: Resistor, Inductor, capacitor - Diode - LEDs - Rectifier - Power Supply - Transistor - Transistor as an amplifier - MOSFET - Logic Gates - Microprocessor - Micro controller - Radio communication - Internet of Things.		

Total:45

TEXT BOOK:

1. Faculty of Mechanical Engineering, "Introduction to Engineering", McGraw Hill Education India Pvt. Ltd., Chennai.

REFERENCES:

1. Arvid R. Eide, Roland D. Jenison, Steven K. Mickelson and Larry L. Northup. , "Engineering Fundamentals and Problem Solving", 7th Edition, McGraw Hill Education, New York, 2018.
2. Navaneethakrishnan P., Selvakumar P., Rajeshkumar G. and Sangeetha R.K., "Basic Civil and Mechanical Engineering", McGraw Hill Education, New Delhi, 2016.
3. Senthilnathan N., Logeswaran T. and Suresh M., "Basic Electrical and Electronics Engineering", McGraw Hill, New Delhi, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	recognize the roles of engineer, measurement quantities and systems in Engineering	Understanding (K2)
CO2	infer the components and principles of mechanical engineering applications	Understanding (K2)
CO3	summarize the process involved in building construction, infrastructure and water conservation	Understanding (K2)
CO4	recognize the fundamental terms involved in electrical engineering	Understanding (K2)
CO5	explain the working of basic electronic components and its applications	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18MEC11 - ENGINEERING DRAWING
(Common to all Engineering and Technology Branches)

Programme & Branch	B.E. & Mechatronics Engineering	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**
General Principles of Orthographic Projection: 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 Solid: 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: 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 Surfaces: 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**
Isometric Projection and Introduction to AutoCAD: 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.		

Total:45

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							1	3	2	2	2	3
CO2	3	2	1	1						3	2	3	2	3
CO3	3	2	1	1					1	3	2	3	2	3
CO4	3	2	1	1						3	2	3	2	3
CO5	3	2	1	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	20	40	40				100

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

18MEL11 - ENGINEERING PRACTICES LABORATORY
(Common to all Engineering and Technology Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	I	ES	0	0	2	1

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.	To prepare a leak proof sheet metal tray/box/funnel using modern power tools.
6.	Welding practice using welding simulator.
7.	Project: Preparing innovative articles using wood/sheet metal.
	PART B – ELECTRICAL AND ELECTRONICS ENGINEERING
8.	Safety Aspects of Electrical Engineering, Electrical Symbols, Components Identification, Fuse selection and installation, Circuit Breakers selection
9.	Wiring circuit for fluorescent lamp and stair case wiring
10.	Measurement of earth resistance
11.	Soldering of simple circuits and trouble shooting
12.	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	3	3	3	3	3				3	3	2	3		
CO2	3	2	1	1					3	2	2	3		
CO3	2	1							3	2	2	3		
CO4	3	2	1	1					3	3	2	3		
CO5	3	2	1	1					3	2	2	3		

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

18EGT21 - ENGLISH FOR COMMUNICATION II

(Common to All BE/BTech Engineering and Technology Branches)

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

Preamble	This course is designed to impart required levels of fluency in using the English Language at B1 level in the CEFR.	
Unit - I	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – VI:**	**9**
Listening – Job and career related descriptions and conversations – requests of different kinds and the responses – Speaking - Career choices and professional skills – making requests and responding to requests – Reading – Using texts about jobs and careers – about different societies and cultural differences – Writing – Resumes, CVs and job oriented advertisements – business and career related emails – Grammar & Vocabulary – Gerunds and elements of comparison – requests and indirect requests.		
Unit - II	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – VII:**	**9**
Listening – Expository and narrative descriptions – information about different cultures, nations and societies - Speaking – Narrating and describing – talking about other countries and other cultures – Reading – Using texts about media and information technology – living abroad and experiencing different cultures – Writing – Blog writing – brochures and tourist pamphlets – Grammar & Vocabulary – The past tense forms - noun phrases and relative clauses.		
Unit - III	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – VIII:**	**9**
Listening – Consumerism – product description – complaints and redressal – environmental issues – ecology – saving the planet – Speaking – Talking about problems, issues, complaints – solutions and redressal – talking about environmental issues – Reading – Using texts on segregating wastes – recycling and reusing – texts on environmental issues – Writing – Online reviews, articles and writing web content – Grammar & Vocabulary – Phrases and sentences used for describing problems – passives – prepositions and infinitives.		
Unit - IV	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – IX:**	**9**
Listening – Education, learning and the choice of courses – various services needed in daily life – self-improvement for success in life – Speaking - Discussions about educational and career oriented issues – talking about everyday services – giving advice and self improvement – Reading – Reading about learning strategies and learning styles – using texts about personality development – Writing – Writing about hobbies – pastime and individual skills – writing short articles on everyday life and personality development – Grammar & Vocabulary – Using of “would” and certain gerund forms – use of modals, verbs, gerunds, negative questions and infinitives.		
Unit - V	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – X:**	**9**
Listening – Historical narratives – biographies and learning about the future – important life events, milestones and happenings of the past – Speaking – Talking about the past, present and the future – talking about important events in life – Reading – Texts about new technologies and future science – using texts about social organization, culture and social practices – Writing – Biographical sketches – historical events – famous personalities, stages of life and getting along with people – Grammar & Vocabulary – Future tense forms – time clauses and certain “if clauses”.		

Total:45

TEXT BOOK:

1. Jack C. Richards, "Interchange, Student’s Book 3", 4th Edition, Cambridge University Press, New York, 2017.

REFERENCES:

1. Jane Willis, "A Framework for Task Based Learning", Longman, Harlow, 1996.
2. Rod Ellis, "Task Based Language Learning and Teaching", Oxford University Press, London, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	use functional grammar for improving communication skills	Applying (K3)
CO2	listen and comprehend different spoken excerpts critically and infer unspoken and implied meanings.	Applying (K3)
CO3	read different genres of texts, infer implied meanings and critically analyze and evaluate them for ideas as well as for method of presentation.	Analyzing (K4)
CO4	write effectively and persuasively and produce different types of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluative writing.	Creating (K6)
CO5	speak effectively, to express opinions clearly, initiate and sustain a discussion and also negotiate using appropriate communicative strategies.	Creating (K6)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	3	3	30	40		24	100
CAT2	3	3	33	43		18	100
CAT3	3	3	33	43		18	100
ESE	3	3	31	45		18	100

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

18MAC21 - MATHEMATICS II

(Common to All Engineering and Technology Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	BS	3	1*	2*	4

Preamble	To impart the knowledge of 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	**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 - II	**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 and Gauss divergence theorems (without proof) – Verification of the above theorems and evaluation of integrals using them.		
Unit - III	**Beta and Gamma Functions:**	**9**
Definition of beta and gamma Functions – Properties – Relation between beta and gamma functions – Transformations of gamma function – Applications of beta and gamma functions: Evaluation of definite integrals in terms of beta and gamma functions.		
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 – 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.	Evaluating indefinite and definite integrals
2.	Evaluating double and triple integrals
3.	Finding the area between two curves
4.	Computing gradient, divergence and curl
5.	Computation of beta and gamma 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 Weeks**

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

TEXT BOOK:

1. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, New Delhi, 2014.

REFERENCES:

1. Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics - II", 2nd Edition, Pearson India Education, New Delhi, 2018.
2. Won Y. Yang, Young K. Choi, Jaekwon Kim, Man Cheol Kim, Jin Kim H. and Taeho Im, "Engineering Mathematics with MATLAB", 1st Edition, CRC Press, London, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Solve problems involving double and triple integrals	Understanding (K2)
CO2	Apply the concept of vectors in engineering problems	Applying (K3)
CO3	Use Beta and Gamma functions to improper evaluate integrals	Applying (K3)
CO4	Identify, construct and apply analytic functions in electrostatics and fluid flow problems	Applying (K3)
CO5	Evaluate complex integrals which is extensively applied in engineering	Applying (K3)
CO6	Evaluate line, double and triple integrals and determine area between two curves using MATLAB	Applying (K3), Manipulation (S2)
CO7	Compute gradient, curl and divergence of a vector function 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	2	2											
CO2	3	2												
CO3	3	2	1											
CO4	3	1												
CO5	3	2	2											
CO6					3									
CO7					2									
CO8					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	10	70				100
CAT2	20	10	70				100
CAT3	20	10	70				100
ESE	20	10	70				100

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

18PHC23 - MATERIALS SCIENCE AND METALLURGY
(Common to Mechatronics & Automobile Engineering branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics	2	BS	3	0	2*	3.5

Preamble: This course aims to impart the knowledge on the physics of ferrous metals and alloys, metal processing, light weight materials, conductors, semiconductors, dielectrics and smart materials. It also describes the failures and testing of materials and the applications of aforementioned materials in mechatronics and automobile engineering and provides motivation towards innovations.

UNIT – I		**9**

Ferrous Metals and Alloys: Introduction – Iron ore – Pig iron – Cast iron – 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		**9**

Metal Processing: Heat Treatment: Annealing – Normalizing – Spheroidizing – Tempering – Austempering – Martempering – Hardening – Case hardening – Carburizing – Age hardening – Induction hardening – Flame hardening – Cyaniding – Nitriding – Carbonitriding – Quenching.

UNIT –III		**9**

Light Weight Materials: Introduction – Aluminum and Aluminum alloys: Duralumin, Magnalumin – Copper and Copper Alloys: Brass, Bronze – Magnesium and Magnesium alloys: Magnesium-Manganese, Magnesium-Aluminium – Polymers: Structure of polymers – Classification of polymers – properties and applications of polymers – Introduction to composites and its applications.

UNIT – IV		**9**

Conducting, Semiconducting, Dielectric and Smart Materials: Conductors – Classical free electron theory – Electrical and Thermal conductivities – Semiconductors – Types of Semiconductor – Intrinsic carrier concentration (qualitative) – Dielectrics and its applications – Metallic glasses – Preparation, properties and applications – Introduction to Shape Memory Alloys and Nanomaterials.

UNIT – V		**9**

Failures and Testing of Materials: Failures of materials: Mechanism of plastic deformation, dislocation, 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.

List of Experiments:

1. Determination of the Young's modulus of stainless steel using non-uniform bending method.
2. Determination of the thermal conductivity of a functional material using Lee's disc arrangement.
3. Determination of the thickness of a nano-crystalline thin film using Air-wedge arrangement.
4. Determination of the specific resistance of a metal using Carey Foster's bridge.
5. Determination of the rigidity modulus of a material using torsional pendulum.

***Alternate Weeks**

Lecture:45, Practical: 15, Total: 60

TEXT BOOK:

1. Balasubramaniam R., "Callister's Materials Science and Engineering", 2nd Edition, Wiley India Pvt. Ltd., 2014.

REFERENCES / MANUAL:

1. Askelend D., "Materials Science and Engineering", Brooks /Cole, 2010.
2. Raghavan V., "Physical Metallurgy: Principles and Practice", PHI Learning Pvt. Ltd., New Delhi, 2015.
3. Tamilarasan K. and Prabu K., "Physics Laboratory Manual", SCM Publishers, Erode, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the composition, properties and applications of the select ferrous metals and their alloys (iron and steel)	Understanding (K2)
CO2:	apply the basic concepts of phase rule, cooling curve and binary phase diagram (Fe-C) to describe the select heat treatment processes of metals	Applying (K3)
CO3:	explain the composition, properties and applications of select light weight materials (non-ferrous metals and their alloys: copper – copper alloys, aluminum – aluminum alloys, magnesium – magnesium alloys), polymers and composites	Understanding (K2)
CO4:	apply the concepts of classical free electron theory to compute electrical and thermal conductivity of metals and to explain the select properties and applications of conductors, semiconductors, dielectrics and smart materials (metallic glasses, SMA and nanomaterials)	Applying (K3)
CO5:	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)	Applying (K3)
CO6:	determine the Young's modulus of stainless steel using the concepts of elasticity and bending moment of a beam	Applying (K3), Precision (S3)
CO7:	determine the thermal conductivity of functional materials using the concept of heat flow through materials, and to determine the thickness of nano-crystalline thin films using the concept of interference of light	Applying (K3), Precision (S3)
CO8:	determine the specific resistance of metals using the concept of electrical conductivity, and to determine the rigidity modulus of materials using the concepts of elasticity	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												
CO2	3	2	1											
CO3	3	2												
CO4	3	2	1											
CO5	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	30	45	25				100
CAT2	30	50	20				100
CAT3	30	40	30				100
ESE	30	40	30				100

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

18CYC22 - ENVIRONMENTAL CHEMISTRY IN MECHANICAL SYSTEMS
(Commmon to Mechanical Engineering and Mechatronics Engineering branches)

Programme & Branch	B.E. Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Chemistry	2	BS	3	0	2*	3.5

Preamble: Environmental Chemistry aims to realize the interdisciplinary and holistic nature of the environment for mechanical and mechatronics engineering students and stimulate them to quest for environment, lubricants, green power technology and environmental impact assessment for sustainable development.

UNIT - I	Chemistry and the Environment:	9

Environment - planet earth - components of environment- atmosphere-hydrosphere-lithosphere-biosphere-interrelationship between components and sub components- environmental pollution – environmental pollutants - toxic effects of pollutants - fluoride, arsenic, chromium, cadmium and lead - recovery and recycling of materials**-** role of an individual in prevention of pollution.

UNIT - II	Environmental Pollution:	9

Definition-causes, effects, control measures and case studies of: a) air pollution - climate change, global warming, acid rain, ozone layer depletion b) water pollution c) soil pollution - solid waste management d) marine pollution e) noise pollution.

UNIT – III	Lubricants, Explosives and their Impact:	9

Lubricants - types of lubricants with examples - liquid lubricants - properties – viscosity index, flash and fire points, cloud and pour points, oiliness, aniline point – solid lubricant – graphite - environmental impacts of lubricants - Explosives - classification - precautions during storage - manufacture of important explosives (TNT, GTN and RDX) - rocket propellants- classification of propellants - environmental impacts of explosives.

UNIT – IV	Green Power Technology:	9

Introduction - types of energy resources- need for green energy - renewable energy resources-solar energy -solar cells- solar cooker, solar dryer and solar ponds -wind energy - wind mill and wind turbine - hydroelectric energy - tidal energy - nano technology for energy sector - role of an individual in conservation of energy resources.

UNIT – V	Environmental Impact Assessment and Auditing:	9

Sustainability - three pillars of sustainability- factors affecting environmental sustainability-approaches for sustainable development - Introduction to EIA - objectives of EIA - steps in EIA - participants of EIA - general approach of environmental auditing - audit programmes in India - ISO 14001 certification - environment protection act – air (prevention and control of pollution) act – water (prevention and control of pollution) act.

List of Experiments:

1. Estimation of chloride ion in the given water sample using Argentometric method.
2. Estimation of chromium (Cr^{6+}) in wastewater sample.
3. Determination of dissolved oxygen in the given wastewater sample.
4. Estimation of molecular weight of the polymer using viscometer.
5. Estimation of copper in the given solution by Iodometric method.

Lecture:45, Practical:15, Total: 60

TEXT BOOK:

1. Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K., Kowshalya V.N., “Environmental Science”, Pearson Education, New Delhi, Revised Edition 2019.

REFERENCES / MANUALS:

1. Jain and Jain, “Engineering Chemistry”, 16th Edition, DhanpatRai Publishing, 2016.
2. Charles H. Eccleston, “Environmental Impact Assessment: A Guide to Best Professional Practices”, CRC Press, 2017.
3. Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., “Chemistry Laboratory Manual”, Rajaganapathy Publishers, Erode, 2018.

* Alternate week

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the knowledge on components of environment to study the impacts of pollutants on it	Applying (K3)
CO2:	manipulate the sources, effects and control methods of various environmental pollution	Applying (K3)
CO3:	determine the types and properties of lubricants, explosives and their impacts on environment	Applying (K3)
CO4:	utilize green power technologies for sustainability	Applying (K3)
CO5:	make use of the knowledge of EIA, EA and environmental legislation laws towards sustainability	Applying (K3)
CO6:	demonstrate the viscometer to estimate the molecular weight of the polymer	Applying (K3), Precision (S3)
CO7:	determine the amount of chloride and copper in the given solution	Applying (K3), Precision (S3)
CO8:	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	2	1	1			3							
CO2	3	2	1	1			3							
CO3	3	2	1	1			3							
CO4	3	2	1	1			3							
CO5	3	2	1	1			3							
CO6	3	2	1	3										
CO7	3	2	1	3										
CO8	3	2	1	3										

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

ASSESSMENT PATTERN - THEORY

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

18CSC11 - PROBLEM SOLVING AND PROGRAMMING
(Common to All Engineering and Technology Branches)

Programme & Branch	B.E.& Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	ES	2	0	2	3

Preamble	This course mainly focuses on the basic concepts of computing, the methodology of problem solving and developing skills in programming using C language.	
Unit - I	**Introduction to Computer and Problem Solving:**	**6**
Overview of computers - Applications of computers - Characteristics of computer - Basic computer Organization - Number System - Problem solving: Planning the computer program – Algorithms - Flowcharts – Pseudocodes - Structuring the logic.		
Unit - II	**Case Study on Problem Solving:**	**6**
Algorithm, Flowchart and Pseudo code for the problems: Exchanging the values of two variables - Finding the biggest number - Counting - Summation of numbers - Factorial computation - Generation of Fibonacci Sequence - Summation of series - Base Conversion - Reversing the digits of an Integer.		
Unit - III	**Introduction to C and Control Statements:**	**6**
Overview of C - Basic structure of a C Program - Executing a C Program - C Character set - Tokens - Keywords and Identifiers - Constants - Variables - Data types - Storage classes - Managing Input and Output operations - Operators and Expressions - Decision making and Branching - Looping - Break and continue statements.		
Unit - IV	**Arrays, Strings and Structures:**	**6**
Arrays - One dimensional and Two dimensional arrays - Handling of character strings: Declaring and initializing string variables - Performing simple string operations - Introduction to structures: Structure definition - Structure declaration - Accessing a structure member - Structure initialization - Unions.		
Unit - V	**Functions:**	**6**
User defined functions: Elements of user defined functions - String handling functions - Library functions (strings and characters manipulation) - Passing arguments to functions – Recursion. Introduction to Pointers: Understanding pointers - Accessing address of a variable - Declaring pointer variables - Initialization of pointer variables - Accessing a variable through its pointer - Parameter passing mechanisms.		

List of Exercises / Experiments :

1.	Writing algorithms and drawing flowcharts using Raptor Tool for problems involving sequential, selective and repetitive structures
2.	Programs for demonstration of working of different types of operators like arithmetic, logical, relational and ternary operators involving sequential structures
3.	Demonstration of programs using decision making statements namely ‘if’, ‘else if’, ‘switch’, conditional and unconditional ‘goto’ (selective structures)
4.	Programs for demonstrating repetitive control statements like ‘for’, ‘while’ and ‘do-while’ (iterative structures)
5.	Demonstration of programs for declaration, initialization and performing operations on one-dimensional and two-dimensional numeric arrays
6.	Demonstration of programs for implementing various string operations like ‘copy’, ‘finding length’, ‘compare’, ‘concatenate’ with and without built-in library functions.
7.	Demonstration of programs for making use of user-defined data types namely structures and unions
8.	Demonstration of modular programming concepts using functions – developing programs using built-in and user-defined functions and parameter passing mechanisms

Lecture:30, Practical:30, Total:60

TEXT BOOK:

1. "Problem Solving and Programming", compiled by Department of CSE, Kongu Engineering College, Internal circulation, 2017.

REFERENCES:

1. Dromey R.G., "How to Solve it by Computer", Pearson Education, 2009.
2. Balagurusamy E., "Fundamentals of Computing and Programming", Tata McGrawHill Education Pvt. Ltd., 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	outline the characteristics, organisation, working principles and applications of computers	Understanding (K2)
CO2	express the solution for the given real world problems in terms of algorithm, flowchart and pseudocode	Applying (K3)
CO3	identify the appropriate looping and control statements in C for providing the solution to the given problems	Understanding (K2)
CO4	demonstrate the usage of arrays, strings and structures to solve the given problems	Understanding (K2)
CO5	apply fundamental modular programming knowledge to solve the given problems and recall the basic concepts of pointers	Understanding (K2)
CO6	demonstrate the execution of flowchart for the given problem using Raptor	Applying (K3), Precision (S3)
CO7	demonstrate the application of control statements using simple C programs	Applying (K3), Precision (S3)
CO8	implement solutions to the given problem using user defined functions and data types	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2													
CO2	2	2	2		2									
CO3		2	1											
CO4		2	1											
CO5		2	1											
CO6	3	2	1	1	1					1				
CO7	3	2	1	1	1					1				
CO8	3	2	1	1	1					1				

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

ASSESSMENT PATTERN - THEORY

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

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

18ECT21 - CIRCUIT ANALYSIS AND NETWORK SYNTHESIS
(Common to Electronics and Communication Engineering & Mechatronics Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	2	PC	3	0	0	3

Preamble: This course provides an insight on basic laws and theorems to solve different DC circuits and networks and to expose them to the rudiments of the course which is essential for subsequent courses.

UNIT – I		9

Circuit Elements and Kirchhoff's Laws: Voltage and Current - Power and Energy – Resistance Inductance and Capacitance Parameter - Energy Sources - Kirchhoff's Voltage Law - Voltage Division-Power in a series Circuit - Kirchhoff's Current Law - Parallel Resistance - Current Division - Power in a Parallel Circuit - Mesh Analysis - Nodal Analysis - Source Transformation Technique.

UNIT – II		9

Useful Theorems in Circuit Analysis: Star-Delta Transformation-Superposition Theorem-Thevenin Theorem-Norton Theorem-Maximum Power Transfer Theorem.

UNIT – III		9

Transient Analysis: Transient analysis of RL, RC and RLC circuits. **Resonance:** Resonance: Series Resonance-Impedance and Phase Angle of a Series Resonant Circuit-Voltages and Currents in a Series Resonant Circuit-Bandwidth of an RLC circuit-Quality Factor(Q) and its Effect on Bandwidth-Parallel Resonance-Resonant Frequency for a Tank Circuit- Q-Factor of Parallel Resonance.

UNIT – IV		9

Two Port Networks: Two-port Network-Open-Circuit Impedance (Z) Parameters-Short-Circuit Admittance (Y) Parameters-Transmission (ABCD) Parameters-Hybrid (H) Parameters-Inter-Relationships of different Parameters-Interconnection of Two-port Network-Lattice Network.

UNIT – V		9

Elements of Realizability and Synthesis of One-Port Networks: Hurwitz Polynomials- Frequency Response of Reactive One Ports - Synthesis of Reactive one ports by Foster's Method and Cauer Method-Synthesis of R-L Network by the Foster and Cauer Method- Synthesis of R-C Network by Foster and Cauer Method.

Total: 45

TEXT BOOK:

1. Sudhakar A. and Shyammohan S. Palli, "Circuits and Networks Analysis and Synthesis", 5th Edition, Tata McGraw-Hill, New Delhi, 2015.

REFERENCES:

1. Hayt W.H., Kemmerly J.E., Durbin S.M., "Engineering Circuit Analysis", 8th Edition, Tata McGraw-Hill, New Delhi, 2013.
2. Ravish R. Singh, "Electrical Networks", 14th Reprint, Tata McGraw-Hill, New Delhi, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	identify the main circuit elements and apply Kirchhoff's Laws to calculate current, voltage and power in typical linear electric circuits using a analytical methods for DC and AC circuits	Applying (K3)
CO2:	reduce and analyse complicated circuits using network theorems	Analyzing (K4)
CO3:	analyse circuit transients for RL,RC and RLC circuits	Analyzing (K4)
CO4:	calculate bandwidth and Q factor of a parallel and series resonance circuits	Analyzing (K4)
CO5:	synthesize the parameters one and two port networks	Evaluating (K5)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18VEC11 - VALUE EDUCATION

(Common to All Engineering and Technology Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	2	HS	2	0	1	1

Preamble	The aim of the course is to make the students to understand the purpose and value of life and to exhibit positive human values.	
Unit - I	**Philosophy of Life Science:**	**4**
Life - Purpose of life (four stages of life) - Philosophy of life (who am I') – Law of nature (cause of the life and body) - Content of the Life (five sheaths) - Goal of life. Five duties in life. Methodology: Life and messages of spiritual and national leaders - The forgotten hero, etc. Project report: Complementing with happiness - Every soul is potentially divine.		
Unit - II	**Human Values - Moral Foundation:**	**4**
Truth, forgiveness, compassion, endurance, humility, non violence,moderate diet, non stealing, self purification, self discipline, self study, content, cleanliness, honesty, and totality in faith - Good habits - Attitude forming for Individual peace. Practical Methods: Personal experience with above characters, Puranic Stories - Self resolve diary maintenance.		
Unit - III	**Social Values:**	**4**
Family - Family System - Greatness of women - World brotherhood (vasudeiva kudumbagam) - Glorious Bharath - Bharathian systems - Past-Present-Future - Team spirit - Goal setting - Economics - Education - Politics - Responsibilities of people - Preserving natural resources. Methodology: Preparing an album on glorious Bharath Past, Present and Future Plans. Goal setting - Management Games.Team Spirit - Yogic Games.		
Unit - IV	**Development of Mental Prosperity:**	**4**
Prosperity of mind - Functions of mind - Obstacles of mind - Practical method to perfect mind is yoga - Types - Uses - Precaution - Contradiction - Kriyas - Asanas - Pranayamas - Meditative techniques. Methodology: Asana - Pranayama - Cyclic meditation - Nada anu sandhana - Meditation - Yogic games for memory. Album on asanas, pranayama and mantra.		
Unit - V	**Maintenance of Physical Health:**	**4**
Human body - Structure - Ten Systems of the body as per modern science.Five elements - Harmonious relationship - Life force - Conserving vitality and health through natural life -Pranic food and its importance - Uses of herbs - Right way of cooking to preserve nutrients - Cause of the disease - Acute and chronic - Disease - Life and death. Methodology: Natural food making, traditional millet dishes. Asanas, pranayamas, cleansing procedures, Quiz on healthy living, Uses of herbs or kitchen garden.		

List of Exercises / Experiments:

1.	List of Loosening Exercises: Neck Movements, Shoulder Joint Movements, Elbow Joint Movement, Wrist Joint Movements, Finger Joint Movements, Rip Joint Movement, Hip Joint Movements, Spinal Cord Movement, Knee Joint Movements, Ankle Joint Movements, Toe Joint Movements.
2.	List of Asanas: Surya Namaskara, Shavasana, Makarasanas, Uttanpadasana, Pawanamuktasana, Sedubandasana, Naukasana, Vipareetakarani, Bhujangasana, Sarpasana, Shalabasana, Dhanurasana, Padmasana,Parvatasana, Vakrasana, Janu Sirashasana, Ustrasana, Yoga Mudra, Meru Tandasana, Tadasana, Katichakrasana, Paadahastasana, Parivarta Trikonasana, Ardha Chakrasana, Viruksasana.
3.	List of Pranayamas: Naadi Sodhana Pranayama, Bhastrika Pranayama, Bhramari Pranayama, Sheetali Pranayama.

Lecture:20, Practical:10, Total:30

TEXT BOOK:

1. Value Education, "Compiled by Vethathiri Maharishi Institute for Spiritual and Intuitional Education", Aliyar, Pollachi, 2018.

REFERENCES:

1. Value Education - Yoga Practical Guide, "Compiled by Padmasoorya Naturopathy and Yoga Foundation", Coimbatore, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the purpose and value of life.	Understanding (K2)
CO2	exhibit positive human values.	Understanding (K2)
CO3	understand social values.	Understanding (K2)
CO4	take steps to develop mental and physical health	Applying (K3), Imitation (S1)

Mapping 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		
CO2						3		3				3		
CO3						3		3				3		
CO4						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							0
CAT2							0
CAT3							0
ESE	25	75					100

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

18MAC31 - MATHEMATICS III

(Common to Civil Engineering, Mechanical Engineering, Mechatronics Engineering, Automobile Engineering, Electronics And Communication Engineering, Electrical And Electronics Engineering , Electronics And Instrumentation Engineering, Chemical Engineering & Food Technology Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	BS	3	1*	2*	4

Preamble	To provide the skills for solving the real time engineering problems involving partial differential equations and impart knowledge in Fourier transform and Z-Transform.	
Unit - I	**Fourier Series:**	**9**
Dirichlet's conditions – General Fourier series – Change of interval – Odd and even functions – Half range Sine series – Half range Cosine series – Harmonic analysis.		
Unit - II	**Partial Differential Equations:**	**9**
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 - III	**Applications of Partial Differential Equations:**	**9**
Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two dimensional heat equation (excluding insulated edges).		
Unit - IV	**Fourier Transform:**	**9**
Fourier Integral theorem (without proof) – Fourier transform pair – Properties (without proof) – Transforms of simple functions – Fourier Sine and Cosine transforms – Properties (without proof) – Convolution theorem and Parseval's identity (Statement and applications only).		
Unit - V	**Z –Transform:**	**9**
Definition – Z-transform of some basic functions – Elementary properties – Inverse Z- transform: Partial fraction method – Residue method – Convolution theorem – Applications of Z-transforms: Solution of difference equations.		

List of Exercises / Experiments :

1.	Expressing given function in terms of Fourier series.
2.	Harmonic Analysis of given data.
3.	Solving second order partial differential equations.
4.	Solution of One dimensional wave equation.
5.	Solution of Two dimensional heat equation.
6.	Determining Fourier and inverse Fourier transform of a given function.
7.	Computing Z- transform of a discrete sequence.
8.	Apply Z- transforms to obtain the solution of difference equations.

***Alternate Weeks**

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

TEXT BOOK:

1. Veerarajan T., "Transforms and Partial Differential Equations", 3rd Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2013.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons Ltd., USA, 2019.
2. Duraisamy C., Vengataasalam S., Arun Prakash K. & Suresh M., "Engineering Mathematics – III", 2nd Edition, Pearson India Education, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	express given function or data in terms of Fourier series	Applying (K3)
CO2	solve the given standard partial differential equations	Applying (K3)
CO3	apply Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations	Applying (K3)
CO4	use the mathematical principles of Fourier transforms which will provide the ability to formulate and solve some of the physical problems of engineering	Applying (K3)
CO5	apply Z transform techniques for analyzing linear time invariant systems	Applying (K3)
CO6	express the given data in Fourier series using MATLAB	Applying (K3), Manipulation (S2)
CO7	solve partial differential equations using PDE Modeler	Applying (K3), Manipulation (S2)
CO8	find Fourier and Z-Transforms using MATLAB built in functions	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

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

18MET31 - ENGINEERING MECHANICS

(Common to Mechanical Engineering & Mechatronics Engineering Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	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**
Statics of Particles: 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**
Statics of Rigid Bodies: 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**
Properties of Surfaces and Solids: 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)**

18MET33 - FLUID MECHANICS AND HYDRAULIC MACHINES

(Common to Mechanical Engineering & Mechatronics Engineering Branches)

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

Preamble	To provide an introduction to the properties and behaviour of fluids under static and dynamic conditions. It introduces dimensional analysis and enables to apply the basic performance analysis to hydraulic turbines and pumps.	
Unit - I	**Fluid Properties and Fluid Statics:**	**9**
Fluid Properties: Definition of fluid - Classifications – Properties. Fluid Statics: Pascal's Law – Pressure variation in a fluid at rest – Absolute Pressure – Gauge Pressure - Atmospheric Pressure - Vacuum Pressure –Simple manometer - differential manometer – Hydrostatic forces- Buoyancy – Floatation - Meta centre.		
Unit - II	**Fluid Kinematics and Fluid Dynamics:**	**9**
Fluid Kinematics: Types of fluid flows – Continuity equation in two and three dimensions (Cartesian co-ordinates) – Velocity and acceleration of fluid particle – Velocity potential function and stream function. Fluid Dynamics: Euler's equation of motion along a streamline – Bernoulli's equation and applications - Venturimeter - Orificemeter - Pitot tube.		
Unit - III	**Flow through Pipes and Dimensional analysis:**	**9**
Flow through Pipes: Flow of viscous fluid through circular pipe – Loss of energy in pipes – Loss of energy due to friction (Darcy-Weisbach and Chezy's formula)- Minor energy losses – Pipes in series - Pipes in parallel – Power transmission through pipes. Dimensional analysis: Buckingham's π theorem – Introduction to boundary layer flows.		
Unit - IV	**Impact of Jet and Hydraulic Turbines:**	**9**
Impact of Jet: Impact of jets – Work done and force exerted by a liquid on stationary and moving flat vanes – Efficiency - Work done - Force exerted by a liquid on unsymmetrical moving curved vane – Velocity triangles. Hydraulic Turbines: Classifications – Design - work done - efficiencies of Pelton Wheel turbine - Francis turbine - Kaplan turbine – Velocity triangles – Specific speed of turbines.		
Unit - V	**Hydraulic Pumps:**	**9**
Hydraulic Pumps: Definition of heads - Efficiencies - Work done of a Centrifugal pump – Velocity triangles - Working principles of single acting and double acting reciprocating pump - Basic principles of indicator diagram – Cavitation – Specific speed of pumps.		

Total: 45

TEXT BOOK:

1. Sukumar Pati, "Fluid Mechanics and Hydraulic Machines", 9th Edition, McGraw Hill Education, Chennai, 2018.

REFERENCES:

1. Hibbeler R.C, "Fluid Mechanics in SI Units". 1st Edition, Pearson India Education Services Pvt. Ltd., Noida, 2015.
2. Munson B.R., Young D.F., and Okiishi T.H, "Fundamentals of Fluid Mechanics", 7th Edition, John Wiley & Sons, Singapore, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	outline the fluid flow properties and study the pressure measurement	Applying (K3)
CO2	solve the problems related to kinematics and dynamics of fluid flow	Applying (K3)
CO3	analyze the energy losses in flow through pipes	Analyzing (K4)
CO4	evaluate the work done and efficiencies of various hydraulic turbines	Analyzing (K4)
CO5	determine the work done and efficiencies by the various hydraulic pumps	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	1										3	2	3
CO2	2	2	1									2	2	3
CO3	3	3	2			1	1					3	2	3
CO4	1	3	2			2	1			2		3	2	3
CO5	2	3	2			2				2		3	2	3

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	35	50				100
CAT2	15	20	50	15			100
CAT3	15	20	50	15			100
ESE	10	25	50	15			100

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

18MTT31 - ANALOG DEVICES AND DIGITAL CIRCUITS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Circuit Analysis and Network Synthesis, Materials Science and Metallurgy	3	PC	3	0	0	3

Preamble	This course provides an introduction to the basic concepts of semiconductor devices. It outlines the design of operational amplifiers and its applications. It introduces the design of combinational and sequential digital circuits.	
Preamble	This course provides an introduction to the basic concepts of semiconductor devices. It outlines the design of operational amplifiers and its applications. It introduces the design of combinational and sequential digital circuits. This course provides an introduction to the basic concepts of semiconductor devices. It outlines the design of operational amplifiers and its applications. It introduces the design of combinational and sequential digital circuits.	
Unit - I	**Semiconductor Devices:**	**9**
Conductors, Semiconductors and Insulators – Properties of Semiconductors – PN Junction Diode - Rectifiers and Filters - Zener Diode – Zener Diode Voltage Regulator – Transistors: Principle of Operation of CE Configurations, Static characteristics, CE Transistor as an Amplifier and Switch- Construction and characteristics of FET.		
Unit - II	**Operational Amplifiers:**	**9**
Introduction – Ideal operational amplifier – inverting amplifier – non-inverting amplifier – voltage follower – Scale changer – Summer - differential amplifier - Instrumentation amplifier –Integrator – Differentiator – ADC – DAC.		
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**
Flip Flops: 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. Floyd, "Electronic Devices", 10th Edition, Pearson Education, New Delhi, 2018.

REFERENCES:

1. Anandkumar A, "Fundamentals of Digital Circuits", 4th Edition, Prentice Hall of India, New Delhi, 2016.
2. Roy Choudhury, "Linear Integrated Circuits", 5th Edition, New Age International, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the basic characteristics of semiconductor devices	Understanding (K2)
CO2	analyze the characteristics of amplifiers and its application	Analyzing (K4)
CO3	verify the Boolean functions using logic gates	Applying (K3)
CO4	design the combinational circuits	Analyzing (K4)
CO5	design the sequential circuits	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	1	1		2							3	2	2
CO2	3	2	1		2							3	3	3
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

ASSESSMENT PATTERN - THEORY

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

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

18MTT32 - MANUFACTURING PROCESSES

(Common to Mechatronics Engineering and Automobile Engineering)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Introduction to Engineering	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 methods and operations - types of broaching machines		

Total:45

TEXT BOOK:

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

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the various foundry techniques like pattern making, molding, casting, melting furnaces and inspection	Understanding (K2)
CO2	categorize various forming processes involving bulk forming and sheet metal operations	Understanding (K2)
CO3	choose the metal removal processes according to the material and geometrical design	Understanding (K2)
CO4	select the metal joining processes based on the properties of base metal	Applying (K3)
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	20	70	10				100
CAT2	20	60	20				100
CAT3	20	70	10				100
ESE	15	65	20				100

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

18MTT33 - SENSORS AND TRANSDUCERS

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

Preamble	To make students familiar about the methods of measurement and to discuss the construction and working principle behind various transducers	
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	**Miscellaneous Transducer and Sensors:**	**9**
Flow measurement: Turbine meter – hot-wire anemometer - Level Measurement: Capacitive and Ultrasonic level sensors. Measurement of Humidity – Sound measurement – Piezoelectric transducer – Hall Effect transducer –Magneto elastic sensor. Digital transducers: Encoders – Fiber optic sensors – Film sensors – Introduction to MEMS and Nano sensors		
Unit - V	**Signal Conditioning and Digital Instruments:**	**9**
DC Bridges: Classification of Resistances-Measurement of Medium Resistance –Wheatstone Bridge, Kelvin‘s Double Bridge. A.C.Bridges: Introduction –Sources and Detectors – Maxwell‘s Inductance Bridge –Wien‘s Bridge – Digital Instruments: Block diagram of Oscilloscope – Digital Storage Oscilloscope		

Total:45

TEXT BOOK:

1. Patranabis D., "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2003.

REFERENCES:

1. Murthy D.V.S., "Transducers and Instrumentation", 2nd Edition, PHI, New Delhi, 2012.
2. Doebelin E.O., "Measurement Systems: Applications and Design", 4th Edition, McGraw Hill International, New York, 1990.

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 various measurements	Understanding (K2)
CO4	explore advanced sensors for measurements	Understanding (K2)
CO5	infer the role of Signal conditioning system which enhances the quality of signal coming from a sensor	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	40	40	20				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)**

18MTL31 - ANALOG DEVICES AND DIGITAL CIRCUITS LABORATORY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	PC	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.	Characteristics of semiconductor diode and zener diode
2.	Input and output characteristics of transistor under CE configuration
3.	Drain characteristics of FET
4.	Half wave and Full wave rectifier
5.	Inverting and Non-inverting amplifiers
6.	A/D and D/A converters
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/MANUAL/SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze the characteristics of semiconductor devices and its application	Understanding (K2), Imitation (S1)
CO2	design amplifiers and converters	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

18MTL32 - MANUFACTURING PROCESSES LABORATORY

(Common to Mechatronics Engineering and Automobile Engineering Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	PC	0	0	2	1
Preamble	This course provides hands-on training to various manufacturing processes and to produce the machine elements using different machine tools.						

List of Exercises / Experiments :

1.	Lathe operations: Step turning, Taper turning and Knurling
2.	Lathe operation: Thread Cutting
3.	Lathe operation: Eccentric turning
4.	Milling machine operation: Spur gear milling / Contour / Key way milling
5.	Shaper / planner machine operation: Key way / Dove tail shape Cutting
6.	Drilling machine operations: Drilling, Reaming and Tapping
7.	Grinding machine operations: Surface grinding and Cylindrical grinding
8.	Preparation of 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 machine elements using centre lathe through single point and multi point cutting tool	Applying (K3), Precision (S3)
CO2	develop the various machine elements using special machines like milling machine, Shaper 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

18MTL33 - SENSORS AND TRANSDUCERS LABORATORY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	PC	0	0	2	1
Preamble	This course enables the student in performing different measurement systems using various sensors to meet the industrial requirements.						

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
5.	Flow measurement using Orifice meter and Rotameter
6.	Diaphragm based Pressure measurement
7.	Capacitive based Level Measurement
8.	Speed Measurement using Encoder and Optocoupler
9.	Measurement of magnetic field strength using hall effect sensor
10.	Measurement of unknown Resistance using Wheastone 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	perform the measurements of different physical parameters	Applying (K3), Imitation (S1)
CO2	demonstrate the characteristics of sensor measurement system	Applying (K3), Imitation (S1)
CO3	perform the signal conditioning circuits for sensor 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

18MAC41 - STATISTICS AND NUMERICAL METHODS

(Common to Civil Engineering, Mechanical Engineering, Mechatronics Engineering, Automobile Engineering, Electrical And Electronics Engineering , Electronics And Instrumentation Engineering, Chemical Engineering & Food Technology Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	4	BS	3	1*	2*	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**
Introduction – Critical region and level of significance – Types of Errors – Large sample tests: Z-test for single mean and difference of means – Small sample tests: Student's t-test for significance of means – F-test for comparison of variances – Chi-square test for goodness of fit and independence of attributes		
Unit - II	**Design of Experiments:**	**9**
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**
Method of false position – Newton-Raphson method – Solution of linear system of equations – Direct methods: Gauss elimination method and Gauss - Jordan method – Iterative methods: Gauss Jacobi and Gauss-Seidel methods.		
Unit - IV	**Interpolation, Numerical Differentiation and Integration:**	**9**
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 and backward interpolation formulae – Numerical integration: Trapezoidal rule – Simpsons 1/3rd rule.		
Unit - V	**Numerical Solution of First order Ordinary Differential Equations:**	**9**
Single step methods: Taylor series method – Euler method – Modified Euler method – Fourth order Runge-Kutta method – Multi step methods: Milne's predictor corrector method – Adam's Bashforth method.		

List of Exercises / Experiments:

1.	Testing significance of means by student's t - test
2.	Testing the independence of attributes by Chi-square test
3.	Analyze the difference in means is statistically significant by Completely Randomized Design
4.	Finding positive root by Regula – Falsi method
5.	Solving simultaneous linear equations by Gauss – Seidel Method
6.	Evaluating definite integrals by Trapezoidal and Simpson's rules
7.	Solution of ODE by Euler and Modified Euler methods
8.	Solution of ODE by Runge-Kutta method

***Alternate Weeks**

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

TEXT BOOK:

1.	Veerarajan T. & Ramachandran T. , "Statistics and Numerical Methods ", 1st Edition, Tata McGraw Hill Education, New Delhi, 2018.

REFERENCES:

1.	Jay L. Devore. , "Probability and Statistics for Engineering and the Sciences ", 9th Edition, Cengage Learning, USA, 2016.
2.	Steven C. Chapra & Raymond P. Canale. , "Numerical Methods for Engineers ", 7th Edition, McGraw-Hill Education, New York, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify large and small samples and apply suitable tests for solving engineering problems	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 ordinary differential equations numerically	Applying (K3)
CO6	test whether the given data is significant by hypothesis testing and ANOVA using MATLAB	Applying (K3), Manipulation (S2)
CO7	use MATLAB for determining numerical solutions of algebraic equations and integral values	Applying (K3), Manipulation (S2)
CO8	obtain the numerical solution of ordinary differential equations 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	2	1	2										
CO2	3	1	2	2										
CO3	3	2	1	1										
CO4	3	1	1	1										
CO5	3	2	1	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)**

18MET41 - STRENGTH OF MATERIALS

(Common to Mechanical & Mechatronics Engineering Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics, Mathematics I, Mathematics II	4	PC	3	1	0	4

Preamble	To understand the concepts of types of stress, strain, strain energy, principal stress, principal planes and biaxial state of stress in thin cylinders and spherical shells. Also, estimate and draw the shearing force and bending moment diagram due to external loads and the bending stresses of the beams. Evaluation of Slope and deflection of beams by 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". 5th 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)**

18EIT43 - DC AND AC MACHINES

(Common to Electronics and Instrumentation Engineering & Mechatronics Engineering branches)

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

Preamble	To understand the construction, operation and behavior of various electrical machines used in real time application and also classifies the different types of starting and speed control techniques and its significance	
Unit - I	**DC Machines:**	**9**
Introduction : 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-Applications.		
Unit - II	**Transformer and Synchronous Machines:**	**9**
Construction and Principle of Operation of single phase transformer-EMF equation- 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	**Induction Machines:**	**9**
Single phase Induction Motor: Construction and Principle of Operation-Types- Applications. Three phase Induction Motor: Construction and Principle of Operation- Torque Equation- Starters: DOL and Star/Delta Starter. Speed Control: Voltage, Frequency, V/f and Rotor Resistance Control– Applications.		
Unit - IV	**Stepper and Servo Motor:**	**9**
Stepper Motor: Classifications- Construction and Principle of Operation – Modes of Excitation-Drive System-Logic Sequencer-Applications. Servo Mechanism – DC Servo motor-AC Servo motor – Applications.		
Unit - V	**Special Machines:**	**9**
Construction, Operation and Applications of: Brushless Permanent Magnet DC Motor Universal Motor– Switched Reluctance Motor- Submersible Bore Well Induction Motor.		

Total:45

TEXT BOOK:

1. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2016.

REFERENCES:

1. Theraja B.L. & Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2012.
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	discuss knowledge on construction and operation of DC and AC Machines	Understanding (K2)
CO2	assess the performance characteristics of machines through problem solving and conducting tests	Applying (K3)
CO3	implement starting and speed control techniques for different machines	Applying (K3)
CO4	compare and contrast various parameters of different electrical machines	Understanding (K2)
CO5	point out appropriate electrical 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	2	1												2
CO2	3	2	1	1	1								1	3
CO3	3	2	1	1	1								1	3
CO4	2	1												2
CO5	3	2	1	1	1								1	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

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

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

18MTT41 - KINEMATICS OF MACHINES

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

Preamble	This course deals with analysis of velocity and acceleration and synthesis of various simple mechanisms. It provides an understanding of cam profile generation; analyze its velocity and acceleration profiles, understanding of gear theory and terminology, working of gear trains and analysis of various gear trains, analyzing the fluctuation in speed in governors mechanisms and friction theories in transmission elements	
Unit - I	**Basics and Kinematics of Basic Mechanisms:**	**9+3**
Classification of mechanisms – Basic kinematic concepts – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law – Kinematic inversions of four-bar chain and slider crank chains. Velocity and Acceleration of simple mechanisms by relative velocity method – Analytical synthesis of slider crank mechanism - Klien's construction for slider crank mechanism – Coriolis Acceleration component		
Unit - II	**Kinematics of Cam:**	**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 profile of plate cams of above - types with reciprocating and oscillating followers like knife – edge follower, roller and flat faced followers. High speed cams – circular arc and tangent cams – Standard cam motion – Pressure angle and undercutting		
Unit - III	**Kinematics of Gears and Gear Trains:**	**9+3**
Theory of Gearing – gear nomenclature, law of gearing, tooth forms, minimum number teeth, length of arc of contact, contact ratio and interference. Gear trains – types, velocity and torque calculation- Parallel axis and epicyclic gear trains		
Unit - IV	**Kinematics of Friction Elements:**	**9+3**
Types of friction - belt, rope and chain drives: Ratio of tensions with Pulleys, sheaves and sprockets - Bearings: Pivot and collar bearings - Clutches: Single plate and multi plate clutches - Brakes: Band and Block brakes		
Unit - V	**Mechanisms of Centrifugal Governor:**	**9+3**
Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling Force		

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, 2014.
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	apply the concepts of kinematics to compute the velocity and acceleration for simple mechanisms	Applying (K3)
CO2	design and analyze the profile of various cam mechanisms for different applications	Analyzing (K4)
CO3	solve and evaluate the kinematic aspects of gears and gear trains	Analyzing (K4)
CO4	apply the concepts of friction properties in mechanisms and mechanical elements	Applying (K3)
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	3	2	2	2								2	3	1
CO2	3	3	2	2								2	3	1
CO3	3	3	2	2								2	3	1
CO4	3	3	2	2								2	3	1
CO5	3	3	2	2								2	3	1

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

ASSESSMENT PATTERN - THEORY

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

18MTT42 - THERMODYNAMICS AND HEAT TRANSFER

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics, Fluid Mechanics and Hydraulic Machines	4	PC	3	1	0	4

Preamble	This course provides insight and applications of first law of thermodynamics, second law of thermodynamics and working principle of IC engines. It also provides knowledge to solve problems in psychrometry and heat transfer.	
Unit - I	**Basic and First Law of Thermodynamics:**	**9+3**
Thermodynamics – Microscopic and macroscopic point of view – Systems, properties, process, path, cycle. Thermodynamic equilibrium – Zeroth law of Thermodynamics – internal energy, enthalpy, specific heat capacities CV and CP, Relationship between CV and CP. First law of Thermodynamics – Application to closed and open systems – Steady Flow Energy Equation (SFEE) – Simple problems.		
Unit - II	**Second Law of Thermodynamics and Entropy:**	**9+3**
Second Law of thermodynamics – Kelvin Planck and Clausius Statements – Equivalents of Kelvin Planck and Clausius statements. Reversibility – Irreversibility, reversible cycle – Carnot theorem, Heat engine, heat pump and refrigerator. Carnot cycle and Clausius theorem, Reversed Carnot cycle ,the property of entropy, the inequality of Clausius – Entropy principle – General expression for entropy – Simple problems in entropy.		
Unit - III	**Internal Combustion Engines:**	**9+3**
: Classification of IC engines - IC engine components and functions. Valve timing diagram and port timing diagram – principle of working and comparison of two stroke and four stroke engines, Comparison of petrol and diesel engines. Fuel supply system-Types - Ignition Systems - Types- Lubrication systems - Types - Cooling systems-Types. Gas power cycles: Otto, Diesel and Dual cycles with p-V and T-s diagrams- workdone and efficiency calculations (Simple problems only).		
Unit - IV	**Psychrometry:**	**9+3**
Psychrometry, Refrigeration and Air-Conditioning: Psychrometry - Psychrometric properties and Processes (Simple processes only) – Dalton's law of partial pressure – Psychrometric chart. Principle of refrigeration – Components of refrigeration system – working of vapour compression refrigeration cycle with p-h and T-s diagrams. Refrigerants - properties and selection. Working vapour absorption refrigeration cycle. Human comfort – Air-conditioning-Types, summer, winter and year round air-conditioning systems.		
Unit - V	**Heat Transfer:**	**9+3**
: Basic Concepts – Mechanism and modes of Heat Transfer. Fourier's Law of heat Conduction - Differential equation of heat conduction. Convection - Heat transfer coefficient– Types of Convection – Free and Forced Convection– Simple problems. Radiation - Stefan Boltzman Law, Kirchhoff's Law – Black Body concept – Grey body radiation.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Rajput R.K, "Thermal Engineering", 10th Edition, Laxmi Publications, New Delhi, 2017 for Units I,II,III,IV
2. Rajput R.K, "Heat and Mass Transfer", 5th Revised Edition, Chand and Co Limited, New Delhi, 2015 for Unit V

REFERENCES:

1. Nag P.K, "Engineering Thermodynamics", 6th 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	analyze the basic concepts, first law of thermodynamics and its applications	Applying (K3)
CO2	interpret concepts of second law of thermodynamics and entropy	Understanding (K2)
CO3	perceive the principle part of engines and their working principle	Understanding (K2)
CO4	apply the thermodynamic relations in physical problems and infer psychrometric chart and solve the problems related Refrigeration and Air conditioning	Applying (K3)
CO5	solve the problems which involves conduction, convection and radiation heat transfers	Applying (K3)

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

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

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

18MTT43 - POWER ELECTRONICS AND DRIVES

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	DC and AC Machines, Analog Devices and Digital Circuits	4	PC	3	0	0	3

Preamble	This course depicts the working principles of power electronic devices, converters, drives and their applications.	
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 Converters:**	**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 – Introduction to inverter –1ϕ and 3ϕ Voltage source inverters –PWM inverters.		
Unit - III	**DC - DC and AC - AC Converter:**	**9**
DC Chopper – Control strategies – Principle of operation – Step up and step down chopper – Single phase AC voltage controller – On - off control and phase control – Sequence control of AC voltage controller – 1ϕ Step up and step down cycloconverters		
Unit - IV	**Electric 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 – slip power recovery control.		

Total:45

TEXT BOOK:

1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.

REFERENCES:

1. Singh M.D. & Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2007.
2. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001.

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	20	15			100
CAT3	30	30	20	20			100
ESE	25	35	20	20			100

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

18EEL43 - DC AND AC MACHINES LABORATORY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Introduction to Enigneering	4	PC	0	0	2	1
Preamble	To analyse the performance of AC and DC machines under various loading conditions and to analyze the behaviour of DC machines for various speed control techniques.						

List of Exercises / Experiments:

1.	Open circuit and load characteristics of separately excited DC shunt generator
2.	Load characteristics of DC series motor
3.	Speed control of DC shunt motor
4.	Open circuit and short circuit tests on single phase transformer.
5.	Load test on three phase transformer with resistive load
6.	Load test on three phase alternator
7.	Load test on three phase squirrel cage induction motor
8.	Speed control of three phase induction motor
9.	Regulation of three phase alternator by EMF method
10.	V and inverted V curves of three phase synchronous motor

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	analyse the load characteristics of DC and AC machines	Analyzing (K4), Manipulation (S2)
CO2	apply the speed control techniques for DC and AC machines	Applying (K3), Manipulation (S2)
CO3	predetermine the regulation and efficiency of DC and AC machines	Analyzing (K4), Manipulation (S2)

Mapping of COs with POs and PSOs

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

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

18MTL41 - POWER ELECTRONICS AND DRIVES LABORATORY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	DC and AC Machines, Analog Devices and Digital Circuits	4	PC	0	0	2	1
Preamble	To realize the characteristics and working of power electronics devices/converters under various load conditions and to provide an insight on numerical computing tools used to design converters						

List of Exercises / Experiments:

1.	Study of SCR characteristics
2.	Study of MOSFET and IGBT characteristics
3.	R, RC and UJT firing circuits for SCR
4.	Single phase half controlled & fully controlled converters
5.	Step up and Step down chopper
6.	IGBT based PWM inverter
7.	Single-phase Cycloconverter
8.	Simulation of closed loop control of converter fed DC motor
9.	Simulation of closed loop control of chopper fed DC motor
10.	Simulation of VSI fed three phase induction motor

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	MATLAB/SIMULINK Software

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	verify the characteristics of power devices and analyze the roll of triggering circuits	Analyzing (K4), Manipulation (S2)
CO2	analyze the performance of rectifier, inverter, chopper and cycloconverter	Analyzing (K4), Manipulation (S2)
CO3	design and analysis of DC and AC drives using MATLAB / SIMULINK	Analyzing (K4), Manipulation (S2)

Mapping of COs with POs and PSOs

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

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

18MTL42 - COMPUTER AIDED DRAFTING LABORATORY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Drawing	4	PC	0	0	2	1
Preamble	This course provides hands on training on development of mechanical and electrical components drawing with 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 joints/couplings for Robotic arm.
4.	Part and assembly drawing of bearings/valves.
5.	Part and assembly drawing of connecting rod/tailstock / Robotic Manipulators.
6.	Study of electrical and electronic symbols.
7.	Circuit design of solid-state emergency light and beeper circuit.
8.	Design of DC power supply unit.
9.	Line diagram of wiring of a drawing hall.
10.	Connection diagram of 3 point starter and DOL starter.

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 with appropriate views	Applying (K3), Manipulation (S2)
CO3	create electrical and electronics 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

18EGL31 - ENGLISH FOR WORKPLACE COMMUNICATION
(Common to all Engineering & Technology Branches)

Programme & Branch	B.E. & Civil 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.	
Unit - I	**Listening:**	**6**
Techniques for effective listening - Listening and note taking - Listening activities using listening texts - Listening to discourse samples of native English speakers – Focussed listening for improving pronunciaition - understanding different accents.		
Unit - II	**Reading:**	**6**
Developing reading skills - Reading aloud - Group reading activities - Reading with correct word stress and intonation.		
Unit - III	**Soft Skills:**	**6**
Attitude - Goal setting - Time Management - Team Work - Telephonic conversation skills.		
Unit - IV	**Writing:**	**6**
Making preparatory notes, drafts and PPT"s for laboratory activities - Word editing features - editing and proof reading..		
Unit - V	**Speaking:**	**6**
Verbal and non-verbal communication - Introducing oneself - Introducing others – Mock Interviews - Making presentations on chosen topics - Group Discussion.		

Total:30

REFERENCES/ MANUALS:

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

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

18MTT51 - 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 and Angular Measurements:**	**9**
Basic concepts: Legal metrology- Precision- Accuracy- Types of errors – Standards of measurement- Traceability – Interchangeability and selective assembly. Introduction to limits, fits and tolerances, Gauge design- Comparators-Angular measurement: bevel protractor - Angle gauges - Sine bar. Surface Finish and Form Measurement: Measurement of surface finish: Terminology – Geometrical irregularities – Roughness – Waviness. Surface- roughness measurement methods. Screw thread metrology: Terminology- Errors in thread, Gears Terminology- Measurement of various elements of gear.		
Unit - V	**Interferometry and LASER Metrology:**	**9**
Principle of light wave interference – Optical flats -Michelson and NPL flatness interferometer, Laser interferometer. Advances in Metrology: Coordinate Measuring Machine (CMM): Types - Constructional features-Possible causes of errors in CMM - Probing system – Performance and applications of CMM. Machine Vision System: Applications of machine vision in measurement- In process and On line measurement.		

Total:45

TEXT BOOK:

1. Narang J.S. & Narang V.D.S., "CNC Machines and Automation", Dhanpat Rai and Co. Pvt. Ltd, New Delhi, 2016 for Units I, II, III.
2. Jain R.K, "Engineering Metrology", Khanna Publishers, New Delhi, 2013 for Units IV, V.

REFERENCES:

1. HMT Limited, "Mechatronics", McGraw-Hill, New Delhi, 2001.
2. Raghavendra N.V. & Krishnamurthy L., "Engineering Metrology and Measurements", Oxford University Press, India, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	estimate the parameters of metal cutting and comprehend the basic components, drives and controls involved in a CNC system	Applying (K3)
CO2	select various tooling systems and fixtures for CNC and identify maintenance features of CNC machines	Understanding (K2)
CO3	develop Part Programming for various machining process	Applying (K3)
CO4	infer linear and angular measurements using various instruments and determine the surface roughness	Understanding (K2)
CO5	perform the form and profile measurement using Coordinate Measuring Machine (CMM) with machine vision system	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

18MTT52 - MICROCONTROLLER PROGRAMMING AND APPLICATIONS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Analog Devices and Digital Circuits	5	PC	3	0	0	3

Preamble	This course is designed to provide basic concepts of microprocessor, introduction to Microcontroller architecture, internal and external peripherals, assembly language programming and embedded C programming. Students will be skilled the use of Embedded C programming environment and how to develop C programming for embedded applications. This course also includes interfacing techniques for sensors and actuators with Microcontroller.	
Unit - I	**8085 Microprocessor:**	**9**
8085 Architecture – Pin configuration – Register organization – Memory organization – Memory and I/O decoding – Addressing modes – Instruction sets – Interrupts.		
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 set – 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**
Application case studies related to: Interfacing of sensors analog and discrete type (Temperature, Pressure, Level, Proximity sensors). Interfacing of actuators (Servo motor, pneumatic cylinders, PWM control of a DC motor). Traffic light control application. Serial communication interface using IoT concept.		

Total:45

TEXT BOOK:

1. Mazidi Muhammad Ali, Mazidi Janice Gillispie and McKinlay Rolin, "The 8051 Microcontroller and Embedded Systems", 2nd Edition, Pearson Education, New Delhi, 2013.
2. Ramesh Goankar, "Microprocessor 8085 Architecture, Programming and Interfacing", 5th Edition, Penram International publishers, Mumbai, 2013.

REFERENCES:

1. Patel, "The 8051 Microcontroller based Embedded Systems", 1st 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	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	Analyzing (K4)
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	20	50	10			100
CAT3	20	20	50	10			100
ESE	20	20	60				100

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

18MTT53 - MACHINE DYNAMICS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mechanics, Kinematics of Machines, Strength of Materials	5	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. It also emphasis on gyroscopic effect on various modes of transport systems, impact of free and forced vibration in various systems.	
Unit - I	**Force Analysis:**	**9+3**
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+3**
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 Free Damped Vibrations:**	**9+3**
Basic features of vibratory systems–types–Single degree of freedom system –Longitudinal Vibrations, Transverse vibration of beams–Natural frequency by energy method, Dunkerly's method-Critical speed damped free vibration of single degree freedom system-Types of damping–free vibration with viscous damping, Critically damped system, under damped system.		
Unit - IV	**Forced and Torsional Vibrations:**	**9+3**
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	**Compensator Design:**	**9+3**
Gyroscopes –Gyroscopic couples – Gyroscopic effects in automobiles, ships and air planes. Automatic control of mechanical systems- Transfer function- viscous damped output		

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, 2014.
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 forced vibrations	Evaluating (K5)
CO4	evaluate the frequencies of torsional vibration systems	Evaluating (K5)
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	2	1	1	1								2		3
CO2	2	3	3	2								2		3
CO3	2	3	3	3	3							2	3	3
CO4	2	3	3	2								2		3
CO5	2	3	3	1								2		3

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

ASSESSMENT PATTERN - THEORY

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

18MTT54 - SYSTEMS AND CONTROL ENGINEERING

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Mathematics I, Mathematics II, Circuit Analysis and Network Synthesis	5	PC	3	1	0	4

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+3**
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		
Unit - II	**System Modeling:**	**9+3**
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+3**
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+3**
Frequency domain specifications – Bode plot - Polar plot - Nyquist stability criterion		
Unit - V	**Compensator Design:**	**9+3**
Need for compensator - Types of compensation - Root Locus Technique - Design of lag and lead compensator using Root Locus		

Lecture:45, Tutorial:15, Total:60

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	10	20	40	30			100
CAT2		30	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)**

18MTL51 - CNC AND METROLOGY LABORATORY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	PC	0	0	2	1
Preamble	This practical course discusses about generation of CNC part programming and to understand about various measurement techniques						

List of 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 etc
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, 2017.
3.	Laboratory manual

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

Mapping of COs with POs and PSOs

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

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

18MTL52 - MICROCONTROLLER PROGRAMMING AND APPLICATIONS LABORATORY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Analog Devices and Digital Circuits	5	PC	0	0	2	1
Preamble	This course exposes the students to the operation of a typical measurement / microcontroller and enable them to develop solutions to different problems / case studies.						

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 Micorcontroller
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.	1Study 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 programming logic and interfacing circuits using simulation software for 89c51 Microcontroller	Applying (K3), Precision (S3)
CO3	develop a 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

18MTL53 - COMPUTER AIDED ENGINEERING LABORATORY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Strength of Materials, Engineering Mechanics	5	PC	0	0	2	1
Preamble	This practical course discusses about modeling and analyzing of 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 application 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

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 Laboratory Manual.

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 packages and CAE tools	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

18GEL51 - PROFESSIONAL SKILLS TRAINING I
(Common to all BE/ BTech / MSc /MCA /BSc Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	EC	0	0	80	2

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

Total: 80

TEXT BOOK:

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

REFERENCES:

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

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

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

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

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

18GET51 - UNIVERSAL HUMAN VALUES
(Common to All BE/BTech branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	MC	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:**	**9**
Need and Basic Guidelines of Value Education – Content and Process of Value Education – Self Exploration – purpose of self-Exploration – Content and Process of Self exploration – Natural Acceptance – Realization and Understanding – Basic Human Aspirations – Continuous Happiness and Prosperity – Exploring Happiness and Prosperity – Basic Requirement for Fulfillment of Human Aspirations – Relationships – Physical Facilities – Right Understanding.		
Unit - II	**Harmony in the Self and Body:**	**9**
Human Begin and Body – Understanding Myself as Co–existence of Self ('I') and Body, Needs of the Self and Body, Activities in the Self and Body, Self ('I') as the Conscious Entity, the Body as the Material Entity – Exercise – Body as an Instrument– Harmony in the Self ('I) – Understanding Myself – Harmony with Body.		
Unit - III	**Harmony in the Family and Society:**	**9**
Harmony in the Family – Justice – Feelings (Values) in Human Relationships – Relationship from Family to Society – Identification of Human Goal – Five dimensions of Human Endeavour.		
Unit - IV	**Harmony in Nature and Existence:**	**9**
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:**	**9**
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: 45

TEXT BOOK:

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

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the significance of value inputs in a classroom, distinguish between values and skills, understand the need, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society.	Understanding (K2)
CO2	distinguish between the Self and the Body, understand the meaning of Harmony in the Self the Co–existence of Self and Body.	Understanding (K2)
CO3	understand 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.	Understanding (K2)
CO4	understand the harmony in nature and existence, and work out their mutually fulfilling participation in the nature.	Understanding (K2)
CO5	distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18MTT61 - 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– Analog- Temperature –Flow–Pressure sensors. Output Devices: Discrete- Relays – contactors – DOL Starter - Solenoid valves, Analog: Control valve-VFD		
Unit - II	**Programmable Logic Controller:**	**9**
Introduction – Architecture of PLC – Principles of operation –Programming devices – Types of PLC – I/O modules: Discrete I/O modules – Analog I/O modules – CPU processor memory module – Selection, Maintenance and troubleshooting of PLC – Soft PLCs.		
Unit - III	**Programming of PLC:**	**9**
Sourcing and sinking concept – Ladder diagram – Conversion of relay ladder to PLC ladder diagram – Instructions: Timer – Counter – Arithmetic – Data and program manipulation – Application case studies-Function block programming		
Unit - IV	**Advanced PLC programming and Communication Protocols:**	**9**
program control-Analog PLC operation – PLC-PID functions – motion control – Data communications: Data highway- DeviceNet-ControlNet-EtherNet/IP-Modbus-Fieldbus- Profibus.		
Unit - V	**SCADA:**	**9**
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 PLC programming using ladder logic	Analyzing (K4)
CO4	combine programming concepts of PLC and SCADA to develop industrial control functions	Analyzing (K4)
CO5	implement PLC and HMI for industrial case studies based on INDUSTRY 4.0	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						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	10	50	20			100
CAT3	10	30	60				100
ESE	20	30	40	20			100

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

18MTT62 - ROBOT KINEMATICS AND DYNAMICS

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	The course on industrial robotics is intended to provide a reasonable understanding of robot manipulator, and mathematics behind position, motion and dynamics of robot.	
Unit - I	**Introduction:**	**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 the 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.

REFERENCES:

1. Groover M.P., "Industrial Robotics, Technology, Programming and Applications", 2nd Edition, McGraw-Hill, New Delhi, 2017.
2. Craig John J., "Introduction to Robotics: Mechanics and Control", 3rd Edition, Pearson Education, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the features of an 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)**

18MTC61 - FLUID POWER SYSTEM

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Fluid Mechanics and Hydraulic Machines	6	PC	3	0	2	4

Preamble	This course is 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		

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

Lecture:45, Practical:30, Total:75

TEXT BOOK:

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

REFERENCES:

1.	Jegadeesa T., "Hydraulics and Pneumatics", NA Edition, 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, 2012.
3.	Majumdar S.R., "Pneumatic Systems – Principles and Maintenance", 2nd Edition, Tata McGraw-Hill, New Delhi, 2015.

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	Analyzing (K4)
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)
CO6	identify the fluid power components and their symbols as used in industry	Applying (K3), Manipulation (S2)
CO7	design, construct and test fluid power circuits with pneumatic, electrical, PLC and logic control for low cost automation	Applying (K3), Manipulation (S2)
CO8	develop and simulate fluid power circuits using simulation software for industrial applications	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2			1	1				1	1	2	2
CO2	2	2	3	1		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
CO6	2	2	2		1						2	2	2	2
CO7	2	3	3		3						2	2	3	3
CO8	2	2	3		3						2	2	3	3

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

ASSESSMENT PATTERN - THEORY

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

18MTL61 - 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 provides practical hand on experience about PLC programming, I/O interfacing and development of SCADA for industrial automation.						

List of Exercises / Experiments:

1.	Introduction to programming /simulation/communication software for PLC programming
2.	Logical testing of I/Os and its interfacing with PLC
3.	Level control using PLC
4.	Linear and sequential actuation of Pneumatic cylinder with Timer and counter functions
5.	Development of HMI for real time parameter monitoring and control
6.	Speed control of motor using soft PLC
7.	Temperature control using PLC and SCADA along with data logging and trending
8.	Pressure Measurement and Flow Control using PLC and SCADA 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 PLC programming for discrete and analog I/Os	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

18MTL62 - 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 industrial robot- components, drive system and end effectors.
2.	Virtual reality robot programming for different tasks.
3.	Creation of Tool Centre Point (TCP) and Work Object using ABB IRB 1410 industrial robot.
4.	Robot programming exercises: Point-to-point and Continuous path programming.
5.	Pick and place operation in teach mode using ABB IRB 1410 industrial robot.
6.	Vision based on line Inspection and sorting of components using ABB IRB 1410 industrial robot.
7.	Development of embedded programming for motion control using Fire Bird – V robot.
8.	Development of embedded programming for velocity control using Fire Bird – V robot.
9.	Development of embedded programming for path planning using Fire Bird – V robot.
10.	Development of embedded programming for obstacle avoidance using Fire Bird – V robot.

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	ABB Robot Studio Manual
3.	Fire Bird – V Software and Hardware manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze the industrial robot 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 an on line inspection system 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

18MTL63 - GRAPHICAL SYSTEM DESIGN LABORATORY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Problem Solving and Programming, Sensors and Transducers	6	PC	0	0	2	1
Preamble	To provide a computer communication interface in acquiring, processing and controlling real time physical variables.						

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, 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.	Creating sub VIs from section of a VI
10.	File Input / File Output function Read / Write a file.
11.	GSD for real time measurement using Thermistor / Piezo-electric sensor
12.	GSD for real time monitoring using Seven-Segment LED Display/ Motor/ Buzzer/ Speaker

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Jerome J., "Virtual Instrumentation Using LabVIEW", PHI Publication, New Delhi, 2010.
2.	Lisa K. Wells & Jeffrey Travis, "LabVIEW for everyone", PHI Publication, New Delhi, 2012.
3.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the software tools in virtual instrumentation	Applying (K3), Manipulation (S2)
CO2	develop programming through LabVIEW graphical programming environment	Applying (K3), Manipulation (S2)
CO3	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	1	2	2				2	2		2	3	3
CO2	3	2	1	2	2				2	2		2	3	3
CO3	3	2	1	2	2				2	2		2	3	3

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

18GEL61 PROFESSIONAL SKILLS TRAINING II
(Common to all BE/ BTech / MSc /MCA /BSc Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	EC	0	0	80	2

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

Total: 80

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18MTP61 - PROJECT WORK I PHASE 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

18MBT71 – ENGINEERING ECONOMICS AND MANAGEMENT

(Common to All BE/BTech Engineering And Technology Branches except Chemical Engineering)

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.

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18GEP71 – COMPREHENSIVE TEST AND VIVA
(Common to all BE/BTech branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	EC	0	0	0	2

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

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

18MTP71 - PROJECT WORK I PHASE II

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	EC	0	0	8	4

Total: 120

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

Mapping of COs with POs and PSOs

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

18MTP81 - PROJECT WORK II

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	8	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	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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18MTE01 - DESIGN OF MECHANICAL ELEMENTS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Strength of Materials	6	PE	3	0	0	3

Preamble	This course provides systematic knowledge about design and analysis of machine elements and transmission elements for suitable product/process development	
Unit - I	**Design Fundamentals:**	**9**
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**
Design of Solid and Hollow shafts – Based on strength, rigidity and deflection – Torsional rigidity – Lateral rigidity – Material constants. Design of Keys – Types – Key ways. Design of rigid and flexible couplings.		
Unit - III	**Design of Spur, Helical, Bevel and Worm Gears:**	**9**
Design of spur, helical, bevel and worm gears – Multi speed gear box design -Spur gear - Forward Traverse. Gears based on interference.		
Unit - IV	**Design of Power screws, Journal Bearings and Springs:**	**9**
Power screws – Types of thread – Self-locking & Overhauling threads – Design of screw jack. Design of Journal Bearings - Cubic mean load– Calculation of Bearing dimensions – Design of Helical springs – Variable loads – Wahl's factor		
Unit - V	**Conveyors and Accessories Design:**	**9**
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		

Total:45

TEXT BOOK:

1. Bhandari V.B., "Design of Machine Elements", 4th Edition, 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.

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	Analyzing (K4)
CO2	design the shafts, keys and couplings with proper assumptions	Analyzing (K4)
CO3	design and analyze the spur, helical, bevel, worm gear drives and multi speed gear box	Analyzing (K4)
CO4	design and analyze the power screws, journal bearings and springs	Analyzing (K4)
CO5	design and analyze the conveyors and their accessories	Analyzing (K4)

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

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

18MTE02 - MACHINE DRAWING

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Drawing	6	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, 2010.

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the basic concepts and BIS conventions of machine drawing	Understanding (K2)
CO2	demonstrate and evaluate the projections, sectioning, limits, fits and tolerance	Applying (K3)
CO3	develop sketches for fasteners and different joints	Applying (K3)
CO4	draw and create the projections and sectional views of various mechanical elements	Analyzing (K4)
CO5	construct assembly drawings of mechanical components conforming to BIS conventions	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								2	2	3
CO2	3	2	1	1								2	2	3
CO3	3	2	1	1								2	2	3
CO4	3	2	1	1								2	2	3
CO5	3	2	1	1								2	2	3

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

ASSESSMENT PATTERN - THEORY

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

18MTE03 - OPERATIONS RESEARCH

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Mathematics I, Mathematics II, Statistics and Numerical Methods	6	PE	3	0	0	3

Preamble	This course provides knowledge and training in using optimization techniques under limited resources for the engineering and business problems	
Unit - I	**Linear Models:**	**9**
Introduction-Phases of OR study – Formation of LPP - 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- 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 Edition, S.Chand and Company Ltd, New Delhi, 2014.

REFERENCES:

1. Vohra N.D, "Quantitative Techniques in Management", 4th edition Edition, McGraw Hill Education, New Delhi, 2009.
2. Taha, Hamdy A, "Operation Research: An Introduction", 9th edition Edition, Pearson Education, Chennai, 2014.
3. Hiller Frederick S. & Lieberman Gerald J, "An Introduction to Operations Research", 9th edition Edition, McGraw-Hill Science, New Delhi, 2011.

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 & valuate optimal job sequence that minimizes the make span	Analyzing (K4)
CO3	construct networks and analyze optimality for various applications	Analyzing (K4)
CO4	identify inventory models and solve for optimality & assess queuing characteristics and solve problems	Applying (K3)
CO5	determine the optimum replacement period for capital equipments and items that fail suddenly	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2						2	2	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	50	10			100
CAT2	10	20	40	30			100
CAT3	10	30	50	10			100
ESE	10	25	45	20			100

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

18MTE04 - MACHINE LEARNING

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Problem Solving and Programming	6	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 Neighbour 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, 2014.
2. Jiawei Han, Micheline Kamber, "Data Mining Concepts and Techniques", 3rd Edition, Elsevier, 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	Applying (K3)
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	interpret the principles of unsupervised learning and genetic algorithm for optimization	Applying (K3)
CO5	interpret the algorithm for learning rules and reinforcement learning	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3	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 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

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

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

18MTE05 - EMBEDDED PROGRAMMING FOR MECHATRONICS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Microcontroller Programming and Applications	6	PE	3	0	0	3

Preamble	This course provides knowledge and skill on advanced Microcontrollers and Embedded programming for Mechatronics applications	
Unit - I	**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 – Application of Case Study.		

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", 15th Edition, Pearson Education Asia, Noida, 2015.

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	analyze IOT based microcontroller hardware for real time applications using IoT	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							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)**

18MTE06 - PROCESS CONTROL AND INSTRUMENTATION

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Microcontroller Programming and Applications, Systems and Control Engineering	6	PE	3	0	0	3

Preamble	This course imparts knowledge on process dynamics and process characteristics. It emphasizes on types of control, tuning of controllers and advanced control systems. This course also includes instrumentation needed for process control and applications of various process control systems	
Unit - I	**Introduction to Process Dynamics:**	**9**
Process Control - Automatic Process Control - Need for Automatic Process Control in Industry - Mathematical Modeling of Processes – First Order Process Systems - level, temperature and pressure - Second Order Process Systems - Interacting and Non-Interacting Systems - Batch and Continuous Process - Self Regulation - Servo and 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, PHI Learning Pvt. Ltd., New Delhi, 2012.

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)**

18GEE01 - FUNDAMENTALS OF RESEARCH

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

Preamble	This course familiarize the fundamental concepts/techniques adopted in research, problem formulation and also disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.	
Unit - I	**Introduction to Research:**	**9**
Introduction to Research: Types and Process of Research - Outcome of Research - Sources of Research Problem - Characteristics of a Good Research Problem - Errors in Selecting a Research Problem - Importance of Keywords.		
Unit - II	**Literature Review:**	**9**
Literature Review: Literature Collection - Methods - Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.		
Unit - III	**Research Methodology:**	**9**
Research Methodology: Appropriate Choice of Algorithms/Methodologies/Methods - Measurement and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations.		
Unit - IV	**Journals and Papers:**	**9**
Journals and Papers: Journals in Science/Engineering - Indexing and Impact factor of Journals. Plagiarism and Research Ethics. Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study.		
Unit - V	**Reports and Presentations:**	**9**
Reports and Presentations: How to Write a Report - Language and Style - Format of Project Report - Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc - Different Reference Formats. Presentation using PPTs. Research Tools.		

Total: 45

TEXT BOOK:

1. Walliman, Nicholas. “Research Methods: The basics”. Routledge, 2017.

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	list the various stages in research and categorize the quality of journals.	Analyzing (K4)
CO2	formulate a research problem from published literature/journal papers	Evaluating (K5)
CO3	write, present a journal paper/ project report in proper format	Creating (K6)
CO4	select suitable journal and submit a research paper.	Applying (K3)
CO5	compile a research report and the presentation	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18MTE07 - PRECISION EQUIPMENT DESIGN

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	CNC and Metrology, Systems and Control Engineering	7	PE	3	0	0	3

Preamble	This course equips the student to realize the precision: equipment design, methods of inspection, design strategies, machines and control.	
Unit - I	**Introduction to Precision Equipment Design:**	**9**
Introduction, Fundamentals of Economic Analysis, The Role of a Design Engineer, Principles of accuracy, repeatability and resolution, Optical sensor systems, Sensor Mounting and Calibration, Beyond Intelligent manufacturing, Reconfigurable systems.		
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**
Standard sizes, Precision engineering principles –design, modeling and simulation, Design roadmap – conceptual analysis, materials selection, kinematic design of bearing and guide ways, Structural analysis – static and dynamic analysis, Key components – guide ways – selection, precision linear and rotating movement.		
Unit - IV	**Parallel Kinematic Machines (PKM):**	**9**
Introduction, Comparison of Serial and parallel systems, Precision design of a PKM – need of PKM - low cost, degrees of freedom, workspace volume, high stiffness and agility, repeatability in movement, low inertia, Configurations and characteristic issues – Design principles – Kinematic modeling.		
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. Nakazawa H., "Principles of Precision Engineering", Oxford University Press, New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	assess the suitability of equipment designs concepts for specific applications	Understanding (K2)
CO2	inspect the errors in various machines like CNC machines	Applying (K3)
CO3	analyze the design strategies of several machine tools and choose the appropriate design approach	Applying (K3)
CO4	perform kinematic analysis for various mechanisms	Applying (K3)
CO5	develop the complete control of the mechanical system to achieve a better positioning and often compensating for errors	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)**

18MTE08 - 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 methods, also high precision finishing process 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 –Application		
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 – Application		

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)**

18MTE09 - MACHINE VISION AND IMAGE PROCESSING

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Graphical System Design Laboratory	7	PE	3	0	0	3

Preamble	This course provides the practical knowledge about the 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 – Parallel digital camera buses– Standard PC buses – Computer buses.		
Unit - IV	**Image Processing Fundamentals:**	**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 and Template matching.		
Unit - V	**Applications and Case Studies:**	**9**
Diameter Inspection of Rivets– Tubing Inspection– Machine Vision in Manufacturing– Glue Check under UV Light– Completeness Check of automotive control component– Multiple Position and Completeness Check of small hybrid circuit– Pin Type Verification– Type and Result Data Management of spark plugs– Robot Guidance.		

Total:45

TEXT BOOK:

1. Alexander Hornberg, "Handbook of Machine Vision", Wiley-VCH, Germany, 2006.

REFERENCES:

1. Davies E.K, "Machine Vision: Theory, Algorithms, Practicalities", 3rd Edition, Elsevier, India, 2005.
2. Milan Sonka, "Image Processing Analysis and Machine Vision", 2007 Edition, Vikas Publishing House, India, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the fundamental concepts of vision system	Understanding (K2)
CO2	apply the knowledge to 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 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	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)**

18MTE10 - INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	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**
Foundations of the Industrial Internet of Things and Cyber Manufacturing Systems - Potentials and Challenges - Components of IIoT - Sensors, Interface, Networks, People &Process, Hype cycle, IoT Market, Trends and future Real life examples, Key terms – IoT Platform, Interfaces, API, clouds, Data Management Analytics, Mining and Manipulation; Role of IIoT in Manufacturing Processes - Use of IIoT in plant maintenance practices, Sustainability through Business excellence tools Challenges and Benefits in implementing IIoT.		
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**
Need of protocols; Types of Protocols, Wi-Fi, Wi-Fi direct, Zigbee, Z wave, Bacnet, BLE, Modbus, SPI , I2C, IIOT protocols –COAP, MQTT,6lowpan, lwm2m, AMPQ IIOT cloud platforms : Overview of cots cloud platforms, Predix, Thingworks, azure etc. Data analytics, cloud services, Business models: SAAS, PAAS, IAAS.		
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. Jeschke, Sabina & Brecher, Christian & Song, Houbing & Rawat, Danda B., "Industrial Internet of Things: Cyber manufacturing Systems", 1st Edition, Springer, New York, 2017.

REFERENCES:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", 1st Edition, Apress, New York, 2017.
2. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", John Wiley& sons publications, United Kingdom, 2013.
3. Olivier Hersent, David Boswarthic &, Omar Elloumi, "The Internet of Things: Key Applications and Protocols", 2nd Edition, Wiley publication, New Jersey, 2012.

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

18MTE11 - BIO MECHATRONICS

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

Preamble	The course focuses on the study of assistive, therapeutic and diagnostic devices to compensate the loss of human physiological functions or to enhance these functions.	
Unit - I	**Introduction to Bio-Mechatronics:**	**9**
Components of Bio mechatronic Systems - Physiological Systems - Sensors and Transducers - Electromechanical Actuators - Feedback Mechanisms - System Representation - Signal Acquisition - Digital Signal Processing		
Unit - II	**Control Mechanism of Biological Systems:**	**9**
Skeletal muscles servomechanism: muscle fibre anatomy – loop control, cardio vascular control mechanism: The Heart as a Pump - Heart-Lung Machines - Artificial Hearts - Heart Assist Devices, respiratory control mechanism: The Mechanics of Respiration - Lung Characteristics - Mechanical Ventilation		
Unit - III	**Prosthetic and Orthotic Devices:**	**9**
Introduction to prosthetics, Passive Prosthetics – walking dynamics, Knee and foot prosthesis. Active prosthesis - Control of Prosthetic Arms and Hands, Leg Mechanisms-Orthotic devices		
Unit - IV	**Wearable Mechatronics Devices:**	**9**
Wearable artificial kidney, wireless capsule endoscope, wearable exoskeletal rehabilitation system, wearable hand rehabilitation		
Unit - V	**Modelling of Bio-mechatronics:**	**9**
Introduction to model the skeletal system using open source software– human leg prosthesis and normal gait vs prosthesis leg analysis - upper extremity kinematic model		

Total:45

TEXT BOOK:

1. Graham M. Brooker, "Introduction to Bio-Mechatronics", Sci Tech Publishing, New Delhi, 2012.

REFERENCES:

1. Raymond Tong Kaiyu, "Bio-mechatronics in Medicine and Healthcare", CRC Press, US, 2011.
2. Jacob Segil, "Handbook of Biomechatronics", Academic Press, US, 2018.
3. Leslie Cromwell, Fred J. Weibell & Erich A. Pfeiffer, “Bio-Medical Instrumentation and Measurements”, 2nd Edition, Pearson Education, New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	summarize the application of mechatronics in medicine	Understanding (K2)
CO2	explain the control mechanisms of biological systems	Understanding (K2)
CO3	explain the working of prosthetic and orthotic devices	Understanding (K2)
CO4	select appropriate dynamic models of bio mechatronic systems	Applying (K3)
CO5	apply computing tools to analyzing kinematic model	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2	1	1		1							2	3
CO2	1	2	3	1		2							2	3
CO3	1	2	3	1		2							2	3
CO4	2	2	3	3		2							2	3
CO5	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	40	30				100
CAT2	20	50	30				100
CAT3	20	30	50				100
ESE	20	40	40				100

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

18MTE12 - 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 perspective.	
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.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	summarize 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	explain the concepts of condition monitoring techniques	Understanding (K2)
CO4	apply the condition monitoring technique for the machine tool among vibration, acoustic emission and sound analysis	Applying (K3)
CO5	summarize the concepts of automatic control in 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)**

18MTE13 - 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: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the finite element concepts used for designing engineering components	Applying (K3)
CO2	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)**

18MTE14 - 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, rapid manufacturing 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	apply the concepts of rapid prototyping in product design and development	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)**

18MTE15 - CYBER PHYSICAL SYSTEMS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Sensors and Transducers, 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 -Countermeasures -System Theoretic Approaches- Examples of Security and Privacy in Action- Approaches to Secure Cyber-Physical Systems- Ongoing Security and Privacy Challenges for CPSs.		
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 and its potential, 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	40	40				100
ESE	25	50	25				100

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

18MTE16 - 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: On completion of the course, the students will be able to		**BT Mapped (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	10	70	20				100
ESE	20	60	20				100

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

18MTE17 - ROBOT PROGRAMMING

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Problem Solving and Programming, Programmable Automation Controllers	7	PE	3	0	0	3

Preamble	This course enables the student as industry ready robot programmer and Application engineer for Manufacturing.	
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:**	**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.		
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 – Costing.		

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)**

18MTE18 - MAINTENANCE ENGINEERING
(Common to Mechanical and Mechatronics Branches)

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

Preamble	This course enable the student to understand the principles, functions and practices adapted in industry for the successful management of maintenance activities and repair of machine elements	
Unit - I	**Principles and Maintenance System Planning:**	**9**
Introduction to repair and Maintenance – Maintenance as business – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems: Maintenance systems – reactive, preventive or proactive systems – Maintainability – Inherent and overall availability – Mean time between failures, Mean time to repairs and mean down time.		
Unit - II	**Condition Based Maintenance:**	**9**
Introduction to Condition based monitoring of equipment and systems; Condition Monitoring Techniques -Vibration analysis– Ultrasonic detection techniques -Thermograph - lubrication methods and its analysis – Motor condition monitoring (MCM); Cost comparison with and without CM; On-load testing and off-load testing methods – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis.		
Unit - III	**Maintenance Techniques:**	**9**
Total Productive Maintenance (TPM) –Relationship between Overall Equipment Effectiveness (OEE) and world class Maintenance – seven modern tools –applications - Ladder of Maintenance improvement–Computerized online health monitoring of machine–data acquisition for effective management of Computerized Maintenance Management System (CMMS).		
Unit - IV	**Failure Analysis and Reliability Engineering and Safety in Maintenance:**	**9**
Defect/failure definition; Failure - rate –mode -reporting – date collection; Failure analysis - tools –fault tree analysis - event tree analysis-Root cause analysis – FMEA – FMECA - System Reliability- series, parallel and mixed configuration – reliability increasing techniques. Safety – Definition – methods of enhancing safety – modern industrial scenarios- safety tools – case studies.		
Unit - V	**Repair Methods of Mechanical and Electrical Equipment:**	**9**
Plain bearings – Rolling element bearings – Flexible coupling and chains for power transmission – overhead and gantry cranes – chain hoists – belt drives. Electrical motors – Maintenance of motor control components – Maintenance of Industrial Batteries.		

Total:45

TEXT BOOK:

1. Srivastava S.K., "Industrial Maintenance Management", 6th Edition, S. Chand & Co, New Delhi, 2016.

REFERENCES:

1. Bhattacharya S.N., "Installation, Servicing and Maintenance", 2nd Edition, S.Chand & Co, New Delhi, 2015.
2. Keith Mobley R., "Maintenance Engineering Handbook", 8th Edition, McGraw Hill Professional, New Delhi, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the principles and functions of maintenance in industry	Understanding (K2)
CO2	interpret the various condition based maintenance principles	Understanding (K2)
CO3	plan and implement maintenance management systems	Understanding (K2)
CO4	synthesize the functional concepts of reliability and safety engineering	Understanding (K2)
CO5	apply various repair methods in basic machine elements	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

18MTE19 - COMPUTER INTEGRATED MANUFACTURING

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Manufacturing Processes, CNC and Metrology, Programmable Automation Controllers	7	PE	3	0	0	3

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

Total:45

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	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)**

18MTE20 - 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	**Engine and Emission Control 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 lightings.		

Total:3

TEXT BOOK:

1. Tom Denton, "Automobile Electrical and Electronics Systems", 5th Edition, Routledge Taylor and Francis Publishers, London, 2018.

REFERENCES:

1. Ribbens William B, "Understanding Automotive Electronics", 8th Edition, Butterworth- Heinemann, Burlington, 2017.
2. James D Halderman, "Automotive Electricity and Electronics", 5th Edition, Pearson Education, New York, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	adapt to the continuous changes in emission norms of India and its supporting electronic systems	Understanding (K2)
CO2	identify the various sensors and actuators for automotive applications	Understanding (K2)
CO3	explain the use of electronic ignition and injection system in automobiles	Understanding (K2)
CO4	evaluate the performance of ECU used in engine management system	Applying (K3)
CO5	apply the concepts of chassis and safety systems for automobile up gradation	Applying (K3)

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

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

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

18MTE21 - MICRO ELECTRO MECHANICAL SYSTEMS
(Common to Mechatronics, Mechanical and Automobile Branches)

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics, Engineering Mechanics, Sensors and Transducers	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: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	express Scaling laws of micro system	Applying (K3)
CO2	interpret the concepts of micro sensors and micro actuators	Understanding (K2)
CO3	choose the fabrication process of microsystem	Applying (K3)
CO4	identify the micro machining process and packaging	Applying (K3)
CO5	design and develop the micro system for various applications	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2									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	30	10			100
CAT2	20	40	30	10			100
CAT3	10	40	30	20			100
ESE	20	30	30	20			100

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

18MTE22 - MOBILE ROBOTICS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Problem Solving and Programming & Robot Kinematics and 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:**	**9**
Mobile Robots – 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: the design space- Wheeled locomotion: case studies.		
Unit - IV	**Perception and Localization:**	**9**
Sensors for mobile robots – Representing Uncertainty - Feature Extraction - Mobile robot localization - Challenge of Localization: Noise and Aliasing - Map Representation - Probabilistic Map-based Localization - Probabilistic Map-Based Localization.		
Unit - V	**Planning and Navigation:**	**9**
Introduction- Competences for Navigation: Planning and Reacting- Navigation Architectures- Modularity for code reuse and sharing- Control localization- Techniques for decomposition- Case studies: tiered robot architectures.		

Total:45

TEXT BOOK:

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

REFERENCES:

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

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

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

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

18MTE23 - DRONE TECHNOLOGY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Robot Kinematics and 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: 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	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	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)**

18MBE49 - ENTREPRENEURSHIP DEVELOPMENT

(Common to All BE/BTech Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Economics and Management	8	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)**

18MBE49 - ENTREPRENEURSHIP DEVELOPMENT
(Common to All Engineering and Technology Branches)

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

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

Total:45

TEXT BOOK:

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

REFERENCES:

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

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

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

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

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

18MTE24 - 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 knowledge on new product planning, concept development, industrial design and prototype development	
Unit - I	**Development Processes and Organizations:**	**9**
Introduction to New Product and Product design- Characteristics of successful product – 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 assembly; Prototyping – Principles – Technologies – planning for prototypes -Robust design – process flow.		

Total:45

TEXT BOOK:

1. Eppinger, S.D.& Ulrich, K.T. , "Product design and development", 6th Edition, McGraw-Hill Higher Education, New Delhi, 2016.

REFERENCES:

1. Devdas Shetty, "Product Design For Engineers", Cengage Learning, Boston, 2015.
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 assembly 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	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)**

18MTE25 - 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 in demand forecasting for production management,. Also develop skills to identify plant location, material handling system and implementation of aggregate planning, supply chain, lean and agile system.	
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. Case study in E-waste supply chain 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. Panneerselvam R, "Production and Operations Management", 3rd Edition, PHI learning, New Delhi, 2012.

REFERENCES:

1. Buffa E.S & Sarin R.K, "Modern Production / Operations Management", 8th Edition, Wiley India Pvt. Ltd, New Delhi, 2013.
2. Devadhasan S.R , Mohansivakumar V, Murugesh R & Shalij P.R, "Lean and Agile Manufacturing- Theoretical, Practical and Research Futurities", PHI Learning, New Delhi, 2012.
3. Sunil Chopra & Peter Meindl, "Supply Chain Management – Strategy, Planning and Operation", 5th Edition, Prentice Hall, New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	adapt production planning concepts and forecast the demand	Understanding (K2)
CO2	select proper location for a plant and design the layout	Applying (K3)
CO3	develop aggregate and facility requirement plan for a manufacturing company	Understanding (K2)
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	40	40				100
CAT3	20	40	40				100
ESE	25	40	35				100

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

18MTE26 - NANOSCIENCE AND TECHNOLOGY

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	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)**

18MTE27 - AVIONICS

Programme & Branch	B.E. & Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Sensors and Transducers, 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.

REFERENCES:

1. Albert Helfrick.D, "Principles of Avionics", 3rd Edition, Avionics Communications Inc, USA, 2004.
2. Cary R .Spitzer, "The Avionics Handbook", 1st Edition, Springer science Business media LLC, USA, 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	built digital avionics architecture	Applying (K3)
CO2	integrate avionics system using digital data buses	Applying (K3)
CO3	apply various cockpit display technologies for avionics	Applying (K3)
CO4	design and build navigation systems	Applying (K3)
CO5	design fly-by-wire and auto pilot systems	Applying (K3)

Mapping of COs with POs and PSOs

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

18MTE28 - 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 equipments	
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 - Field Capacities & Economics. 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 - Threshing Mechanics - Types of Threshers - Straw Combines - Grain Combines - Maize Harvesting - Shelling 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 equipments	Understanding (K2)
CO2	illustrate the working of tillage equipments	Applying (K3)
CO3	identify the fertilizer application equipments and explain its working construction	Applying (K3)
CO4	explain the cutting mechanisms for various crops	Applying (K3)
CO5	illustrate the principle of harvesting equipments 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	1	1
CO2	3	2	1							1		1	1	1
CO3	3	2	1							1		1	1	1
CO4	3	2	1							1		1	1	1
CO5	3	2	1							1		1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

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

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

18MTO01 - DESIGN OF MECHATRONICS SYSTEMS
(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Branches except Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	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:**	**9+3**
Introduction to Mechatronics systems - 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	10	45	45				100

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

18MTO02 - FACTORY AUTOMATION
(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Branches except Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	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, power electronics devices: DIAC, TRIAC, power MOSFET and IGBT.		
Unit - II	**Communication and control systems:**	**9**
Man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.		
Unit - III	**Programmable logic 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, 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", 4th Edition, Pearson Education, New Delhi, 2016.

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 operations 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 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	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	40	10			100
CAT3	20	30	40	10			100
ESE	15	25	40	20			100

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

18MTO03 - DATA ACQUISITION AND VIRTUAL INSTRUMENTATION
(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Branches except Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	2	4

Preamble	Introduces the principles in programming technique with different instrument interfaces. The study on virtual instruments and the basics of data acquisition system introduced in real time systems are discussed.	
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, 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.	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 programming 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)**

18MTO04 - 3D PRINTING AND DESIGN
(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Branches except Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	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 using this technique in Industry 4.0 environment.	
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**
Polymers, 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. Gibson I., Rosen D. W. & Stucker B., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, USA, 2010.

REFERENCES:

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, London, 2011.
2. Sabrie Soloman, "3D Printing and Design", Khanna Publishing House, Delhi, 2020.

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

18MTO05 - DRONE SYSTEM TECHNOLOGY
(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Branches except Mechatronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	OE	3	0	0	3

Preamble	This course strives to identify and introduce Drones or UAVs (Unmanned Aerial Vehicles) as piloted by remote control or on board computers through computer vision and artificial intelligence technologies.	
Unit - I	**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	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	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)**

18MTO06 - ROBOTICS
(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech 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 etc. 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)**

18MTO07 - VIRTUAL AND AUGMENT REALITY IN INDUSTRY 4.0
(Offered by Department of Mechatronics Engineering)

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

Preamble	This course familiarize the basics concept of virtual reality and also analyse the kinematics and dynamics behaviours 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 – The virtual environment – the Computer environment – VR Technology – Model of interaction – VR Systems		
Unit - IV	**VR Hardwares & Softwares:**	**9**
Human factors : Introduction – the eye - the ear- the 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 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	Understanding (K2)
CO4	apply computing tools to development of VR environment	Applying (K3)
CO5	develop Virtual Reality applications in Manufacturing	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	2	2	1	2						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	40	20				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)**

18GEO04 - INNOVATION AND BUSINESS MODEL DEVELOPMENT

(Offered by Department of Mechatronics Engineering)

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

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

Total:45

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18MAO01 - MATHEMATICAL FOUNDATIONS OF MACHINE LEARNING

(Offered by Department of Mathematics)

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

Preamble	To impart the basic knowledge in linear algebra, decomposition of matrices, continuous optimization, linear regression and support vector machines which provide the foundations for machine learning and deep learning.	
Unit - I	**Vector Spaces:**	**9+3**
Definition – Subspaces – Linear dependence and independence – Basis and dimension – Row space, Column space and Null Space – Rank and nullity		
Unit - II	**Linear Transformations:**	**9+3**
Introduction – Kernel and range – Matrices of linear transformations – Change of basis – Rank and nullity.		
Unit - III	**Inner Product Spaces:**	**9+3**
Norms – Inner products – Length and Distance – Angle and Orthogonality – Orthonormal Basis – Gram-Schmidt Process – QR-Decomposition – Orthogonal Projection – Rotations.		
Unit - IV	**Matrix Decomposition And Continuous Optimization:**	**9+3**
Cholesky decomposition – Singular Value Decomposition, Continuous Optimization: Introduction – Unconstrained Optimization – Gradient Descent method – Constrained Optimization – Lagrange Multipliers method – Convex Optimization		
Unit - V	**Linear Regression And Support Vector Machines:**	**9+3**
Parameter Estimation – Maximum Likelihood estimation – Bayesian linear regression – Bayesian parameter estimation of Gaussian distribution, Support Vector Machines: Introduction – Margin and support vectors – Kernels – Primal support vector machine – Dual support vector machine.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

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

REFERENCES:

1. David C. Lay, Steven R. Lay and Judith McDonald, "Linear Algebra and its Applications", 5th Edition, Pearson Education, New Delhi, 2016.
2. Ethem Alpaydin, "Introduction to Machine Learning(Adaptive Computation and Machine Learning series)", 4th Edition, MIT Press, USA, 2020.
3. Duda R.O., Hart E. and Stork D.G., "Pattern Classification", 2nd Edition, John Wiley and Sons, New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the concepts of vector spaces.	Understanding (K2)
CO2	apply the concepts of linear mappings in machine learning.	Applying (K3)
CO3	use the concept of inner product space and decompose the given matrix by means of orthonormal vectors.	Applying (K3)
CO4	apply the knowledge of factorisation of matrices and optimization techniques in clustering and classification of data.	Applying (K3)
CO5	describe the concepts of parameter estimation and support vector machine.	Applying (K3)

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

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	50	40				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	5	25	70				100

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

18MAO02 - GRAPH THEORY AND ITS APPLICATIONS

(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	OE	3	1	0	4

Preamble	To develop rigorous logical thinking and analytical skills by graph theoretic concepts which helps for solving real time engineering problems in networks, computer architecture, compiling techniques, model checking, artificial intelligence, software engineering, expert systems, software/hardware correctness problem.	
Unit - I	**Graphs:**	**9+3**
Introduction – Definition – Types of graphs – Degree of vertex – Walk, path and cycle – Isomorphism – Connected graph – Hamiltonian graph – Euler graph – Digraph – Representations of graphs: Adjacency matrix – Incidence matrix.		
Unit - II	**Trees:**	**9+3**
Introduction – Properties of trees – Pendant vertices in a tree – Distances and centers in a tree – Rooted and binary trees – Spanning tree – Construction of spanning tree: BFS algorithm – DFS algorithm – Tree traversal.		
Unit - III	**Graph Coloring:**	**9+3**
Vertex coloring – Chromatic number – Chromatic partitioning – Independent sets – Chromatic polynomial – Matching – Covering – Four color problem (statement only) – Simple applications.		
Unit - IV	**Basic Algorithms:**	**9+3**
Shortest paths – Shortest path algorithms: Dijkstra's algorithm – Warshall's algorithm – Minimum Spanning tree – Minimal spanning tree algorithms: Prim's algorithm – Krushkal's algorithm – Optimal assignment – Kuhn and Munkres algorithm – Travelling salesman problem: Two optimal algorithm – Closest Insertion Algorithm.		
Unit - V	**Network Flows and Applications:**	**9+3**
Flows and cuts in networks - Max-flow Min-cut Theorem – Algorithms: Flow Augmenting Path – Ford-Fulkerson Algorithm for Maximum Flow – Edmonds and Karp algorithm.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

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

REFERENCES:

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

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

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

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

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

18MAO03 - NUMBER THEORY AND CRYPTOGRAPHY

(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	OE	3	1	0	4

Preamble	To provide the skills for applying various number theoretic algorithms, congruences, primality tests in cryptography and network security and impart knowledge of basic cryptographic techniques.	
Unit - I	**Divisibility Theory and Canonical Decompositions:**	**9+3**
Division algorithm- Base-b representations – number patterns – Prime and composite numbers – Fibonacci and Lucas numbers – Fermat numbers – GCD – Euclidean Algorithm – Fundamental theorem of Arithmetic – LCM.		
Unit - II	**Theory of Congruences:**	**9+3**
Basic concepts – Properties of congruences – Linear congruences – Solution of congruences – Fermat's Little theorem – Euler's theorem – Chinese remainder theorem.		
Unit - III	**Number Theoretic Functions:**	**9+3**
Introduction – Functions τ and σ– Mobius function – Greatest integer function – Euler's Phi function – Euler's theorem – Properties of Euler's function – Applications to Cryptography.		
Unit - IV	**Primality Testing and Factorization:**	**9+3**
Primality testing: Fermat's pseudo primality test – Solvay-Strassen test – Miller-Rabin test – Fibonacci test – Lucas test – Integer factorization: Trial division – Pollard's Rho method – Quadratic sieve method.		
Unit - V	**Classical Cryptographic Techniques:**	**9+3**
Introduction – Substitution techniques – Transposition techniques – Encryption and decryption – Symmetric and asymmetric key cryptography – Steganography.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Thomas Koshy, "Elementary Number Theory with Applications", 2nd Edition, Academic Press, Elsevier, USA, 2007 for Units I, II, III.
2. William Stallings, "Cryptography and Network Security: Principles and Practice", 7th Edition, Pearson Education, New Delhi, 2019 for Units IV, V.

REFERENCES:

1. Ivan Niven, Herbert S. Zukerman & Hugh L. Montgomery, "An Introduction to the Theory of Numbers", Reprint Edition, John Wiley & Sons, New Delhi, 2008.
2. Bernard Menezes, "Cryptography and Network Security", 1st Edition, Cengage Learning India, New Delhi, 2010.

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

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

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

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

18MAO04 - ADVANCED LINEAR ALGEBRA

(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	OE	3	0	0	3

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

Total: 45

TEXT BOOK:

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

REFERENCES:

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

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

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

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

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

18MAO05 - OPTIMIZATION TECHNIQUES

(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	OE	3	0	0	3

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

Total: 45

TEXT BOOK:

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

REFERENCES:

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

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

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

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

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

18PHO01 - THIN FILM TECHNOLOGY
(Offered by Department of Physics)

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

Preamble	This course aims to impart the essential knowledge on deposition, characterization and application of thin films in various engineering fields, and also provides motivation towards innovations.	
Unit - I	**Theories and models of thin film growth:**	**9+3**
Introduction - Theories of thin film nucleation: Impingement, Adsorption and Thermal accommodation - The capillarity model - The atomistic models - Structural consequences of thin film nucleation - The four stages of film Growth - The incorporation of defects during growth.		
Unit - II	**Vacuum technology:**	**9+3**
Principle and working of vacuum pumps: Roots pump, Rotary pump, Diffusion pump, Turbo molecular pump, Cryogenic-pump, Ion pump, Ti-sublimation pump - Measurement of Pressure: Bayet-Albert gauge, Pirani and Penning gauge - Cold cathode and hot cathode ionization gauges - Pressure controlling system (qualitative).		
Unit - III	**Deposition of thin films - Physical methods:**	**9+3**
Thermal evaporation – Electron beam evaporation – Pulsed laser deposition – Ion plating – DC sputtering – RF sputtering – Magnetron sputtering – Reactive sputtering - Molecular beam epitaxy - Demonstration of deposition of thin films by RF sputtering.		
Unit - IV	**Deposition of thin films – Chemical methods:**	**9+3**
Chemical vapor deposition – Sol-gel method - Chemical bath deposition - Hydro thermal methods – Electroplating deposition - Electroless deposition - Spray Pyrolysis - Spin coating.		
Unit - V	**Characterization and Applications of thin films:**	**9+3**
Characterization: X-ray diffraction, Energy dispersive X-ray analysis, Atomic probe microscopy, UV-vis spectroscopy, Four probe resistivity – Applications (qualitative): Thin film resistors, Thin film capacitors, Thin film diodes, Thin film transistors, Thin film solar cells, Thin film gas sensors, Thin films for information storage and Optical coatings.		

Lecture:45, Tutorial:15,Total:60

TEXT BOOK:

1. Maissel L.I. and Glang R., "Hand book of Thin Film Technology", McGraw Hill Inc., 1970 for Units I,II,III, IV.
2. Zhang S., Li L. and Kumar A., "Materials Characterization Techniques", CRC Press, 2009 for Unit V.

REFERENCES:

1. Ohring M., "Material Science of Thin Films", Academic Press, 1992.
2. Goswami A., "Thin Film Fundamentals", New Age International Pvt. Ltd., 2003.
3. Chopra K.L., "Thin Film Phenomena", McGraw Hill Inc., 1969.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	utilize the appropriate theory and models to comprehend the thin film growth process.	Applying (K3)
CO2	apply the principle of vacuum pump to explain select methods to create vacuum and to make use of the principle of vacuum gauge to explain the measurement of vacuum by select methods.	Applying (K3)
CO3	describe the deposition of thin films by select physical methods using the principle of working of respective methods.	Applying (K3)
CO4	explain the deposition of thin films by select chemical methods using the principle of working of respective methods.	Applying (K3)
CO5	make use of select characterization techniques to comprehend the properties of thin films and also to illustrate the various device applications of thin films.	Applying (K3)

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

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

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

18PHO02 - STRUCTURAL AND OPTICAL CHARACTERIZATION OF MATERIALS

(Offered by Department of Physics)

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

Preamble	This course aims to impart the essential knowledge on the characterization of materials using X-ray diffraction, Raman spectroscopy, UV-visible spectroscopy, Electron microscopy and Scanning tunneling microscopy and their application in various engineering fields, and also provides motivation towards innovations.	
Unit - I	**Introduction to Characterization Techniques and X-Ray Diffraction:**	**9**
Importance of materials characterization - Classification of characterization techniques - Destructive and non-destructive techniques - Crystalline materials - Reciprocal lattice - Theory of X-ray diffraction - Powder and Single crystal X-ray diffraction: Instrumentation, XRD pattern, Systematic procedure for structure determination, Particle size determination, Strain calculation - Applications of X ray diffraction measurements.		
Unit - II	**Raman Spectroscopy:**	**9**
Introduction – Pure rotational Raman spectra – Vibrational Raman spectra – Polarization of light and Raman effect – Structure determination – Instrumentation – Near-Infra-Red FT Raman Spectroscopy.		
Unit - III	**Electron Microscopy:**	**9**
Need of Electron Microscopy - Electron Specimen interaction: Emission of secondary electrons, Backscattered electrons, Characteristic X-rays, Transmitted electrons, Specimen interaction volume - Resolution - Scanning electron microscope and Transmission electron microscope: Schematic diagram, Short details of each component and working - Field Emission Gun - Field Emission Scanning electron microscope - Merits of Transmission electron microscope.		
Unit - IV	**Scanning Tunneling Microscopy:**	**9**
Introduction to quantum mechanical tunneling - Basic principles of scanning tunneling microscopy - Two modes of scanning - Interpreting scanning tunneling microscopic images -Applications of scanning tunneling microscopy.		
Unit - V	**Ultra Violet and Visible Spectroscopy:**	**9**
Regions of UV-Visible radiation - Colour and light absorption - The chromophore concept - Beer's and Lambert's laws – Theory of electronic transition - Frank Condon principle – Instrumentation and Working of UV vis spectrometer - Applications of UV visible spectroscopy.		

Total:45

TEXT BOOK:

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

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the concept of X-ray diffraction to determine the crystal structure and related structural parameters of materials.	Applying (K3)
CO2	make use of the concept of Raman effect and Raman spectroscopy to determine the crystal structure and related structural parameters of materials.	Applying (K3)
CO3	determine the micro-structural parameters of materials and to perform surface analysis of materials using the concept of matter waves and electron microscopy.	Applying (K3)
CO4	utilize the concept and phenomenon of quantum mechanical tunneling to interpret the surface image at the atomic level recorded using scanning tunneling microscopy.	Applying (K3)
CO5	apply the theory of UV-Vis spectroscopy to comprehend the working of UV-Vis spectrophotometer.	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18CYO01 - CORROSION SCIENCE AND ENGINEERING

(Offered by Department of Chemistry)

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

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

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

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

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the importance of direct and indirect corrosion to familiarize for industrial needs.	Understanding (K2)
CO2	demonstrate the mechanism of different types of corrosion with respect to the environment.	Applying (K3)
CO3	organize the various types and theory of corrosion to understand the corrosion problems.	Applying (K3)
CO4	utilize the theories and kinetics of corrosion to interpret with the real time applications.	Applying (K3)
CO5	summarize the corrosion prevention methods to avoid corrosion related issues.	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18CYO02 - INSTRUMENTAL METHODS OF ANALYSIS

(Offered by Department of Chemistry)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	BS	3	1	0	4

Preamble	Instrumental methods of analysis aim to prepare the students to have all-encompassing knowledge of spectral methods in order to identify the molecules and reaction mechanism for the process to enhance application towards the industries.	
Unit - I	**Absorption and Emission Spectroscopy:**	**9+3**
Basic concepts of Absorption and emission spectroscopy – representation of spectra – basic elements of practical spectroscopy – signal to noise ratio - techniques for signal to noise enhancement – resolving power – Fourier transform spectroscopy – evaluation of results – basic principles, instrumentation and applications of atomic absorption, atomic fluorescence and atomic emission spectroscopy.		
Unit - II	**IR, Raman and NMR Spectroscopy:**	**9+3**
Infrared spectroscopy – correlation of IR Spectra with molecular structure, instrumentation, samplings technique and quantitative analysis. Raman Spectroscopy – Classical and Quantum theory instrumentation, Structural analysis and quantitative analysis. Nuclear magnetic resonance spectroscopy – basic principles – pulsed Fourier transform NMR spectrometer – elucidation of NMR spectra and quantitative analysis.		
Unit - III	**Surface Studies:**	**9+3**
Surface study – x-ray emission spectroscopy (XES), electron spectroscopy for chemical analysis (ESCA) - UV photo electron spectroscopy (UPS)- X- ray photo electron spectroscopy (XPS) - Auger emission Spectroscopy (AES) - Transmission Electron microscopy (TEM) - Scanning Electron microscopy (SEM) - Surface tunneling microscopy (STEM) - Atomic force microscopy (AFM).		
Unit - IV	**Mass Spectroscopy:**	**9+3**
Mass spectroscopy – Ionization methods in mass spectroscopy – mass analyzer – ion collection systems - correlation of molecular spectra with molecular structure. Instrumentation design and application of Fourier transform mass spectroscopy (FT-MS)- Inductively coupled plasma mass spectroscopy (ICP-MS) - Secondary Ion Mass Spectroscopy (SIMS) and Ion microprobe mass analyzer (IMMA).		
Unit - V	**Thermal Analysis:**	**9+3**
Thermal analysis: principles and instrumentations and applications of thermogravimetry (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), evolved gas detection, thermo mechanical analysis and Thermometric titrimetry.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

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

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate the basics of spectroscopy to understand the instrumentation of various spectral techniques.	Understanding (K2)
CO2	apply the IR, Raman and NMR for quantitative analysis of the sample.	Applying (K3)
CO3	apply the various techniques for the better understanding of surface morphology.	Applying (K3)
CO4	explain the principle, instrumentation of mass spectroscopy for the analysis of organic sample.	Understanding (K2)
CO5	illustrate the thermal analysis for the identification of thermal stability of the compounds.	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18CYO03 - WASTE AND HAZARDOUS WASTE MANAGEMENT

(Offered by Department of Chemistry)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	BS	3	0	0	3

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

Total:45

TEXT BOOK:

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

REFERENCES:

1. VanGuilder & Cliff, "Hazardous Waste Management: An Introduction", Har Cdr Edition, Mercury Learning & Information, Herndon, VA, 2011.
2. Karen Hardt, "Solid Waste Management", 1st Edition, Callisto Reference, Germany, 2018.
3. Majeti Narasimha Vara Prasad, Meththika Vithanage & Anwesha Borthakur, "Handbook of Electronic Waste Management: International Best Practices and Case Studies", 1st Edition, Butterworth-Heinemann, United Kingdom, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the technical points that are required to set up a solid waste management system.	Applying (K3)
CO2	select the various disposal methods of hazardous wastes like radioactive wastes.	Understanding (K2)
CO3	organize the appropriate method for managing e-waste and biomedical wastes.	Applying (K3)
CO4	identify to plan minimization of industrial wastes.	Applying (K3)
CO5	relate the legal legislation to solid waste management.	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18GEO01 – GERMAN LANGUAGE LEVEL 1

(Offered by Department of Electronics and Communication Engineering)

Programme& Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Basics of Language	5,6,7,8	HS	4	0	0	4

Preamble	To acquire the vocabulary as per the Common European framework of German language A1 level competence. This course will help to assimilate the basic grammar structures and gain vocabulary to understand and reciprocate in daily life situations on a broader sense. A thorough learner will be able to gain a comprehensive understanding of the German grammar and confidently articulate in day today situations.	
Unit - I	**Contacts (Kontakte):**	**12**
Understanding Letters, simple instructions, speaking about language learning, finding specific information in text, Acknowledging the theme and understanding conversations, Making appointments. Grammar – Preposition with Dative, Articles in Dative and Accusative possessive articles.		
Unit - II	**Accommodation (Die Wohnung):**	**12**
Understanding Accommodation advertisements, describing accommodation and directions, responding to an invitation, Expressing feelings, Colours. Grammar – Adjective with to be verb, Adjective with *sehr/zu*, Adjective with Accusative, prepositions with Dative		
Unit - III	**Working Environment Communication (ArbeitenSie):**	**12**
Daily Schedule, speaking about past, understanding Job openings advertisements, Opinions, Telephonic conversations, Speaking about Jobs. Grammar – Perfect tense, Participle II – regular and irregular verbs, Conjunctions – *und, oder, aber*.		
Unit - IV	**Clothes and Style (Kleidung und mode) :**	**12**
Clothes, Chats on shopping clothes, reporting on past, Orienting oneself in Supermarkets, Information and research about Berlin. Grammar – Interrogative articles and Demonstrative articles, Partizip II – separable and non-separable verbs, Personal pronouns in Dative, Verbs with Dative.		
Unit - V	**Health and Vacation (Gesundheit und Urlaub):**	**12**
Personal information, Human Body parts, Sports, Understanding instructions and prompts, health tips. Grammar – Imperative with *du/Ihr*, Modal verbs – sollen, müssen, nichtdürfen, dürfen. Suggestions for travel, Path, Postcards, weather, Travel reports, Problems in hotel, Tourist destinations. Grammar – Pronoun: *man*, Question words – *Wer, Wen, Was, Wem*, Adverbs – *Zuerst, dann, Später, ZumSchl*		

Total:60

TEXT BOOK:

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

REFERENCES:

1.	https://ocw.mit.edu – Massachusetts Institute of Technology Open Courseware Refer: German 1 for undergraduate students
2.	https://www.dw.com/en/learn-german - Deutsche Welle , Geramany's International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understanding letters and simple texts	Remembering (K1)
CO2	assimilating vocabulary on accommodation and invitation	Understanding (K2)
CO3	comprehend concept of time, telephonic conversation and job-related information	Understanding (K2)
CO4	understanding how to do shopping in a German store	Understanding (K2)
CO5	understanding body parts and how to plan personal travel	Understanding (K2)

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

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	75					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

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

18GEO02 – JAPANESE LANGUAGE LEVEL 1

(Offered by Department of Electronics and Communication Engineering)

Programme& Branch	All BE/BTech Engineering & Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Basics of Language	5,6,7,8	HS	4	0	0	4

Preamble	To understand the basics of Japanese language which provides understanding of Hiragana, Katakana and 110 Kanjis and provides the ability to understand basic conversations and also enables one to request other person and also understand Casual form	
Unit - I	**Introduction to groups of verbs:**	**12**
tai form-Verb groups-te form-Give and ask permission to do an action-Present continuous form-Restrict other person from doing an action-nouns-Basic Questions		
Unit - II	**Introduction to Casual Form:**	**12**
nai form-Dictionary form-ta form-Polite style and Casual style differences-Conversation in plain style-Place of usage of Polite style and Casual style		
Unit - III	**Express opinions and thoughts:**	**12**
Introduction to new particle-Express someone one's thought-Convey the message of one person to another-Ask someone if something is right -Noun modifications		
Unit - IV	**Introduction to If clause and Kanjis:**	**12**
If clause tara form-Express gratitude for an action done by other person-Hypothetical situation-Particles to use in case of Motion verbs-110 Kanjis		
Unit - V	**Introduction to Counters:**	**12**
How to use numbers-How to use quantifiers-Past form of adjectives and Nouns-Way to say preference-Way of expression degrees of an action-Other necessary particles-How to use numbers-How to use quantifiers-Past form of adjectives		

Total:60

TEXT BOOK:

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

REFERENCES:

1. MargheritaPezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2. Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	read and understand typical expression in Hiragana and Katakana	Remembering (K1)
CO2	understand Polite form and Casual form of Japanese	Understanding (K2)
CO3	comprehend personal communication and express greetings	Understanding (K2)
CO4	understand the Kanjis in Japanese Script	Understanding (K2)
CO5	comprehend concept of time, counters and job-related information	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18GEO03 - DESIGN THINKING FOR ENGINEERS

(Offered by Department of Computer Science and Engineering)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Problem Solving and Programming	7	OE	3	0	0	3

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

Total:45

TEXT BOOK:

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

REFERENCES:

1. Lee Chong Hwa, "Design Thinking The Guidebook", Design Thinking Master Trainers of Bhutan, 2017.
2. Jeanne Liedtka, Tim Ogilvie, and Rachel Brozenske, "The Designing for Growth FieldBook: A Step-by-Step Project Guide", Columbia University Press, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	outline the basic concepts of design thinking	Understanding (K2)
CO2	make use of the mind mapping process for designing any system	Applying (K3)
CO3	develop many creative ideas through structured brainstorming sessions.	Applying (K3)
CO4	develop rapid prototypes to bring the ideas into reality	Applying (K3)
CO5	plan the implementation of the any system considering the real time feedback	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18GEO04 - INNOVATION AND BUSINESS MODEL DEVELOPMENT

(Offered by Department of Mechatronics Engineering)

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

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

Total:45

TEXT BOOK:

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

REFERENCES:

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

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

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18GEO05 - GERMAN LANGUAGE LEVEL 2

(Offered by Department of Electronics and Communication Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	German Language Level 1	**5/6/7/8**	**HS**	**4**	**0**	**0**	**4**

Preamble	This course aims to help the learner to acquire the vocabulary as per the Common European framework of German language A1 level competence. This course will help to assimilate the basic grammar structures and gain vocabulary to understand and reciprocate in daily life situations on a broader sense. A thorough learner will be able to gain a comprehensive understanding of the German grammar and confidently articulate in day today situations.	
Unit - I	**Contacts(Kontakte):**	**12**
Understanding Letters, simple instructions, speaking about language learning, finding specific information in text, Acknowledging the theme and understanding conversations, Making appointments. Grammar – Preposition with Dative, Articles in Dative and Accusative possessive articles.		
Unit - II	**Accomodation(Die Wohnung):**	**12**
Understanding Accommodation advertisements, describing accommodation and directions, responding to an invitation, Expressing feelings, Colours. Grammar – Adjective with to be verb, Adjective with *sehr/zu*, Adjective with Accusative, prepositions with Dative		
Unit - III	**Are you Working?(Arbeiten Sie):**	**12**
Daily Schedule, speaking about past, understanding Job openings advertisements, Opinions, Telephonic conversations, Speaking about Jobs. Grammar – Perfect tense, Participle II – regular and irregular verbs, Conjunctions – *und, oder, aber*.		
Unit - IV	**Clothes and Style(Kleidung und mode):**	**12**
Clothes, Chats on shopping clothes, reporting on past, Orienting oneself in Supermarkets, Information and research about Berlin. Grammar – Interrogative articles and Demonstrative articles, Partizip II – separable and non-separable verbs, Personal pronouns in Dative, Verbs with Dative		
Unit - V	**Health and Vacation(Gesundheit und Urlaub):**	**12**
Personal information, Human Body parts, Sports, Understanding instructions and prompts, health tips. Grammar – Imperative with *du/Ihr*, Modal verbs – sollen, müssen, nicht dürfen, dürfen. Suggestions for travel, Path, Postcards, weather, Travel reports, Problems in hotel, Tourist destinations. Grammar – Pronoun: *man*, Question words – *Wer, Wen, Was, Wem*, Adverbs – *Zuerst, dann, Später, Zum Schl*		

Total: 60

TEXT BOOK:

1	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, “Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs”, Goyal Publishers, Delhi, 2015.

REFERENCES:

1	https://ocw.mit.edu – Massachusetts Institute of Technology Open Courseware
2	https://www.dw.com/en/learn-german - Deutsche Welle , Geramany’s International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand letters and simple texts	Remembering (K1)
CO2	assimilate vocabulary on Accommodation and invitation	Understanding (K2)
CO3	comprehend concept of time, telephonic conversation and job-related information	Understanding (K2)
CO4	understand how to do shopping in a German store	Understanding (K2)
CO5	understand body parts and how to plan personal travel	Understanding (K2)

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

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

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

18GEO06 - GERMAN LANGUAGE LEVEL 3

(Offered by Department of Electronics and Communication Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	German Language Level 2	5/6/7/8	HS	3	0	0	3

Preamble	This course provides enriching information about various everyday situations in personal and professional life and enhances the vocabulary and speaking ability to respond to and also seek information in those situations. It also equips one to express opinions and negotiate appointments. With diligent learning one can capture all basic grammatical structure to answer confidently in everyday situations.	
Unit - I	**All about food (Rund Ums Essen):**	**9**
Understand information about person, Speak about food, Introduce self and others, Understand and explain a picture base story, To justify something, To speak about feelings, To express opinions, To answer questions on a text, To describe a restaurant. Grammar: Possessive Articles in Dative, Yes/No questions, Reflexive verbs, Sentence with 'weil'		
Unit - II	**School days (Nach der Schulzeit):**	**9**
Understand School reports, Speak and write comments about schooldays, To speak about habits, Understand and provide City-Tipps, To Understand School types in Germany and speak about it. Grammar: Modal verbs in Past tense, Positional Verbs, Two-way prepositions in Dativ and Akkusativ.		
Unit - III	**Media in everyday life (Medien in Alltag):**	**9**
To speak about advantages and disadvantages of Media, formulate comparisons, Express your own opinion, Talk about Movies, Understand and Write Movie reviews. Grammar: Comparative degree, Comparative Sentences with 'Als' and 'Wie', Subordinate clause with 'dass', Superlative degree.		
Unit - IV	**Feelings and expressions (Gefühle):**	**9**
Express thanks and congratulations, Talk about feelings, To understand information about festivals and speak about it, To describe a city, Express joy and regrets, Understand and write Blog entries, Write appropriate heading. Grammar: Subordinate Clause with 'Wenn', Adjectives to be used along with definite articles.		
Unit - V	**Profession and Travel (Beruf und Reisen):**	**9**
To have a conversation at ticket counter, To talk about leisure activities, To gather information from Texts, Introduce people, Express career preferences, Ideate the dream job, To prepare and make telephone calls, To understand text about Workplace. Ask for information, Express uncertainty, Understand and give directions, Understand a newspaper article, Say your own opinion, Talk about the way to work, Describe a statistic, Understand information about a trip, Talk about travel. Grammar: Adjective to be used along with indefinite articles, Prepositions, verb – 'werden', Subordinate clause – indirect questions, All units will include elements for reading, writing, speaking and listening.		

Total: 45

TEXT BOOK:

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

REFERENCES:

1. Rosa-Maria Dallapiazza , Eduard von Jan, Till Schonherr, "Tangram 2 (German)" , Goyal Publishers, Delhi, 2011.
2. https://www.dw.com/en/learn-german - Deutsche Welle , Geramany's International Broadcaster

	COURSE OUTCOMES: On completion of the course, the students will be able to	**BT Mapped (Highest Level)**
CO1	understand German food style, restaurant and be able express oneself.	Remembering (K1)
CO2	understand German school system and discuss about habits and provide City-Tipps.	Understanding (K2)
CO3	analyze and compare media in everyday life.	Understanding (K2)
CO4	express feelings, describe a city and write blog entries.	Understanding (K2)
CO5	seek and provide information in a professional setup, give directions to others and talk about travel.	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18GEO07 - GERMAN LANGUAGE LEVEL 4

(Offered by Department of Electronics and Communication Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	German Language Level 3	5/6/7/8	HS	3	0	0	3

Preamble	This course imparts knowledge about interacting with external world, understanding various cultural aspects, behaviour and addressing relationships in personal and professional front. It helps one to understand reports from various media and at work. Enhance learner's grammatical exposure and cover the core basic grammatical concepts which would lay the foundation to have a better hold of the language. With focused learning one should be able to read and respond to reports, write simple formal and informal letters and text messages and be able to engage in simple conversations in known situations.	
Unit - I	**Learning (Lernen):**	**9**
Understanding and describing learning problems, Understanding and giving advice, Giving reasons, Understanding reports about everyday work life, Talking about everyday working life, Understanding a radio report, Understanding and making a mini-presentation. Grammar: Conjunctions- denn,weil, Konjuntiv II: Sollte(suggestions), Genitive, Temporal prepositions – bis, über + Akkusativ,ab+dativ		
Unit - II	**Athletic (Sportlich):**	**9**
Expressing enthusiasm, hope, disappointment, Understanding and writing fan comments, Formulating follow-ups, Making suggestions and reacting, Making an appointment, Understanding a report about an excursion, Understanding difficult texts, Introducing a tourist attraction. Grammar: Conjunctions – deshalb, trotzdem, Verbs with Dativ and Akkusativ		
Unit - III	**Living Together (Zusammen Leben):**	**9**
To complain, apologize & give in, As for something, Understand experience reports, Report on the past, Talk about pets, Respond to information, Write and correct a story. Grammatik: Konjunctiv II- könnte, Subordinate clauses – als and Wenn.		
Unit – IV	**Good Entertainment (Gute Unterhaltung):**	**9**
Talk about music style, Buy concert tickets, Introduce a musician / band, Understand newspaper reports, Give more detailed information about a person, Understand information about painting, Understand description of a picture, Describe a picture. Grammatik: Interrogative Articles: Was fuer eine? , Pronouns – man/jemand/niemand and alles/etwas/nichts , Relative sentences in Nominativ.		
Unit - V	**Passage of time and Culture (Zeitablauf & Kultur):**	**9**
Talk about wishes, Express wishes, Give Suggestions, Understand a conversation, Plan something together, To ask others something, Understand a text, Exchange information, Talk about proverbs, write a story. Understand information about other cultures, Discuss about behavior, Express intentions, Use the appropriate salutation, Understand tips in a text, Talk about forms of addressing others, Give more information, Discuss about clichés and write about them. All units will include elements for reading, writing, speaking and listening. Grammatik: Konjunctiv II (Wishes, Suggestions), Verbs with prepositions, W- questions with prepositions, Relative sentences in Akkusativ, Subordinate clauses with damit and Um…Zu.		

Total: 45

TEXT BOOK:

1. Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, "Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch", Goyal Publishers, Delhi, 2015.

REFERENCES:

1. Rosa-Maria Dallapiazza, Eduard von Jan, Till Schonherr, "Tangram 2 (German)", Goyal Publishers, Delhi, 2011.
2. https://www.dw.com/en/learn-german - Deutsche Welle, Geramany's International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	leverage learning in Workplace, understanding reports and make presentation.	Remembering (K1)
CO2	reciprocate to different situations, make appointment and understand texts.	Understanding (K2)
CO3	handle relationships and respond appropriately to exchange information	Understanding (K2)
CO4	familiarize to various channels of entertainment	Understanding (K2)
CO5	know about various cultural aspects, usage of proverbs and cliches.	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18GEO08 - JAPANESE LANGUAGE LEVEL 2

(Offered by Department of Electronics and Communication Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Japanese Language Level 1	5/6/7/8	HS	4	0	0	4

Preamble	The basic level of Japanese which provides understanding of Hiragana, Katakana and 110 Kanjis and provides the ability to understand basic conversations and also enables one to request other person and also understand Casual form	
Unit - I	**Introduction to groups of verbs:**	**12**
tai form-Verb groups-te form-Give and ask permission to do an action-Present continuous form-Restrict other person from doing an action-nouns-Basic Questions		
Unit - II	**Introduction to Casual Form:**	**12**
nai form-Dictionary form-ta form-Polite style and Casual style differences-Conversation in plain style-Place of usage of Polite style and Casual style		
Unit - III	**Express opinions and thoughts:**	**12**
Introduction to new particle-Express someone one's thought-Convey the message of one person to another-Ask someone if something is right -Noun modifications		
Unit - IV	**Introduction to If clause and remaining Kanjis:**	**12**
If clause tara form-Express gratitude for an action done by other person-Hypothetical situation-Particles to use in case of Motion verbs-50 Kanjis		
Unit - V	**Introduction to giving and receiving with te form and "when, even if" usages:**	**12**
Providing to and getting from differences - Understanding of situations and framing sentences using when and even if..etc.		

Total: 60

TEXT BOOK:

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

REFERENCES:

1. Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2. Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	differentiate groups of verbs and its forms	Remembering (K1)
CO2	understand Polite form and Casual form of Japanese	Understanding (K2)
CO3	comprehend personal communication and express greetings	Understanding (K2)
CO4	understand the Kanjis in Japanese Script and If clause	Understanding (K2)
CO5	comprehend concept of “even if”, “when” and job-related information	Understanding (K2)

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

ASSESSMENT PATTERN - THEORY							
Test / Bloom’s Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

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

18GEO09 - JAPANESE LANGUAGE LEVEL 3

(Offered by Department of Electronics and Communication Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Japanese Language Level 2	5/6/7/8	HS	3	0	0	3

Preamble	The intermediate level of Japanese which provides understanding of all forms ofverbs, adverbs, conjunctions, etc. which includes 150 Kanji's and provides the ability to comprehend conversations encountered in daily life	
Unit - I	**Introduction to Potential verbs:**	**9**
Causes and Reasons-Favouring Expressions-Expressing a State-Potential Verb Sentences-Simultaneous actions-Verb Groups-te Form-Customary Actions-Nouns-Basic Questions and Kanji's.		
Unit - II	**Introduction to Transitive and Intransitive verbs:**	**9**
Consequence of verbs- Embarrassment about Facts- Consequence of Verbs with an Intentions-Affirmative Sentences-Conjunctions-Basic Questions and kanji's.		
Unit - III	**Introduction to Volitional forms:**	**9**
Expressions of Speakers Intention-Expressing Suggestion or Advice-Usage of Adverbs and Quantifiers-Basic Questions and kanji's.		
Unit - IV	**Introduction to Imperative and Prohibitive verbs:**	**9**
Commanding person- Interrogatives-Expressions of Third Person-Actions and its Occurrence - Possibilities of an Action-Changing of States Basic Questions and Kanji's.		
Unit - V	**Introduction to Conditional form and Passive verbs:**	**9**
Description of Requirement and Speaker's Judgement, HabitualActions, Directions and suggestions-Passive forms of Verbs-Basic Questions and Kanji's.		

Total: 45

TEXT BOOK:

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

REFERENCES:

1. Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2. Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	read and understand BasicVocabularies.	Remembering (K1)
CO2	understand Conversations used in daily life.	Understanding (K2)
CO3	comprehend personal communication and express greetings.	Understanding (K2)
CO4	understand the Kanji's in Japanese Script.	Understanding (K2)
CO5	comprehend Coherent conversations in everyday situations.	Understanding (K2)

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

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

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

18GEO10 - JAPANESE LANGUAGE LEVEL 4

(Offered by Department of Electronics and Communication Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Japanese Language Level 3	5/6/7/8	HS	3	0	0	3

Preamble	The intermediate level of Japanese provides understanding of expressions of verbs, its pattern, Relationships which also includes 150 Kanji's and also provides the ability to understand relationship among the people.	
Unit - I	**Introduction to Reasoning:**	**9**
Causes and Sequences-Causes and Effects-Interrogative Patterns-Adjective as a Noun -Basic Questions and Kanji's.		
Unit - II	**Introduction to Exchanging of things:**	**9**
Expressions for Giving and Receiving of Things-Polite Expression of Request-Indicating a Purpose of Actions-Basic Quantifiers-Basic Questions and kanji's.		
Unit - III	**Introduction to States of an Action:**	**9**
Sentence Pattern to Indicate Appearance-Degree of Action and State-Adjectives as Adverbs- Convey information -Basic Questions and kanji's.		
Unit - IV	**Introduction to Causative Verbs:**	**9**
Causative Forms of Verbs-Asking Opportunity to do something-Hypothetical Questions-Judgement and Course of an actions-Basic Questions and Kanji's.		
Unit - V	**Introduction to Relationship in Social Status:**	**9**
Honorific expressions- Respectful expressions- Humble expressions-Polite expressions-Basic Questions and Kanji's.		

Total: 45

TEXT BOOK:

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

REFERENCES:

1. Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2. Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	read and Understand Relationship of a Person.	Remembering (K1)
CO2	understand Conversations Used in Everyday Activities.	Understanding (K2)
CO3	comprehend Contents at Near Natural Speed.	Understanding (K2)
CO4	understand the Kanji's in Japanese Script.	Understanding (K2)
CO5	comprehend Orally Presented Materials.	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

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

18GEO11 - NCC Studies(Army Wing) – I

(Offered by Department of Electrical and Electronics Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5 / 6	OE	3	0	2	4

Preamble	This course is designed especially for NCC Cadets. This course will help develop character, camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working in teams, learning military subjects including weapon training.	
Unit - I	**NCC Organisation and National Integration:**	**9**
NCC Organisation – History of NCC- NCC Organisation- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honours and Awards – Incentives for NCC cadets by central and state govt. National Integration- Unity in diversity- contribution of youth in nation building- national integration council- Images and Slogans on National Integration.		
Unit - II	**Basic physical Training and Drill:**	**9**
Basic physical Training – various exercises for fitness(with Demonstration)-Food – Hygiene and Cleanliness. Drill- Words of commands- position and commands- sizing and forming- saluting- marching- turning on the march and wheeling- saluting on the march- side pace, pace forward and to the rear- marking time- Drill with arms- ceremonial drill- guard mounting.(WITH DEMONSTRATION)		
Unit - III	**Weapon Training:**	**9**
Main Parts of a Rifle- Characteristics of 5.56mm INSAS rifle- Characteristics of .22 rifle- loading and unloading – position and holding- safety precautions – range procedure- MPI and Elevation- Group and Snap shooting- Long/Short range firing(WITH PRACTICE SESSION) - Characteristics of 7.62mm SLR- LMG- carbine machine gun.		
Unit - IV	**Social Awareness and Community Development:**	**9**
Aims of Social service-Various Means and ways of social services- family planning – HIV and AIDS- Cancer its causes and preventive measures- NGO and their activities- Drug trafficking- Rural development programmes - MGNREGA-SGSY-JGSY-NSAP-PMGSY-Terrorism and counter terrorism- Corruption – female foeticide -dowry –child abuse-RTI Act- RTE Act- Protection of children from sexual offences act- civic sense and responsibility		
Unit - V	**Specialized Subject (ARMY):**	**9**
Basic structure of Armed Forces- Military History – War heroes- battles of Indo-Pak war- Param Vir Chakra- Career in the Defence forces- Service tests and interviews-Fieldcraft and Battlecraft-Basics of Map reading including practical.		

Lecture :45, Practical:30, Total:75

TEXT BOOK:

1. "National Cadet Corps- A Concise handbook of NCC Cadets", Ramesh Publishing House, New Delhi, 2014.

REFERENCES:

1. "Cadets Handbook – Common Subjects SD/SW", published by DG NCC, New Delhi.
2. "Cadets Handbook- Specialized Subjects SD/SW", published by DG NCC, New Delhi.
3. "NCC OTA Precise", published by DG NCC, New Delhi.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	display sense of patriotism, secular values and shall be transformed into motivated youth who will contribute towards nation building through national unity and social cohesion.	Applying (K3)
CO2	demonstrate Health Exercises, the sense of discipline, improve bearing, smartness, turnout, develop the quality of immediate and implicit obedience of orders..	Applying (K3)
CO3	basic knowledge of weapons and their use and handling.	Applying (K3)
CO4	understanding about social evils and shall inculcate sense of whistle blowing against such evils and ways to eradicate such evils	Applying (K3)
CO5	acquaint, expose & provide knowledge about Army/Navy/ Air force and to acquire information about expansion of Armed Forces, service subjects and important battles.	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	-	-	-	-	-	-
CAT2	-	-	-	-	-	-	-
CAT3	-	-	-	-	-	-	-
ESE	The examination and award of marks will be done by the Ministry of Defence, Government of India which includes all K1 to K6 knowledge levels. The maximum marks for the End Semester Examination is 500 marks. It will be converted to 100 marks.						

18GEO12 - NCC STUDIES (AIR WING) – I

(Offered by Department of Information Technology)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5 / 6	OE	3	0	2	4

Preamble	This course is designed especially for NCC Cadets. This course will help develop character , camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working in teams, honing qualities such as self-discipline, self-confidence, self-reliance and dignity of labour in the cadets.	
Unit – I	**NCC Organization and National Integration:**	**9**
NCC Organization – History of NCC- NCC Organization- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honors' and Awards – Incentives for NCC cadets by central and state govt. History and Organization of IAF-Indo-Pak War-1971-Operation Safed Sagar. National Integration- Unity in diversity- contribution of youth in nation building- national integration council- Images and Slogans on National Integration.		
Unit – II	**Drill and Weapon Training:**	**9**
Drill- Words of commands- position and commands- sizing and forming- saluting- marching- turning on the march and wheeling- saluting on the march- side pace, pace forward and to the rear- marking time- Drill with arms- ceremonial drill- guard mounting.(WITH DEMONSTRATION). Main Parts of a Rifle- Characteristics of .22 rifle- loading and unloading – position and holding- safety precautions – range procedure- MPI and Elevation- Group and Snap shooting- Long/Short range firing (WITH PRACTICE SESSION).		
Unit – III	**Principles of Flight:**	**9**
Laws of motion-Forces acting on aircraft–Bernoulli's theorem-Stalling-Primary control surfaces – secondary control surfaces-Aircraft recognition.		
Unit - IV	**Aero Engines:**	**9**
Introduction of Aero engine-Types of engine-piston engine-jet engines-Turboprop engines-Basic Flight Instruments-Modern trends.		
Unit – V	**Aero Modeling:**	**9**
History of aero modeling-Materials used in Aero-modeling-Types of Aero-models – Static Models-Gliders-Control line models-Radio Control Models-Building and Flying of Aero-models.		

Lecture :45, Practical30, Total:75

TEXT BOOK:

1	"National Cadet Corps- A Concise handbook of NCC Cadets" by Ramesh Publishing House, New Delhi,2014.

REFERENCES:

1	"Cadets Handbook – Common Subjects SD/SW" by DG NCC, New Delhi.
2	"Cadets Handbook – Specialised Subjects SD/SW" by DG NCC, New Delhi.
3	"NCC OTA Precise" by DGNCC, New Delhi.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	display sense of patriotism, secular values and shall be transformed into motivated youth who will carry out nation building through national unity and social cohesion.	Applying (K3)
CO2	demonstrate the sense of discipline with smartness and have basic knowledge of weapons and their use and handling	Applying (K3)
CO3	illustrate various forces and moments acting on aircraft	Applying (K3)
CO4	outline the concepts of aircraft engine and rocket propulsion	Applying (K3)
CO5	design, build and fly chuck gliders/model airplanes and display static models.	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	-	-	-	-	-	-
CAT2	-	-	-	-	-	-	-
CAT3	-	-	-	-	-	-	-
ESE	The examination and award of marks will be done by the Ministry of Defence, Government of India which includes all K1 to K6 knowledge levels. The maximum marks for the End Semester Examination is 500 marks. It will be converted to 100 marks.						