

# **KONGU ENGINEERING COLLEGE**

(Autonomous Institution Affiliated to Anna University, Chennai)

**PERUNDURAI ERODE – 638 060**

**TAMILNADU INDIA**



## **REGULATIONS, CURRICULUM & SYLLABI - 2020**

**(CHOICE BASED CREDIT SYSTEM)**

**(For the students admitted during 2018 - 2019 and onwards)**

## **MASTER OF ENGINEERING DEGREE IN MECHATRONICS ENGINEERING**

**DEPARTMENT OF MECHATRONICS ENGINEERING**





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**KONGU ENGINEERING COLLEGE**  
**PERUNDURAI ERODE – 638 060**  
**(Autonomous)**

**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.

**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

- Providing value based quality education for the development of students as competent and responsible citizens.
- Contributing to the nation and beyond through research and development
- Continuously improving 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

**2020 REGULATIONS**

**PROGRAM EDUCATIONAL OBJECTIVES (PEOs)**

Graduates of M.E. MECHATRONICS ENGINEERING will

- PEO1: Design and develop Mechatronics solutions by integrating mechanical engineering, electronic control and robot system concepts
- PEO2: Exhibit research aptitude and life-long learning in the working environment
- PEO3: Solve real world needs using robots and troubleshoot industrial problems



### MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

### PROGRAM OUTCOMES (POs)

**Engineering Post Graduates will be able to:**

- PO1** Independently carry out research /investigation and development work to solve practical problems
- PO2** Write and present a substantial technical report/document
- PO3** Identify, formulate and analyze Mechatronics engineering problems and provide solutions using modern engineering and IT tools

### MAPPING OF PEOs WITH POs

| PEO\PO | PO1 | PO2 | PO3 |
|--------|-----|-----|-----|
| PEO1   | 3   | 2   | 3   |
| PEO2   | 3   | 3   | 3   |
| PEO3   | 2   | 2   | 3   |

1 – Slight, 2 – Moderate, 3 – Substantial



**KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638060**

**(An Autonomous Institution Affiliated to Anna University)**

**REGULATIONS 2020**

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

**MASTER OF ENGINEERING (ME) / MASTER OF TECHNOLOGY (MTech) DEGREE PROGRAMMES**

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

**1. DEFINITIONS AND NOMENCLATURE**

In these Regulations, unless otherwise specified:

- i. “University” means ANNA UNIVERSITY, Chennai.
- ii. “College” means KONGU ENGINEERING COLLEGE.
- iii. “Programme” means Master of Engineering (ME) / Master of Technology (MTech) Degree programme
- iv. “Branch” means specialization or discipline of ME/MTech Degree programme, like Construction Engineering and Management, Information Technology, etc.
- v. “Course” means a Theory / Theory cum Practical / Practical course that is normally studied in a semester like Engineering Design Methodology, Machine Learning Techniques, 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                                  |
|-----------|---|
| ME        | Construction Engineering and Management |
|           | Structural Engineering                  |
|           | Engineering Design                      |
|           | Mechatronics Engineering                |
|           | VLSI Design                             |
|           | Embedded Systems                        |
|           | Power Electronics and Drives            |
|           | Control and Instrumentation Engineering |
|           | Computer Science and Engineering        |
| MTech     | Information Technology                  |
|           | Chemical Engineering                    |
|           | Food Technology                         |

## 3. ADMISSION REQUIREMENTS

Candidates seeking admission to the first semester of the ME/MTech Degree programme shall be required to have passed an appropriate qualifying Degree Examination of Anna University or any examination of any other University or authority accepted by the Anna University, Chennai as equivalent thereto, subject to amendments as may be made by the Anna University, Chennai from time to time. The candidates shall also be required to satisfy all other conditions of admission 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 ME / MTech programme shall have a curriculum with syllabi comprising of theory, theory cum practical, practical courses in each semester and 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) 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. Foundation Courses (FC)
- ii. Professional Core (PC) Courses
- iii. Professional Elective (PE) Courses
- iv. Open Elective (OE) Courses
- v. Employability Enhancement Courses (EC) like Innovative Project, Internship cum Project work in Industry or elsewhere, Project Work

## 4.2 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 ME/MTech programme is 72.

## 4.3 Employability Enhancement Courses

A candidate shall be offered with the employability enhancement courses like innovative project, internship cum project work and project work during the programme to gain/exhibit the knowledge/skills.

### 4.3.1 Innovative Project

A candidate shall earn two credits by successfully completing the project by using his/her innovations in second semester during his/her programme.

### 4.3.2 Internship cum Project Work

The curriculum enables a candidate to go for full time internship during the third semester and can earn credits through it for his/her academics vide clause 7.6 and clause 7.12. Such candidate shall earn the minimum number of credits as mentioned in the third semester of the curriculum other than internship by either fast track mode or through approved courses in online mode or by self study mode. Such candidate can earn the number of credits for the internship same as that of Project Work in the third semester. Assessment procedure is to be followed as specified in the guidelines approved by the Academic Council.



#### **4.3.4 Project Work**

A candidate shall earn nine credits by successfully completing the project work in fourth semester during the programme inside the campus or in industries.

#### **4.4 Value Added Courses / Online Courses / Self Study Courses**

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

**4.4.1 Value Added Courses:** Value Added courses each with One / Two credits shall be offered by the college with the prior approval from respective Board of Studies. A candidate can earn a maximum of three 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. 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 (up to second semester).

**4.4.5** A candidate can earn a maximum of 15 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 second to fourth semesters the candidates have the option of registering for additional elective/Honors courses or dropping of already registered additional elective/Honors 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 six.

**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 ME / MTech Degree programme in 4 consecutive semesters (2 Years), but in any case not more than 8 semesters (4 Years).

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

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

## **6. COURSE REGISTRATION FOR THE EXAMINATION**

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

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

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

## **7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS**



- 7.1** The ME/MTech programmes consist of Theory Courses, Theory cum Practical courses, Practical courses, Innovative Project, Internship cum Project work and Project Work. 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 |
|---------|--|--|--------------------------|
| 1.      | Theory / Practical   | 50   | 50                       |
| 2.      | Theory cum Practical   | The distribution of marks shall be decided based on the credit weightage assigned to theory and practical components respectively. |                          |
| 3.      | Innovative Project/ Project Work / Internship cum Project Work | 50   | 50                       |
| 4.      | Value Added Course   | The distribution of marks shall be decided based on the credit the credit weightage assigned                                       | ---                      |
| 5.      | 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, innovative project and internships 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.<br>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 duration of three hours.

#### **7.4 Theory cum Practical Courses**

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

#### **7.5 Practical Courses**

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

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

#### **7.6 Project Work**

**7.6.1** Project work shall be carried out individually. Candidates can opt for full time internship (vide clause 7.8) in lieu of project work in third semester. 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 and the Viva-Voce Examination shall be distributed as below.

| Continuous Assessment<br>(Max. 50 Marks) |       |   |       |   |       | End Semester Examination<br>(Max. 50 Marks) |                                |           |           |
|--|-------|---|-------|---|-------|---|--------------------------------|-----------|-----------|
| Review I<br>(Max..10 Marks)              |       | Review II<br>(Max.. 20 Marks)               |       | Review III<br>(Max. 20 Marks)               |       | Report<br>Evaluation<br>(Max. 20<br>Marks)  | Viva - Voce<br>(Max. 30 Marks) |           |           |
| Rv.<br>Com                               | Guide | Review<br>Committee<br>(excluding<br>guide) | Guide | Review<br>Committee<br>(excluding<br>guide) | Guide | Ext. Exr.                                   | Guid<br>e                      | Exr.<br>1 | Exr.<br>2 |
| 5  | 5     | 10  | 10    | 10  | 10    | 20  | 10                             | 10        | 10        |

**7.6.4** The Project Report prepared according to approved guidelines and duly signed by the Guide and Project Co-ordinator shall be submitted to Head of the Department. A candidate 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. This applies to both Internship cum Project work and Project work.

**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** Every candidate shall, based on his/her project work, publish a paper in a reputed journal or reputed conference in which full papers are published after usual review. A copy of the full paper accepted and proof for that shall be produced at the time of evaluation.

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

**7.6.8** 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 7.6.7.

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

## **7.7 Innovative Project**

The evaluation method shall be same as that of the Project Work as per clause 7.6 excluding clause 7.6.6.



### **7.8 Internship cum Project Work**

Each candidate shall submit a brief report about the internship undergone and a certificate issued from the organization concerned at the time of Viva-voce examination to the review committee. The evaluation method shall be same as that of the Project Work as per clause 7.6 excluding 7.6.6.

### **7.9 Value Added Course**

Two assessments shall be conducted during the value added course duration by the offering department concerned.

### **7.10 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.

### **7.11 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.

### **7.12 Audit Course**

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

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

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

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

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

## **8. REQUIREMENTS FOR COMPLETION OF A SEMESTER**

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- 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.
- 8.1.3** In addition to clause 8.1.1 or 8.1.2, a candidate shall secure not less than 60 % attendance in each course.
- 8.1.4** A candidate shall be deemed to have completed the requirements of study of any semester only if he/she has satisfied the attendance requirements (vide clause 8.1.1 to 8.1.3) and has registered for examination by paying the prescribed fee.
- 8.1.5** Candidate's progress is satisfactory.
- 8.1.6** Candidate's conduct is satisfactory and he/she was not involved in any indisciplined activities in the current semester.
- 8.2.** The candidates who do not complete the semester as per clauses from 8.1.1 to 8.1.6 except 8.1.3 shall not be permitted to appear for the examinations at the end of the semester and not be permitted to go to the next semester. They have to repeat the incomplete semester in next academic year.
- 8.3** The candidates who satisfy the clause 8.1.1 or 8.1.2 but do not complete the course as per clause 8.1.3 shall not be permitted to appear for the end semester examination of that course alone. They have to repeat the incomplete course in the subsequent semester when it is offered next.

## **9. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION**

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



- 9.2** When a candidate is deputed for a National / International Sports event during End Semester examination period, supplementary examination shall be conducted for such a candidate on return after participating in the event within a reasonable period of time. Such appearance shall be considered as first appearance.
- 9.3** A candidate who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of letter grades / marks.

## **10. PROVISION FOR WITHDRAWAL FROM EXAMINATIONS**

- 10.1** A candidate may, for valid reasons, be granted permission to withdraw from appearing for the examination in any regular course or all regular courses registered in a particular semester. Application for withdrawal is permitted only once during the entire duration of the degree programme.
- 10.2** The withdrawal application shall be valid only if the candidate is otherwise eligible to write the examination (vide clause 9) and has applied to the Principal for permission prior to the last examination of that semester after duly recommended by the Head of the Department.
- 10.3** The withdrawal shall not be considered as an appearance for deciding the eligibility of a candidate for First Class with Distinction/First Class.
- 10.4** If a candidate withdraws a course or courses from writing end semester examinations, he/she shall register the same in the subsequent semester and write the end semester examinations. A final semester candidate who has withdrawn shall be permitted to appear for supplementary examination to be conducted within reasonable time as per clause 14.
- 10.5** The final semester candidate who has withdrawn from appearing for project viva-voce for genuine reasons shall be permitted to appear for supplementary viva-voce examination within reasonable time with proper application to Controller of Examinations and on payment of prescribed fee.

## **11. PROVISION FOR BREAK OF STUDY**





- 11.1** A candidate is normally permitted to avail the authorised break of study under valid reasons (such as accident or hospitalization due to prolonged ill health or any other valid reasons) and to rejoin the programme in a later semester. He/She shall apply in advance to the Principal, through the Head of the Department, stating the reasons therefore, in any case, not later than the last date for registering for that semester examination. A candidate is permitted to avail the authorised break of study only once during the entire period of study for a maximum period of one year. However, in extraordinary situation the candidate may apply for additional break of study not exceeding another one year by paying prescribed fee for the break of study.
- 11.2** The candidates permitted to rejoin the programme after break of study / prevention due to lack of attendance shall be governed by the rules and regulations in force at the time of rejoining.
- 11.3** The candidates rejoining in new Regulations shall apply to the Principal in the prescribed format through Head of the Department at the beginning of the readmitted semester itself for prescribing additional/equivalent courses, if any, from any semester of the regulations in-force, so as to bridge the curriculum in-force and the old curriculum.
- 11.4** The total period of completion of the programme reckoned from the commencement of the semester to which the candidate was admitted shall not exceed the maximum period specified in clause 5 irrespective of the period of break of study in order to qualify for the award of the degree.
- 11.5** If any candidate is prevented for want of required attendance, the period of prevention shall not be considered as authorized break of study.
- 11.6** If a candidate has not reported to the college for a period of two consecutive semesters without any intimation, the name of the candidate shall be deleted permanently from the college enrollment. Such candidates are not entitled to seek readmission under any circumstances.

## **12. PASSING REQUIREMENTS**

- 12.1** A candidate who secures not less than 50 % of total marks (continuous assessment and end semester examination put together) prescribed for the course with a minimum of 50 % 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, but the grade awarded shall be only the lowest passing grade irrespective of the marks secured.

### **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 ME / MTech Degree provided the candidate has

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



- ii. Successfully gained the required number of total credits as specified in the curriculum corresponding to the candidate's programme within the stipulated time (vide clause 5).
- iii. Successfully passed any additional courses prescribed by the respective Board of Studies whenever readmitted under regulations other than R-2020 (vide clause 11.3)
- iv. No disciplinary action pending against him / her.

## 17. CLASSIFICATION OF THE DEGREE AWARDED

### 17.1 First Class with Distinction:

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

- Should have passed the examination in all the courses of all the four semesters in the **First Appearance** within four consecutive semesters 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 regulation to another regulation 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 four semesters in the **First Appearance** within four consecutive semesters 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 four semesters within six consecutive semesters excluding authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from the examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 7.00

### **17.3 Second Class:**

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

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

## **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 ME / MTech programme.

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| CURRICULUM BREAKDOWN STRUCTURE   |           |           |           |           |                         |  |
|--|-----------|-----------|-----------|-----------|-------------------------|--|
| Summary of Credit Distribution   |           |           |           |           |                         |  |
|  | Semester  |           |           |           | Total number of credits | Curriculum Content (% of total number of credits of the program) |
|  | I         | II        | III       | IV        |                         |  |
| <b>FC</b>  | <b>7</b>  | <b>-</b>  | <b>-</b>  | <b>-</b>  | <b>7</b>                | <b>9.72</b>  |
| <b>PC</b>  | <b>12</b> | <b>15</b> | <b>-</b>  | <b>-</b>  | <b>27</b>               | <b>37.50</b>   |
| <b>PE</b>  | <b>3</b>  | <b>6</b>  | <b>3</b>  | <b>6</b>  | <b>18</b>               | <b>25.00</b>   |
| <b>EC</b>  |           | <b>2</b>  | <b>9</b>  | <b>9</b>  | <b>20</b>               | <b>27.78</b>   |
| Semester wise Total  | <b>22</b> | <b>23</b> | <b>12</b> | <b>15</b> | <b>72</b>               | <b>100.00</b>  |
|  |           |           |           |           |                         |  |
| Category   |           |           |           |           |                         | Abbreviation   |
| Lecture hours per week   |           |           |           |           |                         | <b>L</b>   |
| Tutorial hours per week  |           |           |           |           |                         | <b>T</b>   |
| Practical, Project work, Internship, Professional Skill Training, Industrial Training hours per week |           |           |           |           |                         | <b>P</b>   |
| Credits  |           |           |           |           |                         | <b>C</b>   |

| CATEGORISATION OF COURSES         |             |   |   |   |   |          |     |  |
|-----------------------------------|-------------|---|---|---|---|----------|-----|--|
| FOUNDATION COURSES (FC)           |             |   |   |   |   |          |     |  |
| S. No.                            | Course Code | Course Name                                   | L | T | P | C        | Sem |  |
| 1.                                | 20AMT13     | Applied Mathematics for Electronics Engineers | 3 | 1 | 0 | 4        | 1   |  |
| 2.                                | 20GET11     | Introduction to Research                      | 2 | 1 | 0 | 3        | 1   |  |
| <b>Total Credits to be earned</b> |             |   |   |   |   | <b>7</b> |     |  |



| PROFESSIONAL CORE (PC)                 |                  |  |   |   |   |    |     |                |
|--|------------------|--|---|---|---|----|-----|----------------|
| S. No.                                 | Course Code      | Course Name  | L | T | P | C  | Sem | Domain/ Stream |
| 1.                                     | 20MMT11 /20MMT12 | Bridge Course Electronics (or)<br>Bridge Course Mechanical | 3 | 1 | 0 | 4  | 1   | AE             |
| 2.                                     | 20MMT13          | Control System Engineering                                 | 3 | 0 | 0 | 3  | 1   | AE             |
| 3.                                     | 20MMT14          | Sensors and IoT  | 3 | 0 | 0 | 3  | 1   | AE             |
| 4.                                     | 20MML11          | Control System Engineering Laboratory                      | 0 | 0 | 2 | 1  | 1   | AE             |
| 5.                                     | 20MML12          | Sensors and IoT Laboratory                                 | 0 | 0 | 2 | 1  | 1   | AE             |
| 6.                                     | 20MMC21          | Fluid power system   | 3 | 0 | 2 | 4  | 2   | PS             |
| 7.                                     | 20MMC22          | Robot kinematics and dynamics                              | 3 | 0 | 2 | 4  | 2   | AS             |
| 8.                                     | 20MMT21          | Embedded Systems and control                               | 3 | 0 | 0 | 3  | 2   | AE             |
| 9.                                     | 20MMT22          | Integrated Automation Controllers                          | 3 | 0 | 0 | 3  | 2   | AE             |
| 10.                                    | 20MML21          | Embedded Systems and PLC laboratory                        | 0 | 0 | 2 | 1  | 2   | AE             |
| Total Credits to be earned             |                  |  |   |   |   | 27 |     |                |
| PROFESSIONAL ELECTIVE (PE)             |                  |  |   |   |   |    |     |                |
| S. No.                                 | Course Code      | Course Name  | L | T | P | C  | Sem | Domain/ Stream |
|  |                  | <b>ELECTIVE-1</b>  |   |   |   |    |     |                |
| 1.                                     | 20MME01          | Computer Numerically Controlled Machines                   | 3 | 0 | 0 | 3  | 1   | AE             |
| 2.                                     | 20MME02          | Industrial Drives  | 3 | 0 | 0 | 3  | 1   | AE             |
| 3.                                     | 20MME03          | Metrology and Computer Aided Inspection                    | 3 | 0 | 0 | 3  | 1   | PD             |
|  |                  | <b>ELECTIVE-2</b>  |   |   |   |    |     |                |
| 4.                                     | 20MME04          | MEMS Design  | 3 | 0 | 0 | 3  | 2   | PD             |
| 5.                                     | 20MME05          | Virtual Instrumentation                                    | 3 | 0 | 2 | 4  | 2   | AE             |
| 6.                                     | 20MME06          | Factory Automation and CIM                                 | 3 | 0 | 0 | 3  | 2   | AE             |
|  |                  | <b>ELECTIVE-3</b>  |   |   |   |    |     |                |
| 7.                                     | 20MME07          | Process Control Engineering                                | 3 | 0 | 0 | 3  | 2   | AE             |
| 8.                                     | 20MME08          | Applied Finite Element Method                              | 3 | 0 | 0 | 3  | 2   | PD             |
| 9.                                     | 20MME09          | Composite materials  | 3 | 0 | 0 | 3  | 2   | PD             |
|  |                  | <b>ELECTIVE-4</b>  |   |   |   |    |     |                |
| 10.                                    | 20MME10          | Machine Tool Control and Condition Monitoring              | 3 | 0 | 0 | 3  | 3   | PS             |
| 11.                                    | 20MME11          | Industrial Data Communication                              | 3 | 0 | 0 | 3  | 3   | AE             |
| 12.                                    | 20MME12          | Artificial Intelligence and Machine Learning               | 3 | 0 | 0 | 3  | 3   | AS             |
|  |                  | <b>ELECTIVE-5</b>  |   |   |   |    |     |                |
| 13.                                    | 20MME13          | Machine Vision System                                      | 3 | 0 | 0 | 3  | 4   | AE             |
| 14.                                    | 20MME14          | Product Design and Development                             | 3 | 0 | 0 | 3  | 4   | PD             |
| 15.                                    | 20MME15          | Drone technology   | 3 | 0 | 0 | 3  | 4   | AS             |
|  |                  | <b>ELECTIVE-6</b>  |   |   |   |    |     |                |
| 16.                                    | 20MME16          | Autonomous Mobile robotics                                 | 3 | 0 | 2 | 4  | 4   | AS             |
| 17.                                    | 20MME17          | Additive Manufacturing                                     | 3 | 0 | 0 | 3  | 4   | PS             |
| 18.                                    | 20GET13          | Innovation, Entrepreneurship and Venture Development       | 3 | 0 | 0 | 3  | 4   | GE             |
| EMPLOYABILITY ENHANCEMENT COURSES (EC) |                  |  |   |   |   |    |     |                |



| S. No.                     | Course Code | Course Name                 | L | T | P  | C  | Sem | Domain/ Stream |
|----------------------------|-------------|-----------------------------|---|---|----|----|-----|----------------|
| 1.                         | 20MMP21     | Innovative Project          | 0 | 0 | 4  | 2  | 2   | NA             |
| 2.                         | 20MMP31     | Internship cum Project Work | 0 | 0 | 18 | 9  | 3   | NA             |
| 3.                         | 20MMP41     | Project Work                | 0 | 0 | 18 | 9  | 4   | NA             |
| Total Credits to be earned |             |                             |   |   |    | 20 |     |                |

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



## KEC R2020: SCHEDULING OF COURSES – M.E. (MECHATRONICS ENGINEERING)

| Sem. | Course 1   | Course 2  | Course 3  | Course 4   | Course 5                                      | Course 6                                       | Course 7   | Course 8  | Course 9  | Credits |
|------|--|---|---|--|---|--|--|---|---|---------|
| I    | 20AMT12<br>Advanced Mathematics<br>(PC-3-1-0-4)  | 20MMT11/<br>20MMT12<br>Bridge Course<br>Electronics (or)<br>Bridge Course<br>Mechanical<br>(PC-3-1-0-4) | 20GET11<br>Introduction<br>to Research<br>(PC-2-1-0-3)        | 20MMT13<br>Control System<br>Engineering<br>(PC-3-0-0-3)           | 20MMT14<br>Sensors and<br>IoT<br>(PC-3-0-0-3) | Elective-I<br>(Professional)<br>(PC-3-0-0-3)   | 20MML11<br>Sensors and IoT<br>laboratory<br>(PC-0-0-2-1)             | 20MML12<br>Control<br>System<br>Engineering<br>Laboratory<br>(PC-0-0-2-1) |   | 22      |
| II   | 20MMC21<br>Fluid Power<br>System<br>(PC-3-0-2-4) | 20MMC22<br>Robot<br>kinematics and<br>dynamics<br>(PC-3-0-2-4)  | 20MMT21<br>Embedded<br>systems and<br>control<br>(PC-3-0-0-3) | 20MMT22<br>Integrated<br>Automation<br>Controllers<br>(PC-3-0-0-3) | Elective-II<br>(Professional)<br>(PC-3-0-0-3) | Elective-III<br>(Professional)<br>(PC-3-0-0-3) | 20MML21<br>Embedded<br>Systems and<br>PLC Laboratory<br>(PC-0-0-2-1) |   | 20MMP21<br>Innovative<br>Project<br>(0-0-4-2)                 | 23      |
| III  | Elective-IV<br>(Professional)<br>(PC-3-0-0-3)    |   |   |  |   |  |  |   | 20MMP31<br>Internship<br>cum<br>Project<br>Work<br>(0-0-18-9) | 12      |
| IV   | Elective-V<br>(Professional)<br>(PC-3-0-0-3)     | Elective-VI<br>(Professional)<br>(PC-3-0-0-3)   |   |  |   |  |  |   | 20MMP41<br>Project<br>Work<br>(0-0-18-9)                      | 15      |

**Total Credits: 72**





## MAPPING OF COURSES WITH PROGRAM OUTCOMES

| Sem. | Course Code         | Course Title   | PO1 | PO2 | PO3 |
|------|---------------------|--|-----|-----|-----|
| I    | 20MMT11/<br>20MMT12 | Bridge Course Electronics (or)<br>Bridge Course Mechanical | ✓   | ✓   | ✓   |
| I    | 20AMT12             | Advanced Mathematics for Mechatronics                      | ✓   |     |     |
| I    | 20GET11             | Introduction to Research                                   | ✓   | ✓   | ✓   |
| I    | 20MMT13             | Control System Engineering                                 | ✓   | ✓   | ✓   |
| I    | 20MMT14             | Sensors and IoT  | ✓   | ✓   | ✓   |
| I    | 20MML11             | Control System Engineering Laboratory                      | ✓   | ✓   | ✓   |
| I    | 20MML12             | Sensors and IoT Laboratory                                 | ✓   | ✓   | ✓   |
| II   | 20MMC21             | Fluid power system   | ✓   | ✓   | ✓   |
| II   | 20MMC22             | Robot kinematics and dynamics                              | ✓   | ✓   | ✓   |
| II   | 20MMT21             | Embedded systems and control                               | ✓   | ✓   | ✓   |
| II   | 20MMT22             | Integrated Automation Controllers                          | ✓   | ✓   | ✓   |
| II   | 20MML21             | Embedded systems and PLC laboratory                        | ✓   | ✓   | ✓   |
| II   | 20MMP21             | Innovative Project   | ✓   | ✓   | ✓   |
| III  | 20MMP31             | Internship cum Project Work                                | ✓   | ✓   | ✓   |
| IV   | 20MMP41             | Project Work   | ✓   | ✓   | ✓   |
| I    | 20MME01             | Computer Numerically Controlled Machines                   | ✓   | ✓   | ✓   |
| I    | 20MME02             | Industrial Drives  | ✓   | ✓   | ✓   |
| I    | 20MME03             | Metrology and Computer Aided Inspection                    | ✓   | ✓   | ✓   |
| II   | 20MME04             | MEMS Design  | ✓   | ✓   | ✓   |
| II   | 20MME05             | Virtual Instrumentation                                    | ✓   | ✓   | ✓   |
| II   | 20MME06             | Factory Automation and CIM                                 | ✓   | ✓   | ✓   |
| II   | 20MME07             | Process Control Engineering                                | ✓   | ✓   | ✓   |
| II   | 20MME08             | Applied Finite Element Method                              | ✓   | ✓   | ✓   |
| II   | 20MME09             | Composite materials  | ✓   | ✓   | ✓   |
| III  | 20MME10             | Machine Tool Control and Condition Monitoring              | ✓   | ✓   | ✓   |



|     |         |  |   |   |   |
|-----|---------|--|---|---|---|
| III | 20MME11 | Industrial Data Communication                | ✓ | ✓ | ✓ |
| III | 20MME12 | Artificial Intelligence and Machine Learning | ✓ | ✓ | ✓ |
| IV  | 20MME13 | Machine Vision System                        | ✓ | ✓ | ✓ |
| IV  | 20MME14 | Product Design and Development               | ✓ | ✓ | ✓ |
| IV  | 20MME15 | Drone technology                             | ✓ | ✓ | ✓ |
| IV  | 20MME16 | Autonomous Mobile robotics                   | ✓ | ✓ | ✓ |
| IV  | 20MME17 | Additive Manufacturing                       | ✓ | ✓ | ✓ |
| IV  | 20GET13 | Innovation and Business Model Development    | ✓ | ✓ | ✓ |



## M.E. MECHATRONICS ENGINEERING CURRICULUM-R2020

| SEMESTER – I                          |  |              |   |   |        |               |     |       |          |
|---------------------------------------|--|--------------|---|---|--------|---------------|-----|-------|----------|
| Course Code                           | Course Title   | Hours / Week |   |   | Credit | Maximum Marks |     |       | Category |
|                                       |  | L            | T | P |        | CA            | ESE | Total |          |
| Theory / Theory with Practical        |  |              |   |   |        |               |     |       |          |
| 20AMT12                               | Advanced Mathematics                                       | 3            | 1 | 0 | 4      | 50            | 50  | 100   | FC       |
| 20GET11                               | Introduction to Research                                   | 2            | 1 | 0 | 3      | 50            | 50  | 100   | FC       |
| 20MMT11/<br>20MMT12                   | Bridge Course Electronics (or)<br>Bridge Course Mechanical | 3            | 1 | 0 | 4      | 50            | 50  | 100   | PC       |
| 20MMT13                               | Control System Engineering                                 | 3            | 0 | 0 | 3      | 50            | 50  | 100   | PC       |
| 20MMT14                               | Sensors and IoT  | 3            | 0 | 0 | 3      | 50            | 50  | 100   | PC       |
|                                       | Professional Elective-I                                    | 3            | 0 | 0 | 3      | 50            | 50  | 100   | PE       |
| Practical / Employability Enhancement |  |              |   |   |        |               |     |       |          |
| 20MML11                               | Control System Engineering Laboratory                      | 0            | 0 | 2 | 1      | 50            | 50  | 100   | PC       |
| 20MML12                               | Sensors and IoT Laboratory                                 | 0            | 0 | 2 | 1      | 50            | 50  | 100   | PC       |
| Total Credits to be earned            |  |              |   |   | 22     |               |     |       |          |

| SEMESTER – II                         |                                     |              |   |   |        |               |     |       |          |
|---------------------------------------|-------------------------------------|--------------|---|---|--------|---------------|-----|-------|----------|
| Course Code                           | Course Title                        | Hours / Week |   |   | Credit | Maximum Marks |     |       | Category |
|                                       |                                     | L            | T | P |        | CA            | ESE | Total |          |
| THEORY                                |                                     |              |   |   |        |               |     |       |          |
| 20MMC21                               | Fluid Power System                  | 3            | 0 | 2 | 4      | 50            | 50  | 100   | PC       |
| 20MMC22                               | Robot Kinematics and Dynamics       | 3            | 0 | 2 | 4      | 50            | 50  | 100   | PC       |
| 20MMT21                               | Embedded Systems and Control        | 3            | 0 | 0 | 3      | 50            | 50  | 100   | PC       |
| 20MMT22                               | Integrated Automation Controllers   | 3            | 0 | 0 | 3      | 50            | 50  | 100   | PC       |
|                                       | Professional Elective II            | 3            | 0 | 0 | 3      | 50            | 50  | 100   | PE       |
|                                       | Professional Elective III           | 3            | 0 | 0 | 3      | 50            | 50  | 100   | PE       |
| Practical / Employability Enhancement |                                     |              |   |   |        |               |     |       |          |
| 20MML21                               | Embedded Systems and PLC Laboratory | 0            | 0 | 3 | 1      | 50            | 50  | 100   | PC       |
| 20MMP21                               | Innovative Project                  | 0            | 0 | 4 | 2      | 50            | 50  | 100   | EC       |
| Total Credits to be earned            |                                     |              |   |   | 23     |               |     |       |          |

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| SEMESTER – III                        |                             |              |   |    |        |               |     |       |          |
|---------------------------------------|-----------------------------|--------------|---|----|--------|---------------|-----|-------|----------|
| Course Code                           | Course Title                | Hours / Week |   |    | Credit | Maximum Marks |     |       | Category |
|                                       |                             | L            | T | P  |        | CA            | ESE | Total |          |
| Practical / Employability Enhancement |                             |              |   |    |        |               |     |       |          |
|                                       | Professional Elective IV    | 3            | 0 | 0  | 3      | 50            | 50  | 100   | PE       |
| 20MMP31                               | Internship cum Project Work | 0            | 0 | 18 | 9      | 50            | 50  | 100   | EC       |
| Total Credits to be earned            |                             |              |   |    | 12     |               |     |       |          |

| SEMESTER – IV                |                          |              |   |    |        |               |     |       |              |
|------------------------------|--------------------------|--------------|---|----|--------|---------------|-----|-------|--------------|
| Course Code                  | Course Title             | Hours / Week |   |    | Credit | Maximum Marks |     |       | Cate<br>gory |
|                              |                          | L            | T | P  |        | CA            | ESE | Total |              |
| THEORY/THEORY WITH PRACTICAL |                          |              |   |    |        |               |     |       |              |
|                              | Professional Elective-V  | 3            | 0 | 0  | 3      | 50            | 50  | 100   | PE           |
|                              | Professional Elective-VI | 3            | 0 | 0  | 3      | 50            | 50  | 100   | PE           |
| PRACTICAL                    |                          |              |   |    |        |               |     |       |              |
| 20MMP41                      | Project Work             | 0            | 0 | 18 | 9      | 50            | 50  | 100   | EC           |
| Total Credits to be earned   |                          |              |   |    | 15     |               |     |       |              |

**Total Credits: 72**



| LIST OF PROFESSIONAL ELECTIVES |  |            |   |   |        |     |
|--------------------------------|--|------------|---|---|--------|-----|
| Course Code                    | Course Title   | Hours/Week |   |   | Credit | CBS |
|                                |  | L          | T | P |        |     |
|                                | <b>SEMESTER I</b>                                    |            |   |   |        |     |
|                                | <b>ELECTIVE-I</b>                                    |            |   |   |        |     |
| 20MME01                        | Computer Numerically Controlled Machines             | 3          | 0 | 0 | 3      | PE  |
| 20MME02                        | Industrial Drives                                    | 3          | 0 | 0 | 3      | PE  |
| 20MME03                        | Metrology and Computer Aided Inspection              | 3          | 0 | 0 | 3      | PE  |
|                                | <b>SEMESTER II</b>                                   |            |   |   |        |     |
|                                | <b>ELECTIVE-II</b>                                   |            |   |   |        |     |
| 20MME04                        | MEMS Design  | 3          | 0 | 0 | 3      | PE  |
| 20MME05                        | Virtual Instrumentation                              | 3          | 0 | 2 | 4      | PE  |
| 20MME06                        | Factory Automation and CIM                           | 3          | 0 | 0 | 3      | PE  |
|                                | <b>ELECTIVE-III</b>                                  |            |   |   |        |     |
| 20MME07                        | Process Control Engineering                          | 3          | 0 | 0 | 3      | PE  |
| 20MME08                        | Applied Finite Element Method                        | 3          | 0 | 0 | 3      | PE  |
| 20MME09                        | Composite Materials                                  | 3          | 0 | 0 | 3      | PE  |
|                                | <b>SEMESTER III</b>                                  |            |   |   |        |     |
|                                | <b>ELECTIVE-IV</b>                                   |            |   |   |        |     |
| 20MME10                        | Machine Tool Control and Condition Monitoring        | 3          | 0 | 0 | 3      | PE  |
| 20MME11                        | Industrial Data Communication                        | 3          | 0 | 0 | 3      | PE  |
| 20MME12                        | Artificial Intelligence and Machine Learning         | 3          | 0 | 0 | 3      | PE  |
|                                | <b>SEMESTER IV</b>                                   |            |   |   |        |     |
|                                | <b>ELECTIVE-V</b>                                    |            |   |   |        |     |
| 20MME13                        | Machine Vision System                                | 3          | 0 | 2 | 4      | PE  |
| 20MME14                        | Product Design and Development                       | 3          | 0 | 0 | 3      | PE  |
| 20MME15                        | Drone Technology                                     | 3          | 0 | 0 | 3      | PE  |
|                                | <b>ELECTIVE-VI</b>                                   |            |   |   |        |     |
| 20MME16                        | Autonomous Mobile Robotics                           | 3          | 0 | 2 | 4      | PE  |
| 20MME17                        | Additive Manufacturing                               | 3          | 0 | 0 | 3      | PE  |
| 20GET13                        | Innovation, Entrepreneurship and Venture Development | 3          | 0 | 0 | 3      | PE  |



## 20AMT12 ADVANCED MATHEMATICS

| Programme & Branch | M.E. Mechatronics Engineering & M.E. Engineering Design | Sem. | Category | L | T | P | Credit |
|--------------------|---|------|----------|---|---|---|--------|
| Prerequisites      | Calculus, Matrices and Laplace Transform                | 1    | FC       | 3 | 1 | 0 | 4      |

|   |  |     |
|---|--|-----|
| Preamble  | This course will help the students to develop knowledge to identify and formulate problems in mechanical engineering using mathematical tools such as probability, calculus of variations and solve ordinary and partial differential equations by employing transform and numerical techniques. |     |
| Unit - I  | Random Variables and Probability Distributions:  | 9+3 |
| Random variable – Probability mass function – Probability density function – Moments – Moment generating functions – Discrete distributions – Binomial distribution – Poisson distribution – Geometric distribution – Continuous distributions - Uniform distribution – Exponential distribution – Normal distribution. |  |     |
| Unit - II   | Calculus of Variations:  | 9+3 |
| Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems - Direct methods : Ritz and Kantorovich methods.   |  |     |
| Unit - III  | Transform Methods: Laplace Transform Methods:  | 9+3 |
| Solution of one-dimensional wave equation - Solution of one-dimensional heat equation – <b>Fourier transform methods:</b> Solution of Diffusion equation – Solution of one-dimensional wave equation – Solution of Laplace equation.  |  |     |
| Unit - IV   | Numerical Solution of Ordinary Differential Equations:   | 9+3 |
| Runge - Kutta methods for system of IVPs – Numerical stability of Runge - Kutta method – Adams - Bashforth multistep method – Shooting method –Solution of BVP : Finite difference method – Collocation method and orthogonal collocation method.   |  |     |
| Unit - V  | Numerical Solution of Partial Differential Equations:  | 9+3 |
| Solution of one dimensional wave equation – Solution of diffusion equation – Explicit and implicit methods – Solution of Elliptic equation: Solution of Laplace equation – Solution of Poisson equation.  |  |     |

**Lecture:45, Tutorial:15, Total: 60**

### REFERENCES:

|    |   |
|----|---|
| 1. | Richard Johnson, Miller & Freund's, "Probability and Statistics for Engineers", 7 <sup>th</sup> Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2007. |
| 2. | Gupta, A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.   |
| 3. | Sankara Rao K, "Introduction to Partial Differential Equations", 3 <sup>rd</sup> Edition, PHI Learning Pvt. Ltd, 2011.                                      |
| 4. | Smith, G. D., "Numerical Solutions of Partial Differential Equations: Finite Difference Methods", Clarendon Press, 1985.                                    |
| 5. | Curtis F. Gerald, Patrick O.Wheatley, "Applied Numerical Analysis", 7 <sup>th</sup> Edition, Pearson Education India, 2009.                                 |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| CO1  | handle engineering problems involving discrete and continuous random variables.  | Applying (K3)                        |
| CO2  | solve problems involving functional that occur in various branches of engineering disciplines.   | Applying (K3)                        |
| CO3  | apply Laplace and Fourier transforms solve to initial value, initial-boundary value and boundary value problems in Partial Differential Equations. | Applying (K3)                        |
| CO4  | solve ordinary differential equations using finite difference and finite element methods.  | Applying (K3)                        |
| CO5  | solve elliptic partial differential equations by using finite difference methods.  | Applying (K3)                        |

| <b>Mapping of COs with POs and PSOs</b>                         |            |            |            |
|---|------------|------------|------------|
| <b>COs/POs</b>  | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1   | 1          |            |            |
| CO2   | 1          |            |            |
| CO3   | 3          |            |            |
| CO4   | 3          |            |            |
| CO5   | 3          |            |            |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy |            |            |            |

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



**20GET11 INTRODUCTION TO RESEARCH**  
(Common to all ME / MTech Engineering and Technology Branches)

| Programme & Branch | M.E.- Embedded Systems | Sem. | Category | L | T | P | Credit |
|--------------------|------------------------|------|----------|---|---|---|--------|
| Prerequisites      | Nil                    | 1    | FC       | 2 | 1 | 0 | 3      |

|          |   |  |  |  |  |  |  |
|----------|---|--|--|--|--|--|--|
| Preamble | Preamble: This course will familiarize the fundamental concepts/techniques adopted in research, problem formulation and patenting. Also will disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools. |  |  |  |  |  |  |
|----------|---|--|--|--|--|--|--|

|                 |                             |            |
|-----------------|-----------------------------|------------|
| <b>Unit - I</b> | <b>Concept of Research:</b> | <b>6+3</b> |
|-----------------|-----------------------------|------------|

Meaning and Significance of Research: Skills, Habits and Attitudes for Research - Time Management - Status of Research in India. Why, How and What a Research is? - 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 - Literature Collection – Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.

|                  |                                       |            |
|------------------|---------------------------------------|------------|
| <b>Unit - II</b> | <b>Research Methods and Journals:</b> | <b>6+3</b> |
|------------------|---------------------------------------|------------|

Interdisciplinary Research - Need for Experimental Investigations - Data Collection Methods - Appropriate Choice of Algorithms / Methodologies / Methods - Measurement and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations. Journals in Science/Engineering - Indexing and Impact factor of Journals - Citations - h Index - i10 Index - Journal Policies - How to Read a Published Paper - Ethical issues Related to Publishing - Plagiarism and Self-Plagiarism.

|                   |  |            |
|-------------------|--|------------|
| <b>Unit - III</b> | <b>Paper Writing and Research Tools:</b> | <b>6+3</b> |
|-------------------|--|------------|

Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study - When and Where to Publish? - Journal Selection Methods. Layout of a Research Paper - Guidelines for Submitting the Research Paper - Review Process - Addressing Reviewer Comments. Use of tools / Techniques for Research - Hands on Training related to Reference Management Software - EndNote, Software for Paper Formatting like LaTeX/MS Office. Introduction to Origin, SPSS, ANOVA etc., Software for detection of Plagiarism.

|                  |   |            |
|------------------|---|------------|
| <b>Unit - IV</b> | <b>Effective Technical Thesis Writing/Presentation:</b> | <b>6+3</b> |
|------------------|---|------------|

How to Write a Report - Language and Style - Format of Project Report - Use of Quotations - Method of Transcription Special Elements: Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc. - Different Reference Formats. Presentation using PPTs.

|                 |   |            |
|-----------------|---|------------|
| <b>Unit - V</b> | <b>Nature of Intellectual Property:</b> | <b>6+3</b> |
|-----------------|---|------------|

Patents - Designs - Trade and Copyright. Process of Patenting and Development: Technological research - innovation - patenting - development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents.

**Lecture: 30, Tutorial:15, Total:45**

**REFERENCES:**

|    |   |
|----|---|
| 1. | DePoy, Elizabeth, and Laura N. Gitlin, "Introduction to Research-E-Book: Understanding and Applying Multiple Strategies", Elsevier Health Sciences, 2015. |
| 2. | Walliman, Nicholas, "Research Methods: The basics", Routledge, 2017.  |
| 3. | Bettig Ronald V., "Copyrighting culture: The political economy of intellectual property", Routledge, 2018.  |





| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |   | <b>BT Mapped<br/>(Highest Level)</b> |
|--|---|--------------------------------------|
| 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)                        |

| <b>Mapping of COs with POs and PSOs</b> |            |            |            |            |            |
|---|------------|------------|------------|------------|------------|
| <b>COs/POs</b>                          | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> |
| CO1                                     | 3          | 2          | 1          |            |            |
| CO2                                     | 3          | 2          | 3          |            |            |
| CO3                                     | 3          | 3          | 1          |            |            |
| CO4                                     | 3          | 2          | 1          |            |            |
| CO5                                     | 3          | 2          | 1          |            |            |

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

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

\* ±3% may be varied



## 20MMT11 BRIDGE COURSE ELECTRONICS

| Programme & Branch | M.E. Mechatronics Engineering | Sem. | Category | L | T | P | Credit |
|--------------------|-------------------------------|------|----------|---|---|---|--------|
| Prerequisites      | Nil                           | 1    | PC       | 3 | 0 | 0 | 3      |

|   |  |     |
|---|--|-----|
| Preamble  | This course provides the knowledge on basic working principle and characteristics of electronic devices, electrical drives and special machines. |     |
| Unit - I  | Basic Electronics:   | 9+3 |
| Intrinsic and Extrinsic Semiconductors – Junction diode Characteristics and its applications – Special purpose diodes: Zener diode – Tunnel diode – Schottky diode – Varactor diode - LED, Photodiode of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers – Voltage Regulators.  |  |     |
| Unit - II   | Bipolar Junction Transistor:   | 9+3 |
| CE, CB, CC Configurations and Characteristics –Transistor as an amplifier – JFET – MOSFET – UJT – Need for biasing and biasing methods - Single stage transistor amplifier - Cascading amplifiers – Oscillators.  |  |     |
| Unit - III  | Operational Amplifiers and its Applications:   | 9+3 |
| Operational amplifier (op-amp) – DC and AC performance Characteristics - Arithmetic operations using op-amp - Applications: Instrumentation amplifier, Sample and Hold circuits, Clippers, Clampers, Peak detectors - Op-amp as comparator - Schmitt trigger - Applications of comparator - Waveform generator: square, sine, triangular waves - Multivibrators - Voltage regulators. |  |     |
| Unit - IV   | Power Electronics:   | 9+3 |
| Operating mechanism, characteristics and applications of power diodes, SCR, Diac, Triac, SCS, GTO, LASCR – two transistor model of SCR Controlled Rectifiers: single phase – three phase Rectifying circuits and filters - Regulated power supply – SMPS – UPS.   |  |     |
| Unit - V  | Electrical Drives and Special Machines:  | 9+3 |
| Basic Elements – Types of Electric Drives – Factors influence the choice of electrical drives – Loading conditions and classes of duty. Constructional details and operation of single phase induction motors – Shaded pole induction motor – Linear reluctance motor – Hysteresis Motor – Servo Motors.  |  |     |

**Lecture:45, Tutorial:15, Total:60**

### REFERENCES:

|    |  |
|----|--|
| 1. | Sedha R.S., "Applied Electronics", S. Chand & Co., Revised Edition, 2008.  |
| 2. | Sergio Franco, "Design with operational amplifiers and analog integrated circuits", 4 <sup>th</sup> Edition, McGraw Higher Ed, 2016. |
| 3. | Muhammed H. Rashid, "Power Electronics Circuits, Devices and Applications", 4 <sup>th</sup> Edition, PHI, 2013.                      |
| 4. | Dubey G.K., "Fundamentals of Electrical Drives", 2 <sup>nd</sup> Edition, Narosa Publishing House, New Delhi, 2015.                  |
| 5. | Janardanan E.G., "Special Electrical Machines", PHL Learning Pvt. Ltd., Delhi, 2014.   |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| CO1  | explain the basics of semiconductor devices and its relevant characteristics | Analyzing (K4)                       |
| CO2  | identify the characteristics of BJT and OP-AMPs                              | Evaluating (K5)                      |
| CO3  | analyze the performance of OP-AMP and its applications                       | Creating (K6)                        |
| CO4  | infer the power electronic devices   | Applying (K3)                        |
| CO5  | explain the basics of electrical drives and special machines                 | Applying (K3)                        |

| <b>Mapping of COs with POs and PSOs</b>                         |            |            |            |
|---|------------|------------|------------|
| <b>COs/POs</b>  | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1   | 2          | 1          | 3          |
| CO2   |            | 1          | 3          |
| CO3   | 2          | 1          | 3          |
| CO4   |            | 1          | 3          |
| CO5   | 2          | 1          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy |            |            |            |

#### ASSESSMENT PATTERN

| <b>Test /<br/>Bloom's<br/>Category*</b> | <b>Remembering<br/>(K1) %</b> | <b>Understanding<br/>(K2) %</b> | <b>Applying<br/>(K3) %</b> | <b>Analyzing<br/>(K4) %</b> | <b>Evaluating<br/>(K5) %</b> | <b>Creating<br/>(K6) %</b> | <b>Total<br/>%</b> |
|---|-------------------------------|---------------------------------|----------------------------|-----------------------------|------------------------------|----------------------------|--------------------|
| CAT 1                                   | 20                            | 30                              | 50                         |                             |                              |                            | 100                |
| CAT 2                                   | 20                            | 20                              | 60                         |                             |                              |                            | 100                |
| CAT 3                                   | 20                            | 20                              | 60                         |                             |                              |                            | 100                |
| ESE                                     | 20                            | 20                              | 60                         |                             |                              |                            | 100                |

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



## 20MMT12 BRIDGE COURSE MECHANICAL

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

|  |  |  |     |
|--|--|--|-----|
| Preamble   | This course provides the knowledge of basic Mechanical Engineering concepts, mechanisms, design of machine elements and machine tools characteristics. |  |     |
| Unit - I   | Mechanisms:  |  | 9+3 |
| Kinematics – Links, pairs and mechanisms - 4 Bar mechanism – Crank rocker - Slider crank mechanisms – Inversions – Determination of Velocity and acceleration of simple mechanisms.  |  |  |     |
| Unit - II  | Friction:  |  | 9+3 |
| Types of friction – simple contact friction- belt and rope drives - Ratio of tensions- friction in screw and nuts – Bearings- pivot, collar, journal bearings and rolling element - Plate and disc clutches –basics of brakes, Springs – Close coiled and Leaf spring.   |  |  |     |
| Unit - III   | Shafts, Gears and Gear Trains:   |  | 9+3 |
| Design of shafts –Couplings –Gears – law of gearing - Spur gear – Design of gears - Gear trains - simple and compound gear trains - determination of speed and torque in epicyclic gear trains.  |  |  |     |
| Unit - IV  | Vibration:   |  | 9+3 |
| Single degree of freedom systems – Forced, damped vibrations – System response time constant –Vibration isolation – Torsional vibrations – Two/ Three rotor systems – torsionally equivalent system.   |  |  |     |
| Unit - V   | Machine Tools:   |  | 9+3 |
| Machine tool construction features and operations: lathe, milling machine, drilling machine – Drive system for machine tools – mechanical, hydraulic and electric- stepped and variable speeds – spindle speeds and feed drives – Additive Manufacturing (Basics only) – 3D printer machine building for FDM technology. |  |  |     |

**Lecture:45, Tutorial:15, Total:60**

### REFERENCES:

|    |  |
|----|--|
| 1. | Shigley, J.E., Pennock, G.R. and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw-Hill Inc., 2010.                  |
| 2. | Budyna,R.G. and Nisbett.K.J., "Shigley's Mechanical Engineering Design" Mcgraw Hill International Edition, 2014.             |
| 3. | Kalpakjian,S. and Schmid,S., "Manufacturing Processes for Engineering Materials", 6th Edition, Pearson, Prentice Hall, 2016. |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| CO1  | determine the velocity and acceleration for rigid links in four bar and slider crank mechanisms                    | Analyzing (K4)                       |
| CO2  | evaluate the influence of friction behavior in mechanical elements like bearings, clutches, brakes and belt drives | Analyzing (K4)                       |
| CO3  | design a mechanical system with shafts, couplings, gears and gear drives with realistic constraints                | Analyzing (K4)                       |
| CO4  | assess the effect of vibrations in linear and torsional systems  | Analyzing (K4)                       |
| CO5  | interpret the various machine tools and drive mechanisms for subtractive and additive processes                    | Understanding (K2)                   |

| <b>Mapping of COs with POs and PSOs</b>                         |            |            |            |
|---|------------|------------|------------|
| <b>COs/POs</b>  | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1   | 3          | 3          | 1          |
| CO2   | 3          |            | 2          |
| CO3   | 1          | 3          | 3          |
| CO4   | 1          |            | 3          |
| CO5   | 1          | 2          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy |            |            |            |

#### ASSESSMENT PATTERN

| <b>Test /<br/>Bloom's<br/>Category*</b> | <b>Remembering<br/>(K1) %</b> | <b>Understanding<br/>(K2) %</b> | <b>Applying<br/>(K3) %</b> | <b>Analyzing<br/>(K4) %</b> | <b>Evaluating<br/>(K5) %</b> | <b>Creating<br/>(K6) %</b> | <b>Total<br/>%</b> |
|---|-------------------------------|---------------------------------|----------------------------|-----------------------------|------------------------------|----------------------------|--------------------|
| CAT 1                                   | 10                            | 10                              | 50                         | 30                          |                              |                            | 100                |
| CAT 2                                   | 10                            | 10                              | 50                         | 30                          |                              |                            | 100                |
| CAT 3                                   | 10                            | 30                              | 60                         | --                          |                              |                            | 100                |
| ESE                                     | 10                            | 10                              | 50                         | 30                          |                              |                            | 100                |

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



## 20MMT13 CONTROL SYSTEM ENGINEERING

| Programme & Branch | M.E. Mechatronics Engineering | Sem. | Category | L | T | P | Credit |
|--------------------|-------------------------------|------|----------|---|---|---|--------|
| Prerequisites      | Nil                           | 1    | PC       | 3 | 0 | 0 | 3      |

|  |   |   |
|--|---|---|
| Preamble   | This course imparts knowledge on the components and their representation of control systems, time response, frequency response, stability of the systems and state variable analysis. |   |
| UNIT – I   | System Modeling:  | 9 |
| Control System: Terminology and Basic Structure-Feed forward and Feedback control theory– Mathematical modeling: Electrical systems, Mechanical systems, Electro Mechanical systems – Electrical analogous for mechanical systems – Block diagram reduction techniques, Signal flow graph -Mason's gain formula .  |   |   |
| UNIT – II  | Time Response Analysis:   | 9 |
| Test signals – Time response of I and II order systems – Time domain specifications – Steady state error – Generalized error series – Concepts of stability – Routh Hurwitz criterion – Root locus.  |   |   |
| UNIT – III   | Frequency Response Analysis:  | 9 |
| Frequency domain specifications – Correlation between time and frequency domain specifications – Bode plot, Polar plot – Nyquist stability criterion.  |   |   |
| UNIT – IV  | Compensators Design:  | 9 |
| Realization of basic compensators – Cascade compensation in time domain and frequency domain –Design of Lag, Lead and Lag, Lead compensator using root locus - PD, PI,PID control systems  |   |   |
| UNIT – V   | State Space Analysis:   | 9 |
| Continuous and discrete time state variable theory – State space formulation – State space representation using physical variables, phase variables and canonical variables - Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models – Solution of state equations – Controllability - Observability. |   |   |

**Lecture:45**

### REFERENCES:

|   |   |
|---|---|
| 1 | Ogata K., "Modern Control Engineering", 5 <sup>th</sup> Edition, Pearson Education/ PHI, New Delhi, 2015.                             |
| 2 | Nise Norman S., "Control Systems Engineering", 7 <sup>th</sup> Edition, Wiley Publishers, 2018.                                       |
| 3 | Nagrath I.J. and Gopal M., "Control Systems Engineering", 6 <sup>th</sup> Edition, New Age International Publishers, New Delhi, 2018. |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest<br/>Level)</b> |
|--|--|--|
| CO1  | develop the mathematical model of an Electrical, Mechanical and Electro mechanical systems | Applying (K3)                            |
| CO2  | interpret the time response analysis of the system   | Applying (K3)                            |
| CO3  | interpret the frequency response and stability of the system                               | Applying (K3)                            |
| CO4  | demonstrate the compensation techniques for stabilizing the system                         | Applying (K3)                            |
| CO5  | identify continuous and discrete time state variable theory                                | Applying (K3)                            |

| <b>Mapping of COs with POs and PSOs</b>                         |            |            |            |
|---|------------|------------|------------|
| <b>COs/POs</b>  | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| 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

| <b>Test /<br/>Bloom's<br/>Category*</b> | <b>Remembering<br/>(K1) %</b> | <b>Understanding<br/>(K2) %</b> | <b>Applying<br/>(K3) %</b> | <b>Analyzing<br/>(K4) %</b> | <b>Evaluating<br/>(K5) %</b> | <b>Creating<br/>(K6) %</b> | <b>Total<br/>%</b> |
|---|-------------------------------|---------------------------------|----------------------------|-----------------------------|------------------------------|----------------------------|--------------------|
| CAT 1                                   | 10                            | 15                              | 75                         |                             |                              |                            | 100                |
| CAT 2                                   | 10                            | 15                              | 75                         |                             |                              |                            | 100                |
| CAT 3                                   | 10                            | 15                              | 75                         |                             |                              |                            | 100                |
| ESE                                     | 10                            | 10                              | 80                         |                             |                              |                            | 100                |

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



### 20MMT14 SENSORS AND IoT

| Programme & Branch | M.E. Mechatronics Engineering | Sem. | Category | L | T | P | Credit |
|--------------------|-------------------------------|------|----------|---|---|---|--------|
| Prerequisites      | Nil                           | 1    | PC       | 3 | 0 | 0 | 3      |

|   |   |   |
|---|---|---|
| Preamble  | This course inculcate the basic knowledge about sensors used to measure various physical quantities like resistance, pressure, flow, level, humidity and understanding the fundamentals of IoT and domain specific deployments. |   |
| UNIT – I  | Introduction to Measurement   | 9 |
| Units and Standards - Instrument classification - Characteristics of Instruments - Static and dynamic. <b>Non-electrical Transducers:</b> Classification of transducers - Temperature Measurement: Filled system thermometer - Bimetallic thermometer - Pressure Transducers: Elastic transducers - Bourdon gauge - Bellows - Diaphragm. Vacuum: McLeod gauge, thermal conductivity gauge - Ionization gauge. |   |   |
| UNIT – II   | Electrical Transducers  | 9 |
| Turbine flow meter, Electromagnetic flow meter - Hot wire anemometer - Ultrasonic Meter - Resistive transducers - Potentiometer - RTD - Thermistor - Thermocouple - Radiation Pyrometer.  |   |   |
| UNIT – III  | Force, Displacement, Magnetic and Digital Sensors   | 9 |
| Strain gauges - Force measurement - Inductive transducer - LVDT - RVDT - Capacitive transducer – Piezo-electric transducer – Magnetic Sensor- Types –Magneto resistive – Hall effect – Current sensor - Digital displacement transducers. Digital transducers: Encoders – Fiber optic sensors – Film sensors - Introduction to MEMS and Nano sensors.   |   |   |
| UNIT – IV   | Internet of Things  | 9 |
| Introduction- Physical design of IoT – Logical design of IoT- IoT enabling technologies- IoT levels and deployment templates – IoT and M2M – IoT system Management with NETCONF-YANG  |   |   |
| UNIT – V  | IoT Design platform   | 9 |
| IoT design methodology – steps – IoT physical devices- arduino and raspberry pi – interfacing and Programming with sensor applications. <b>Domain specific IoTs:</b> Home automation- smart cities –environment – energy – retail – Logistics – agriculture – Industry- health and life style.  |   |   |

Lecture:45

#### REFERENCES:

|   |  |
|---|--|
| 1 | Patranabis D., "Sensor and Actuators", 2 <sup>nd</sup> Edition, Prentice Hall of India, 2005.  |
| 2 | Doebelin E.O., "Measurement Systems - Applications and Design", 6 <sup>th</sup> Edition, Tata McGraw Hill, New Delhi, 2017.                      |
| 3 | Bahga, A. and Madiseti, V. "Internet of Things: A Hands-On Approach" 1 <sup>st</sup> Edition, Orient Blackswan Private Limited, New Delhi, 2015. |





| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest<br/>Level)</b> |
|--|--|--|
| CO1  | demonstrate the basic concepts of measurement system and categorize the different type of non-electrical transducers | Understanding (K2)                       |
| CO2  | correlate the different type of electrical transducers for various applications                                      | Understanding (K2)                       |
| CO3  | infer the role of sensors in evolving technologies   | Understanding (K2)                       |
| CO4  | demonstrate the basic concepts of Internet of Things and deployment platforms  | Understanding (K2)                       |
| CO5  | develop a sensor based IoT applications and infer the different domain specific IoTs.                                | Applying (K3)                            |

| <b>Mapping of COs with POs and PSOs</b>                         |            |            |            |
|---|------------|------------|------------|
| <b>COs/POs</b>  | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1   | 1          | 2          | 3          |
| CO2   | 2          | 2          | 3          |
| CO3   | 2          | 3          | 3          |
| CO4   | 2          | 2          | 3          |
| CO5   | 3          | 3          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy |            |            |            |

#### ASSESSMENT PATTERN

| <b>Test /<br/>Bloom's<br/>Category*</b> | <b>Remembering<br/>(K1) %</b> | <b>Understanding<br/>(K2) %</b> | <b>Applying<br/>(K3) %</b> | <b>Analyzing<br/>(K4) %</b> | <b>Evaluating<br/>(K5) %</b> | <b>Creating<br/>(K6) %</b> | <b>Total<br/>%</b> |
|---|-------------------------------|---------------------------------|----------------------------|-----------------------------|------------------------------|----------------------------|--------------------|
| CAT 1                                   | 20                            | 80                              |                            |                             |                              |                            | 100                |
| CAT 2                                   | 20                            | 80                              |                            |                             |                              |                            | 100                |
| CAT 3                                   | 10                            | 60                              | 40                         |                             |                              |                            | 100                |
| ESE                                     | 10                            | 60                              | 30                         |                             |                              |                            | 100                |

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



### 20MML11 CONTROL SYSTEM ENGINEERING LABORATORY

|                               |  |             |                 |          |          |          |               |
|-------------------------------|--|-------------|-----------------|----------|----------|----------|---------------|
| <b>Programme &amp; Branch</b> | <b>M.E. Mechatronics Engineering</b>   | <b>Sem.</b> | <b>Category</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>Credit</b> |
| <b>Prerequisites</b>          | <b>NIL</b>   | <b>1</b>    | <b>PC</b>       | <b>0</b> | <b>0</b> | <b>2</b> | <b>1</b>      |
| <b>Preamble</b>               | This course provides hands-on training on design, develop and analyze the control systems in various forms for real time applications. |             |                 |          |          |          |               |

#### List of Exercises / Experiments:

|     |  |
|-----|--|
| 1.  | Study of classification of systems   |
| 2.  | Transfer function model using block diagram reduction techniques using MATLAB. |
| 3.  | Time response analysis of second order system using MATLAB                     |
| 4.  | Development and analysis of mechanical translational system                    |
| 5.  | Development and analysis of mechanical rotational system                       |
| 6.  | Development and analysis of electrical system using op-amp                     |
| 7.  | Development and analysis of electromechanical system using gears               |
| 8.  | Stability analysis with root locus using MATLAB                                |
| 9.  | Frequency domain analysis with bode plot using MATLAB                          |
| 10. | Closed loop analysis of PID controller for position control system             |
| 11. | Design of compensators for first order system                                  |
| 12. | Design and implementation of simple controller for real time application       |

**Total:30**

#### REFERENCES/MANUAL/SOFTWARE:

|    |                   |
|----|-------------------|
| 1. | Laboratory Manual |
|----|-------------------|

| <b>COURSE OUTCOMES:</b>                                   |  | <b>BT Mapped (Highest Level)</b> |
|---|--|----------------------------------|
| On completion of the course, the students will be able to |  |                                  |
| CO1   | design, modeling and analysis of systems                               | Analyzing (K4), Precision (S3)   |
| CO2   | analyze the stability of system  | Analyzing (K4), Precision (S3)   |
| CO3   | design and analyze compensators and controller for various application | Analyzing (K4), Precision (S3)   |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 3          | 2          | 3          |
| CO2  | 3          | 2          | 3          |
| CO3  | 3          | 2          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |



## 20MML12 SENSORS AND IoT LABORATORY

|                               |   |             |                 |          |          |          |               |
|-------------------------------|---|-------------|-----------------|----------|----------|----------|---------------|
| <b>Programme &amp; Branch</b> | <b>M.E. Mechatronics Engineering</b>  | <b>Sem.</b> | <b>Category</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>Credit</b> |
| <b>Prerequisites</b>          | <b>NIL</b>  | <b>1</b>    | <b>PC</b>       | <b>0</b> | <b>0</b> | <b>2</b> | <b>1</b>      |
| <b>Preamble</b>               | This course provides hands-on training on design, develop and analyze the control systems in various forms for real time applications.. |             |                 |          |          |          |               |

### 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 with arduino programming. |
| 10. | Measurement of unknown Resistance using Wheatstone bridge with IoT.                       |
| 11. | Measurement of unknown Inductance using Maxwell Bridge with IoT.                          |
| 12. | Measurement of unknown Capacitance using Schering Bridge with IoT.                        |

**Total:30**

### REFERENCES/MANUAL/SOFTWARE:

|    |                   |
|----|-------------------|
| 1. | Laboratory Manual |
|----|-------------------|

| <b>COURSE OUTCOMES:</b>                                   |  | <b>BT Mapped (Highest Level)</b>   |
|---|--|------------------------------------|
| On completion of the course, the students will be able to |  |                                    |
| CO1   | analyze the characteristics of temperature , displacement , capacitive and strain gauge sensor and transducers | Understanding (K2), Imitation (S1) |
| CO2   | demonstrate the characteristics of non-electrical and electrical sensors and transducers                       | Understanding (K2), Imitation (S1) |
| CO3   | experiment with different sensor applications with IoT deployment  | Applying (K3), Manipulation (S2)   |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 2          | 2          | 3          |
| CO2  | 2          | 2          | 3          |
| CO3  | 3          | 3          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |



## 20MMC21 FLUID POWER SYSTEM

| Programme & Branch | M.E. Mechatronics Engineering | Sem. | Category | L | T | P | Credit |
|--------------------|-------------------------------|------|----------|---|---|---|--------|
| Prerequisites      | NIL                           | 2    | PC       | 3 | 0 | 2 | 4      |

|          |   |
|----------|---|
| Preamble | This course deals with the design of a system which generate, control and transmission of power using pressurized fluids. |
|----------|---|

|                 |   |          |
|-----------------|---|----------|
| <b>Unit - I</b> | <b>Fundamentals and Power Source of Hydraulic System:</b> | <b>9</b> |
|-----------------|---|----------|

Basics, Types and structure of fluid power systems – Pascal's Law and its application – Fluid properties – Losses in pipes, valves and fittings – Advantages and applications of Fluid power systems. Fluid power symbols – Hydraulic pumps: Gear, Vane and Piston pumps, Pump Performance, Characteristics and Selection - Sizing of hydraulic pumps.

|                  |  |          |
|------------------|--|----------|
| <b>Unit - II</b> | <b>Control Components of Hydraulic System:</b> | <b>9</b> |
|------------------|--|----------|

Direction control valves: Three-way valve, Four way valve, Check valve and shuttle valve – Actuation mechanism of DCV – Pressure control valves: Pressure relief, Pressure Reducing, Counter balance, Sequencing and Unloading Valves – Flow control valves and its types – Proportional Valves – Servo valves and its types.

|                   |  |          |
|-------------------|--|----------|
| <b>Unit - III</b> | <b>Fundamentals of Pneumatic System:</b> | <b>9</b> |
|-------------------|--|----------|

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.

|                  |                                    |          |
|------------------|------------------------------------|----------|
| <b>Unit - IV</b> | <b>Fluid Power Circuit Design:</b> | <b>9</b> |
|------------------|------------------------------------|----------|

Circuit design methods: Cascade method, Step counter method and KV Map method (two / three-cylinder circuits) – Basic pneumatic circuits – Electrical components and electrical controls for Fluid power circuits – Introduction to Fluid logic devices and applications – Accumulator: Types and application circuits – Pressure intensifier circuits – PLC applications in Fluid power circuit.

|                 |   |          |
|-----------------|---|----------|
| <b>Unit - V</b> | <b>Industrial Circuits and Maintenance:</b> | <b>9</b> |
|-----------------|---|----------|

Industrial circuits: Speed control circuits – Regenerative cylinder circuits – Pump unloading circuit – Double pump circuit – Counter balance valve circuit – Hydraulic cylinder sequencing circuit – Automatic cylinder reciprocating circuit – Cylinder synchronizing circuits – Fail safe circuits - Sealing devices: Types and materials – Installation, Maintenance and trouble shooting of Fluid Power systems.

### List of Exercises / Experiments:

|     |   |
|-----|---|
| 1.  | Design and testing of speed control circuits (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**

### REFERENCES:

|    |   |
|----|---|
| 1. | Esposito Anthony, "Fluid Power with Applications", 7 <sup>th</sup> Edition, Pearson Higher Education, New York, 2015. |
| 2. | Jegadeesa T., "Hydraulics and Pneumatics", I.K International Publishing House Pvt. Ltd., New Delhi, 2015.             |
| 3. | Majumdar S.R., "Oil Hydraulic Systems – Principles and Maintenance", 2nd Edition, Tata McGraw-Hill, New Delhi, 2012.  |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| CO1  | identify fluid power components and their symbols as used in industry and also select suitable pump for hydraulic power pack                           | Understanding (K2)<br>Imitation (S1) |
| CO2  | choose appropriate control valves for fluid power applications   | Applying (K3)<br>Manipulation (S2)   |
| CO3  | select pneumatic components and fluid power actuators for low cost automation  | Analysing (K4)<br>Precision (S3)     |
| CO4  | design and construct a fluid power circuits real time applications   | Applying (K3)<br>Manipulation (S2)   |
| CO5  | design, construct, test, install, maintain and trouble shoot fluid power circuits for engineering applications   | Analysing (K4)<br>Precision (S3)     |
| CO6  | Select the appropriate fluid power components and their symbols to design and simulate the industrial circuits   | Applying (K3),<br>Precision (S3)     |
| CO7  | design, construct and test fluid power circuits with Manual, Mechanical, hydraulic, pneumatic and electrical actuation methods for low cost automation | Applying (K3),<br>Precision (S3)     |
| CO8  | develop and simulate fluid power circuits using simulation software for industrial applications  | Applying (K3),<br>Precision (S3)     |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  |            | 2          | 3          |
| CO2  | 2          |            | 3          |
| CO3  | 2          |            | 3          |
| CO4  |            | 1          | 3          |
| CO5  | 2          | 2          | 3          |
| CO6  | 2          | 2          | 3          |
| CO7  | 2          | 2          | 3          |
| CO8  | 2          | 2          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

| <b>ASSESSMENT PATTERN - THEORY</b> |                           |                             |                        |                         |                          |                        |                |
|------------------------------------|---------------------------|-----------------------------|------------------------|-------------------------|--------------------------|------------------------|----------------|
| <b>Test / Bloom's Category*</b>    | <b>Remembering (K1) %</b> | <b>Understanding (K2) %</b> | <b>Applying (K3) %</b> | <b>Analyzing (K4) %</b> | <b>Evaluating (K5) %</b> | <b>Creating (K6) %</b> | <b>Total %</b> |
| CAT1                               | 10                        | 60                          | 30                     | -                       | -                        | -                      | 100            |
| CAT2                               | 10                        | 55                          | 35                     | -                       | -                        | -                      | 100            |
| CAT3                               | 10                        | 40                          | 50                     | -                       | -                        | -                      | 100            |
| ESE                                | 15                        | 50                          | 35                     | -                       | -                        | -                      | 100            |

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

**20MMC22 ROBOT KINEMATICS AND DYNAMICS**

| Programme & Branch | M.E. Mechatronics Engineering                      | Sem. | Category | L | T | P | Credit |
|--------------------|--|------|----------|---|---|---|--------|
| Prerequisites      | Bridge Course Mechanical and Advanced Mechatronics | 2    | PC       | 3 | 0 | 2 | 4      |

|  |  |   |
|--|--|---|
| Preamble   | The course on Robotics Engineering is intended to provide a reasonable understanding of robotics and robot anatomy, the mathematics behind kinematics and dynamics of robot. It also involves controlling the robot motion using different control strategies. |   |
| Unit - I   | Introduction   | 9 |
| History of robotics – Robot Anatomy – Robot specifications - Work space – Degree of freedom - Joint types - Types of robots – Precision of movements - End effectors – Dexterity - Robot applications.   |  |   |
| Unit - II  | Robot Kinematics   | 9 |
| Descriptions: Position, Orientations and translation – Mapping: Changing from frame to frame – Operators: Translations, Rotation and Transformation - Homogeneous Transformation matrices - Forward and Inverse kinematics - Representation of links using Denavit - Hartenberg parameters |  |   |
| Unit - III   | Velocity and Static Force  | 9 |
| Introduction - Linear and angular velocities of a rigid body - Velocity propagation – Derivation of Jacobian matrix for Serial manipulator – Singularities - Static force of serial manipulator.   |  |   |
| Unit - IV  | Robot Dynamics   | 9 |
| Acceleration of a rigid body - Inertia of a link - Equations of motion for serial manipulators: Euler Lagrange formulation, Newton Euler formulation — Inverse dynamics of serial manipulator.   |  |   |
| Unit - V   | Robot Control  | 9 |
| Point to point and Continuous path motions – Joint trajectory Vs Cartesian trajectory – Trajectory planning – Trajectory following - Disturbance rejection – PD and PID control – Computer torque control - Adaptive control – Feedback linearization control.                             |  |   |

**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- Painting, Pick and place and switch off intruder alarm. |
| 3.  | Virtual reality robot programming for different tasks- Stacking of blocks and Machining of billets.            |
| 4.  | Creation of Tool Centre Point (TCP) and Work Object using ABB IRB 1410 industrial robot.                       |
| 5.  | Pick and place operation in teach mode using ABB IRB 1410 industrial robot.                                    |
| 6.  | Machine tending operation in teach mode using ABB IRB 1410 industrial robot.                                   |
| 7.  | Robot programming exercises - Point-to-point programming.  |
| 8.  | Robot programming exercises - Continuous path programming.   |
| 9.  | Robot programming exercises – Path planning in offline mode.   |
| 10. | Vision based On-line Inspection and sorting of components using ABB IRB 1410 industrial robot.                 |

**Lecture:45, Practical:30, Total:75****REFERENCES:**

|    |   |
|----|---|
| 1. | Groover M.P., Weiss M., Magel R.N., Odrey N.G. and Dulta A., "Industrial Robotics, Technology, Programming and Applications", 2 <sup>nd</sup> Edition, McGraw-Hill Companies, 2012. |
| 2. | Saeed B. Niku, "Introduction to Robotics: Analysis, Control, Applications", 2 <sup>nd</sup> Edition, Wiley India Pvt. Ltd., 2012.   |
| 3. | Craig John J., "Introduction to Robotics: Mechanics and Control", 4 <sup>th</sup> Edition, Pearson/Prentice Hall Publication, 2018.   |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| CO1  | interpret the industrial manipulator anatomy and estimate the gripping force of robot end effector | Applying (K3)                        |
| CO2  | develop the forward and inverse kinematics for serial manipulators                                 | Applying (K3)                        |
| CO3  | formulate Jacobian matrix for velocity and static force analysis of serial manipulators            | Applying (K3)                        |
| CO4  | formulate dynamic equations for serial manipulators  | Applying (K3)                        |
| CO5  | apply the scheme of trajectory planning and control for manipulator motion control                 | Applying (K3)                        |
| CO6  | analyze the industrial robot work cell problems  | Analyzing (K4),<br>Manipulation (S2) |
| CO7  | develop robot programming through online /offline mode   | Creating (K6),<br>Precision (S3)     |
| CO8  | develop an online inspection system using machine vision   | Creating (K6),<br>Precision (S3)     |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 2          | -          | 3          |
| CO2  | 2          | -          | 3          |
| CO3  | 2          | -          | 3          |
| CO4  | 2          | -          | 3          |
| CO5  | 2          | -          | 3          |
| CO6  | 2          | 3          | 3          |
| CO7  | 3          | 3          | 3          |
| CO8  | 3          | 3          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

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



## 20MMT21 EMBEDDED SYSTEMS AND CONTROL

| Programme & Branch | M.E. Mechatronics Engineering                      | Sem. | Category | L | T | P | Credit |
|--------------------|--|------|----------|---|---|---|--------|
| Prerequisites      | Bridge Course Mechanical and Advanced Mechatronics | 2    | PC       | 3 | 0 | 0 | 3      |

|  |   |   |
|--|---|---|
| Preamble   | Microcontroller has become important building block in digital electronics design. 8051/PIC microcontroller architecture, programming, and interfacing is dealt in detail in this course. Interfacing, assembly language programming and interfacing of 8051/PIC microcontroller and its application in industry are also covered in this course. |   |
| Unit - I   | 8051 Microcontroller  | 9 |
| Microcontroller and embedded processors - Overview of the 8051 family - 8051 microcontroller architecture - Memory organization of 8051 - PSW register - Register banks and stack, Input/ Output ports, pins.                                    |   |   |
| Unit - II  | 8051 Embedded C Programming   | 9 |
| Introduction to Embedded C Programming - Timer/Counter - Serial Communications Interrupts - Instruction set - Addressing modes - I/O port Programming - Timer / counter programming - Serial communications Programming - Interrupt Programming. |   |   |
| Unit - III   | PIC Microcontrollers Architecture   | 9 |
| PIC microcontroller overview and features - Harvard architecture - Pipelining – Architecture of PIC18- PinDescription-Memory organization: Program memory-Data Memory -Register Organization.  |   |   |
| Unit - IV  | PIC 18 Features   | 9 |
| I/O Ports Timers Counters-Capture/ Compare - PWM- External Hardware Interrupts- USART-ADC-Interfacing to External memory.  |   |   |
| Unit - V   | PIC 18 Embedded C Programming   | 9 |
| Addressing Modes - Instruction set-Simple Programs. I/O port programming - Timer/Counter programming - Serial communications Programming - ADC Programming - Application case studies.   |   |   |

**Total:45**

### REFERENCES:

|    |   |
|----|---|
| 1. | Mazidi Muhammad Ali and Mazidi Janice Gillispie, "The 8051 Microcontroller and Embedded Systems", 2 <sup>nd</sup> Edition, Pearson Education, 2013.                 |
| 2. | Mazidi Muhammad Ali, Mckinlay Rolin .D., and Causey Danny, "PIC Microcontroller and Embedded Systems using Assembly and C for PIC18", Pearson Education Asia, 2008. |
| 3. | David Den Haring, Kai Qian, and Li Cao., "Embedded Software Development With C", Springer, 2009.  |





| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |   | <b>BT Mapped<br/>(Highest Level)</b> |
|--|---|--------------------------------------|
| CO1  | explain the organization of 8051 microcontroller and its programming concepts | Understanding (K2)                   |
| CO2  | interpret the basic architecture and features of PIC18 microcontroller        | Understanding (K2)                   |
| CO3  | develop Embedded C programming for 89c51 and PIC microcontroller              | Applying (K3)                        |
| CO4  | experiment with microcontroller hardware for a given industrial application   | Applying (K3)                        |
| CO5  | develop microcontroller hardware for industrial applications                  | Creating (K6)                        |

| <b>Mapping of COs with POs</b> |            |            |            |
|--------------------------------|------------|------------|------------|
| <b>COs/POs</b>                 | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1                            | 1          | 1          | 3          |
| CO2                            | 1          | 1          | 3          |
| CO3                            | 3          | 2          | 2          |
| CO4                            | 3          | 2          | 3          |
| CO5                            | 3          | 2          | 3          |

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

| <b>ASSESSMENT PATTERN - THEORY</b> |                           |                             |                        |                         |                          |                        |                |
|------------------------------------|---------------------------|-----------------------------|------------------------|-------------------------|--------------------------|------------------------|----------------|
| <b>Test / Bloom's Category*</b>    | <b>Remembering (K1) %</b> | <b>Understanding (K2) %</b> | <b>Applying (K3) %</b> | <b>Analyzing (K4) %</b> | <b>Evaluating (K5) %</b> | <b>Creating (K6) %</b> | <b>Total %</b> |
| CAT1                               | 20                        | 30                          | 50                     |                         |                          |                        | 100            |
| CAT2                               | 20                        | 20                          | 60                     |                         |                          |                        | 100            |
| CAT3                               | 10                        | 20                          | 70                     |                         |                          |                        | 100            |
| ESE                                | 10                        | 30                          | 70                     |                         |                          |                        | 100            |

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



## 20MMT22 INTEGRATED AUTOMATION CONTROLLERS

|                               |                                      |             |                 |          |          |          |               |
|-------------------------------|--------------------------------------|-------------|-----------------|----------|----------|----------|---------------|
| <b>Programme &amp; Branch</b> | <b>M.E. Mechatronics Engineering</b> | <b>Sem.</b> | <b>Category</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>Credit</b> |
| <b>Prerequisites</b>          | <b>Sensors and IOT</b>               | <b>2</b>    | <b>PC</b>       | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b>      |

|   |   |   |
|---|---|---|
| Preamble  | This course is intended for learning the device layer components and Architecture and Operations of programmable logic controller, Fundamentals of Programming and problem solving using logic ladder diagrams. This course is also giving the ideas of Fundamentals Networking of PLC, SCADA architecture and Distributed control system and its case studies. |   |
| Unit - I  | Device Layer Components:  | 9 |
| Input Devices- Pushbuttons – Proximity Sensors- Read switch –float switch-pressure switch-temperature switch-limit switch-Encoders – MCB - Output Devices – Relays – Contactors – OLR – DOL Starter - Solenoid valves-relay logic program for simple industrial case studies.   |   |   |
| Unit - II   | Programmable Logic Controller:  | 9 |
| Parts of PLC – Principles of operation – PLC sizes – PLC hardware components – I/O modules – Programming devices- different modes of PLC operation-maintenance and troubleshooting procedure.   |   |   |
| Unit - III  | PLC Programming:  | 9 |
| Types of PLC programming – Simple instructions – Latching relays - Converting simple relay ladder diagram into PLC ladder diagram-Timer instructions – On Delay, Off Delay and Retentive Timers – Counter instructions – Up Counter, Down Counter and Up Down Counters- Program control instructions – Data manipulating instructions, math instruction – Closed loop control.                                |   |   |
| Unit - IV   | Networking of PLC and SCADA:  | 9 |
| Networking of PLCs – Data communication — data highway- serial communication- device net –control net – Ethernet IP –Modbus- field bus – Profibus DP - OPC function. Supervisory Control and Data Acquisition – Architecture – Remote terminal units – Master Terminal units – Operator interface – security considerations – alarming- control change screen- status screen-graphics and trending – reports. |   |   |
| Unit - V  | Distributed Control System and Case Studies:  | 9 |
| Evolution – Architectures – Comparison – Local control unit – Process interfacing issues – Communication facilities. Operator interfaces – Low level and high-level operator interfaces – Operator displays – Engineering interfaces – Low level and high-level engineering interfaces – Applications of DCS in – Pulp and paper environment – Petroleum – Refining environment.                              |   |   |

**Total: 45**

### REFERENCES:

|    |   |
|----|---|
| 1. | Petrusella Frank D., "Programmable Logic Controllers", 4 <sup>th</sup> Edition, McGraw-Hill, New York, 2016.  |
| 2. | Webb John, W and Reis Ronald A., "Programmable Logic Controllers: Principles and Applications", 5 <sup>th</sup> Edition, Prentice Hall of India, New Delhi, 2011. |
| 3. | Stuart Boyer A., "SCADA Supervisory Control and Data Acquisition", 4 <sup>th</sup> Edition ISA, USA, 2010.  |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| CO1  | infer the device layer components functions and its role in industrial automation system                                       | Understanding (K2)                   |
| CO2  | explain the PLC architecture, Programming device, installation procedures and trouble shooting                                 | Applying (K3)                        |
| CO3  | develop PLC program using diverse functions of PLCs for a given application  | Applying (K3)                        |
| CO4  | explain the basic networking protocols for PLC, application development procedures in SCADA and manage data, alarm and storage | Understanding (K2)                   |
| CO5  | illustrate the architecture of DCS, interfaces and its applications  | Understanding (K2)                   |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 2          | 2          | 3          |
| CO2  | 2          | 2          | 3          |
| CO3  | 3          | 2          | 3          |
| CO4  | 3          | 2          | 3          |
| CO5  | 2          | 2          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

| <b>ASSESSMENT PATTERN - THEORY</b> |                           |                             |                        |                         |                          |                        |                |
|------------------------------------|---------------------------|-----------------------------|------------------------|-------------------------|--------------------------|------------------------|----------------|
| <b>Test / Bloom's Category*</b>    | <b>Remembering (K1) %</b> | <b>Understanding (K2) %</b> | <b>Applying (K3) %</b> | <b>Analyzing (K4) %</b> | <b>Evaluating (K5) %</b> | <b>Creating (K6) %</b> | <b>Total %</b> |
| CAT1                               | 10                        | 60                          | 30                     |                         |                          |                        | 100            |
| CAT2                               | 10                        | 50                          | 50                     |                         |                          |                        | 100            |
| CAT3                               | 20                        | 80                          |                        |                         |                          |                        | 100            |
| ESE                                | 10                        | 60                          | 40                     |                         |                          |                        | 100            |

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



## 20MML21 EMBEDDED SYSTEM AND PLC LABORATORY

|                               |   |             |                 |          |          |          |               |
|-------------------------------|---|-------------|-----------------|----------|----------|----------|---------------|
| <b>Programme &amp; Branch</b> | <b>M.E. Mechatronics Engineering</b>  | <b>Sem.</b> | <b>Category</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>Credit</b> |
| <b>Prerequisites</b>          | <b>NIL</b>  | 2           | PC              | 0        | 0        | 2        | 1             |
| <b>Preamble</b>               | This course provides hands on training on concepts of Embedded programming and PLC programming in real time applications. |             |                 |          |          |          |               |

### List of Exercises / Experiments:

|     |  |
|-----|--|
| 1.  | Introduction to Embedded C programming and simulation software                         |
| 2.  | Interfacing of switch, LED and seven segment LED                                       |
| 3.  | Interfacing of LCD   |
| 4.  | Interfacing of high power devices for the given case study                             |
| 5.  | Study on Interfacing sensors, microcontroller with IoT module                          |
| 6.  | Introduction to programming /simulation/communication software for PLC programming     |
| 7.  | logical testing of I/Os and its interfacing with PLC                                   |
| 8.  | Level control using PLC  |
| 9.  | Linear and sequential actuation of Pneumatic cylinder with Timer and counter functions |
| 10. | Development of HMI for real time parameter monitoring and control                      |

**Total:30**

### REFERENCES/MANUAL/SOFTWARE:

|    |                   |
|----|-------------------|
| 1. | Laboratory Manual |
|----|-------------------|

| <b>COURSE OUTCOMES:</b>                                   |  | <b>BT Mapped (Highest Level)</b> |
|---|--|----------------------------------|
| On completion of the course, the students will be able to |  |                                  |
| CO1   | build and simulate Embedded C programming for 89C51 microcontroller                                | Analyzing (K4), Precision (S3)   |
| CO2   | build and simulate PLC programming for discrete and analog I/Os                                    | Analyzing (K4), Precision (S3)   |
| CO3   | develop plant level automation for real process plant control using Microcontroller, PLC and SCADA | Analyzing (K4), Precision (S3)   |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 3          | 2          | 3          |
| CO2  | 3          | 2          | 3          |
| CO3  | 3          | 2          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |



## 20MME01 COMPUTER NUMERICALLY CONTROLLED MACHINES

| SUMMER SEM- OPEN NUMERICAL- CONTROLLED MACHINES  |  |      |          |   |   |   |        |
|--|--|------|----------|---|---|---|--------|
| Programme & Branch   | M.E. Mechatronics Engineering  | Sem. | Category | L | T | P | Credit |
| Prerequisite   | Nil  | I    | PC       | 3 | 0 | 0 | 3      |
| Preamble   | This course provides the fundamental knowledge and programming concepts of CNC machines. |      |          |   |   |   |        |
| UNIT – I   | Construction Features of CNC Machines  |      |          |   |   |   | 9      |
| Introduction - CNC Machine Building, Drives and Controls: Drive Mechanism, Spindle Drives, Axes drives, Feed drives, Linear Motors and Actuators, Magnetic Levitation. Power transmission elements - Spindle bearing – Arrangement and installation - Guide ways – Configuration and design, friction and anti-friction LM guide ways, Retrofitting.   |  |      |          |   |   |   |        |
| UNIT – II  | Control Systems for CNC Machines and CAD/CAM Integration:                                |      |          |   |   |   | 9      |
| Interfacing – Monitoring – Diagnostics – Machine data – Sources of errors - Compensations for Machine accuracy – DNC – Adaptive control CNC systems. Concepts of High speed Machining and micro machining. Networking - networking techniques, LAN, components - Graphics standards – Data exchange format, evolution - features of various interfaces GKS, IGES, DXF, PDES, STEP etc., Process planning, Computer Aided process planning (CAPP) - Variant, generative Approaches. |  |      |          |   |   |   |        |
| UNIT – III   | CNC Programming:   |      |          |   |   |   | 9      |
| Structure of CNC program, Part Program Terminology Coordinate system, G & M codes, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, sub routines, mirroring features, Manual part programming for CNC turning and machining centre – APT programming for various machines in FANUC - Computer aided part programming - Post processing.   |  |      |          |   |   |   |        |
| UNIT – IV  | Tooling System and Management:   |      |          |   |   |   | 9      |
| Tooling system - Interchangeable tooling system – Preset, Qualified and semi-qualified tools – Coolant fed tooling system – Modular fixturing – Quick change tooling system – Automatic head changers – Tooling requirements for Turning and Machining centers – Tool holders – Tool assemblies – Tool Magazines – ATC Mechanisms – Tool management.   |  |      |          |   |   |   |        |
| UNIT – V   | Economics of CNC Operations  |      |          |   |   |   | 9      |
| Factors influencing selection of CNC machines - Cost of operation of CNC machines - Practical aspects of introducing CNC machines - Maintenance features of CNC machines - Preventive and other maintenance requirements.  |  |      |          |   |   |   |        |

**Total: 45**

### REFERENCES:

|    |  |
|----|--|
| 1. | Michael Fitzpatrick N.E., and Arlington W.A., "Machining and CNC Technology", 3 <sup>rd</sup> Edition, Mc Graw Hill Education, 2014. |
| 2. | Alan Overby, "CNC Machining Handbook: Building, Programming and Implementation", The McGraw-Hill Companies Inc., 2011.               |
| 3. | Peter smid, "CNC Programming Handbook", 3 <sup>rd</sup> Edition,. Industrial Press Inc., 2018.                                       |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |   | <b>BT Mapped<br/>(Highest Level)</b> |
|--|---|--------------------------------------|
| CO1  | Explain the basic components and mechanisms of CNC system             | Understanding (K2)                   |
| CO2  | Interpret the control system concepts used in CNC machine             | Understanding (K2)                   |
| CO3  | Formulate part programming for turning and milling Process            | Applying (K3)                        |
| CO4  | select proper tooling systems and fixtures for holding the work piece | Understanding (K2)                   |
| CO5  | Infer the economic concepts of CNC machines                           | Understanding (K2)                   |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 2          | 1          | 3          |
| CO2  | 3          | 3          | 1          |
| CO3  | 3          | 2          | 2          |
| CO4  | 3          | 1          | 1          |
| CO5  | 2          | 3          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

| <b>ASSESSMENT PATTERN - THEORY</b> |                           |                             |                        |                         |                          |                        |                |
|------------------------------------|---------------------------|-----------------------------|------------------------|-------------------------|--------------------------|------------------------|----------------|
| <b>Test / Bloom's Category*</b>    | <b>Remembering (K1) %</b> | <b>Understanding (K2) %</b> | <b>Applying (K3) %</b> | <b>Analyzing (K4) %</b> | <b>Evaluating (K5) %</b> | <b>Creating (K6) %</b> | <b>Total %</b> |
| CAT1                               | 20                        | 80                          |                        |                         |                          |                        | 100            |
| CAT2                               | 20                        | 65                          | 15                     |                         |                          |                        | 100            |
| CAT3                               | 20                        | 80                          |                        |                         |                          |                        | 100            |
| ESE                                | 20                        | 70                          | 10                     |                         |                          |                        | 100            |

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



## 20MME02 INDUSTRIAL DRIVES

| SUMMER INDUSTRIAL DRIVES   |  |      |          |   |   |   |        |
|--|--|------|----------|---|---|---|--------|
| Programme & Branch   | M.E. Mechatronics Engineering  | Sem. | Category | L | T | P | Credit |
| Prerequisite   | Nil  | I    | 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 –1 $\phi$ and 3 $\phi$ 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 – 1 $\phi$ 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**

### REFERENCES:

|    |   |
|----|---|
| 1. | Bimbhra B.S., "Power Electronics", 5 <sup>th</sup> Edition, Kanna Publishers, New Delhi, 2012.                          |
| 2. | Singh M.D. and Kanchandhani K.B., "Power Electronics" Tata McGraw – Hill Publishing Company, 2007.                      |
| 3. | Gopal K. Dubey, "Fundamentals of Electrical Drives", 2 <sup>nd</sup> Edition, Narosa Publishing House, New Delhi, 2001. |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| 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)                        |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 3          | 1          | 2          |
| CO2  | 3          | 1          | 2          |
| CO3  | 3          | 1          | 2          |
| CO4  | 3          | 1          | 2          |
| CO5  | 3          | 1          | 2          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

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





### 20MME03 METROLOGY AND COMPUTER AIDED INSPECTION

| Programme & Branch  |   | M.E. Mechatronics Engineering | Sem. | Category | L | T | P | Credit |
|---|---|-------------------------------|------|----------|---|---|---|--------|
| Prerequisite  |   | Sensors and IOT               | I    | PC       | 3 | 0 | 0 | 3      |
| Preamble  | This course make the learner to design and fabricate inspection methods and systems incorporating electronic systems for inspection and quality control in engineering. |                               |      |          |   |   |   |        |
| UNIT – I  | Linear and Angular Measurements:  |                               |      |          |   |   |   | 9      |
| Basic concept – Legal metrology- Precision- Accuracy- Types of errors – Standards of measurement- traceability – Interchange ability and selective assembly, gauge blocks, limit gauges - Gauge design. Comparators: mechanical, electronic, optical and pneumatic - Angular measurement: bevel protractor - Angle gauges - Sine bar – Autocollimator - Profile projectors.   |   |                               |      |          |   |   |   |        |
| UNIT – II   | Surface Finish and Form Measurement:  |                               |      |          |   |   |   | 9      |
| Measurement of surface finish: terminology – Roughness – Waviness – Evaluation of surface finish - Stylus probe instrument – Talysurf – Screw thread metrology: errors in thread – Pitch error – Measurement of various elements - Two and three wire method - Best wire size - Thread gauges - Floating carriage micrometer. Measurement of gears - Terminology- Measurement of various elements of gear - Tooth thickness - Constant chord and base tangent method - Parkinson Gear Tester. |   |                               |      |          |   |   |   |        |
| UNIT – III  | Laser Metrology:  |                               |      |          |   |   |   | 9      |
| Characteristics of LASER sources, LASER micrometer, LASER interferometer – Constructional features - Sources of errors – Measurement of position error, straightness and angle of machine tools, LASER alignment telescope, LASER triangulation techniques. In-process and post process gauging, Automatic gauging, Tool wear measurement, Roundness measurement using LASER, Flexible inspection systems.  |   |                               |      |          |   |   |   |        |
| UNIT – IV   | Co-Ordinate Measuring Machines:   |                               |      |          |   |   |   | 9      |
| Coordinate Metrology, types of CMM, constructional features - Structural elements - Drive systems -Support systems - Displacement transducers - Probing system – Software - Control system, temperature fundamentals and accuracy enhancement   |   |                               |      |          |   |   |   |        |
| UNIT – V  | Image Processing and Machine Vision System:   |                               |      |          |   |   |   | 9      |
| Image processing: Image acquisition and digitization – Windowing – Segmentation - Thresholding - Edge detection techniques, interpretation - Grey scale correlation – Template matching, applications in Inspection, interfacing machine vision and robot, Reverse engineering Applications.  |   |                               |      |          |   |   |   |        |

**Total: 45**

#### REFERENCES:

|    |   |
|----|---|
| 1. | Connie Dotson, Roger Harlow and Richard Thompson, "Fundamentals of Dimensional Metrology", 4th Edition, Thompson Asia, Singapore, 2003. |
| 2. | Jain R.K., "Engineering Metrology", 21st Edition, Khanna Publishers, New Delhi, 2018.   |
| 3. | Gupta I.C., "A Text Book of Engineering Metrology", 7th Edition, Dhanpat Rai Publications, New Delhi, 2018.                             |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| CO1  | infer linear and angular measurements using various instruments              | Understanding (K2)                   |
| CO2  | determine the surface roughness and form features measurements               | Applying (K3)                        |
| CO3  | appraise laser Interferometry and recent advancements in metrology           | Applying (K3)                        |
| CO4  | make profile measurements using Coordinate Measuring Machine (CMM)           | Applying (K3)                        |
| CO5  | apply the principle of image processing and machine vision system techniques | Applying (K3)                        |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 3          | 2          | 2          |
| CO2  | 3          | 2          | 2          |
| CO3  | 3          | 2          | 2          |
| CO4  | 3          | 2          | 2          |
| CO5  | 3          | 2          | 2          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

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

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

**20MME04 MEMS DESIGN**

| SEMESTER – II MEMS DESIGN   |  |      |          |   |   |   |        |
|---|--|------|----------|---|---|---|--------|
| Programme & Branch  | M.E. Mechatronics Engineering  | Sem. | Category | L | T | P | Credit |
| Prerequisite  | Sensors and IOT and Bridge course mechanical   | II   | PC       | 3 | 0 | 0 | 3      |
| Preamble  | This course equips the students to understand the concepts of Micro mechatronics and apply the knowledge of micro fabrication techniques for various applications. |      |          |   |   |   |        |
| UNIT – I  | Materials for MEMS and Scaling Laws  |      |          |   |   |   | 9      |
| : Overview - Microsystems and microelectronics - Working principle of Microsystems - Si as a substrate material - Mechanical properties - Silicon compounds - Silicon piezo resistors - Gallium arsenide - Quartz-piezoelectric crystals - Polymer - Scaling laws in Miniaturization.   |  |      |          |   |   |   |        |
| UNIT – II   | Micro Sensors, Micro Actuators:  |      |          |   |   |   | 9      |
| Micro sensors - Micro actuation techniques - Micro actuators – Micromotors – Microvalves – Micro grippers – Micro accelerometer: introduction, types, actuating principles, design rules, modeling and simulation, verification and testing, applications.  |  |      |          |   |   |   |        |
| UNIT – III  | Mechanics for Microsystem Design:  |      |          |   |   |   | 9      |
| Static bending of thin plates - Mechanical vibration - Thermo mechanics - Thermal stresses - Fracture mechanics - Stress intensity factors, fracture toughness and interfacial fracture mechanics-Thin film Mechanics-Overview of Finite Element Stress Analysis.   |  |      |          |   |   |   |        |
| UNIT – IV   | Fabrication Process and Micromachining:  |      |          |   |   |   | 9      |
| Photolithography - Ion implantation - Diffusion – Oxidation – CVD - Physical vapor deposition - Deposition by epitaxy - Etching process- Bulk Micro manufacturing - Surface micro machining – LIGA –SLIGA.  |  |      |          |   |   |   |        |
| UNIT – V  | Micro System Design, Packaging and Applications:   |      |          |   |   |   | 9      |
| Design considerations - Process design - Mechanical design – Mechanical Design using Finite Element Method-Micro system packaging – Die level - Device level - System level – Packaging techniques - Die preparation - Surface bonding - Wire bonding – Sealing - Applications of micro system in Automotive industry: Bio medical, Aerospace and Telecommunications – CAD tools to design a MEMS device. |  |      |          |   |   |   |        |

**Total: 45****REFERENCES:**

|    |  |
|----|--|
| 1. | Tai-Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw-Hill, New Delhi, 2008.                      |
| 2. | Mohamed Gad-el-Hak, "The MEMS Handbook", CRC Press, 2009.  |
| 3. | Bao M.H., "Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes", Elsevier, New York, 2000. |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |   | <b>BT Mapped<br/>(Highest Level)</b> |
|--|---|--------------------------------------|
| CO1  | interpret the concepts of MEMS materials and scaling laws | Remembering (K1)                     |
| CO2  | explain the principles of micro sensors and actuators     | Understanding (K2)                   |
| CO3  | apply the mechanics for micro system design               | Applying (K3)                        |
| CO4  | design and fabrication of microsystem                     | Applying (K3)                        |
| CO5  | design of microsystem packaging and application           | Applying (K3)                        |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 2          | 2          | 3          |
| CO2  | 2          | 2          | 3          |
| CO3  | 2          | 2          | 3          |
| CO4  | 3          | 2          | 3          |
| CO5  | 3          | 2          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

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



## 20MME05 VIRTUAL INSTRUMENTATION

| COMPLEX VIRTUAL INSTRUMENTATION  |   |      |          |   |   |   |        |
|--|---|------|----------|---|---|---|--------|
| Programme & Branch   | M.E. Mechatronics Engineering   | Sem. | Category | L | T | P | Credit |
| Prerequisite   | Nil   | II   | PC       | 3 | 0 | 2 | 4      |
| Preamble   | This course is designed to impart the principles in programming technique with different instrument interfaces and the basics of data acquisition system introduced in real time. |      |          |   |   |   |        |
| 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, Global variables, Case structures and Sequence structures |
| 3. | GSD using Timed structures, Formula nodes and Event structures                       |
| 4. | GSD using Waveform graph, Waveform chart, XY graph                                   |
| 5. | GSD using String functions, editing, formatting and parsing string                   |
| 6. | GSD using Arrays functions and multi-dimensional arrays                              |
| 7. | GSD using Clusters operations: assembling clusters and disassembling clusters        |
| 8. | GSD real time measurement using Thermistor / Piezo-electric sensor                   |

**Lecture:45, Practical:30, Total: 75**

### REFERENCES:

|    |   |
|----|---|
| 1. | Jeffery Travis and Jim Kring, "LabVIEW for Everyone: Graphical programming made easy and Fun", 3 <sup>rd</sup> Edition, Pearson Education, India, 2009. |
| 2. | Gupta, Joseph and John, "Virtual Instrumentation using LabVIEW", 2 <sup>nd</sup> Edition, Tata McGraw Hill, 2010.                                       |
| 3. | Rick Bitter, "LabVIEW Advanced Programming Techniques", 2 <sup>nd</sup> Edition, Taylor & Francis Group, 2006.  |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |   | <b>BT Mapped<br/>(Highest Level)</b> |
|--|---|--------------------------------------|
| CO1  | demonstrate the basic concepts about virtual instrumentation                                  | Applying (K3)                        |
| CO2  | interpret the software tools in virtual instrumentation                                       | Applying (K3)                        |
| CO3  | develop programming through LabVIEW graphical programming environment                         | Applying (K3)                        |
| CO4  | experiment with data acquisition hardware and LabVIEW software                                | Applying (K3)                        |
| CO5  | select the hardware and software concept of data acquisition system for advanced applications | Applying (K3)                        |
| CO6  | interpret the software tools in virtual instrumentation                                       | Applying (K3),<br>Manipulation (S2)  |
| CO7  | develop programming through LabVIEW graphical programming environment                         | Applying (K3),<br>Manipulation (S2)  |
| CO8  | perform interface of data acquisition hardware with LabVIEW software                          | Applying (K3),<br>Manipulation (S2)  |

| <b>Mapping of COs with POs</b> |            |            |            |
|--------------------------------|------------|------------|------------|
| <b>COs/POs</b>                 | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1                            | 2          | 1          | 3          |
| CO2                            | 3          | 1          | 3          |
| CO3                            | 3          | 1          | 3          |
| CO4                            | 3          | 1          | 3          |
| CO5                            | 3          | 1          | 3          |
| CO6                            | 3          | 1          | 3          |
| CO7                            | 3          | 1          | 3          |
| CO8                            | 3          | 1          | 3          |

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

| <b>ASSESSMENT PATTERN - THEORY</b> |                           |                             |                        |                         |                          |                        |                |
|------------------------------------|---------------------------|-----------------------------|------------------------|-------------------------|--------------------------|------------------------|----------------|
| <b>Test / Bloom's Category*</b>    | <b>Remembering (K1) %</b> | <b>Understanding (K2) %</b> | <b>Applying (K3) %</b> | <b>Analyzing (K4) %</b> | <b>Evaluating (K5) %</b> | <b>Creating (K6) %</b> | <b>Total %</b> |
| CAT1                               | 40                        | 40                          | 20                     |                         |                          |                        | 100            |
| CAT2                               | 10                        | 30                          | 30                     | 30                      |                          |                        | 100            |
| CAT3                               | 10                        | 30                          | 30                     | 30                      |                          |                        | 100            |
| ESE                                | 15                        | 25                          | 40                     | 20                      |                          |                        | 100            |

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



### 20MME06 FACTORY AUTOMATION AND CIM

| COMBINED FACTORY AUTOMATION AND CMM   |  |      |          |   |   |   |        |
|---|--|------|----------|---|---|---|--------|
| Programme & Branch  | M.E. Mechatronics Engineering  | Sem. | Category | L | T | P | Credit |
| Prerequisite  | Nil  | II   | PC       | 3 | 0 | 0 | 3      |
| Preamble  | This course impart fundamental knowledge about automation in the field of production and assembly lines. |      |          |   |   |   |        |
| UNIT – I  | Introduction to Automation:  |      |          |   |   |   | 9      |
| Principles and strategies - Elements of an automated system –Levels of automation – Automation in production systems – Automated manufacturing systems – Types – Reasons for automation. Material handling systems – Types – Design considerations – AGVs – Types and applications – Vehicle guidance technology - Storage systems – Performance – Methods – Automated storage systems.                                       |  |      |          |   |   |   |        |
| UNIT – II   | Transfer Machines:   |      |          |   |   |   | 9      |
| Types, transfer machines for housing type parts, transfer systems, turning devices, pallets, mechanisms for locating and clamping housing type parts. Transfer machines for shaft production and gear production. Continuous rotary transfer lines - Layout and output. Transfer lines, Automatic Pallet Changer, Modular Fixtures.   |  |      |          |   |   |   |        |
| UNIT – III  | Production Planning & Control and Computerised Process Planning:   |      |          |   |   |   | 9      |
| Process Planning –Computer Aided Process Planning (CAPP) –Logical steps in Computer Aided Process Planning –Aggregate Production Planning and Master Production Schedule –Material Requirement Planning – Capacity Planning -Control Systems -Shop Floor Control -Inventory Control. Brief on Manufacturing Resource Planning (MRP-II) and Enterprise Resource Planning (ERP) –Supply Chain Management (SCM) –Simple Problems |  |      |          |   |   |   |        |
| UNIT – IV   | 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 – V  | CAQC and Production Planning:  |      |          |   |   |   | 9      |
| Benefits of CAQC - Computer Aided Inspection - Contact and Non-contact Inspection Methods - Optical and Non-optical types - Computer Aided Testing - Co-ordinate Measuring Machines (CMM).  |  |      |          |   |   |   |        |

**Total: 45**

#### REFERENCES:

1. Groover M.P., "Automation, Production Systems, and Computer-integrated Manufacturing", 4<sup>th</sup> Edition, Pearson Education, 2016.
2. Groover M.P. and Zimmers E.W., "Computer Aided Design and Manufacturing", Pearson Education, 2011.
3. Nand K. Jha, "Handbook of Flexible Manufacturing Systems", Academic Press, Orlando, 2006.



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |   | <b>BT Mapped<br/>(Highest Level)</b> |
|--|---|--------------------------------------|
| CO1  | infer the automation principles, automated manufacturing systems and material handling systems                      | Understanding (K2)                   |
| CO2  | demonstrate about the transfer machines for production process  | Applying (K3)                        |
| CO3  | prepare the process plan and classify the parts using different coding methods                                      | Understanding (K2)                   |
| CO4  | identify the coding systems for different manufacturing parts in a manufacturing industry                           | Applying (K3)                        |
| CO5  | Illustrate computer aided quality control techniques and production planning methods in a manufacturing environment | Applying (K3)                        |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 2          | 1          | 3          |
| CO2  | 3          | 2          | 3          |
| CO3  | 3          | 1          | 2          |
| CO4  | 2          | 2          | 3          |
| CO5  | 3          | 2          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

| <b>ASSESSMENT PATTERN - THEORY</b> |                           |                             |                        |                         |                          |                        |                |
|------------------------------------|---------------------------|-----------------------------|------------------------|-------------------------|--------------------------|------------------------|----------------|
| <b>Test / Bloom's Category*</b>    | <b>Remembering (K1) %</b> | <b>Understanding (K2) %</b> | <b>Applying (K3) %</b> | <b>Analyzing (K4) %</b> | <b>Evaluating (K5) %</b> | <b>Creating (K6) %</b> | <b>Total %</b> |
| CAT1                               | 30                        | 60                          | 10                     |                         |                          |                        |                |
| CAT2                               | 20                        | 60                          | 20                     |                         |                          |                        |                |
| CAT3                               | 15                        | 65                          | 20                     |                         |                          |                        |                |
| ESE                                | 15                        | 65                          | 20                     |                         |                          |                        |                |

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





### 20MME07 PROCESS CONTROL ENGINEERING

| SUMMER 1 PROCESS CONTROL ENGINEERING   |   |      |          |   |   |   |        |
|--|---|------|----------|---|---|---|--------|
| Programme & Branch   | M.E. Mechatronics Engineering   | Sem. | Category | L | T | P | Credit |
| Prerequisite   | Nil   | II   | 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**

#### REFERENCES:

|    |   |
|----|---|
| 1. | Krishnaswamy K., "Process Control", 2 <sup>nd</sup> Edition, New Age International Pvt. Ltd. Publishers, New Delhi, 2013.                                   |
| 2. | George Stephanopoulos, "Chemical Process Control-An Introduction to Theory and Practice", 1 <sup>st</sup> Edition, PHI Learning Pvt. Ltd., New Delhi, 2012. |
| 3. | Johnson C.D., "Process Control Instrumentation Technology", 8 <sup>th</sup> Edition, Prentice-Hall, New Delhi, 2006.  |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| 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  | recommend the advanced control system for various process  | Applying (K3)                        |
| CO4  | choose the instrumentation to control the process  | Understanding (K2)                   |
| CO5  | apply suitable control for process control systems   | Applying (K3)                        |

| <b>Mapping of COs with POs</b> |            |            |            |
|--------------------------------|------------|------------|------------|
| <b>COs/POs</b>                 | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1                            | 3          | 2          | 3          |
| CO2                            | 3          | 2          | 3          |
| CO3                            | 3          | 2          | 3          |
| CO4                            | 3          | 2          | 3          |
| CO5                            | 3          | 2          | 3          |

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

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



### 20MME08 APPLIED FINITE ELEMENT METHOD

| Programme & Branch   | M.E. Mechatronics Engineering   | Sem. | Category | L | T | P | Credit |
|--|---|------|----------|---|---|---|--------|
| Prerequisite   | Strength of Materials   | II   | 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 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      |
| Introduction to 2-D Finite element modeling – Plane stress – Plane Strain – Displacement Equations – Element Matrices – Element Equations – Formulation using Natural Coordinates.   |   |      |          |   |   |   |        |
| 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.   |   |      |          |   |   |   |        |
| 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**

#### REFERENCES:

|    |  |
|----|--|
| 1. | Rao S.S., "The Finite Element Method in Engineering", 5 <sup>th</sup> Edition, Butterworth-Heinemann, 2014.  |
| 2. | Cook R.D., Malkus D.S., Plesha M.E. and Witt R.J., "Concepts and Applications of Finite Element Analysis", 4 <sup>th</sup> Edition, John Wiley & Sons, 2007. |
| 3. | Reddy J.N., "An Introduction to the Finite Element Method", Tata McGraw Hill, International Edition, 2006.   |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |   | <b>BT Mapped<br/>(Highest Level)</b> |
|--|---|--------------------------------------|
| 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)                        |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 3          | 1          | 2          |
| CO2  | 3          | 1          | 2          |
| CO3  | 3          | 1          | 2          |
| CO4  | 3          | 1          | 2          |
| CO5  | 3          | 1          | 2          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

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



### 20MME09 COMPOSITE MATERIALS

|   |   |             |                 |          |          |          |               |
|---|---|-------------|-----------------|----------|----------|----------|---------------|
| <b>Programme &amp; Branch</b>   | <b>M.E. Mechatronics Engineering</b>  | <b>Sem.</b> | <b>Category</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>Credit</b> |
| <b>Prerequisite</b>   | <b>Nil</b>  | <b>II</b>   | <b>PE</b>       | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b>      |
| <b>Preamble :</b>   | This course is designed to impart the composite materials manufacturing process and its evaluation procedures for various applications. |             |                 |          |          |          |               |
| <b>UNIT – I</b>   | <b>Basics of Fibers, Matrices and Composites:</b>   |             |                 |          |          |          | <b>9</b>      |
| Basics of fibers, matrices and composites: Definition – Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic, Aramid and Natural fibers. Matrices – Polymer, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Fiber surface treatments, Fillers and Additives.   |   |             |                 |          |          |          |               |
| <b>UNIT – II</b>  | <b>Manufacturing:</b>   |             |                 |          |          |          | <b>9</b>      |
| Bag molding – Compression molding – Pultrusion – Filament winding – Resin film infusion - Elastic reservoir molding - Tube rolling – Quality inspection methods. Processing of metal matrix composites (MMC) – Diffusion bonding – Stir casting – Squeeze casting.  |   |             |                 |          |          |          |               |
| <b>UNIT – III</b>   | <b>Performance:</b>   |             |                 |          |          |          | <b>9</b>      |
| Static mechanical properties – Tensile, Flexural and Compressive -Fatigue and impact properties – Environmental effects – Long term properties, Fracture behavior- CT and SENB- Damage tolerance.   |   |             |                 |          |          |          |               |
| <b>UNIT – IV</b>  | <b>Mechanics:</b>   |             |                 |          |          |          | <b>9</b>      |
| Fiber content, density and void content. Rule of mixture -Volume and mass fractions – Density - Void content, Evaluation of four elastic moduli based on strength of materials approach and semi-empirical model-Longitudinal Young's modulus-Transverse Young's modulus–Major Poisson's ratio-In-plane shear modulus, Ultimate strengths of a unidirectional lamina. Characteristics of Fiber-reinforced lamina–Laminates–Lamination theory. |   |             |                 |          |          |          |               |
| <b>UNIT – V</b>   | <b>Design:</b>  |             |                 |          |          |          | <b>9</b>      |
| Failure Predictions, Laminate Design Consideration-Design criteria-Design allowable -Design guidelines, Joint design-Bolted and Bonded Joints, Design Examples-Design of a tension member – Design of a compression member – Design of a beam-Design of a torsional member, Application of Finite element method (FEM) for design and analysis of laminated composites.   |   |             |                 |          |          |          |               |

**Total: 45**

#### REFERENCES:

1. Mallick P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", 3<sup>rd</sup> Edition, Taylor and Francis, 2008.
2. Mallick P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", 3<sup>rd</sup> Edition, Taylor and Francis, 2008.
3. Bhagwan D. Agarwal, Lawrence J. Broutman, Chandrashekar K., "Analysis and Performance of Fiber Composites", 4<sup>th</sup> Edition, John Wiley & Sons, New York, October 2017.



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| CO1  | understand the basics of fibers and its characteristics            | Understanding (K2)                   |
| CO2  | develop composite materials using various manufacturing techniques | Understanding (K2)                   |
| CO3  | assess the various properties of composite materials               | Applying (K3)                        |
| CO4  | model and evaluate the composite materials and its characteristics | Applying (K3)                        |
| CO5  | create the design patterns for manufacturing of composites         | Analyzing (K3)                       |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 3          | 1          | 2          |
| CO2  | 3          | 1          | 2          |
| CO3  | 3          | 1          | 2          |
| CO4  | 3          | 1          | 2          |
| CO5  | 3          | 1          | 2          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

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

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



## 20MME10 MACHINE TOOL CONTROL AND CONDITION MONITORING

| Programme & Branch  | M.E. Mechatronics Engineering  | Sem. | Category | L | T | P | Credit |
|---|--|------|----------|---|---|---|--------|
| Prerequisite  | Nil  | III  | PC       | 3 | 0 | 0 | 3      |
| Preamble :  | This course impart the knowledge in machine tool control and condition monitoring in a 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-Macro programming for tool life monitoring and Management                   |  |      |          |   |   |   |        |
| UNIT – III  | Condition Monitoring   |      |          |   |   |   | 9      |
| Introduction – 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**

### REFERENCES:

|    |   |
|----|---|
| 1. | Mishra R.C., Pathak K., "Maintenance Engineering and Management", 2 <sup>nd</sup> Edition, Prentice Hall of India Pvt. Ltd., 2016             |
| 2. | Mikell P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing" Pearson Education India, 2016                      |
| 3. | Robert Bond Randall – Vibration-Based Condition Monitoring – Industrial, Aerospace and Automotive applications, John Wiley & Sons Ltd., 2011. |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| 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  | select the condition monitoring technique for the machine tool among vibration, acoustic emission and sound analysis | Applying (K3)                        |
| CO5  | select appropriate condition monitoring technique for machine tool control applications                              | Applying (K3)                        |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 3          | 1          | 2          |
| CO2  | 3          | 2          | 2          |
| CO3  | 3          | 2          | 3          |
| CO4  | 3          | 2          | 3          |
| CO5  | 2          | 3          | 2          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

| <b>ASSESSMENT PATTERN - THEORY</b> |                           |                             |                        |                         |                          |                        |                |
|------------------------------------|---------------------------|-----------------------------|------------------------|-------------------------|--------------------------|------------------------|----------------|
| <b>Test / Bloom's Category*</b>    | <b>Remembering (K1) %</b> | <b>Understanding (K2) %</b> | <b>Applying (K3) %</b> | <b>Analyzing (K4) %</b> | <b>Evaluating (K5) %</b> | <b>Creating (K6) %</b> | <b>Total %</b> |
| CAT1                               | 10                        | 70                          | 10                     |                         |                          |                        |                |
| CAT2                               | 10                        | 60                          | 20                     |                         |                          |                        |                |
| CAT3                               | 10                        | 50                          | 40                     |                         |                          |                        |                |
| ESE                                | 10                        | 60                          | 30                     |                         |                          |                        |                |

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





### 20MME11 INDUSTRIAL DATA COMMUNICATION

| COMPUTER INDUSTRIAL DATA COMMUNICATION  |   |      |          |   |   |   |        |
|---|---|------|----------|---|---|---|--------|
| Programme & Branch  | M.E. Mechatronics Engineering   | Sem. | Category | L | T | P | Credit |
| Prerequisite  | Nil   | III  | PC       | 3 | 0 | 0 | 3      |
| Preamble :  | This course enable the graduates to understand the data networks, communication protocols and modes of industrial automation. |      |          |   |   |   |        |
| 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 –Standard ETHERNET Configuration.  |   |      |          |   |   |   |        |
| 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. <b>Profibus:</b> 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: AS interface:   |      |          |   |   |   | 9      |
| Introduction, Physical layer, Data link layer and Operating characteristics. <b>Devicenet:</b> Introduction, Physical layer, Data link layer and Application layer. <b>Industrial Ethernet:</b> Introduction – core elements of Ethernet, Ethernet frame format, topology overview- Overview of Ethernet versions – 10Base Ethernet and 100Base Ethernet. |   |      |          |   |   |   |        |

**Total: 45**

#### REFERENCES:

1. Bela G. Liptak and HalitEren, "Instrument Engineers Handbook: Process Software and Digital Networks", Volume 3, 4<sup>th</sup> Edition, CRS Press, 2011.
2. Mackay S., Wright E., Reynders D. and Park J., "Practical Industrial Data Networks: Design, Installation and Troubleshooting", Newnes Publication, Elsevier, 2004.
3. Berge J., "Field Buses for Process Control: Engineering, Operation, and Maintenance", ISA Press, 2004.



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |   | <b>BT Mapped<br/>(Highest Level)</b> |
|--|---|--------------------------------------|
| CO1  | demonstrate the basic network requirements for Industrial automation        | Understanding (K2)                   |
| CO2  | infer the data network fundamentals   | Understanding (K2)                   |
| CO3  | infer the HART and MODBUS Protocol for Networked Industrial Automation      | Understanding (K2)                   |
| CO4  | recommend the FIELDBUS AND PROFIBUS for industrial automation network       | Understanding (K2)                   |
| CO5  | realize the functions of AS-I, Devicenet and Ethernet in industrial network | Apply (K3)                           |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 2          | 2          | 3          |
| CO2  | 3          | 2          | 3          |
| CO3  | 1          | 2          | 3          |
| CO4  | 1          | 2          | 3          |
| CO5  | 1          | 2          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

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

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



## 20MME12 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

| SUMMER ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING   |  |      |          |   |   |   |        |
|---|--|------|----------|---|---|---|--------|
| Programme & Branch  | M.E. Mechatronics Engineering  | Sem. | Category | L | T | P | Credit |
| Prerequisite  | Nil  | III  | PC       | 3 | 0 | 0 | 3      |
| Preamble :  | This course provides basic knowledge about Artificial Intelligence and its applications and different types of machine learning and their implementation for real world problems |      |          |   |   |   |        |
| UNIT – I  | Intelligent Agents:  |      |          |   |   |   | 9      |
| Concept of Rationality, Environments and Structure. Solving Problems by Searching: Problem-Solving Agents, Example, Searching for Solutions, Search Strategies and constraint Satisfaction Problems   |  |      |          |   |   |   |        |
| UNIT – II   | Logical Agents:  |      |          |   |   |   | 9      |
| Knowledge-Based Agents, Wumpus World, Propositional Logic, Propositional Theorem. <b>First-Order Logic:</b> Representation, Syntax and Semantics, Using First-Order Logic and Knowledge Engineering. <b>Inference in First-Order Logic:</b> Unification and Lifting, Forward and Backward Chaining, Resolution. |  |      |          |   |   |   |        |
| UNIT – III  | Introduction to Machine Learning:  |      |          |   |   |   | 9      |
| Machine Learning Applications - Types of Machine learning - <b>Supervised Learning:</b> Building good training sets – Data Pre-processing - Decision tree learning. Bayesian Decision Theory: Introduction – Classification.  |  |      |          |   |   |   |        |
| UNIT – IV   | Artificial Neural Networks:  |      |          |   |   |   | 9      |
| Introduction – Representations – Problems – Perceptron – Multilayer network and Back Propagation Algorithm. <b>Unsupervised Learning:</b> K-Means clustering - Hierarchical clustering.   |  |      |          |   |   |   |        |
| UNIT – V  | Reinforcement Learning:  |      |          |   |   |   | 9      |
| Single state case – Elements – Model based learning –Temporal difference learning – Generalization.   |  |      |          |   |   |   |        |

**Total: 45**

### REFERENCES:

|    |  |
|----|--|
| 1. | Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3 <sup>rd</sup> Edition, Pearson Education, 2016. |
| 2. | Ethem Alpaydin, "Introduction to Machine Learning", 3 <sup>rd</sup> Edition, Prentice Hall India, 2015.                          |
| 3. | Sebastian Raschka, "Python Machine Learning", 3 <sup>rd</sup> Edition, Packt Publishing, 2019.                                   |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |   | <b>BT Mapped<br/>(Highest Level)</b> |
|--|---|--------------------------------------|
| CO1  | define intelligent agents and apply searching for solving problems  | K2                                   |
| CO2  | apply propositional and first order logic in ai   | K3                                   |
| CO3  | utilize supervised learning methods to solve real world problems  | K3                                   |
| CO4  | design solutions for the given problem using artificial neural networks and unsupervised learning methods | K3                                   |
| CO5  | recognize the need of reinforcement learning in ai applications   | K2                                   |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 3          | 2          | 2          |
| CO2  | 3          | 3          | 3          |
| CO3  | 3          | 3          | 3          |
| CO4  | 3          | 3          | 3          |
| CO5  | 3          | 2          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

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

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



### 20MME13 MACHINE VISION SYSTEM

| Programme & Branch  | M.E. Mechatronics Engineering  | Sem. | Category | L | T | P | Credit |
|---|--|------|----------|---|---|---|--------|
| Prerequisites   | Virtual Instrumentation  | IV   | 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. <b>Introduction to Building a Machine Vision Inspection:</b> 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:   |      |          |   |   |   | 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.<br><b>Camera Computer Interface:</b> 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**

#### REFERENCES:

|    |   |
|----|---|
| 1. | Alexander Hornberg, "Handbook of Machine Vision", Wiley-VCH, 2006.  |
| 2. | Davies E.K., "Machine Vision: Theory, Algorithms, Practicalities", 3 <sup>rd</sup> Edition, Elsevier, 2005. |
| 3. | Milan Sonka, "Image Processing Analysis and Machine Vision", Vikas Publishing House, 2007.                  |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| CO1  | interpret the fundamental concepts of vision system                        | Understanding (K2)                   |
| CO2  | choose the components for designing the machine vision system              | Understanding (K2)                   |
| CO3  | learn about the concept of lighting system and various computer interfaces | Understanding (K2)                   |
| CO4  | identify the concept of image processing techniques                        | Applying (K3)                        |
| CO5  | analyze the machine vision system through real time applications           | Analyzing (K4)                       |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 3          | 1          | 2          |
| CO2  | 3          | 1          | 2          |
| CO3  | 3          | 1          | 2          |
| CO4  | 3          | 1          | 2          |
| CO5  | 3          | 1          | 2          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

| <b>ASSESSMENT PATTERN - THEORY</b> |                           |                             |                        |                         |                          |                        |                |
|------------------------------------|---------------------------|-----------------------------|------------------------|-------------------------|--------------------------|------------------------|----------------|
| <b>Test / Bloom's Category*</b>    | <b>Remembering (K1) %</b> | <b>Understanding (K2) %</b> | <b>Applying (K3) %</b> | <b>Analyzing (K4) %</b> | <b>Evaluating (K5) %</b> | <b>Creating (K6) %</b> | <b>Total %</b> |
| CAT1                               | 20                        | 80                          |                        |                         |                          |                        | 100            |
| CAT2                               | 20                        | 50                          | 30                     |                         |                          |                        | 100            |
| CAT3                               | 20                        | 60                          | 20                     |                         |                          |                        | 100            |
| ESE                                | 20                        | 55                          | 25                     |                         |                          |                        | 100            |

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



## 20MME14 PRODUCT DESIGN AND DEVELOPMENT

| SUMMARY PRODUCT DESIGN AND DEVELOPMENT  |  |      |          |   |   |   |        |
|---|--|------|----------|---|---|---|--------|
| Programme & Branch  | M.E. Mechatronics Engineering  | Sem. | Category | L | T | P | Credit |
| Prerequisites   | Nil  | IV   | 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**

### REFERENCES:

1. Eppinger, S.D. and Ulrich, K.T. “ Product design and development”, 6<sup>th</sup> edition, McGraw-Hill Higher Education, 2016
2. Devdas Shetty, “Product Design For Engineers”, Cengage Learning, 2015.
3. Maddock M. and Uriarte L., “Brand New: Solving the Innovation Paradox – How Great Brands Invent and Launch New Products, Services and Business Models”, John Wiley & Sons, Inc., Hoboken, New Jersey, 2011.
4. Roozenburg, N. F., & Eekels, J., “Product design: fundamentals and methods”, John Wiley & Sons Inc, 1995.



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |   | <b>BT Mapped<br/>(Highest Level)</b> |
|--|---|--------------------------------------|
| 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                                | Analysing (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)                       |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 3          | 1          | 2          |
| CO2  | 3          | 1          | 2          |
| CO3  | 3          | 1          | 2          |
| CO4  | 3          | 1          | 2          |
| CO5  | 3          | 1          | 2          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

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

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





## 20MME15 DRONE TECHNOLOGY

| Programme & Branch  | M.E. Mechatronics Engineering  | Sem. | Category | L | T | P | Credit |
|---|--|------|----------|---|---|---|--------|
| Prerequisites   | Sensors and IOT, Bridge course mechanical and Industrial Robotics  | IV   | 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**

### REFERENCES:

|    |  |
|----|--|
| 1. | Paul Fahlstrom, Thomas Gleason, "Introduction to UAV Systems", 4 <sup>th</sup> edition, John Wiley & Sons, 2012.         |
| 2. | Randal W. Beard and Timothy W. McLain, "Small Unmanned Aircraft: Theory and Practice", Princeton University Press, 2010. |
| 3. | Jha, "Theory, Design, and Applications of Unmanned Aerial Vehicles", CRC Press, 2016.                                    |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |   | <b>BT Mapped<br/>(Highest Level)</b> |
|--|---|--------------------------------------|
| CO1  | acquire the basic knowledge about the development and potential of UAV in professional activities | Applying (K3)                        |
| CO2  | interpret the features and characteristics of an Unmanned Aerial System                           | Applying (K3)                        |
| 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  | Applying (K3)                        |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 3          | 1          | 3          |
| CO2  | 3          | 1          | 3          |
| CO3  | 3          | 1          | 3          |
| CO4  | 3          | 1          | 3          |
| CO5  | 3          | 1          | 3          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

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

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



### 20MME16 AUTONOMOUS MOBILE ROBOTICS

| Programme & Branch   | M.E. Mechatronics Engineering  | Sem. | Category | L | T | P | Credit   |
|--|--|------|----------|---|---|---|----------|
| Prerequisite   | Robot Kinematics and Dynamics  | IV   | PC       | 3 | 0 | 2 | 4        |
| <b>Preamble</b> :  | 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. |      |          |   |   |   |          |
| <b>UNIT – I</b>  | <b>Mobile Robot Kinematics:</b>  |      |          |   |   |   | <b>9</b> |
| Introduction - Kinematic models and constraints – Manoeuvrability – Workspace – Motion control   |  |      |          |   |   |   |          |
| <b>UNIT – II</b>   | <b>Locomotion:</b>   |      |          |   |   |   | <b>9</b> |
| Introduction – Key issues for locomotion – Legged mobile robots – Wheeled mobile robots – Aerial mobile robots   |  |      |          |   |   |   |          |
| <b>UNIT – III</b>  | <b>Perception:</b>   |      |          |   |   |   | <b>9</b> |
| Introduction - Sensors for mobile robots – Fundamentals of computer vision and image processing – Feature extraction based on range data - Image feature extraction – Place recognition. |  |      |          |   |   |   |          |
| <b>UNIT – IV</b>   | <b>Localization:</b>   |      |          |   |   |   | <b>9</b> |
| Introduction – Challenges of localization – Belief representation – Map representation – Probabilistic Map-Based localization – Autonomous map building.                                 |  |      |          |   |   |   |          |
| <b>UNIT – V</b>  | <b>Planning and Navigation:</b>  |      |          |   |   |   | <b>9</b> |
| Introduction – Competence for Navigation: Planning and Reacting – Path planning – Obstacle avoidance – Navigation architectures.   |  |      |          |   |   |   |          |

| <b>List of Experiments:</b> |  |
|-----------------------------|--|
| 1.                          | Study of Fire Bird – V robot and its accessories.  |
| 2.                          | Development of embedded programming for Buzzer interfacing using Fire Bird – V robot.                            |
| 3.                          | Development of embedded programming for LCD interfacing using Fire Bird – V robot.                               |
| 4.                          | Development of embedded programming for motion control using Fire Bird – V robot.                                |
| 5.                          | Development of embedded programming for position control using Fire Bird – V robot.                              |
| 6.                          | Development of embedded programming for velocity control using Fire Bird – V robot.                              |
| 7.                          | Development of embedded programming for ADC interfacing using Fire Bird – V robot.                               |
| 8.                          | Development of embedded programming for path planning using Fire Bird – V robot.                                 |
| 9.                          | Development of embedded programming for obstacle avoidance using Fire Bird – V robot.                            |
| 10.                         | Development of embedded programming for wireless motion control of Fire Bird V robot using ZigBee Communication. |

**Lecture:45, Practical:30, Total:75**

#### REFERENCES:

|    |  |
|----|--|
| 1. | Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", 2 <sup>nd</sup> Edition, MIT Press, Cambridge, 2011. |
| 2. | Farbed Fahimi, "Autonomous Robots – Modeling, Path Planning and Control", Springer, 2009.  |
| 3. | Alonzo Kelly, "Mobile Robotics: Mathematics, Models and Methods", Cambridge University Press, 2013.  |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| CO1:   | develop the kinematic model of mobile robots             | Evaluating (K5)                      |
| CO2:   | interpret the different concepts of locomotion           | Applying (K3)                        |
| CO3:   | select the sensory devices for environmental perception  | Applying (K3)                        |
| CO4:   | identify the techniques for localization                 | Applying (K3)                        |
| CO5:   | apply the concepts of planning and navigation            | Applying (K3)                        |
| CO6:   | develop embedded programming for motion control          | Applying (K3),<br>Manipulation (S2)  |
| CO7:   | develop embedded programming for planning and navigation | Creating (K6),<br>Precision (S3)     |
| CO8:   | develop embedded programming for wireless control        | Creating (K6),<br>Precision (S3)     |

| <b>Mapping of COs with POs</b> |            |            |            |
|--------------------------------|------------|------------|------------|
| <b>COs/POs</b>                 | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1                            | 2          |            | 3          |
| CO2                            | 2          |            | 3          |
| CO3                            | 2          |            | 3          |
| CO4                            | 2          |            | 3          |
| CO5                            | 2          |            | 3          |
| CO6                            | 3          | 2          | 3          |
| CO7                            | 3          | 2          | 3          |
| CO8                            | 3          | 2          | 3          |

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

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



## 20MME17 ADDITIVE MANUFACTURING

| Programme & Branch   | M.E. Mechatronics Engineering   | Sem. | Category | L | T | P | Credit |
|--|---|------|----------|---|---|---|--------|
| Prerequisite   | Nil   | IV   | 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**

### REFERENCES:

|    |   |
|----|---|
| 1. | Chua.C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and Applications", World scientific, Newjersy, 2010. |
| 2. | Pham D.T. and Dimov S.S, "Rapid Manufacturing", Springer -Verlag, London, 2011.   |
| 3. | Amitabha Ghosh, "Rapid Manufacturing a brief Introduction", Affiliated East West Press, New Delhi, 2011.                |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |  | <b>BT Mapped<br/>(Highest Level)</b> |
|--|--|--------------------------------------|
| 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)                        |

| <b>Mapping of COs with POs</b>                                   |            |            |            |
|--|------------|------------|------------|
| <b>COs/POs</b>   | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> |
| CO1  | 3          | 2          | 2          |
| CO2  | 3          | 2          | 2          |
| CO3  | 3          | 2          | 2          |
| CO4  | 3          | 2          | 2          |
| CO5  | 3          | 2          | 2          |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |            |            |            |

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



## 20GET13 - INNOVATION, ENTREPRENEURSHIP AND VENTURE DEVELOPMENT

|  |   |      |          |   |   |   |        |
|--|---|------|----------|---|---|---|--------|
| Programme & Branch   | All ME/MTech, MCA Programmes  | Sem. | Category | L | T | P | Credit |
| Prerequisite   | Nil   | 4    | PE       | 3 | 0 | 0 | 3      |
| Preamble   | This course will direct the students on how to employ their innovations towards a successful entrepreneurial venture development. |      |          |   |   |   |        |
| UNIT – I   | Innovation and Entrepreneurship:  |      |          |   |   |   | 9      |
| Creativity and Innovation – Types of innovation – challenges in innovation- steps in innovation management- Meaning and concept of entrepreneurship - Role of Entrepreneurship in Economic Development - Factors affecting Entrepreneurship – Entrepreneurship vs Intrapreneurship   |   |      |          |   |   |   |        |
| UNIT – II  | Design Thinking and Product Design:   |      |          |   |   |   | 9      |
| Design Thinking and Entrepreneurship – Design Thinking Stages: Empathize – Define – Ideate – Prototype – Test. Design thinking tools: Analogies – Brainstorming – Mind mapping. 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 – III   | Business Model Canvas (BMC) and Business Plan Preparation:  |      |          |   |   |   | 9      |
| Lean Canvas and BMC - difference and building blocks- BMC: Patterns – Design – Strategy – Process–Business model failures: Reasons and remedies. Objectives of a Business Plan - Business Planning Process and Preparation   |   |      |          |   |   |   |        |
| UNIT – IV  | 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   |   |      |          |   |   |   |        |
| UNIT – V   | Venture Planning and Means of Finance:  |      |          |   |   |   | 9      |
| Startup Stages - Forms of Business Ownership - Sources of Finance – Idea Grant – Seed Fund – Angel & Venture Fund – Institutional Support to Entrepreneurs – Bank and Institutional Finance to Entrepreneurs   |   |      |          |   |   |   |        |

**Total : 45**

### REFERENCES:

|    |   |
|----|---|
| 1. | Gordon E. & Natarajan K., "Entrepreneurship Development", 6th Edition, Himalaya Publishing House, Mumbai, 2017.                       |
| 2. | Sangeeta Sharma, "Entrepreneurship Development", 1st Edition, PHI Learning Pvt. Ltd., New Delhi, 2017.                                |
| 3. | Charantimath Poornima M., "Entrepreneurship Development and Small Business Enterprises", 3rd Edition, Pearson Education, Noida, 2018. |
| 4. | Robert D. Hisrich, Michael P. Peters & Dean A. Shepherd, "Entrepreneurship", 10th Edition, McGraw Hill, Noida, 2018.                  |



| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |   | <b>BT Mapped<br/>(Highest Level)</b> |
|--|---|--------------------------------------|
| CO1:   | understand the relationship between innovation and entrepreneurship                 | Understanding (K2)                   |
| CO2:   | understand and employ design thinking process during product design and development | Analysing (K4)                       |
| CO3:   | develop suitable business models as per the requirement of the customers            | Analysing (K4)                       |
| CO4:   | Practice the procedures for protection of their ideas' IPR                          | Applying (K3)                        |
| CO5:   | understand and plan for suitable type of venture and modes of finances              | Applying (K3)                        |

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

| <b>ASSESSMENT PATTERN - THEORY</b> |                    |                      |                 |                  |                   |                 |         |
|------------------------------------|--------------------|----------------------|-----------------|------------------|-------------------|-----------------|---------|
| 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)