DEGREE OF MASTER

OF

ENGINEERING

M.E. CAD/CAM ROBOTICS CURRICULUM & SYLLABI

(2023 AND ONWARDS)

(REGULAR PROGRAMME)

Department of Mechanical Engineering

FACULTY OF ENGINEERING

KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University) Established Under Section 3 of UGC Act 1956

Accredited with A+ Grade by NAAC in Second Cycle

Pollachi Main Road, Eachanari Post,
Coimbatore – 641 021. INDIA

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(Deemed to be University)
(Established Under Section 3 of UGC Act 1956)
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Eachanari Post, Coimbatore – 641 021. INDIA

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

FACULTY OF ENGINEERING
POST GRADUATE PROGRAMME
(M.E. – CAD/CAM ROBOTICS)
REGULAR PROGRAMME

REGULATIONS
(2023)

KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University)
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FACULTY OF ENGINEERING

POST GRADUATE PROGRAMME
REGULAR PROGRAMME
REGULATIONS 2023
CHOICE BASED CREDIT SYSTEM

These Regulations are effective from the academic year 2023-24 and applicable to the students admitted to M. E. / M. Tech. Programmes during the academic year 2023-24 and onwards.

1. ADMISSION

1.1. Candidates seeking admission to the first semester of the four semesters M.E./M.Tech.Degree Programme:

Should have passed the B.E/B.Tech. Degree Examination prescribed by the AICTE, Delhi, Government of India or any similar Examination of any other University or authority accepted by the Karpagam Academy of Higher Education as equivalent thereto.

Eligibility criteria for admission in the first semester are given in the table below.

SL. NO.	PROGRAMME	ELIGIBILITY CRITERIA
1.	M.E. Computer Science and Engineering	B.E / B.Tech. in Computer Engineering / InformationTechnology / Any allied Computer Science.
2.	M.E. Structural Engineering	B.E/B.Tech. in Civil Engineering / Geo Informatics Engineering / Civil and Rural Engineering.
3.	M.E. VLSI Design	B.E/B.Tech. in Electronics and Communication Engineering / Electrical and Electronics Engineering / Computer Science Engineering / InformationTechnology / Electronics and Telecommunication Engineering
4.	M.E. CAD/CAM Robotics	B.E/B.Tech. in Mechanical Engineering / Metallurgy / Automobile Engineering / Production Engineering.
5.	M.E. Power System Engineering	B.E / B.Tech. Electrical and Electronics Engineering.

2. PROGRAMMES OFFERED

A candidate may undergo a programme in any one of the branches of study approved by theUniversity as given below.

List of M.E. and M.Tech. Degree Programmes

1.M.E. Computer Science and Engineering
2.M.E. Structural Engineering
3.M.E. VLSI Design
4.M.E. CAD/CAM Robotics
5.M.E. Power System Engineering

3. MODE OF STUDY:

3.1 Full–Time:

In this mode of study, the candidates are required to attend classes regularly on the specified working days of the University.

3.2 Change from full time mode of study to part time mode is not permitted**.**

3.3 Change from one programme to another programme is not permitted.

4. DURATIONS OF THE PROGRAMMES:

4.1. The minimum and maximum period for completion of the P.G. Programme are given below:

Programme	Min. No. of Semesters	Max. No. of Semesters
M. E./M. Tech.	4	8

4.2. Each semester shall normally consist of 90 working days or 360 hours for full–time mode of study. The Dean and HOD shall ensure that every teacher imparts instruction as per the number of periods specified in the syllabus and that the teacher teaches the full content of the specified syllabus for the course being taught.

4.3. The prescribed credits required for the award of degree shall be within the limits specified below.

PROGRAMME	PRESCRIBED CREDIT RANGE
M. E./M. Tech.	**65 to 75**

4.4. Credits will be assigned to the courses for different modes of study as given below:

No. of credits per lecture period per week	1
No. of credits per tutorial period per week	1
No. of credits for 3 periods of laboratory course per week	2
No. of credits for 3 periods of project work per week	2

5. STRUCTURE OF THE PROGRAMME

5.1. Every programme will have a curriculum and syllabi consisting of core theory courses, elective courses, seminars / practical courses and project work.

- The elective courses from the curriculum are to be chosen with the approval of the Head ofthe Department.
- The medium of instruction for all courses, examinations, seminar presentations and projectthesis shall be English**.**
- Choice Based Credit System is implemented offering Choice in professional core and professional Electives.

5.2. MAXIMUM MARKS

- The maximum marks assigned to different courses shall be as given below:

Each of the theory and practical course (excluding project work) shall carry maximum of 100 marks of which 40 marks will be through Continuous Internal Assessment (CIA) and 60 marks through End Semester Examination (ESE).

5.3. PROJECT WORK

The project work for M. E./M. Tech. consists of two Phases, Phase– I and Phase – II. Phase – I is to be undertaken during III semester and Phase – II, is during IV semester.

All the students are advised to do their project work within the campus. However, as a special case, if a student is able to get a project from a government organization or private or public sector company with a turn over about Rs.50 crores, he/she may be permitted to do his/her project work in that institution/research organization/industry.

6. EVALUATION OF PROJECT WORK

The evaluation of Project Work for Phase I & Phase II shall be done independently in the respective semesters. The total marks for project work including Phase I and II are 400. The project work pertained to Phase I is evaluated through Continuous Internal Assessment only. No End Semester Examination will be conducted for the Phase I. The maximum internal marks for Phase I are 100. For Phase – II, the maximum internal mark is 120 and the maximum End Semester Examination mark is 180. The total marks for Phase – II is 300. The overall passing minimum is 50 %.

6.1. The Project Report prepared according to approved guidelines and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the COE through theHOD and the Dean.

6.2. The evaluation of the Project work Phase – I will be purely internal by forming a committee by HOD/ Dean. During CIA of Phase – I, there will be a Viva–Voce Examination by a team consisting of the Supervisor, and an Internal Examiner (other than the Supervisor). The evaluation of the

Project work Phase – II will be based on the project report submitted in Phase – II and a Viva–Voce Examination by a team consisting of the Supervisor, an Internal Examiner and an External Examiner for each programme. The External Examiner shall be appointed by the Karpagam academy of Higher Education for Phase – II evaluation.

6.3. If a candidate fails to submit the project report on or before the specified deadline, he/she is deemed to have failed in the project work and shall re–enroll for the same in a subsequent semester.

6.4. If a candidate fails in the Viva–Voce examinations of Phase–I, he/she has to resubmit the project report within 30 days from the date of declaration of the results. If he/she fails in the Viva–Voce examination of Phase–II of project work, he/she shall resubmit the project report within 60 days from the date of declaration of the results. For this purpose, the same Internal and External Examiner shall evaluate the resubmitted report.

6.5. Every candidate shall publish a paper of his or her findings in a peer reviewed journal or present in an International Conference or apply for a patent out of his / her project work. Reprints of the journal publication/acceptance letter from the journal publisher orProceedings of the International conference/ acceptance letter from the Conference Organizer or application of patent shall be attached to the report of the project work. Such acknowledgements shall be sent to the Controller of Examinations along with the evaluation marks by the team of examiners without which the thesis shall not be accepted.

6.6. A copy of the approved project report after the successful completion of Viva–Voce Examination shall be kept in the respective department as well as in the Karpagam academy of Higher Education library.

7 REQUIREMENTS FOR COMPLETION OF THE SEMESTER

7.1 A candidate will be permitted to take the End Semester Examination of any semester, if

i) the candidate secures not less than 75% of attendance during the semester and

ii) the conduct of the candidate has been satisfactory

7.2 A candidate who has secured attendance between 65% and 74% (both included), due to medical reasons (Hospitalization/Accident/Specific Illness) or due to participation in Karpagam academy of Higher Education / District / State / National / International level sports or due to participation in Seminar / Conference / Workshop / Training Programme / Voluntary Service / Extension activities or similar programmes with prior permission from the Registrar shall be given exemption from prescribed attendance requirements and shall be permitted to take the examination on the recommendation of the concerned Head of the Department and Dean to condone the lack of attendance. The Head of the Department has to verify and certify the genuineness of the case before recommending to the Dean.

7.3 However, a candidate who has secured attendance less than 65 % in the current semester shall not be permitted to appear for the current ESE. But he/she will be permitted to appear for his/her arrear examination if any and he/she has to re do the course by rejoining the semester in which attendance is less than 65% with proper approval of the "Students' Affairs Committee" and Registrar.

8 CLASS ADVISORS

To help the students in planning their courses of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a teacher of the Department who shall function as Class Advisor for those students throughout their period of study. Such Class Advisors shall advise the students and monitor the courses undergone by the students, check the attendance and progress of the students attached to him/her and counsel them periodically. If necessary, the Class Advisor may display the cumulative attendance particulars in the Department Notice Board.

9 CLASS COMMITTEE

9.1 Every class shall have a class committee consisting of teachers of the class concerned, student representatives [two boys and two girls] and the concerned Head of the Department. It is like the 'Quality Circle' with the overall goal of improving the teaching–learning process. The functions of the class committee include

i) Solving problems experienced by students in the class room and in the laboratories.

ii) Clarifying the regulations of the degree programme and the details of rules therein particularly Clause 2 and 3 which should be displayed on department Notice–Board.

iii) Informing the student representatives, the details of Regulations regarding weightage used for each assessment.

iv) Informing the student representatives, the academic schedule including the dates of assessments and the syllabus coverage for each assessment.

v) In the case of practical courses (laboratory/project work, etc.) the breakup of marks for each experiment/exercise /module of work, should be clearly discussed in the class committee meeting and informed to the students.

vi) Analyzing the performance of the students of the class after each test and finding the ways and means of solving problems, if any.

vii) Identifying the weak students, if any, and requesting the teachers concerned to provide some additional academic support to them.

9.2 The class committee shall be constituted within the first week of each semester.

9.3 At least 4 student representatives (usually 2 boys and 2 girls) shall be included in the class committee.

9.4 The Chairperson of the Class Committee may convene the meeting of the class committee.

9.5 The Dean may participate in any Class Committee of the Faculty.

9.6 The Chairperson is required to prepare the minutes of every meeting, submit the same to Dean within two days of the meeting and arrange to circulate it among the students and teachers concerned. If there are some points in the minutes requiring action by the Management, the same shall be brought to the notice of the Registrar by the HOD through theDean.

9.7 The first meeting of the Class Committee shall be held within one week from the date of commencement of the semester, in order to inform the students about the nature and weightage of assessments within the framework of the regulations. Two or three subsequent meetings may be held in a semester at suitable intervals. During these meetings the student members representing the entire class, shall meaningfully interact and express their opinions and suggestions of the other students of the class in order to improve the effectiveness of the teaching–learning process.

10. COURSE COMMITTEE FOR COMMON COURSES

Each common theory course offered to more than one discipline or group, shall have a "Course Committee" comprising all the teachers handling the common course with one of them nominated as Course Coordinator. The nomination of the Course Coordinator shall be made by the Dean depending upon whether all the teachers teaching the common course belong to a single department or to several departments. The 'Course Committee' shall meet in order to arrive at a common schemeof evaluation for the test and shall ensure a uniform evaluation of the tests. Where ever feasible, the Course Committee may also prepare a common question paper for the Internal Assessment test(s).

11. PROCEDURE FOR AWARDING MARKS FOR INTERNAL ASSESSMENT

11.1 Every teacher is required to maintain an 'ATTENDANCE AND ASSESSMENT RECORD' which consists of attendance marked in each theory or practical or project work class, the test marks and the record of class work (topic covered), separately for each course.

11.2 CONTINUOUS INTERNAL ASSESSMENT (CIA):

The performance of students in each subject will be continuously assessed by the respective teachers as per the guidelines given below:

THEORY COURSES:

S. No.	CATEGORY	MAXIMUM MARKS
1.	Paper Presentation *	15
2.	Attendance	5
3.	Test – I #	10
4.	Test – II #	10
	TOTAL	40

***** One refereed journal paper related to the subject and approved by the teacher should be critically presented. The Paper Presentation should be evaluated by a committee and marks should be entered in Automation software on or before 60th working day of the semester.

The test scripts should be evaluated and marks should be entered in Automation software on or before 4th working day after the last test.

PATTERN OF TEST QUESTION PAPER:

INSTRUCTION	REMARKS
Maximum Marks	60
Duration	2 Hours
Part- A	1 to 9 Two Mark Questions, uniformly covering the two units of the syllabus. All the 9 Questions are to be answered. **(9 x 2 =18Marks)**.
Part- B	Question 10 to 12 will be of either-or type, covering two units of the syllabus. Each Question may have subdivision. **(3 x 14 =42 Marks)**.

PRACTICAL COURSES:

S. No	CATEGORY	MAXIMUM MARKS
1.	Attendance	5
2.	Observation work	5
3.	Record work	5
4.	Model examination	15
5.	Viva – voce [Comprehensive]	10
	TOTAL	40

Every practical exercise / experiment shall be evaluated based on the conduct of exercise/ experiment and records maintained.

11.3 ATTENDANCE

MARKS DISTRIBUTION FOR ATTENDANCE

S. No.	Attendance %	Marks
1	91 and above	5.0
2	86-90	4.0
3	81-85	3.0
4	75-80	2.0
5	Less than 75	0

12. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION (ESE)

A candidate shall normally be permitted to appear for the ESE of any semester commencing from I semester if he/she has satisfied the semester completion requirements (Subject to Clause 5) and has registered for examination in all courses of the semester. Registration is mandatory for Semester Examinations as well as supplementary examinations failing which the candidate will not be permitted to move to the higher semester.

A candidate already appeared for a subject in a semester and passed the examination is not entitled to reappear in the same subject for improvement of grade.

13. END SEMESTER EXAMINATION

ESE will be held at the end of each semester for each subject, for 100 marks, later scaled down to 60 marks.

PATTERN OF ESE QUESTION PAPER:

INSTRUCTION	REMARKS
Maximum Marks	100
Duration	3 Hours
Part - A	Part A will be online Examination. 20 Objective type Questions. Covering all the 5 units. **20*1= 20 Marks (Online Examination)**
Part- B	21 to 25 Two Mark Questions, uniformly covering the Five units of the syllabus. All the 5 Questions are to be answered. **(5 *2= 10Marks)**.
Part- C	Question 26 to 30 will be of either-or type, covering Five units of the syllabus. Each Question may have subdivision. **(5*14=70 Marks)**

14. PASSING REQUIREMENTS

14.1 Passing minimum: The passing minimum for CIA is 20 (i.e. out of 40 marks). The passing minimum for End Semester Examination is 30 (i.e. out of 60 marks).

The overall passing minimum for theory/laboratory course is 50 (Sum of his/her score in internal and external examination) out of 100 marks.

14.2 If the candidate fails to secure a pass in a particular course ESE, it is mandatory that candidate shall register and reappear for the examination in that course during the subsequent semester when examination is conducted in that course. Further, the candidate should continue to register and reappear for the examination till a pass is secured in such supplementary exam within the stipulated maximum duration of the programme (Clause 2.1).

The CIA marks obtained by the candidate in his/her first or subsequent appearance where he/she secures a pass shall be retained by the office of the Controller of Examinations and considered valid for all remaining attempts till the candidate secures a pass in his/her ESE.

14.3 If a candidate fails to secure a pass in a particular course CIA, it is mandatory that candidate shall register and reappear for the CIA in that course during the subsequent semester when CIA is conducted in that course by the faculty member assigned for that particular course during that semester by the concerned HOD. Further, the candidate should continue to register and reappear for the CIA till a pass is secured in such supplementary exam within the stipulated maximum duration of the programme (Clause 2.1).

15. AWARD OF LETTER GRADES

15.1 All assessments of a course will be done on absolute mark basis. However, for the purpose of reporting the performance of a candidate, letter grades, each carrying certain number of points, will be awarded as per the range of total marks (out of 100) obtained by the candidate in each subject as detailed below:

Letter grade	Marks Range	Grade Point	Description
O	91 - 100	10	OUTSTANDING
A+	81- 90	9	EXCELLENT
A	71-80	8	VERY GOOD
B+	66- 70	7	GOOD
B	61 – 65	6	ABOVE AVERAGE
C	55 - 60	5	AVERAGE
P	50 - 54	4	PASS
RA	<50	-	REAPPEARANCE
AB		0	ABSENT

15.2 GRADE SHEET

After results are declared, Grade sheets will be issued to each student which will contain the following details:

i The list of courses enrolled during the semester and the grade scored.

ii The Grade Point Average (**GPA**) for the semester and

iii The Cumulative Grade Point Average (**CGPA**) of all courses enrolled from first semester onwards.

GPA is the ratio of the sum of the products of the number of Credits (**C**) of courses enrolled and the Grade Points (**GP**) corresponding to the grades scored in those courses, taken for all the courses to the sum of the number of credits of all the courses in the semester.

CGPA will be calculated in a similar manner, considering all the courses enrolled from first semester.

RA grade will be excluded for calculating **GPA** and **CGPA**.

$$GPA = \frac{\text{Sum of } [C*GP]}{\text{Sum of } C}$$

15.3 REVALUATION

A candidate can apply for revaluation of his/her semester examination answer paper in a theory course, within 2 weeks from the declaration of results, on payment of a prescribed fee through proper application to the Controller of Examinations through the Head of the Department and Dean. A candidate can apply for revaluation of answer scripts for not exceeding 5 subjects at a time. The Controller of Examinations will arrange for the revaluation and the results will be intimated to the candidate through the Head of the Department and Dean. Revaluation is not permitted for Supplementary examination, Practical examination and Project Work.

16. ELIGIBILITY FOR AWARD OF DEGREE

A student shall be declared to be eligible for award of Degree if he/she has

- Successfully gained required number of total credits as specified in the curriculum corresponding to his/her programme within the stipulated time.
- No disciplinary action is pending against him/her.

The award of degree must be approved by the Board of Management of Karpagam academy of Higher Education.

17. CLASSIFICATION OF THE DEGREE AWARDED

17.1 A candidate who qualifies for the award of the Degree (vide Clause 14) having passed the examination in all the courses in his/her first appearance within the specified minimum

number of semesters (vide Clause 2.1) securing a CGPA of not less than 8.0 shall be declared to have passed the examination in First Class with Distinction.

17.2 A candidate who qualifies for the award of the Degree (vide Clause 14) having passed the examination in all the courses within the specified minimum number of semesters (vide Clause 2.1) plus one semester securing CGPA of not less than 6.5 shall be declared to have passed the examination in First Class. For this purpose, the withdrawal from examination (vide Clause 16) will not be construed as an appearance. Further, the authorized break ofstudy (vide Clause 18) will not be counted for the purpose of classification.

17.3 All other candidates (not covered in Clauses 15.1 and 15.2) who qualify for the award of the degree (vide Clause 14) shall be declared to have passed the examination in **Second Class**.

18. PROVISION FOR WITHDRAWAL FROM END–SEMESTER EXAMINATION

18.1 A candidate may for valid reasons and on prior application, be granted permission to withdraw from appearing for the examination of any one course or consecutive examinations of more than one course in a semester examination. Withdrawal application shall be valid only if the candidate is otherwise eligible to write the examination.

18.2 Such withdrawal shall be permitted only once during the entire period of study of the degree programme.

18.3 Withdrawal application is valid only if it is made within 10 days prior to the commencement of the examination in that course or courses and recommended by the Head of the Department and Dean and approved by the Registrar.

18.3.1 Not withstanding the requirement of mandatory TEN days' notice, applications for withdrawal for special cases under extraordinary conditions will be considered on the merit of the case.

18.4 Withdrawal shall not be construed as an appearance for the eligibility of a candidate for First Class with Distinction. This provision is not applicable to those who seek withdrawal during IV semester.

18.5 Withdrawal from the ESE is **NOT** applicable to supplementary courses.

18.6 The candidate shall reappear for the withdrawn courses during the examination conducted in the subsequent semester.

19. PROVISION FOR AUTHORISED BREAK OF STUDY

19.1 Break of Study shall be granted only once for valid reasons for a maximum of one year during the entire period of study of the degree programme. However, in extraordinary situation the candidate may apply for additional break of study not exceeding another one year by paying prescribed fee for break of study. If a candidate intends to temporarily discontinue the programme in the middle of the

semester for valid reasons and to rejoin the programme in a subsequent year, permission may be granted based on the merits of the case provided he/she applies to the Registrar, but not later than the last date for registering for the ESE of the semester in question, through the Head of the Department and Dean stating the reasons thereof and the probable date of rejoining the programme.

19.2 The candidate thus permitted to rejoin the programme after the break shall be governed by the curriculum and regulations in force at the time of rejoining. Such candidates may have to do additional courses, if any as per the curriculum and regulations in force at that period of time.

19.3 The authorized break of study (for a maximum of one year) will not be counted for the duration specified for passing all the courses for the purpose of classification (vide Clause 15). However, additional break of study granted will be counted for the purpose of classification.

19.4 The total period for completion of the programme reckoned from, the commencement of the first semester to which the candidate was admitted shall not exceed the maximum period specified in

19.5 Clause 2.1 irrespective of the period of break of study (vide Clause 18.1) in order that he/she may be eligible for the award of the degree.

19.6 If any student is detained for want of requisite attendance, progress and good conduct, the period spent in that semester shall not be considered as permitted 'Withdrawal' or 'Break of Study' Clause 16 and 18 respectively is not applicable for this case.

20. SPECIAL SUPPLEMENTARY ESE:

After the publication of IV semester results, if a student has an arrear in any theory course of the entire programme, he/she will be permitted to apply within 15 days of the publication of results, and appear for a special supplementary examination.

21. DISCIPLINE

Every student is required to observe disciplined and decorous behavior both inside and outside the Karpagam academy of Higher Education and not to indulge in any activity which will tend to bring down the prestige of the Karpagam academy of Higher Education. The erring student will be referred to the Disciplinary Committee constituted by the Karpagam academy of Higher Education, to inquire into acts of indiscipline and recommend to the Karpagam academy of Higher Education about the disciplinary action to be taken. If a student indulges in malpractice in any of the CIA/ESE he/she shall be liable for punitive action as prescribed by the Karpagam academy of Higher Education from time to time.

22. REVISION OF REGULATION AND CURRICULUM

The Karpagam academy of Higher Education may from time-to-time revise, amend or change the Regulations, Scheme of Examinations and syllabi if found necessary on the recommendations of Board of Studies, Academic Council and Board of Management of Karpagam academy of Higher Education.

Programme Educational Objectives (PEO's)

1. Provide students with contemporary tools and technology related to design engineering to comprehend, analyze, design, and produce novel products and solutions for the modern manufacturing issues.
2. Empowering students with extensive knowledge on robotics and automation, fostering the growth of industries and endeavoring to solve the societal and technical issues.
3. To nurture students with a professional and ethical behavior, adept communication abilities, strong teamwork aptitude, a multidisciplinary mindset, and the skill to connect computer integrated manufacturing engineering issues to wider engineering and societal contexts.

Programme Outcomes (PO's)

- **PO1 - Engineering Knowledge:** Ability to apply knowledge of mathematics, science and engineering fundamentals for solving the complex engineering problems.
- **PO2 - Problem Analysis:** Identify, formulate, design, review and analyze the complex engineering problems, by conceptual and fundamental principles of mechanical design and mathematics to reach value added sustainable solutions.
- **PO3 - Designs / development of solution:** Design solutions for complex engineering problems and design system components/processes that meet the specified needs with appropriate consideration for the public health and safety, cultural, societal and environmental consideration.
- **PO4 - Conduct investigations of complex Problems** Use research-based knowledge and research techniques including design of experiments, design analysis and interpretation of data and compiling the information to provide valid conclusions.
- **PO5 - Modern tool usage:** To understand and apply modern techniques and design tools for the design and analysis of mechanical systems, components and tools.
- **PO6 - The engineer and society:** Understand the impact of engineering solutions in a societal context and to be able to respond effectively to the needs for sustainable development.
- **PO7 - Environment and sustainability:** Understanding the mechanism of pollutant formation and its control techniques.
- **PO8 - Ethics:** Understanding of human and ethical responsibilities towards the profession and society.

- **PO9 - Individual and team work:** Function effectively as an individual, and as a member or a leader in diverse teams, and in multi-disciplinary situations.
- **PO10 - Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **PO11 - Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **PO12 - Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes (PSO's)

- **PSO1:** To provide a comprehensive understanding of engineering problem analysis and equip students with the skills necessary to excel in research within their selected field.
- **PSO2:** Students beamed fundamentally and real time problem-solving skills by the use of advanced design tools, computer aided manufacturing and robotics laboratory.

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(Deemed to be University Established Under Section 3 of UGC Act, 1956)
Accredited with A+ Grade by NAAC in Second Cycle
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FACULTY OF ENGINEERING

M.E. CAD/CAM ROBOTICS

CURRICULUM AND SYLLABI

(2023 Batch Onwards)

SEMESTER I

Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		PSO	PO	L	T	P		CIA	ESE	Total	
								40	60	100	
23MECCR101	Applied Mathematics for Engineers	1	1,2,3,12	3	1	0	4	40	60	100	1
23MECCR102	Computer Application in Design	2	1,2,3,4,5,10,12	3	0	0	3	40	60	100	3
23MECCR103	Mechatronics	1	1,2,3,5, 10,12	3	0	0	3	40	60	100	5
23MECCR104	Computer Integrated Manufacturing	2	1,2,3,10, 12	3	0	0	3	40	60	100	7
23MECCR105	Advanced Manufacturing Processes	1	1,2,10, 12	3	0	0	3	40	60	100	9
23MECCR1E*	Professional Elective I	-	-	3	0	0	3	40	60	100	-
23MECCR111	CAD/CAM Laboratory	1	1,2,3,5, 10,11,12	0	0	4	2	40	60	100	11
Total				18	1	4	21	280	420	700	

SEMESTER II

Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		PSO	PO	L	T	P		CIA	ESE	Total	
								40	60	100	
23MECCR201	Advanced Finite Element Analysis	1	1,2,3,4,5,6,9	3	1	0	4	40	60	100	13
23MECCR202	Industrial Robotics and Expert Systems	1	1,2,9,10,12	3	0	0	3	40	60	100	15
23MECCR203	Computer-Aided Tooling for Manufacturing	1	1,2,3,4,5,10,12	3	0	0	3	40	60	100	17
23MECCR204	Tribology in Design	1	1,2,3,5,7,9,10,12	3	0	0	3	40	60	100	19
23MECCR205	Design for Sustainability	1	1,2,3,4,5,8,10,12	3	0	0	3	40	60	100	21
23MECCR2E*	Professional Elective II	-	-	3	0	0	3	40	60	100	-
23MECCR211	Robotics Laboratory	2	1,2,3,5,6,9,10,11	0	0	4	2	40	60	100	23
Total				18	1	4	21	280	420	700	

SEMESTER III											
Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		PSO	PO	L	T	P		CIA	ESE	Total	
								40	60	100	
23MECCR301	Research Methodology	1	1,2,5,8, 10,12	3	0	0	3	40	60	100	24
23MECCR3E*	Professional Elective III	-	-	3	0	0	3	40	60	100	-
23MECCR3E*	Professional Elective IV	-	-	3	0	0	3	40	60	100	-
23MECCR391	Project Work Phase - I & Viva voce	1,2	1,2,3,4,5,6,10,11,12	0	0	12	6	80	120	200	27
Total				9	0	12	15	200	300	500	

SEMESTER IV											
Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		PSO	PO	L	T	P		CIA	ESE	Total	
								40	60	100	
23MECCR491	Project Work Phase - II & Viva voce	1,2	1,2,3,4,5,6,10,11,12	0	0	24	12	160	240	400	28
Total				0	0	24	12	160	240	400	

PROFESSIONAL ELECTIVE I

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
23MECCR1E01	Optimization Techniques	3	0	0	3	40	60	100	29
23MECCR1E02	Additive Manufacturing and Tooling	3	0	0	3	40	60	100	31
23MECCR1E03	Kinematics and Dynamics of Robotics	3	0	0	3	40	60	100	33
23MECCR1E04	Product Design and Tooling	3	0	0	3	40	60	100	35

PROFESSIONAL ELECTIVE II

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
23MECCR2E01	Modeling Simulation and Analysis	3	0	0	3	40	60	100	37
23MECCR2E02	Industrial Automation and Its application	3	0	0	3	40	60	100	39
23MECCR2E03	Control Systems in Robotics	3	0	0	3	40	60	100	41
23MECCR2E04	Vibration Analysis and Diagnosis	3	0	0	3	40	60	100	43

PROFESSIONAL ELECTIVE III

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
23MECCR3E01	Modern Material Handling Systems	3	0	0	3	40	60	100	45
23MECCR3E02	CAD for Smart Manufacturing	3	0	0	3	40	60	100	47
23MECCR3E03	Vision System	3	0	0	3	40	60	100	49
23MECCR3E04	Computational Fluid Dynamics	3	0	0	3	40	60	100	51

PROFESSIONAL ELECTIVE IV

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
23MECCR3E05	Micro Electro Mechanical Systems (MEMS)	3	0	0	3	40	60	100	53
23MECCR3E06	Emerging Materials for Robots	3	0	0	3	40	60	100	55
23MECCR3E07	Artificial Intelligent for Robotics	3	0	0	3	40	60	100	57
23MECCR3E08	Design for Manufacturing, Assembly and Environment	3	0	0	3	40	60	100	59

Total Marks: 2300

Total number of credits: 69

PEO: Programme Educational Objectives **PO: Programme Outcomes**

L: Lecture Hour **T: Tutorial Hour** **CIA: Continuous Internal**

Assessment: Practical Hour **C: No. of Credits** **ESE: End Semester Examinations**

Note:

1. The passing minimum for Mandatory course is 50 marks out of 100 marks. There will be two tests,of which one will be class test covering 50% of syllabus for 50 marks and other for 50 marks.
2. A student will be eligible to get Post Graduate degree with Honors or additional Minor Engineering,if he/she completes an additional 6 credits. These could be acquired through MOOCs.

SEMESTER I

23MECCR101 **APPLIED MATHEMATICS FOR ENGINEERS** **4H-4C**

Instruction Hours/week: L: 3 T:1 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- Introduce Fourier Transform, Laplace equation and Poisson equation which is central to many applications in Engineering apart from its use in solving one-dimensional heat conduction and wave equation problems.
- Acquaint the student with Fourier Transform method in solving Laplace equation and Poisson equations in various situations.
- Acquaint the student familiar with the concept of variation and functional through calculus of variations.
- Introduce finite difference methods to solve one-dimensional parabolic equation.
- To make the students to solve various engineering problems.

COURSE OUTCOMES

Students undergoing this course will be able to

- Apply Fourier transform techniques for one dimensional heat flow equation and one-dimensional wave equation.
- Make use of Laplace and Fourier transforms in elliptic equations.
- Apply the concept of functional, strong, weak and Euler's equations in simple variation problems.
- Interpret the solutions for one-dimensional parabolic equation using finite difference method.
- Utilize finite difference method for one-dimensional parabolic equations.

UNIT I ONE DIMENSIONAL WAVE AND HEAT EQUATIONS 9

Fourier Transform methods – one-dimensional heat conduction problems, infinite and Semi-infinite rod – Laplace Equation – Poisson Equation.

UNIT II ELLIPTIC EQUATION 9

Laplace equation -Solution of Laplace's equation by means of Fourier transforms in a half-plane, in an infinite strip and in a semi-infinite strip-Solution of Poisson
equation by Fourier transform method.

UNIT II CALCULUS OF VARIATIONS 9

Concept of variation and its properties – Euler's equation – Functional dependent on first and higher order derivatives – Functionals dependent on functions of several independent variables

UNIT IV FINITE DIFFERENCE METHODS FOR ONE DIMENSIONAL PARABOLIC EQUATIONS 9

One dimensional parabolic equation – Explicit and Crank-Nicolson Schemes – Thomas Algorithm – Weighted average approximation.

UNIT V FINITE DIFFERENCE METHODS FOR TWO DIMENSIONAL PARABOLIC EQUATIONS 9

Dirichlet and Neumann conditions – Two Dimensional parabolic equations – ADI method. Applications of parabolic equations.

TOTAL: 45 HOURS

TEXT BOOK

1. Sankara Rao. K, Numerical Methods in Engineering, Khanna Publishers India Pvt. Ltd., New Delhi, 2011.
2. E Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, Tenth Edition, 2015.
3. M.K.Jain, S.R.K. Iyengar and R.K.Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, Fifth Edition, 2007.

REFERENCE BOOK

1. Andrews, L.C. and Shivamoggi, B.K. Integral Transforms for Engineers, Macmillan Publishing Company, New York,1999
2. Gupta, A.S., Calculus of Variations with Applications, Prentice Hall of India Pvt. Ltd., New Delhi, 2013
3. Spiegel, M.R., Theory and Problems of Complex Variables and its Application (Schaum's Outline Series), McGraw Hill Book Co., Singapore, 2017.
4. K. Sankara Rao, Introduction to Partial Differential Equations, 3rd edition, PHI Learning Private Ltd, New Delhi-110001, 2011.

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C101.1	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C101.2	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C101.3	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C101.4	2	1	-	-	-	-	-	-	-	-	-	1	1	-
C101.5	3	2	1	-	-	-	-	-	-	-	-	1	1	-
Average	**2.8**	**1.8**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**1.0**	**-**

SEMESTER I

23MECCR102 COMPUTER APPLICATION IN DESIGN 3H-3C

Instruction Hours/week: L: 3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Apply computer graphics fundamentals for better visualization in CAD simulations.
- Use curve and surface modeling techniques to represent complex shapes in CAD.
- Develop interactive programs using programming languages for solving design challenges in CAD.
- Implement solid modeling techniques to create intricate geometries in CAD simulations.
- Enhance visual realism in CAD by applying shading, coloring, and other visualization techniques.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Utilize modeling techniques for accurate shape representation in CAD.
- Develop interactive programs for design problem-solving in CAD.
- Identify solid modeling for complex geometry creation in CAD.
- Apply visual realism in CAD simulations using shading and coloring techniques.
- Construct Assembly of parts using CAD software.

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 9

Output primitives (points, lines, curves, etc.,), 2-D and 3-D transformation (Translation, scaling, rotators) windowing - view ports - clipping transformation.

Representation of curves – Bezier curves - cubic spline curve - B – Spline curves - Rational curves –Surface Modeling techniques - surface patch – Coon’s patch- bi-cubic patch – Bezier and B-spline surfaces – Volume modeling – Boundary models – CSG- other modeling techniques.

UNIT II INTRODUCTION TO CAD SOFTWARE 9

Writing interactive programs to solve design problems and production of drawings - using any languages like Python and Java programming etc.- the creation of surfaces - solids, etc. using solid modeling packages (prismatic and revolved parts).

UNIT III SOLID MODELING 9

Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modeling.

Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc.– Communication standards.

UNIT IV VISUAL REALISM 9

Hidden – Line – Surface – solid removal algorithms shading – coloring. Introduction to parametric and variational geometry-based software and their principles of creation of prismatic and lofted parts using these packages.

UNIT V ASSEMBLY OF PARTS 9

Assembly modeling - interferences of positions and orientation - tolerances analysis - mass property calculations - mechanism simulation.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Radhakrishnan P and Subramanyan S, CAD/CAM/CIM, 2nd edition, New Age International Pvt. Ltd, 2008
2. Ibrahim Zeid, CAD/CAM Theory and Practice,2nd edition, McGraw Hill Inc., New York, 2009

REFERENCE BOOKS:

1. Vera B Anand, Computer Graphics and Geometric Modeling for Engineers,1st edition, John Wiley & Sons, New York, 2000
2. Barry Hawhes, The CAD/CAM Process,1st edition, Pitman Publishing, London, 2007(digital)
3. William M Newman and Robert Sproul, Principles of Interactive Computer Graphics,1st edition, McGraw Hill Inc., New York, 2001.

WEBSITES:

1. https://www.vssut.ac.in/lecture_notes/lecture1530947994.pdf
2. https://community.wvu.edu/~bpbettig/MAE455/Lecture_1_CAD_intro.pdf
3. https://transport.itu.edu.tr/docs/librariesprovider99/dersnotlari/dersnotlarires112e/not/cadd-1.pdf?sfvrsn=4

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C102.1	3	2	1	-	2	-	-	-	-	1	-	2	-	2
C102.2	3	2	1	-	2	-	-	-	-	1	-	2	-	2
C102.3	3	2	1	-	2	-	-	-	-	1	-	2	-	2
C102.4	3	2	1	-	2	-	-	-	-	1	-	2	-	2
C102.5	3	2	1	-	2	-	-	-	-	1	-	2	-	2
Average	**3.0**	**2.0**	**1.0**	**-**	**2.0**	**-**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**-**	**2.0**

SEMESTER I

23MECCR103 MECHATRONICS 3H-3C

Instruction Hours/week: L: 3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The Goal of this course is for students

- To understand the concepts of sensors and transducers.
- To provide an overview of actuation systems.
- To expose students on fundamentals of microprocessor.
- To provide knowledge about various types of controllers
- To facilitate the understanding of PLC program using ladder logic.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

- Explain the concepts of sensors and transducers.
- Develop the actuation systems.
- Apply interfacing concepts in microprocessor.
- Choose controllers for a given application.
- Model a mechatronics system.

UNIT I SENSORS AND TRANSDUCERS 9

Introduction to Mechatronics – Systems – Measurement Systems – Control Systems –Traditional design – Microprocessor based Controllers. Introduction to sensors – Performance Terminology – Static and Dynamic characteristics – Displacement – Position and Proximity – Velocity and Motion – Fluid Pressure – Temperature Sensors – Light Sensors – Selection of Sensors – Signal processing – Servo systems.

UNIT II ACTUATORS 9

Pneumatic and Hydraulic Systems – Directional Control Valves – Rotary Actuators. Mechanical Actuation Systems – Cams – Gear Trains – Ratchet and pawl – Belt and Chain Drives – Bearings. Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – D.C Motors – A.C Motors – Stepper Motors.

Introduction to system models– Building block of Mechanical, Electrical, Fluid and Thermal Systems.

UNIT III MICROPROCESSORS 9

Introduction – Architecture – pin configuration Instruction set – Programming of Microprocessors using 8085 instructions – Interfacing. Input and output devices – interfacing D/A converters and A/D converters – Application – Temperature control – Stepper motor control.

UNIT IV CONTROLLERS 9

Introduction – Continuous and discrete process Controllers – Control Mode – Two – Step mode – Proportional Mode –Derivative Mode – Integral Mode – PID Controllers –Digital Controllers – Adaptive Control – Digital Logic Control – Micro Processors Control. Introduction to PLC – Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Data Handling – Analog Input / Output Selection of a PLC.

UNIT V MECHATRONIC SYSTEMS DESIGN 9

Stages in designing Mechatronics Systems – Traditional and Mechatronic Design – Possible Design Solutions - Case Studies of Mechatronics Systems, Pick and place robot – automatic Car Park Systems – Engine Management Systems – Introduction to MEMS.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Bolton W, Mechatronics (Anna University): A Multidisciplinary Approach, 1stedition, Pearson Prentice Hall, Delhi, 2008
2. Michael B. Histand David G. Alciatore, Introduction to Mechatronics and Measurement Systems, 4th edition, McGraw–Hill International Editions, New York, 2014

REFERENCE BOOKS

1. Nitaigour Prem chand Mahalik, Mechatronics: Principles, Concepts and Applications, 1st edition, McGraw–Hill Education, New Delhi, 2003
2. Ghosh P.K and Sridhar P.R, Introduction to Microprocessors for Engineers and Scientist, 3rd edition, Prentice Hall of India, New Delhi, 2009

WEBSITES:

1. https://archive.nptel.ac.in/courses/112/107/112107298/
2. https://nptel.ac.in/courses/112103174

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C103.1	2	1	-	-	2	-	-	-	-	1	-	2	2	-
C103.2	3	2	1	-	2	-	-	-	-	1	-	2	2	-
C103.3	3	2	1	-	2	-	-	-	-	1	-	2	2	-
C103.4	3	2	1	-	2	-	-	-	-	1	-	2	2	-
C103.5	3	2	1	-	2	-	-	-	-	1	-	2	2	-
Average	**2.8**	**1.8**	**1.0**	**-**	**2.0**	**-**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**2.0**	**-**

SEMESTER I

23MECCR104 COMPUTER INTEGRATED MANUFACTURING 3H-3C

Instruction Hours/week: L: 3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

- To develop an ability to apply knowledge of mathematics, science, and engineering aspects.
- To increase the ability to know the application of principles of group technology in computer aided process planning.
- To develop the ability to apply knowledge on working of the shop floor control and data collection system in FMS.
- To enhance knowledge on data management and communication.
- To develop the knowledge on open system and database terminologies.

COURSE OUTCOMES:

Upon completion of this course, the student can able to

- Make use of computer integrated manufacturing concepts in industries.
- Apply the principles of group technology in computer aided process planning.
- Identify the working process of the shop floor control
- Utilize the automated data collection system in FMS.
- Develop CIM architecture for practical application.

UNIT I INTRODUCTION 9

The meaning and origin of CIM– the changing manufacturing and management scene – External communication – islands of automation and software–dedicated and open systems–manufacturing automation protocol – product related activities of a company– marketing engineering – production planning – plant operations – physical distribution– business and financial management.

UNIT II GROUPTECHNOLOGY 9

Group technology– – part families – Classification and coding – Approaches to computer aided process planning – variant approach and generative approaches

UNIT III SHOP FLOOR CONTROL AND INTRODUCTION OF FMS 9

Shop floor control–phases –factory data collection system –automatic identification methods– Bar code technology– automated data collection system. FMS–components of FMS – types –FMS workstation –material handling and storage systems– FMS layout –computer control systems–application and benefits.

UNIT IV CIM IMPLEMENTATION AND DATA COMMUNICATION 9

CIM and company strategy – system modeling tools –IDEF models – activity cycle diagram – CIM open system architecture (CIMOSA)– manufacturing enterprise wheel–CIM architecture – Product data management–CIM implementation software. Communication fundamentals– local area networks –topology – LAN implementations – network management and installations –MRP, ERP concepts

UNIT V OPEN SYSTEM AND DATA BASE FOR CIM 9

Open systems–open system inter connection – manufacturing automations protocol and technical office protocol (MAP /TOP). Development of databases –database terminology– architecture of database systems–data modeling and data associations –relational data bases – database operators – advantages of data base and relational database.

TOTAL: 45 HOURS

TEXT BOOK

1. Mikell.P.Groover, Automation, Production Systems and computer integrated manufacturing, Pearson Education, Delhi, 2011.
2. Yoremkoren, Computer Integrated Manufacturing system, McGraw-Hill, New York, 2005.

REFERENCE BOOK

1. Kant Vajpayee S, Principles of computer integrated manufacturing, Prentice Hall India, New Delhi, 2003.
2. Radhakrishnan P and Subramanyan S, CAD/CAM/CIM, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000

WEB REFERENCES

1. http://en.wikipedia.org/wiki/Computer-integrated_manufacturing
2. http://www.technologystudent.com/rmprp07/intman1.html
3. http://www.computerintegratedmanufacturing.com/

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C104.1	3	2	1	-	1	-	-	-	-	1	-	1	-	2
C104.2	3	2	1	-	1	-	-	-	-	1	-	1	-	2
C104.3	3	2	1	-	1	-	-	-	-	1	-	1	-	2
C104.4	3	2	1	-	1	-	-	-	-	1	-	1	-	2
C104.5	3	2	1	-	1	-	-	-	-	1	-	1	-	2
Average	**3.0**	**2.0**	**1.0**	**-**	**1.0**	**-**	**-**	**-**	**-**	**1.0**	**-**	**1.0**	**-**	**2.0**

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SEMESTER I

23MECCR105 ADVANCED MANUFACTURING PROCESSES 3H-3C

Instruction Hours/week: L: 3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is to

- Understand surface cleaning, coating methods, and their economic implications.
- Introduce advanced machining techniques and their applications.
- Explore advanced machining methods like laser, plasma, and electron beam machining.
- Learn about ceramic and composite processing techniques and challenges.
- Gain insights into microelectronics fabrication and integration with modern technologies.

COURSE OUTCOMES

Upon completion of this course, the students can able

- Explain the methods of surface coating and their economic implications.
- Summarize the principles and characteristics of mechanical and electrical energy-based machining processes.
- Compare the working principles of thermal chemical energy-based machining processes.
- Illustrate the steps involved in the processing of particulate ceramics and composite materials.
- Outline the stages involved in the fabrication of microelectronic devices.

UNIT– I SURFACE TREATMENT 9

Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapour deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

UNIT– II NON-TRADITIONAL MACHINING 9

Introduction, need, AJM, Parametric Analysis, Process capabilities, USM –Mechanics of cutting, models, Parametric Analysis, WJM –principle, equipment, process characteristics, performance, EDM – principles, equipment, generators, analysis of R-C circuits, MRR, Surface finish, WEDM.

UNIT–III LASER BEAM MACHINING 9

Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Plasma Arc Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Electron Beam Machining - Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Electro Chemical Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.

UNIT– IV PROCESSING OF CERAMICS 9

Applications, characteristics, classification. Processing of particulate ceramics, Powder preparations, consolidation, Drying, sintering, Hot compaction, Area of application, finishing of ceramics. Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

UNIT– V FABRICATION OF MICROELECTRONIC DEVICES 9

Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in microelectronics, surface mount technology, Integrated circuit economics. E-Manufacturing, nanotechnology, and micromachining, High speed Machining.

TOTAL: 45 Periods

TEXT BOOKS

1. Dearnley, P. A. Introduction to surface engineering. Cambridge University Press, 2017.
2. Benedict, Gary F. Nontraditional manufacturing processes. Vol. 19. CRC press, 1987.
3. Chawla, Krishan K. Composite materials: science and engineering. Springer Science & Business Media, 2012.
4. Franssila, Sami. Introduction to microfabrication. John Wiley & Sons, 2010.

REFERENCE BOOKS

1. Grzesik, Wit. Advanced machining processes of metallic materials: theory, modelling and applications. 2nd Ed, Elsevier, 2017.
2. James SR. Introduction to the principles of ceramic processing. John Willey and Sons Inc, New York. 1988.

WEBSITES

1. https://home.iitk.ac.in/~nsinha/Non-traditional-machining
2. https://www.mems-exchange.org/MEMS/fabrication.html

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C105.1	2	-	-	-	-	-	-	-	-	1	-	2	2	-
C105.2	2	-	-	-	-	-	-	-	-	1	-	2	2	-
C105.3	2	-	-	-	-	-	-	-	-	1	-	2	2	-
C105.4	2	1	-	-	-	-	-	-	-	1	-	2	2	-
C105.5	2	1	-	-	-	-	-	-	-	1	-	2	2	-
Average	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**2.0**	**-**

SEMESTER I

23MECCR1E* **PROFESSIONAL ELECTIVE - I** **3H-3C**

Instruction Hours/week: L: 3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

SEMESTER I

23MECCR111 CAD/CAM LABORATORY 4 H- 2 C

Instruction Hours/week: L: 0 T:0 P: 3 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is for students,

- To explain students with manual CNC part programming for turning machines using SIEMENS system.
- To explain students with manual CNC part programming for milling using FANUC system
- To create part programs for milling and turning machines using CAM packages.
- To introduce the concept of printing parts using additive manufacturing
- To introduce Relational database management system in Material requirements planning.

COURSE OUTCOMES

Students undergoing this course will be able to

- Create 3D models of machine elements using SolidWorks.
- Construct 2D drawings from 3D models using SolidWorks.
- Compile program using FANUC coding system in a CNC machine.
- Compile program using FANUC coding system in a milling machine.
- Design part programs using CAM packages for milling and turning machines.

LIST OF EXERCISE

COMPUTER AIDED DESIGN

1. 3D modeling of various machine elements using various options like protrusion, cut, sweep, draft, loft, blend, rib.
2. Assembly – creating assembly from parts – assembly constraints
3. Conversion of 3D solid model to 2D drawing – different views, sections, isometric view and dimensioning.
4. Introduction to Surface Modeling.
5. Introduction to File Import, Export – DXF, IGES, STL, STEP

Note: Any one of the 3D MODELING software‘s like SOLIDWORKS, CREO, CATIA, NX Software, AutoCAD etc.

COMPUTER AIDED MANUFACTURING

1. Programming and simulation for various operations using canned cycle for CNC turning Centre.
2. Programming and simulation for machining of internal surfaces in CNC turning Centre.
3. CNC code generation using CAM software packages – Turning.
4. Programming and simulation for profile milling operations.
5. Programming and simulation for circular and rectangular pocket milling.
6. CNC code generation using CAM software packages – Milling
7. Study on Dimensional and geometric measurement of machined features using VMS and CMM.
8. Study on RDBMS and its application in problems like inventory control MRP.

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C111.1	3	2	1	-	1	-	-	-	-	2	1	2	3	-
C111.2	3	2	1	-	1	-	-	-	-	2	1	2	3	-
C111.3	3	2	1	-	-	-	-	-	-	2	1	2	3	-
C111.4	2	1	-	-	-	-	-	-	-	2	1	2	3	-
C111.5	2	1	-	-	-	-	-	-	-	2	1	2	3	-
Average	**2.6**	**1.6**	**1.0**	**-**	**1.0**	**-**	**-**	**-**	**-**	**2.0**	**1.0**	**2.0**	**3.0**	**-**

SEMESTER II

23MECCR201 ADVANCED FINITE ELEMENT ANALYSIS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Recognize and classify various types of physical problems that can be solved using FEA.
- Analyze one-dimensional problems related to bars, trusses, beams, and frames using appropriate finite element techniques.
- Synthesize information to select appropriate interpolation functions and shape functions for different types of finite elements.
- Design and construct finite element models for complex engineering systems, including boundary conditions and constraints.
- Effectively communicate the results of finite element analyses through written reports, diagrams, and presentations.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Apply mathematical models and variational techniques to derive the weak form of governing equations for given physical problems.
- Analyze one-dimensional problems involving bars, trusses, beams, and frames using finite element techniques, considering dynamic and modal behavior.
- Construct finite element models, considering appropriate boundary conditions, constraints, and degrees of freedom.
- Evaluate numerical results from finite element analyses to draw engineering conclusions and make design recommendations.
- Apply finite element analysis to solve practical engineering problems, demonstrating problem-solving skills and critical thinking in diverse application areas.

UNIT I FUNDAMENTAL CONCEPTS AND PROBLEM CLASSIFICATION 9

Physical Problems and FEA in Computer-Aided Design - Stresses, Equilibrium, and Boundary Conditions - Strain-Displacement and Stress-Strain Relations - Linear and nonlinear material laws, Temperature Effects - Tensors, Indicial Notations, Deformation Gradients - Classification of Deformations, Degrees of Freedom - Solid Mechanics and Fluid Mechanics Problems.

UNIT II TECHNIQUES OF DISPLACEMENT-BASED FEA 9

Mathematical Models and Approximate Solutions - Minimization and Variational Procedures - Interpolation Polynomial and Nodal Approximations - Strong and Weak Forms, Galerkin's Approach

Shape and Interpolation Functions for 1D, 2D & 3D - Hermite, Lagrange, and Other Interpolation Functions.

UNIT III ONE-DIMENSIONAL PROBLEMS: BARS & TRUSSES 9

Introduction and Local-Global Coordinate Systems - Finite Element Stiffness and Load Matrix in Local Coordinates - Assembly of Global Stiffness Matrix and Load Vector - Boundary Conditions and Linear System Solution - Dynamic Analysis and Modal Frequencies - Example Problems in Trusses.

UNIT IV ONE-DIMENSIONAL PROBLEMS: BEAMS AND FRAMES 9

Finite Element Modeling of Beam Elements - Formulation of Element Matrices - Assembly of Global Stiffness Matrix, Mass Matrix, and Load Vector - Euler-Bernoulli and Timoshenko Beam Elements

Plane Frame and Space Frame Analysis - Solution Algorithms and Modal Frequencies.

UNIT V TWO-DIMENSIONAL AND VECTOR VARIABLE ANALYSIS 9

Formulation of 2D Problems with PDEs - Energy Principle Solution Algorithm - Constant Strain Triangles and Quadrilaterals - Modeling Boundary Conditions - Scalar Variable Problems (e.g., Heat Transfer) - Plane Stress, Plane Strain, Axisymmetric Elements - Isoparametric Elements and Higher Order Elements.

TOTAL: 45 HOURS

TEXTBOOKS:

1. Rao S.S, The Finite Element Method in Engineering, 4th Edition, Butter worth Heinemann imprint, USA, 2011
2. Daryl L. Logan, A First Course in the Finite Element Method, 5th Edition, Cengage Learning, Stamford, USA, 2011

REFERENCE BOOKS:

1. Tirupathi R. Chandrupatla, Ashok D. Belegundu, Introduction to Finite Elements in Engineering: International Edition, 4th Edition, Pearson Education Limited, 2014
2. David V Hutton, Fundamentals of Finite Element Analysis, 1st Edition, Tata McGraw–Hill Education, 2005.

WEBSITES:

1. https://www.academia.edu/39083992/Advanced_Finite_Element_Methods
2. https://www.iist.ac.in/sites/default/files/people/IN08026/FEM.pdf
3. https://mae.ufl.edu/nkim/egm6352/Chap0_Intro_2017.pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C201.1	3	2	1	-	2	-	-	-	-	1	-	2	3	-
C201.2	3	3	2	1	2	-	-	-	-	1	-	2	3	-
C201.3	3	2	1	-	2	-	-	-	-	1	-	2	3	-
C201.4	3	3	2	1	2	-	-	-	-	1	-	2	3	-
C201.5	3	2	1	-	2	-	-	-	-	1	-	2	3	-
Average	**3.0**	**2.4**	**1.4**	**1.0**	**2.0**	**-**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**3.0**	**-**

SEMESTER II

23MECCR202 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The Goal of this course is for students

- To learn about knowledge for Controlling the Robot motion.
- To understand the concepts of range sensors and Robotic vision system
- To gain about knowledge for design of robotics.
- To expose about robot programming, artificial intelligence and expert systems.
- To learn about the applications of robot.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

- Outline the concepts of Robot Kinematics and robot programming.
- Summarize the design of drive systems and controlling the Robot motion
- Relate the concepts of range sensors and Robotic vision system
- Interpret the knowledge for the design of robotics.
- Explain about robot programming, artificial intelligence and expert systems.

UNIT I INTRODUCTION AND ROBOT KINEMATICS 9

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT-II ROBOT DRIVES AND CONTROL 9

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT-III ROBOT 9

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system

UNIT-IV ROBOT CELL DESIGN AND APPLICATION 9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial applications of Robots.

UNIT-V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 9

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

TOTAL: 45 HOURS

TEXT BOOKS

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, “Robotics Control, Sensing,Vision and Intelligence”, Mc Graw Hill, 1987.
2. Yoram Koren,” Robotics for Engineers’ Mc Graw-Hill, 1987.

REFERENCE BOOKS

1. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, “Robotics Engineering-An Integrated Approach”, Prentice-Hall of India Pvt. Ltd., 1984.
2. Timothy Jordanides et al, “Expert Systems and Robotics”, Springer-Verlag, NewYork, May 1991.

WEBSITES

1. https://www.robotics.org/
2. https://roboticsandautomationnews.com

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C202.1	2	1	-	-	-	-	-	-	1	1	-	1	1	-
C202.2	2	1	-	-	-	-	-	-	1	1	-	1	1	-
C202.3	2	1	-	-	-	-	-	-	1	1	-	1	1	-
C202.4	2	1	-	-	-	-	-	-	1	1	-	1	1	-
C202.5	2	1	-	-	-	-	-	-	1	1	-	1	1	-
Average	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**1.0**	**-**	**1.0**	**1.0**	**-**

SEMESTER II

23MECCR203 COMPUTER AIDED TOOLING FOR MANUFACTURING 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is to

- Understand the integration of CAD, NC, and CAM systems to optimize manufacturing processes.
- Explore the different approaches to Computer-Aided Process Planning (CAPP) and their role.
- Gain insight into geometric tolerances, tolerance analysis, and modern quality control methods.
- Learn the process of reverse engineering.
- Develop strategies for effective data management in reverse engineering projects.

COURSE OUTCOMES

Upon completion of this course, the students can able

- Explain the concept of CAD/CAM integration and its significance in optimizing production processes.
- Summarize the role of process planning in CAD/CAM integration and its benefits.
- Outline the importance of geometric tolerances and their application in ensuring product quality.
- Relate the purpose and significance of reverse engineering in modern product development.
- Illustrate the strategies for managing data in reverse engineering projects.

UNIT– I COMPUTER AIDED MANUFACTURING 9

Manufacturing Processes – Removing, Forming, Deforming and joining – Integration equipment. Integrating CAD, NC and CAM – Machine tools – Point to point and continuous path machining, NC, CNC and DNC – NC Programming – Basics, Languages, G Code, M Code, APT – Tool path generation and verification – CAD/CAM NC Programming – Production Control – Cellular Manufacturing

UNIT– II COMPUTER AIDED PROCESS PLANNING 9

Role of process planning in CAD/CAM Integration – Computer Aided Process Planning – Development, Benefits, Model and Architecture – CAPP Approaches – Variant, Generative and Hybrid – Process and Planning systems – CAM-I, D-CLASS and CMPP – Criteria in selecting a CAPP System.

UNIT–III COMPUTER AIDED INSPECTION 9

Engineering Tolerances – Need for Tolerances – Conventional Tolerances – FITS and LIMITS – Tolerance Accumulation and Surface quality – Geometric Tolerances – Tolerances Practices in design, Drafting and manufacturing – Tolerance Analysis – Tolerance synthesis – Computer Aided Quality control – Contact Inspection Methods – Non-Contact Inspection Methods - Non optical.

UNIT– IV REVERSE ENGINEERING 9

Scope and tasks of Reverse Engineering – Domain Analysis – Process Duplicating – Tools for RE – Developing Technical data – Digitizing techniques – Construction of surface model – Solid part model – Characteristic evaluation – Software's and its application – CMM and its feature capturing – surface and solid modeling.

UNIT– V DATA MANAGEMENT 9

Strategies for Reverse Engineering Data management – Software application – Finding renewable software components – Recycling real time embedded software – Design experiments to evaluate a RE tools – Rule based detection for RE user interface – RE of assembly programs

TOTAL: 45 HOURS

TEXT BOOKS

1. Ibrahim Zeid and R. Sivasubramanian, "CAD/CAM Theory and Practice", Revised First special Indian Edition, Tata Mc Graw Hill Publication, 2007
2. David D. Bedworth, Mark R. Henderson, Philp M. Wolfe, "Computer Integrated Design and manufacturing", Mc Graw Hill International series, 1991
3. Catherine A. Ingle, "Reverse Engineering", Tata Mc Graw Hill Publication, 1994

REFERENCE BOOKS

1. Donald R. Honra, "Co-ordinate measurement and reverse Engineering, American Gear Manufacturers Association.
2. Ibrahim Zeid, "Mastering CAD/CAM", special Indian Edition, Tata Mc Graw Hill Publication, 2007
3. Linda Wills, "Reverse Engineering" Kluwer Academic Press, 1996.

WEBSITES

1. https://www.cirp.net/
2. https://www.gdandtbasics.com/

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C203.1	2	1	-	-	-	-	-	-	-	1	-	2	1	-
C203.2	2	1	-	1	1	-	-	-	-	1	-	2	1	-
C203.3	2	1	-	1	1	-	-	-	-	1	-	2	1	-
C203.4	2	1	-	1	1	-	-	-	-	1	-	2	1	-
C203.5	2	1	-	1	1	-	-	-	-	1	-	2	1	-
Average	**2.0**	**1.0**	**-**	**1.0**	**1.0**	**-**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**1.0**	**-**

SEMESTER II

23MECCR204 TRIBOLOGY IN DESIGN 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Explore friction, wear, and lubrication concepts in fluid dynamics.
- Use measurement methods to analyze engineering surface properties.
- Study friction theories and behaviors in fluid dynamics.
- Investigate various wear mechanisms in fluid dynamics.
- Examine lubricants and their roles in fluid dynamics.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Apply friction, wear, and lubrication knowledge to fluid dynamics.
- Summarize the measurement techniques for engineering surface analysis.
- Select friction theories in fluid dynamics contexts.
- Interpret wear mechanisms impacting fluid dynamics.
- Identify lubricant properties and usage in fluid dynamics.

UNIT I INTRODUCTION 9

Introduction to Friction, Wear, and Lubrication. Types of friction, wear, and lubrication.

UNIT II ENGINEERING SURFACES 9

Properties and Measurement, Typical surface layers, Measurement Methods (Surface Profilometry, Optical Microscopy, Electron Microscopy), Surface Contact.

UNIT III FRICTION 9

Measurement Methods, Adhesion, Deformation, Friction Theories, Stick-slip, Rolling Friction of Metals, Friction of Non-Metallic friction theory and friction behaviors of metals Materials.

UNIT IV WEAR 9

Types of Wear and its Mechanisms (Adhesive, Abrasive Wear, Erosive Wear, processes, wear theory, wear behaviors of Corrosive/Oxidative Wear, Fatigue Wear), Wear of metals and non-metals, Wear of Ceramics, Wear of Polymers, Wear instruments for measuring friction and wear. Test (Pin on Disc Tribometer, Reciprocating Tribometer), Wear reduction methods.

UNIT V LUBRICANTS AND LUBRICATION 9

Lubricants and their types, Purpose of Lubrication, General Properties of Liquid Lubricants, Animal and Vegetable Oils, Mineral oils, Synthetic oils, Blended Oils, Lubricant Additives, Semi Solid Lubricant or Greases, Solid Lubricants, Testing of Lubricants (Viscometer, Four Ball Tester).

TOTAL: 45 HOURS

TEXTBOOKS:

1. Engineering Tribology, Gwidon W. Stachowiak and Andrew W. Batchelor, 4th Edition,2014.
2. Tribology: Friction and Wear of Engineering Materials, Ian Hutchings and Philip Shipway, 2nd Edition, 2017.

REFERENCE BOOKS:

1. Introduction to Tribology, Bharat Bhushan, Wiley, 2nd Edition, 2002.
2. Engineering Tribology by. Prasanth Sahoo, Prentice Hall India Learning Private Limited, 2005.
3. Fundamentals of Tribology, Ramsay Gohar and Homer Rahnejat, Imperial College Press, 2nd Edition, 2012.

WEBSITES:

1. https://nitsri.ac.in/Department/Mechanical%20Engineering/Tribology_in_Machine_Design.pdf
2. https://easyengineering.net/tribology-in-machine-design/
3. https://www.nationalbronze.com/Tribology%20Handbook%20(2nd%20Edition).pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C204.1	3	2	1	-	-	-	-	-	-	1	-	2	3	-
C204.2	2	1	-	-	-	-	-	-	-	1	-	2	3	-
C204.3	3	2	1	-	-	-	-	-	-	1	-	2	3	-
C204.4	2	1	-	-	-	-	-	-	-	1	-	2	3	-
C204.5	3	2	1	-	-	-	1	-	-	1	-	2	3	-
Average	**2.6**	**1.6**	**1.0**	**-**	**-**	**-**	**1.0**	**-**	**-**	**1.0**	**-**	**2.0**	**3.0**	**-**

SEMESTER II

23MECCR205 DESIGN FOR SUSTAINABILITY 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is for the students to:

- Understand the fundamental principles of computer graphics and its applications.
- Learn about 2D and 3D transformations and their role in rendering graphics.
- Explore windowing, viewports, and clipping techniques in computer graphics.
- Understand different curve representation methods and their applications.
- Gain knowledge about surface modeling techniques and volume modeling.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

- Define the concepts of computer graphics and its importance in various fields.
- Apply translation, scaling, and rotation transformations to 2D and 3D objects.
- Analyze and implement windowing, viewports, and clipping operations.
- Compare and contrast different curve representation methods.
- Evaluate surface and volume models using various techniques.

UNIT- I INTRODUCTION 9

Introduction - Economics of process selection - General design principles for manufacturability; Geometric Dimensioning & Tolerance (GD&T) – Form tolerancing: straightness, flatness, circularity, cylindricity – Profile tolerancing: profile of a line, and surface – Orientation tolerancing: angularity, perpendicularity, parallelism – Location tolerancing: position, concentricity, symmetry – run out tolerancing: circular and total–Supplementary symbols.

UNIT- II CAST & WELDED COMPONENTS DESIGN 9

Design considerations for: Sand cast – Die cast – Permanent mold parts. Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment. Resistance welding–Design considerations for: Spot–Seam–Projection–Flash & Upset weldment.

UNIT- III FORMED & MACHINED COMPONENTS DESIGN 9

Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts – Forged parts. Design considerations for: Turned parts– Drilled parts – Milled, planned, shaped and slotted parts– Ground parts.

UNIT- IV DESIGN FOR ASSEMBLY 9

Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly– Computer Application for DFMA.

UNIT- V DESIGN FOR ENVIRONMENT 9

Introduction– Environmental objectives–Global issues–Regional and local issues–Basic DFE methods– Design guide lines–Example application–Life cycle assessment–Basic method–AT&T's environmentally responsible product assessment-Weighted sum assessment method–Life cycle assessment method– Techniques to reduce environmental impact–Design to minimize material usage–Design for disassembly– Design for recyclability–Design for manufacture–Design for energy efficiency –Design to regulations and standards

TOTAL: 45 HOURS

TEXT BOOKS:

1. Boothroyd, G, 2nd Edition 2002, Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Bralla, Design for Manufacture handbook, McGrawhill,1999.

REFERENCE BOOK:

1. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, MarcelDekker,1994.

WEBSITES:

1. http://www.sdmsite.org/
2. https://www.sustainabledesignresource.com/

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	PO11	PO12	PSO1	PSO2
C205.1	3	2	1	1	-	-	-	-	-	1	-	1	2	-
C205.2	3	2	1	1	1	-	-	-	-	1	-	1	2	-
C205.3	3	2	1	1	-	-	-	-	-	1	-	1	2	-
C205.4	3	2	1	1	1	-	-	-	-	1	-	1	2	-
C205.5	3	2	1	1	-	-	-	2	-	1	-	1	2	-
Average	**3.0**	**2.0**	**1.0**	**1.0**	**1.0**	**-**	**-**	**2.0**	**-**	**1**	**-**	**1.0**	**2.0**	**-**

SEMESTER II

23MECCR2E* **PROFESSIONAL ELECTIVE II** **3 H - 3 C**

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

SEMESTER II

23MECCR211 ROBOTICS LABORATORY 4 H - 2 C

Instruction Hours/week: L: 0 T: 0 P: 4 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Apply logic principles to program basic AND, OR, and NOT solutions for robotic systems.
- Demonstrate understanding of latching concepts in PLC for efficient control.
- Execute mathematical operations and use timers/counters in robotic programming.
- Implement command programs for accurate position control of robots.
- Utilize soft PLC for achieving effective velocity control in robotic systems.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Develop logic-based programs for fundamental logic operations (AND, OR, NOT) in robotic applications.
- Apply latching concepts in PLC to enhance control and stability in robotic processes.
- Utilize timers, counters, and mathematical operations to create efficient robotic control routines.
- Model command programs enabling precise position control of robotic devices.
- Experiment with soft PLC techniques to achieve smooth and controlled velocity in robotic movements.

LIST OF EXPERIMENTS ON ROBOTICS

1. Programs on logic based on solutions of AND, OR, NOT.
2. Latching concepts in PLC
3. Timer counter/ Mathematical operations.
4. Position control through command program.
5. Velocity control through soft PLC
6. VFD speed control using commands
7. Movements of different robot axes.
8. Point to Point, LIN, CIRC Operations.
9. Sequencing and looping operations.

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C211.1	3	2	1	-	1	-	-	-	-	2	-	-	-	3
C211.2	3	2	1	-	1	2	-	-	-	-	-	-	-	2
C211.3	3	2	1	-	1	-	-	-	2	-	-	-	-	2
C211.4	3	2	1	-	1	-	-	-	-	2	2	-	-	1
C211.5	3	2	1	-	1	2	-	-	2	2	-	-	-	3
Average	**3.0**	**2.0**	**1.0**	**-**	**1.0**	**2.0**	**-**	**-**	**2.0**	**2.0**	**2.0**	**-**	**-**	**2.2**

SEMESTER III

23MECCR301 RESEARCH METHODOLOGY 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students

- To Understand an Intellectual honesty and research integrity.
- To Understand the Publication ethics, standards and Identification of publication misconduct
- To Outline about the authorship and Use of plagiarism software
- To Explain about the database and research metrics.
- To Build their foundation for research in CAD/CAM and Robotics.

COURSE OUTCOMES:

Upon Completion of this course the students will be able

- Identify the Research Methodology and Research & Publication Ethics.
- Summarize the concept of Intellectual honesty and research integrity
- Explain about Intellectual honesty and research integrity.
- Relate the Publication ethics, standards and Identification of publication misconduct
- Identify the Software tools for plagiarism

UNIT I PHILOSOPHY AND ETHICS 9

Introduction to Philosophy: Definition, nature and scope, concept, branches- Ethics: Definition, moral Philosophy, nature of moral judgments and reactions.

UNIT II SCIENTIFIC CONDUCT 9

Ethics with respect to science and research – Intellectual honesty and research integrity – scientific misconduct: Falsification – Fabrication and plagiarism (FFP) – Redundant Publications: duplicate and overlapping publications – salami slicing – Selective reporting and misrepresentation of date.

UNIT III PUBLICATION ETHICS 9

Publication Ethics: Definition, introduction and importance – Best practices / standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest -Publication Misconduct: definition, concept, problems that lead to unethical behavior and vice versa, type-Violation of publication ethics,

Authorship and contributorship – Identification of publication misconduct, complaints and appeals-Predatory publishers and journals

UNIT IV PUBLICATION MISCONDUCT 9

Group Discussions: Subject specific ethical issues, FFP, authorship- Conflicts of interest-Complaints and appeals: examples and Fraud from India and abroad.

Software tools: Use of plagiarism software like Tumitin, Urkund and other open source software tools

UNIT V DATABASE AND IPR 9

Database: Database –e-content Development. Indexing database-Citation database: Web of Science, Scopus, etc Research Metrics: Impact Factor of journal as per journal citation Report, SNP, SJR, IPP, Cite score- Metrics: h-index, 110 indexes, altmetrics. IPR: Patent-Copyrights-Trademark-Geographical Indication.

TOTAL: 45 HOURS

TEXT BOOKS

1. Best Practice Guidelines on Publishing Ethics: A Publisher's Perspective, Second Edition, 2014 John Wiley & Sons, Ltd.
2. Wager E. The Committee on Publication Ethics (COPE): Objectives and achievements 1997- 2012. Presse Med. 2012.

REFERENCE BOOKS

1. Carlson RV, Boyd KM, Webb DJ. The revision of the Declaration of Helsinki: Past, present and future. Br J Clin Pharmacol. 2004.
2. Kambadur Muralidhar, Amit Ghosh, & Ashok Kumar Singhvi "ETHICS in Science Education, Research and Governance",

WEBSITE:

1. https://bbamantra.com/research-methodology/
2. https://research-methodology.net/

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C102.1	2	1	-	-	1	-	-	1	-	1	-	2	1	-
C102.2	2	1	-	-	-	-	-	1	-	1	-	2	1	-
C102.3	2	1	-	-	1	-	-	1	-	1	-	2	1	-
C102.4	2	1	-	-	-	-	-	1	-	1	-	2	1	-
C102.5	2	1	-	-	-	-	-	1	-	1	-	2	1	-
Average	**2.0**	**1.0**	**-**	**-**	**1.0**	**-**	**-**	**1.0**	**-**	**1.0**	**-**	**2.0**	**1.0**	**-**

SEMESTER III

23MECCR3E* **PROFESSIONAL ELECTIVE - III** **3 H - 3 C**

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

SEMESTER III

23MECCR3E* **PROFESSIONAL ELECTIVE - IV** **3 H - 3 C**

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

SEMESTER III

23MECCR391 PROJECT WORK PHASE – I & VIVA VOCE 16 H - 8 C

Instruction Hours/week: L: 0 T: 0 P: 16 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Cultivate skills to innovate new ideas and select a suitable problem.
- Equip to apply subject knowledge to obtain solutions to real-world problems.
- Equip to explore the various solutions and propose a solution based on findings.
- Develop skills in project planning, scheduling, handling technical challenges and completing the project under constraints.
- Develop skills to document the significant findings and outcomes.

COURSE OUTCOMES:

Upon completion of this course the students will be able to:

- Summarize the literature survey.
- Identify the research gap
- Identify a suitable real-world problem.
- Choose the best methodology based on the research gap and problem.
- Analyze the data collected and interpret the findings/ solutions /improvements

COURSE DESCRIPTION

Individual student works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completingthe work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. The project work carried out in this semester may be a standalone project or part of the work of project work carried out in the fourth semester.

The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

CO PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C391.1	2	1	-	-	1	1	-	-	-	3	2	2	2	1
C391.2	3	2	1	-	1	1	-	-	-	3	2	2	2	1
C391.3	3	2	1	-	1	1	-	-	-	3	2	2	2	1
C391.4	3	2	1	-	1	1	-	-	-	3	2	2	2	1
C391.5	3	3	2	1	1	1	-	-	-	3	2	2	2	1
Average	**2.8**	**2.0**	**1.3**	**1.0**	**1.0**	**1.0**	**-**	**-**	**-**	**3.0**	**2.0**	**2.0**	**2.0**	**1.0**

SEMESTER IV

23MECCR491 **PROJECT WORK PHASE – II & VIVA VOCE** **24 H - 12 C**

Instruction Hours/week: L: 0 T: 0 P: 24 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVE

The goal of this course is for the students to:

- Cultivate skills to innovate new ideas and select a suitable problem.
- Equip to apply subject knowledge to obtain solutions to real-world problems.
- Equip to explore the various solutions and propose a solution based on findings.
- Develop skills in project planning, scheduling, handling technical challenges and completing the project under constraints.
- Develop skills to document the significant findings and outcomes.

COURSE OUTCOMES

Upon completion of this course the students will be able to:

- Identify a suitable real-world problem.
- Apply subject knowledge to solve the problem.
- Analyze the data collected and interpret the findings/ solutions /improvements
- Choose the best solution based on the evaluation criteria.
- Summarize technical findings effectively.

COURSE DESCRIPTION

Individual student works on a topic approved by the head ofthe department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A projectreport and a research article related to same work may be submit and same will accepted by WoS/SCI/SCIE indexed journal are required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

CO PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C491.1	3	3	3	3	1	1	-	-	-	3	3	2	3	2
C491.2	3	3	3	3	1	1	-	-	-	3	3	2	3	2
C491.3	3	3	3	3	1	1	-	-	-	3	3	2	3	2
C491.4	3	3	3	3	1	1	-	-	-	3	3	2	3	2
C491.5	3	3	3	3	1	1	-	-	-	3	3	2	3	2
Average	**3.0**	**3.0**	**3.0**	**3.0**	**1.0**	**1.0**	**-**	**-**	**-**	**3.0**	**3.0**	**2.0**	**3.0**	**2.0**

PROFESSIONAL ELECTIVE I

23MECCR1E01 OPTIMIZATION TECHNIQUES 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Use optimization techniques to solve complex engineering problems with nonlinear functions.
- Solve one-dimensional optimization problems using methods like Fibonacci and golden section.
- Apply interpolation methods and quadratic approaches for multivariable optimization.
- Analyze direct and indirect methods for constrained nonlinear optimization.
- Apply integer and dynamic programming techniques to solve engineering problems.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Solve engineering optimization problems using nonlinear techniques.
- Apply methods like Fibonacci and golden section for one-dimensional optimization.
- Identify interpolation and quadratic methods for multivariable optimization.
- Analyze and select suitable methods for constrained nonlinear optimization.
- Apply integer programming and dynamic programming for real-world problems.

UNIT I NONLINEAR OPTIMIZATION 9

Introduction – unconstrained optimization - one-dimensional optimization – elimination methods – Fibonacci method, golden section methods – interpolation methods – quadratic, direct route method – multivariable optimization - direct search methods – pattern search methods – univariate method, hooks and Jeeves method, simplex method – descent methods – steepest descent, Newton methods.

UNIT II CONSTRAINED NONLINEAR OPTIMIZATION 9

Direct methods – the complex method, cutting plane method – indirect methods – interior and exterior penalty function methods, Khun-Tucker conditions, Lagrangian method.

UNIT III INTEGER AND DYNAMIC PROGRAMMING 9

Introduction to integer programming – solution techniques - graphical method, the branch, and bound technique, Gomary's cutting plane method, examples of the application in manufacturing/design systems – introduction to dynamic programming - bellman's principle of optimality, examples of the application on routing problem, inventory problem.

UNIT IV NETWORK OPTIMIZATION MODELS 9

Terminology of networks – the shortest route problem – the minimum spanning tree problem – the maximum flow problem – the minimum cost flow problem – the network simplex method.

UNIT V NON-TRADITIONAL OPTIMIZATION MODELS 9

Introduction to non-traditional optimization, computational complexity – NP-hard, NP-complete, no free lunch theorem – working principles of simulated annealing, Tabu search, and neural networks, simple applications. Introduction to Genetic Algorithms, Ants Colony Algorithm, Particle Swarm Algorithm, Hybrid Algorithms, and Simple Applications.

TOTAL: 45 HOURS

TEXTBOOKS:

1. Singiresu S Rao, “Engineering Optimization: Theory and Practice”, Wiley-Interscience, Third Edition, 1996.
2. Kalyanmoy Deb, “Optimization for engineering design”, Prentice Hall India Pvt. Ltd., New Delhi, 2000.
3. David E Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Addison Wesley Pub Co., 1989.
4. Marco Dorigo and Thomas Stutzle, “Ant Colony Optimization”, Prentice Hall of India, 2005.

REFERENCE BOOKS:

1. Maurice Clerc, “Particle Swarm Optimization”, ISTE, 2007
2. Dimitri P Bertsekas, “Dynamic Programming: Deterministic and Stochastic Models”, Prentice Hall, 1987.
3. Stephen G Nash and Ariela Sofer, “Linear and Nonlinear Programming”, McGraw Hill College Div., 1995.
4. Fred Glover, Manuel Laguna and Fred Laguna, “Tabu Search”, Kluwer Academic Publishers,1997.

WEBSITES:

1. https://www.shsu.edu/~eco_dgf/web_chapter_a.pdf
2. https://mis.alagappauniversity.ac.in/siteAdmin/dde-admin/uploads/3/PG_M.Sc._Mathematics_31132%20OPTIMIZATION%20TECHNIQUES.pdf
3. https://archive.nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L2slides.pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C1E01.1	3	3	2	3	2	2	-	-	3	3	3	3	2	-
C1E01.2	3	3	2	3	2	2	-	-	3	3	3	2	2	-
C1E01.3	3	3	2	3	2	2	-	-	3	3	3	2	2	-
C1E01.4	3	3	2	3	2	2	-	-	3	3	3	2	2	-
C1E01.5	3	3	2	3	2	2	-	-	3	3	3	2	2	-
Average	**3.0**	**3.0**	**2.0**	**3.0**	**2.0**	**2.0**	**-**	**-**	**3.0**	**3.0**	**3.0**	**2.1**	**2.0**	**-**

23MECCR1E02 ADDITIVE MANUFACTURING AND TOOLING 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSEOBJECTIVES

The goal of this course is for students

- Develop an understanding of the principles, development, and applications of Additive Manufacturing (AM).
- Apply reverse engineering and CAD modeling techniques to prepare data for rapid prototyping.
- Analyze the specifics of various AM processes like SLA, SGC, FDM, LOM, SLS, and LENS, including materials and limitations.
- Evaluate the quality, accuracy, and suitability of parts produced by different AM processes.
- Integrate AM concepts into tooling solutions for industries like automotive, aerospace, and electronics, considering benefits and constraints.

COURSEOUTCOMES

Upon completion of this course, the students can able to

- Explain the core concepts and significance of Additive Manufacturing in modern product development.
- Apply reverse engineering techniques and CAD modeling principles for efficient data preparation.
- Analyze various AM processes, assessing their strengths, weaknesses, and practical applications.
- Evaluate the quality and suitability of parts created by different AM methods in real-world scenarios.
- Interpret the additive manufacturing concepts to design tooling solutions for industries, considering industrial requirements and limitations.

UNIT– I INTRODUCTION 9

Need - Development of AM systems – AM process chain - Impact of AM on Product Development- Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes- Benefits Applications.

UNIT– II REVERSE ENGINEERING AND CAD MODELING 9

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

UNIT–III RAPID PROTOTYPE 9

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT– IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 9

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

UNIT– V TOOLING **9**

Classification, Soft tooling, Production tooling, Bridge tooling, direct and indirect tooling, Fabrication processes, Applications Case studies automotive, aerospace and electronics industries

TOTAL HOURS:45

TEXT BOOKS

1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
2. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.

REFERENCES

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

WEBSITES

1. https://www.additivemanufacturing.media/articles/big-ideas-in-am-10-examples-of-3d-printed-tooling
2. https://amchronicle.com/insights/applications-and-benefits-of-am-in-tooling/

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C1E02.1	2	1	-	-	3	2	-	-	-	1	1	1	3	-
C1E02.2	3	2	1	-	3	2	-	-	1	1	1	1	3	-
C1E02.3	3	2	1	-	3	2	-	-	-	1	1	1	3	-
C1E02.4	3	2	1	-	3	2	-	-	-	1	1	1	3	-
C1E02.5	3	2	1	-	3	2	-	-	1	1	1	1	3	-
Average	**2.8**	**1.8**	**0.8**	**-**	**3.0**	**2.0**	**-**	**-**	**0.4**	**1.0**	**1.0**	**1.0**	**3.0**	**-**

23MECCR1E03 ADDITIVE MANUFACTURING AND TOOLING 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Apply kinematic principles to understand robotic motion.
- Solve direct kinematics problems for different robot types.
- Select joint angles using inverse kinematics for various robots.
- Plan robot workspace, trajectories, and perform pick-and-place tasks.
- Analyze robotic dynamics using equations, models, and solve related problems.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Identify the robot position and orientation using rotation and angles.
- Explain the robot positions through direct kinematics for various designs.
- Summarize the inverse kinematics for different robotic setups.
- Plan motion paths, workspace limits, and execute pick-and-place actions.
- Examine robotic forces and motion equations, apply models to real cases.

UNIT I INTRODUCTION 9

Introduction, position and orientation of objects coordinates frame rotation matrix Euler angles roll, pitch and yaw angles coordinate transformations joint variables and position of each effectors

UNIT II DIRECT KINEMATICS 9

Dot and cross products coordinate frames rotations homogeneous co-ordinates link coordinates D-H representation the ARM equation. Direct kinematic analysis for four axis SCARA robot and six axis articulated robots.

UNIT III INVERSE KINEMATICS 9

The inverse kinematics problem general properties of solutions tool configuration inverse kinematic of four axis SCARA robot and six axis articulated robot.

UNIT IV WORKSPACE ANALYSIS AND TRAJECTORY PLANNING 9

Workspace analysis work envelope of a four axis SCARA robot and five axis articulated robot workspace fixtures the pick and place operations continuous path motion interpolated motion straight line motion

UNIT V MANIPULATOR DYNAMICS 9

Lagrange's equation kinetic and potential energy. Link inertia tensor link Jacobian manipulator inertia tensor. Gravity generalized forces, Lagrange- Euler dynamic model, dynamic model of a two-axis planar robot Newton Euler formulation. Lagrange Euler formulation problems

TOTAL: 45 HOURS

TEXT BOOKS:

1. Ghosal. A, “Robotics: Fundamental Concepts and Analysis,” McGraw Hill, 2008.
2. Reza N. Jazar, “Theory of Applied Robotics: Kinematics, Dynamics, and Control”, Springer, 2010.

REFERENCE BOOKS:

1. Robert J schilling, “Fundamentals of robotics analysis and control,” prentice hall of India Pvt. Ltd., 2000.
2. Sciavicco L., Siciliano B.: Modeling and control of robot manipulators, New York (N.Y.): McGraw-Hill, 1996.

WEBSITES:

1.https://u0011821.pages.gitlab.kuleuven.be/robotics/2009-HermanBruyninckx-robot-kinematics-and-dynamics.pdf
2. https://old.mu.ac.in/wp-content/uploads/2014/04/Robotics-IDOL.pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C1E03.1	3	2	1	-	1	-	-	-	-	2	-	-	2	2
C1E03.2	3	2	1	-	1	-	-	-	-	2	-	-	2	3
C1E03.3	2	1	1	-	1	-	-	-	-	2	-	-	2	1
C1E03.4	3	2	1	-	1	-	-	-	1	-	-	-	1	2
C1E03.5	3	2	1	2	1	-	-	-	1	2	-	1	1	2
Average	**2.8**	**1.8**	**1.0**	**0.4**	**1.0**	**0.4**	**-**	**-**	**0.4**	**1.6**	**-**	**0.2**	**1.6**	**2**

23MECCR1E04 PRODUCT DESIGN AND TOOLING 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVE

The goal of this course is for students

- Understand the fundamentals and advantages of fluid power systems.
- Identify various applications of fluid power systems.
- Differentiate between hydraulic and pneumatic systems.
- Gain knowledge about hydraulic and pneumatic components and symbols.
- Analyze the properties of hydraulic fluids and air for system selection.

COURSE OUTCOMES

At the end of the course, the students will be able to

- Explain the concept and benefits of fluid power systems.
- Identify and classify different applications of fluid power.
- Compare and contrast hydraulic and pneumatic systems.
- Interpret fluid power symbols and understand component functions.
- Evaluate and select appropriate hydraulic fluids and air for specific applications.

UNIT I FLUID POWER SYSTEMS AND FUNDAMENTALS 9

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid powersystems, Properties of hydraulic fluids and air – selection of hydraulic fluids – components of fluid power system Fluid power symbols. Applications of Pascals Law– Losses in pipe, valves and fittings – comparison betweenhydraulic and pneumatics.

UNIT II HYDRAULIC POWER SOURCES AND ACTUATORS 9

Sources of Hydraulic Power: Pumping theory – Pump classification – Gear pump, Vane Pump, piston pump, Pressure boosting pumps, construction and working of pumps – pump performance – Variable displacement pumps. Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Doubleacting special cylinders like tanden, Rodless, Telescopic, Cushioning mechanism, Construction of double actingcylinder, Rotary actuators – Fluid motors, Gear, Vane and Piston motors, Rotary distributor.

UNIT III HYDRAULIC CONTROL VALVES AND COMPONENTS 9

Construction of Control Components: Direction control valve – 3/2 way valve – 4/2 way valve – Shuttle valve – check valve – pressure control valve – pressure reducing valve, sequence valve, Flow control valve – Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram. Accumulators and Intensifiers: Types of accumulators – Accumulators circuits, sizing of accumulators, intensifier – Applications of Intensifier - Intensifier circuit.

UNIT IV PNEUMATIC SYSTEMS AND COMPONENTS 9

Pneumatic Components: Compressors – Filter, Regulator and Lubricator UNIT Air control valves, Quick exhaustvalves, pneumatic actuators. Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Pneumohydraulic circuit, Sequential circuit design for simple applications using cascade method.

UNIT V DESIGN OF PNEUMATIC CIRCUITS 9

Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics – Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic

circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting.

TOTAL: 45 HOURS

TEXT BOOKS

1. Anthony Esposito, Fluid Power with Applications, 1st edition, Pearson Education, New Delhi, 2013
2. Majumdar S. R, Oil Hydraulic Systems: Principles and Maintenance, 1st edition, Tata McGraw–Hill, NewDelhi, 2000.
3. IlangoSivaraman, Introduction To Hydraulics And Pneumatics, 3rdedition,, PHI Learning Pvt. Ltd, NewDelhi, 2017.

WEBSITES

1. https://www.thinkful.com/blog/product-design-tools/
2. https://www.hotjar.com/product-design/tools/

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	PO11	PO12	PSO1	PSO2
C1E04.1	3	2	1	-	1	-	-	-	-	1	-	1	2	-
C1E04.2	3	2	1	-	1	-	-	-	-	1	-	1	2	-
C1E04.3	3	2	1	-	1	-	-	-	-	1	-	1	2	-
C1E04.4	3	2	1	-	1	-	-	-	-	1	-	1	2	-
C1E04.5	3	2	1	-	1	-	-	-	-	1	-	1	2	-
Average	**3.0**	**2.0**	**1.0**	**-**	**1.0**	**-**	**-**	**-**	**-**	**1.0**	**-**	**1.0**	**2.0**	**-**

PROFESSIONAL ELECTIVE II

23MECCR2E01 MODELING SIMULATION AND ANALYSIS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSEOBJECTIVES

The goal of this course is for students

- Gain a comprehensive understanding of simulation's historical context, nature, limitations, and diverse applications.
- Apply various modeling approaches to represent real-world scenarios, including manual simulation for queuing and inventory problems.
- Assess the quality of random number generation using different techniques and statistical tests.
- Analyze the process of generating random variates for diverse distributions using techniques like the inverse transform and empirical methods.
- Develop skills to enhance system performance through input modeling, verification, validation, variance reduction, and output analysis.

COURSE OUTCOMES

Learners should be able to

- Explain about simulation's historical context, nature, limitations, and diverse applications.
- Apply various modeling approaches to represent real-world scenarios, including manual simulation for queuing and inventory problems.
- Assess the quality of random number generation using different techniques and statistical tests.
- Analyze the process of generating random variates for diverse distributions using techniques like the inverse transform and empirical methods.
- Develop skills to enhance system performance through input modeling, verification, validation, variance reduction, and output analysis.

UNIT I INTRODUCTION TO SIMULATION 9

Definition – history - nature of computer modeling and simulation, limitations of simulation, areas of application. System and environment**:** Components of a system – types of simulation - discrete and continuous systems. Modeling approaches – simulation examples - manual simulation using event scheduling, single channel queue, two server queue, simulation of inventory problem.

UNIT II RANDOM NUMBER GENERATION AND TESTING 9

Techniques for generating random numbers - midsquare method - midproduct method - constant multiplier technique - additive congruential method - linear congruential method – combined linear congruential generators – feedback shift register generators - tests for random numbers – frequency test - the Kolmogorov-Smirnov test, the chi-square test. Independence test – runs up and runs down, runs above and below the mean, autocorrelation.

UNIT III RANDOM VARIATE GENERATION 9

Inverse transform technique - exponential distribution, uniform distribution, Weibull distribution, Triangular distribution. Empirical continuous distribution - generating approximate normal variates - Erlang distribution. empirical discrete distribution - discrete uniform distribution - poisson distribution - geometric distribution - acceptance - rejection technique for poisson distribution - gamma distribution.

UNIT IV STAGES IN MODEL BUILDING 9

Input modeling – data collection, identifying the distribution with data, parameter estimation, goodness of fit tests, selecting input models without data, models of arrival processes. verification and validation of simulation models – variance reduction techniques, antithetic variables, calibration and validation of models. output analysis –stochastic nature of output data, measures of performance and their estimation, output analysis for terminating simulation.

UNIT V MANUFACTURING SYSTEMS MODELING 9

Objectives and performance measures – modeling system randomness – sources of randomness, machine downtime.

TOTAL HOURS: 45

TEXT BOOKS

1. Jerry Banks, John S, Carson II, Barry L Nelson and David M Nicol, “Discrete Event System Simulation”, Prentice Hall Inc., 2006.
2. Law A M, “Simulation Modeling and Analysis”, Tata McGraw Hill Companies Inc, 2008.
3. Gordon G, “Systems Simulation”, Prentice Hall Ltd., 2006.

REFERENCES

1. Narsingh Deo, “System Simulation with Digital Computer”, Prentice Hall of India, 2007.
2. Francis Neelamkovil, “Computer Simulation and Modeling”, John Wiley and Sons, 1987.
3. Ruth M Davis and Robert M O'Keefe, “Simulation Modeling with Pascal”, Prentice Hall Inc., 1989.

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C2E01.1	3	2	1	2	2	-	-	-	-	-	1	-	3	-
C2E01.2	3	2	1	2	2	-	-	-	-	-	1	-	3	-
C2E01.3	3	2	1	2	2	-	-	-	-	-	1	-	3	-
C2E01.4	3	2	1	2	2	-	-	-	-	-	1	-	3	-
C2E01.5	3	2	1	2	2	-	-	-	-	-	1	-	3	-
Average	**3.0**	**2.0**	**1.0**	**2.0**	**2.0**	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**3.0**	**-**

23MECCR2E02 INDUSTRIAL AUTOMATION AND ITS APPLICATION 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is for students

- Gain a comprehensive understanding of the principles, strategies, and levels of industrial automation.
- Analyze the functions and components of advanced automation systems, including hydraulic actuators and intelligent systems.
- Apply knowledge of material handling and identification technologies to design efficient material transport and storage systems.
- Evaluate different types of manufacturing systems, such as manufacturing cells, FMS, and GT, and assess their planning and implementation strategies.
- Create and design control solutions using various automation technologies, including industrial control systems, SCADA systems, and distributed control systems.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to

- Identify the foundational principles, strategies, and levels of industrial automation, including hydraulic actuators and intelligent systems.
- Analyze and optimize material handling and storage systems using automatic identification methods for efficient industrial processes.
- Evaluate and implement diverse manufacturing systems, such as manufacturing cells and FMS.
- Choose effective control solutions by utilizing a range of automation technologies, including industrial control systems, SCADA systems, and distributed control systems.
- Apply programming, trajectory planning, and simulation techniques for automation, and showcase understanding through case studies in various industrial applications.

UNIT I INTRODUCTION TO INDUSTRIAL AUTOMATION 9

Intelligent Systems, Hydraulic Actuators for Industrial Automation, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines. (SLE: Analysis of Transfer Lines)

UNIT II MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES 9

Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods. (SLE: Material Identification Methods)

UNIT III AUTOMATED MANUFACTURING SYSTEMS 9

Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation. Quality Control Systems: Traditional and Modern Quality Control Methods, SPC Tools, Inspection Principles and Practices, Inspection Technologies. (SLE: Usage of SPC tools using excel or Minitab).

UNIT IV CONTROL TECHNOLOGIES IN AUTOMATION 9

Industrial Control Systems, Process Industries Versus Discrete-Manufacturing Industries, Continuous Versus Discrete Control, Computer Process and its Forms. Introduction & Automatic Process Control, Building Blocks of Automation Systems: LAN, Analog &Digital I/O Modules, SCADA Systems& RTU. Distributed Control System: Functional Requirements, Configurations & some popular Distributed Control Systems. (SLE: Display Systems in Process Control Environment.)

UNIT V AUTOMATION AND INDUSTRIAL CONTROL APPLICATIONS 9

Electric Drives, Sensors and Vision used for automation, Trajectory planning, Automation Algorithm, Programming and flow control for automation. Modeling and Simulation for Plant Automation: Introduction, need for system Modeling, Building Mathematical Model of a Plant, Modern Tools & Future Perspective. Industrial Control Applications: Cement, Thermal, Water Treatment & Steel Plants. (SLE: Cases Studies minimum one for Cement, Thermal, Water Treatment & Steel Plants applications).

TOTAL: 45 HOURS

TEXT BOOKS

1. Automation, "Production Systems and Computer Integrated Manufacturing",M.P.Groover, Pearson Education.5th edition, 2009.
2. "Computer Based Industrial Control"- Krishna Kant, EEE-PHI,2nd edition,2010

REFERENCES

1. "An Introduction to Automated Process Planning Systems"- Tiess Chiu Chang & Richard A. Wysk.
2. "Performance Modeling of Automated Manufacturing Systems",-Viswanandham, PHI, 1st edition, 2009.
3. G.S. Hegde, "A Textbook on Industrial Robotics", University Science Press, Second Edition 2008, ISBN 978-81-318-051803

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C2E02.1	3	2	1	-	2	-	-	-	-	2	-	-	3	-
C2E02.2	3	2	1	1	2	-	-	-	2	3	-	-	3	-
C2E02.3	3	2	1	1	2	-	-	-	3	2	2	-	3	-
C2E02.4	3	2	1	1	2	-	-	-	3	3	2	-	3	-
C2E02.5	3	2	1	1	2	-	-	-	2	3	2	2	3	-
Average	**3.0**	**2.0**	**1.0**	**1.0**	**2.0**	**-**	**-**	**-**						

23MECCR2E03 CONTROL SYSTEMS IN ROBOTICS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSEOBJECTIVE

The goal of this course is for students

- Comprehend basic control system components like mechanical and electrical systems using math models.
- Study how control systems respond over time and frequency, using various inputs to assess performance.
- Apply methods for stability assessment to design stable control systems.
- Solve equations for different types of systems and explore their controllability.
- Evaluate control system parts, understanding their uses and selection criteria.

COURSE OUTCOMES

At the end of the course, the student will be able to:

- Grasp control system basics and depict them with math models.
- Analyze control systems' behavior in time and frequency domains, assessing performance against standards.
- Apply stability analysis to design stable control systems.
- Solve equations for different systems, considering controllability.
- Evaluate control system parts and comprehend their uses and how to choose them.

UNIT I SYSTEMS AND THEIR REPRESENTATION 9

Basic elements in Control Systems - Mathematical Models - Mechanical translational - Mechanical rotational - Electrical systems - Transfer functions - Block diagrams. Reduction techniques - signal flow graph-Thermal-Hydraulic-Pneumatic Systems.

UNIT II TIME AND FREQUENCY RESPONSE 9

Time domain specifications-types of test inputs-I and II order systems-response generalized error series-steady state error-frequency domain specifications-polar plot, bode plot

UNIT III STABILITY OF CONTROL SYSTEMS 9

Characteristic equation-location of roots in S plane for stability - Routh Hurwitz criterion-root locus technique construction-Gain and phase margin-Nyquist stability criterion.

UNIT IV STATE VARIABLE ANALYSIS AND DESIGN 9

Concepts of state variables and state model -state models for linear continuous time systems
Solution of state equations - Concepts of controllability and observability - State variables and Linear Discrete-time systems - problems.

UNIT V CONTROL SYSTEM COMPONENTS 9

Servomotor-stepper motor- synchro -resolver- amplidyne - planar motor: types, principle, Application and Selection-Passive Compliances

TEXT BOOKS

1. A. Nagoor Kani, “Control Systems,” RBA publications (P) Ltd., 2007
2. M. Gopal, “Control Systems principles and Design,” Tata McGraw-Hill Publishing Company Limited,” 2003.

REFERENCES

1. K. Ogata, “Modern Controls Engineering,” Prentice Hall of India Pvt. Ltd, 2005.
2. B.C. Kuo, “Automatic Control Systems Control System Engineering,” Prentice Hall of India Pvt. Ltd., 2004.
3. I.J. Nagrath and Gopal, “Control System Engineering,” New age international (P) Ltd., 2006.

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C2E03.1	3	2	1	-	2	-	-	-	-	1	-	2	2	-
C2E03.2	3	2	1	1	2	-	-	-	-	1	-	2	2	-
C2E03.3	3	2	1	1	2	-	-	-	-	1	-	2	2	-
C2E03.4	3	2	1	1	2	-	-	-	-	1	-	2	2	-
C2E03.5	3	2	1	1	2	-	-	-	-	1	-	2	2	-
Average	**3.0**	**2.0**	**1.0**	**0.8**	**2.0**	**-**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**2.0**	**-**

23MECCR2E04 VIBRATION ANALYSIS AND DIAGNOSIS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Apply forced vibration analysis techniques to single-degree freedom systems.
- Utilize Fourier analysis to examine system response to non-harmonic excitations.
- Employ methods like Duhamel's Integral for analyzing responses to arbitrary loading.
- Investigate forced vibrations in multi-degree freedom systems using modal analysis.
- Evaluate different techniques for vibration monitoring and analysis in industrial applications.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Analyze forced vibrations in single-degree freedom systems subjected to non-harmonic and transient excitation.
- Interpret system response using Fourier analysis and predict behavior under arbitrary loading.
- Utilize Duhamel's Integral to calculate the system's response to various loading conditions.
- Apply modal analysis to analyze forced vibrations in multi-degree freedom systems.
- Evaluate the applicability of vibration analysis techniques for diagnosing industrial systems and implementing vibration monitoring.

UNIT I FORCED VIBRATION SYSTEM 9

Forced vibration with non-harmonic and transient excitation of single-degree freedom systems, Fourier analysis, Response to arbitrary loading (Duhamel’s Integral), Impulse response, Mechanical shock, Parametric Excitation.

UNIT II MULTI-DEGREE FREEDOM SYSTEMS 9

Two-degree Freedom System, Multi-degree Freedom systems, modal analysis, Matrix iteration Method, Transfer matrix Method, Myklestadt-Prohl Method, Rayleigh’s minimum principle, Stodola’s Method, Hoizer’s Method.

UNIT III VIBRATIONS OF CONTINUOUS SYSTEMS 9

Vibrations of Continuous systems governed by wave equation and Euler Bernoulli equation, strings, membranes, rods, beams.

UNIT IV VIBRATION ANALYSIS AND VIBRATION MONITORING 9

Experimental Methods in Vibration Analysis, industrial applications – rotors and other systems, vibration standards, vibration monitoring.

UNIT V CONDITION MONITORING THROUGH VIBRATION ANALYSIS 9

Frequency analysis, Filters, Vibration signature of active systems, vibration limits and standards. Contaminant analysis, SOAP and other contaminant monitoring techniques.

TOTAL: 45 HOURS

TEXTBOOKS:

1. P. Srinivasan, “Mechanical Vibration analysis” – 2nd Ed., TMH.1995
2. J.G. Rao & K. Gupta, “Introductory course on Theory and Practice of Mechanical Vibrations”, – New Age Publication, 1995.

REFERENCE BOOKS:

1. L. Meirovitch, “Elements of Vibration Analysis”, Tata McGraw Hill, Second edition, 2007.
2. W. T. Thomson, “Theory of Vibration with Applications”, CBS Publ., 1990.

WEBSITES:

1. https://www.emerson.com/documents/automation/brochure-vibration-analysis-for-machinery-health-diagnosis-ams-en-6652272.pdf
2. https://www.tinex-diagnostika.si/slike/PRUFTECHNIK_Vibration_Handbook.pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C2E04.1	3	2	1	-	-	-	-	-	-	2	-	2	2	-
C2E04.2	3	2	1	-	-	-	-	-	-	2	-	2	2	-
C2E04.3	3	2	1	-	-	-	-	-	-	2	-	2	2	-
C2E04.4	3	2	1	-	-	-	-	-	-	2	-	2	2	-
C2E04.5	3	2	1	-	-	-	-	-	-	2	-	2	2	-
Average	**3.0**	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**2.0**	**-**	**2.0**	**2.0**	**-**

PROFESSIONAL ELECTIVE III

23MECCR3E01 MODERN MATERIAL HANDLING SYSTEMS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Apply principles of material handling to select appropriate equipment for various applications.
- Analyze the components and theory of hoisting equipment for efficient material handling.
- Utilize different load handling equipment and attachments for specific material handling needs.
- Evaluate various surface and overhead transportation equipment options for effective material movement.
- Assess the design and functionality of elevating and conveying equipment for efficient material transfer.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Select suitable material handling equipment based on application requirements.
- Evaluate the components and operational theory of hoisting equipment for safe and effective usage.
- Apply diverse load handling equipment and attachments to enhance material handling processes.
- Analyze and recommend appropriate surface and overhead transportation equipment for optimized material movement.
- Assess the design and functionality of elevating and conveying equipment for seamless material transfer.

UNIT I FLEXIBLE HOISTING APPLIANCES 9

Types, Selection and applications of material handling equipments, choice of material handling equipment - hoisting equipment components and theory of hoisting equipment-chain and ropes - selection of ropes, pulleys, pulley systems, sprockets and drums.

UNIT II LOAD HANDLING EQUIPMENTS AND BRAKES 9

Forged standard hooks- forged Ramshorn hooks-solid triangular eye hooks- crane grabs, electric lifting magnetic - grabbing attachments for loose materials. arresting gear - brakes: shoe, band and cone types-elements of shoe brakes -thermal calculation in shoe brakes.

UNIT III SURFACE AND OVERHEAD TRANSPORTATION EQUIPMENTS 9

Hand operated trucks- powered trucks -tractors - electronically controlled tractors - hand truck on rails - industrial railroad equipments: locomotives – winches – capstans – turntables – monorail conveyors -pipe rail systems - flat bar monorails. Rail traveling mechanism, cantilever and monorail cranes, cogwheel drive, monocable tramways - reversible tramways.

UNIT IV ELEVATING EQUIPMENTS 9

Continuous - motion vertical conveyors – reciprocating - motion vertical conveyors - stackers – work levelers and tail gates - industrial lifts - passenger lifts - freight elevators - mast type elevators - vertical skip hoist elevators, bucket elevators: design, loading and bucket arrangements.

UNIT V CONVEYING EQUIPMENTS 9

Belt conveyors - chain conveyors - apron conveyors – escalators - flight conveyors - roller conveyors - oscillating conveyors. design of belt conveyors, screw conveyors and pneumatic conveyors.

(Use of approved design data book is permitted)

TOTAL: 45 HOURS

TEXTBOOKS:

1. Chowdary. R. B and Tagore. G. R.N, "Materials Handling Equipment," Khanna Publishers, 1996.
2. Rudenko. N, "Materials Handling Equipment," MIR Publishers, 1969.
3. Spivakovsky. A. O and Dyachkov. V. K., "Conveying Machines," MIR Publishers, 1985.

REFERENCE BOOKS:

1. Alexandrov, M, "Industrial Robotics," MIR Publishers, 1981.
2. Boltzharol, A, "Materials Handling Handbook," Tata McGraw Hill, 1958.
3. Lingaiah. K. and Narayana Iyengar, "Machine Design Data Hand Book," Suma Publishers, 1983.

WEBSITES:

1. https://users.encs.concordia.ca/~andrea/indu421/Presentation%207%20(MH).pdf
2. https://me.gecgudlavalleru.ac.in/images/admin/pdf/1594616688_III-I-Material-Handling-(OE).pdf
3. https://www2.isye.gatech.edu/~mgoetsch/cali/logistics_systems_design/material_handling_systems/material_handling_systems.pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C3E01.1	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E01.2	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E01.3	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E01.4	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E01.5	3	2	1	-	-	-	-	-	-	1	-	1	2	-
Average	**3.0**	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**1.0**	**2.0**	**-**

23MECCR3E02 CAD FOR SMART MANUFACTURING 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is to

- Understand the fundamental concepts of smart manufacturing.
- Explore various types of manufacturing systems
- Analyze the key performance indicators of manufacturing system performance.
- Study flexible production methods, lean practices, and agile manufacturing approaches.
- Explore the implementation of computer integration, digital manufacturing, and smart systems to optimize manufacturing processes and competitiveness.

COURSE OUTCOMES

Upon completion of this course, the students can able

- Explain the core concepts of smart manufacturing.
- Outline the characteristics and functions of various manufacturing systems.
- Explain the key performance indicators used to measure manufacturing system performance.
- Discuss the concept of group technology and cellular manufacturing.
- Explain the concept of digital and smart manufacturing systems.

UNIT I OVERVIEW OF COMPONENTS OF MANUFACTURING SYSTEM 9

Overview, Scope of smart manufacturing, components of manufacturing systems, Design, operation, and control of manufacturing systems.

UNIT II TYPES OF MANUFACTURING SYSTEMS 9

Single station cells, manual assembly lines, automated production lines, transfer lines, analysis automated assembly systems.

UNIT III PERFORMANCE OF MANUFACTURING SYSTEM 9

Productivity, quality, reliability, agility, responsiveness, sustainability, utilization & availability, flexibility, reconfigurability, resiliency, efficiency and effectiveness of manufacturing system, metrics and key performance indicators.

UNIT IV GROUP TECHNOLOGY AND CELLULAR MANUFACTURING 9

Flexible manufacturing systems, changeable manufacturing systems, Just-In-Time and lean production, automation. Agile/demand driven manufacturing, Quick response manufacturing, world class manufacturing and holonic manufacturing systems.

UNIT V COMPUTER INTEGRATED MANUFACTURING 9

Enterprise Integration (ISA-95 and other standards), Digital Manufacturing and smart manufacturing systems.

TOTAL: 45 HOURS

TEXT BOOKS

1. M. P. Groover, “Automation, Production systems and Computer Integrated Manufacturing”. 3rd edition, Pearson Education, 2015. ISBN: 978-9332549814.
2. N. Singh, “Systems Approach to Computer Integrated Design and Manufacturing”, 1st edition, Wiley India, 2011. ISBN: 978-8126530410.
3. E. Turban, L. Volonino, “Information Technology for Management: Transforming Organizations in the Digital Economy”, 7th edition, Wiley India Private Limited, 2010. ISBN: 978-8126526390.

REFERENCE BOOKS

1. G. Chryssolouris, “Manufacturing Systems: Theory and Practice”. 2nd edition, Springer, 2006. ISBN: 978-1441920676.
2. W. J. Hopp, M. L. Spearman, “Factory Physics”, 3rd edition, Waveland Press, 2011.
3. R. Askin and C. Standridge, “Modeling and Analysis of Manufacturing Systems”, 1st edition, John Wiley, 1992. ISBN: 978-0-471-51418-3.

WEBSITES

1. https://www.leanproduction.com/
2. https://www.isa.org/standards-and-publications/isa-standards

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C3E02.1	2	1	-	-	-	-	-	-	-	1	-	1	2	-
C3E02.2	2	1	-	-	-	-	-	-	-	1	-	1	2	-
C3E02.3	2	1	-	-	-	-	-	-	-	1	-	1	2	-
C3E02.4	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E02.5	2	1	-	-	-	-	-	-	-	1	-	1	2	-
Average	**2.2**	**1.2**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**1.0**	**2.0**	**-**

23MECCR3E03 VISION SYSTEM 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Understand the characterizing and interpreting the information from images.
- Classify the basic preprocessing techniques
- Describe the object recognition techniques
- Determine the hold site and gripper orientation based on collision fronts is described.
- Evaluate the existing vision systems and a case study for Navigation

COURSE OUTCOMES:

Upon completion of this course the students will be able to:

- Explain about the extracting, characterizing and interpreting the information from images.
- Identify the basic preprocessing techniques
- Apply the Object recognition techniques for various applications
- Determine the hold site and gripper orientation based on collision fronts for robotics
- Estimate review of existing vision systems and a case study for Navigation.

UNIT I INTRODUCTION 9

Human vision - Machine vision and computer vision-benefits of machine vision -Block diagram and function of machine vision system implementation of industrial machine vision system.

UNIT II IMAGE ACQUISITION 9

Scene constraints-lighting sources, types and setups - Lighting parameters -working principle-Analog and Digital Cameras - General problem in capturing the image-selection of camera-optics in camera.

UNIT III IMAGE PROCESSING 9

Image formation - filtering technique - Pixel processing - Processing of binary and grey scale images-Operators-types-segmentation-edge detection-Morphology.

UNIT IV IMAGE ANALYSIS 9

Feature extraction-decision making pattern recognition - colour image processing -3D image processing.

UNIT V MACHINE VISION APPLICATION 9

Machine vision applications in manufacturing, electronics, printing, pharmaceutical, textile and Bio medical field - Case studies.

TOTAL: 45 HOURS

TEXT BOOKS:

1. P.A. Janaki Raman, “Robotics and Image Processing an Introduction,” Tata Mc Graw Hill Publishing company Ltd.,1995.
2. Richard.O.Duda, Peter.E.Hurt, “Pattern Classification and Scene,” Analysis Publishers. 2000.

REFERENCE BOOKS:

1. K.S. Fu, R.C., Gonzalez, C.S.G., Lee, “Robotics Control, Sensing Vision and Intelligence,” Mc Graw Hill Book Company, 1987.
2. NelloZuech, “Understanding and Applying Machine Vision,” Marcel dekker Inc., 2000.

WEBSITES:

1. https://onlinecourses.nptel.ac.in/noc19_cs58/preview

2. https://www.vision-systems.com/

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C3E03.1	2	1	-	-	-	-	-	-	-	1	-	1	2	-
C3E03.2	2	1	-	-	-	-	-	-	-	1	-	1	2	-
C3E03.3	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E03.4	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E03.5	3	2	1	-	-	-	-	-	-	1	-	1	2	-
Average	**2.6**	**1.6**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**1.0**	**2.0**	**-**

23MECCR3E04 COMPUTATIONAL FLUID DYNAMICS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Explain the Governing Equations of viscous fluid flows.
- Understand numerical modelling and its role in the field of fluid flow and heat transfer.
- Estimate the students to know the various discretization methods, solution procedures and turbulence modelling.
- Create confidence to solve complex problems in the field of fluid flow and heat transfer.
- Realize basic properties of computational methods – accuracy, stability, consistency.

COURSE OUTCOMES:

Upon completion of this course the students will be able to:

- Identify, solve engineering problems by computational fluid dynamics.
- List the importance of governing equations involved in CFD
- Solve problems in the field of fluid flow and heat transfer.
- Simplify the heat conduction problems using finite difference method.
- Analyze the solutions for convection and diffusion problems.

UNIT I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETIZATION TECHNIQUES 9

Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions – Discretization techniques using finite difference methods – Taylor's Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II DIFFUSION PROCESSES: FINITE VOLUME METHOD 9

Steady one-dimensional diffusion, Two and three-dimensional steady state diffusion problems, Discretization of unsteady diffusion problems – Explicit, Implicit and Crank- Nicholson's schemes, Stability of schemes.

UNIT III CONVECTION - DIFFUSION PROCESSES: FINITE VOLUME METHOD 9

One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme

UNIT IV FLOW PROCESSES: FINITE VOLUME METHOD 9

Discretization of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms

UNIT V MODELLING OF COMBUSTION AND TURBULENCE 9

Mechanisms of combustion and Chemical Kinetics, Overall reactions and intermediate reactions, Reaction rate, Governing equations for combusting flows. Simple Chemical Reacting System (SCRS), Turbulence - Algebraic Models, One equation model & k – ε, k – ω models – Standard and High and Low Reynolds number models.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Ghoshdastidar, P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998.
2. John D. Anderson. J R. "Computational Fluid Dynamics-The Basics with Applications" McGraw- Hill International Editions, 1995.
3. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.

REFERENCE BOOKS:

1. Subas and V. Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation,1980.
2. Versteeg and Malalasekera, N, "An Introduction to computational Fluid Dynamics The Finite Volume Method," Pearson Education, Ltd., Second Edition, 2014.

WEBSITES:

1. https://nptel.ac.in/courses/112105045
2. https://www.coursera.org/learn/applied-computational-fluid-dynamics

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C3E04.1	3	2	1	-	-	2	-	-	-	1	-	2	2	-
C3E04.2	3	2	1	-	1	2	-	-	-	1	-	2	2	-
C3E04.3	3	2	1	-	1	2	-	-	-	1	-	2	2	-
C3E04.4	3	2	1	-	-	2	-	-	-	1	-	2	2	-
C3E04.5	3	2	1	-	1	2	-	-	-	1	-	2	2	-
Average	**3.0**	**2.0**	**1.0**	**-**	**1.0**	**2.0**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**2.0**	**-**

PROFESSIONAL ELECTIVE IV

23MECCR3E05 MICRO ELECTRO MECHANICAL SYSTEMS (MEMS) 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
- To Educate on the rudiments of Micro fabrication techniques.
- To introduce various sensors and actuators
- To Understand the feasibility of piezo and resistive sensors
- To introduce different materials used for MEMS

COURSE OUTCOMES:

Upon completion of this course the students will be able to:

- Identify the knowledge to fabricate MEMS devices.
- Summarize the on rudiments of micro fabrication techniques
- Explain about sensors and actuators.
- Relate the feasibility of piezo and resistive sensors
- Identify the various materials used to state MEMS

UNIT I INTRODUCTION 9

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis– Flexural beam bending- Torsional deflection.

UNIT II SENSORS AND ACTUATORS – I 9

Ethics with respect to science and research – Intellectual honesty and research integrity – scientific misconduct: Falsification – Fabrication and plagiarism (FFP) – Redundant Publications: duplicate and overlapping publications – salami slicing – Selective reporting and misrepresentation of date.

UNIT III SENSORS AND ACTUATORS – II 9

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators - Micromagnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys

UNIT IV MICROMACHINING 9

Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

UNIT V POLYMER AND OPTICAL MEMS 9

Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Stephen D Senturia, "Microsystem Design", Springer Publication, 2016.
2. Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture” Tata McGraw Hill, New Delhi, 2012.

REFERENCE BOOKS:

1. Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2016.
2. "Microelectromechanical Systems" by Dilip Kumar Bhattacharya and Brajesh Kumar Kaushik, 2018

WEBSITES:

1. https://www.studocu.com/in/course/
2. https://www.universitywafer.com/mems.html

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
C3E05.1	3	2	1	-	-	-	-	-	2	1	-	2	2	2
C3E05.2	2	1	-	-	-	-	-	-	2	1	-	2	2	2
C3E05.3	2	1	-	-	-	-	-	-	2	1	-	2	2	2
C3E05.4	2	1	-	-	-	-	-	-	2	1	-	2	2	2
C3E05.5	3	2	1	-	-	-	-	-	2	1	-	2	2	2
Average	**2.4**	**1.4**	**1.0**	**-**	**-**	**-**	**-**	**-**	**2.0**	**1.0**	**-**	**2.0**	**2.0**	**2.0**

23MECCR3E06 EMERGING MATERIALS FOR ROBOTS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To impart knowledge on methods of synthesizing and modifying carbon nanomaterials including graphene, fullerenes, CNTs, Graphite whiskers, cones, and polyhedral crystals
- To understand methods of characterizing carbon nanomaterials
- To apply carbon nanomaterials in the fields of biosensors, biomedicine, water desalination, and photo-induced energy conversion.
- To impart knowledge on structure, properties and applications of nanomaterials
- To learn about the structure, properties, processing and applications of common thermoplastics, thermosets and elastomers.

COURSE OUTCOMES:

Upon completion of this course the students will be able to:

- Explain the methods of synthesizing and modifying carbon nanomaterials including graphene, fullerenes,
- Identify the advanced Nanomaterials.
- Classify the engineering plastics
- Explain about the smart materials.
- Interpret the concept of composite materials

UNIT I CARBON NANOMATERIALS 9

Graphene: Synthesis, Properties, and Applications; Fullerene C60 Architectures in Materials Science; Graphite Whiskers, Cones, and Polyhedral Crystals; Epitaxial Graphene and Carbon Nanotubes on Silicon Carbide; Cooperative Interaction - Crystallization, and Properties of Polymer–Carbon Nanotube Nanocomposites; Carbon Nanotube Biosensors; Carbon Nanostructures in Biomedical Applications, Field Emission from Carbon Nanotubes; Nanocrystalline Diamond; Carbon Onions; Carbide-Derived Carbons; Templated and Ordered Mesoporous Carbons; Oxidation and Purification of Carbon Nanostructures;

UNIT II ADVANCED MATERIALS 9

Nanomaterials Fundamentals: Atomic Structure, molecules and phase, 0-D, 1-D, 2-D and 3-D nanomaterials, nanostructured metals, MOx, MSx, and nanocarbon; structure-property relationships – optical, catalytic, mechanical, thermal, electrical properties; MEMS and NEMS nanoscale Optoelectronics

UNIT III POLYMERS 9

Types, Commodity Plastics: PE, PP, PVC, PS; Engineering Plastics: PA, Fluoropolymers, Polyesters; Thermosets – Phenolics and Epoxy Resins; Rubbers: Natural and Synthetic, Additives; High-Performance Polymers: PEEK; Structure-Property Relationships: Chemical Properties, Solubility, Mechanical Properties, Calorimetric Properties, Electrical Properties, Optical Properties, Acoustic Properties, Processability.

UNIT IV SMART MATERIALS 9

Introduction to smart Materials, Shape Memory Alloys, Super Alloys, High Entropy Alloys, Magnetorheological and Electrorheological Fluids, Gels

UNIT V COMPOSITE MATERIALS 9

Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Types of Reinforcements/Fibers: Role and Selection or reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers,

TOTAL: 45 Hours

TEXT BOOKS:

1. Yury Gogotsi, Volker Presser, "Carbon Nanomaterials", 2nd ed., CRC Press, 2013.
2. William D. Callister&David G. Rethwisch, Fundamentals of Materials Science and Engineering: An Integrated Approach, 5thedition, International Student Version, John Wiley & Sons, Inc., 2016.

REFERENCE BOOKS:

1. M. Wilson, K. Kannangara, G. Smith, M. Simmons and B. Raguse, "Nanotechnology: Basic Science and Emerging Technologies", Chapman and Hall, 2012.
2. Nouailhat, "An Introduction to Nanosciences and Nanotechnology", Wiley-ISTE, 2018.

WEBSITES:

1. https://www.cs.rochester.edu/users/faculty/nelson/courses/csc_robocon/robot_manual/materials.html
2. https://www.protolabs.com/en-gb/resources/blog/manufacturing-robotics-report-materials/

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
C3E06.1	2	1	-	-	-	-	-	-		1	-	1	1	-
C3E06.2	3	2	1	-	-	-	-	-		1	-	1	1	-
C3E06.3	2	1	-	-	-	-	-	-		1	-	1	1	-
C3E06.4	2	1	-	-	-	-	-	-		1	-	1	1	-
C3E06.5	2	1	-	-	-	-	-	-		1	-	1	1	-
Average	**2.2**	**1.2**	**1.0**	**-**	**-**	**-**	**-**	**-**		**1.0**	**-**	**1.0**	**1.0**	**-**

23MECCR3E07 ARTIFICIAL INTELLIGENCE FOR ROBOTICS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Study the concepts of Artificial Intelligence.
- Learn the methods of solving problems using Artificial Intelligence.
- Introduce the concepts of Expert Systems and machine learning.
- Learn about the details of Kalman filter and networks
- Learn about planning and reasoning artificial intelligence.

COURSE OUTCOMES:

Upon completion of this course the students will be able to:

- Identify problems that are amenable to solution by AI methods.
- Identify appropriate AI methods to solve a given problem.
- choose a given problem in the language/framework of different AI methods.
- Interpret the basic AI algorithms.
- Design and carry out an empirical evaluation of different algorithms on a problem formalization.

UNIT I INTRODUCTION TO ROBOTICS 9

Introduction to Robotics Fundamentals of Robotics, Robot Kinematics: Position Analysis, Dynamic Analysis and Forces, Robot Programming languages & systems: Introduction, the three levels of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages.

UNIT II ARTIFICIAL INTELLIGENCE 9

Introduction to Artificial Intelligence. Applications- Games, theorem proving, natural language processing, vision and speech processing, robotics, expert systems. AI techniques- search knowledge, abstraction.

UNIT III PROBLEM SOLVING 9

State space search; Production systems, search space control: depth-first, breadth-first search. Heuristic search - Hill climbing, best-first search, branch and bound. Problem Reduction, Constraint Satisfaction End, Means-End Analysis. LA* Algorithm, L(AO*) Algorithm.

UNIT IV KNOWLEDGE REPRESENTATION 9

Knowledge Representation issues, first order predicate calculus, Horn Clauses, Resolution, Semantic Nets, Frames, Partitioned Nets, Procedural Vs Declarative knowledge, Forward Vs Backward Reasoning.

UNIT V EXPERT SYSTEM 9

Introduction to expert system, need and justification for expert systems, knowledge acquisition, Case studies: MYCIN,R1

TOTAL: 45 HOURS

TEXT BOOKS:

1. E. Rich and K. Knight, “Artificial intelligence”, TMH, 2nd ed., 2012.
2. N.J. Nilsson, “Principles of AI”, Narosa Publ. House, 2020.

REFERENCE BOOKS:

1. D.W. Patterson, “Introduction to AI and Expert Systems”, PHI,2013.
2. Peter Jackson, “Introduction to Expert Systems”, AWP, M.A., 2012.

WEBSITES:

1 . https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_robotics.htm
2. https://www.javatpoint.com/robotics-and-artificial-intelligence

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
C3E07.1	3	2	1	2	2	2	-	-	2	-	2	2	2	2
C3E07.2	3	2	1	3	3	2	-	-	2	-	2	2	2	2
C3E07.3	3	2	1	2	2	2	-	-	2	-	2	2	2	2
C3E07.4	3	2	1	3	2	2	-	-	2	-	2	2	2	2
C3E07.5	3	2	1	2	2	2	-	-	2	-	2	2	2	2
Average	**3.0**	**2.0**	**1.0**	**2.4**	**2.2**	**2.0**	**-**	**-**	**2.0**	**-**	**2.0**	**2.0**	**2.0**	**2.0**

3.

23MECCR3E08 DESIGN FOR MANUFACTURING, ASSEMBLY 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Apply design principles to enhance manufacturability and mechanical factors.
- Evaluate factors influencing form design considering working principle, material, and manufacturing processes.
- Design components with machining considerations for improved machinability and economy.
- Redesign castings for optimal parting lines, core reduction, and machining efficiency.
- Integrate environmental considerations in design for sustainability and reduced impact.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Design components with manufacturability and assembly in mind.
- Create form designs that account for working principles, materials, and manufacturing methods.
- Develop component designs optimized for machining, economy, and assembly.
- Redesign castings to minimize core requirements and machining complexities.
- Integrate environmental concerns into design decisions, promoting sustainability and adherence to regulations.

UNIT I INTRODUCTION 9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances -Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.

UNIT II FACTORS INFLUENCING FORM DESIGN 9

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION 9

Design features to facilitate machining - drills - milling cutters - keyways – Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.

UNIT IV COMPONENT DESIGN - CASTING CONSIDERATION 9

Redesign of castings based on parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

UNIT V DESIGN FOR THE ENVIRONMENT 9

Introduction – Environmental objectives – Global issues – Regional and local issues –Basic DFE methods – Design guide lines – Example application – Lifecycle assessment –Basic method – AT and T's environmentally responsible product assessment – Weighted sum assessment method – Lifecycle

assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly –Design for recyclability – Design for remanufacture – Design for energy efficiency –Design to regulations and standards.

Total: 45 Hours

TEXTBOOKS:

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
3. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
4. Fixel, J. Design for the Environment, McGraw Hill., 1996.

REFERENCE BOOKS:

1. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
2. Harry Peck, Designing for manufacture, Pitman– 1973.

WEBSITES:

1. http://brharnetc.edu.in/br/wp-content/uploads/2018/11/29.pdf
2. https://www.energy.gov/sites/default/files/2021-07/Module_3D.pdf
3. https://www.dfma.com/forum/2019pdf/dewhurstpres.pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C3E08.1	3	2	1	-	-	2	-	-	2	1	-	1	2	-
C3E08.2	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E08.3	3	2	1	2	3	-	-	-	-	1	-	1	2	-
C3E08.4	3	2	1	2	3	-	-	-	-	1	-	1	2	-
C3E08.5	3	2	1	-	-	3	3	2	-	1	-	1	2	-
Average	**3.0**	**2.0**	**1.0**	**2.0**	**3.0**	**3.0**	**3.0**	**2.0**	**2.0**	**1.0**	**-**	**1.0**	**2.0**	**-**