B.S. Abdur Rahman ™
Crescent
Institute of Science & Technology
Deemed to be University u/s 3 of the UGC Act, 1956

Regulations 2022
Curriculum and Syllabi
(As approved by the 20th Academic Council)
April - 2023

M.Tech.
(CAD-CAM)

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REGULATIONS 2022

CURRICULUM AND SYLLABI

(As approved by the 20th Academic Council)

APRIL – 2023

M.TECH. CAD-CAM

VISION AND MISSION OF THE INSTITUTION

VISION

B.S. Abdur Rahman Crescent Institute of Science and Technology aspires to be a leader in Education, Training and Research in multidisciplinary areas of importance and to play a vital role in the Socio-Economic progress of the Country in a sustainable manner.

MISSION

- To blossom into an internationally renowned Institute.
- To empower the youth through quality and value-based education.
- To promote professional leadership and entrepreneurship.
- To achieve excellence in all its endeavors to face global challenges.
- To provide excellent teaching and research ambience.
- To network with global Institutions of Excellence, Business, Industry and Research Organizations.
- To contribute to the knowledge base through Scientific enquiry, Applied Research and Innovation.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION AND MISSION

VISION

To excel in providing quality education and training through Undergraduate and Postgraduate programs and carryout quality research in the field of Mechanical Engineering.

MISSION

- To provide a good learning experience through appropriate design of curriculum and syllabi that facilitate students to gain thorough understanding of the fundamental concepts and applications in Mechanical Engineering

- To equip students to solve challenging problems in Mechanical Engineering and related areas taking in to account their impact on the society

- To facilitate students to develop good communication, leadership and managerial skills through team approach in conducting experiments and projects

- To pursue academic and collaborative research activities with industry and other research institutions ensuring high quality in publications and other research outputs

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES

M.Tech. (CAD – CAM)

PROGRAMME EDUCATIONAL OBJECTIVES:

- To provide a holistic approach in learning through well designed courses involving fundamental concepts and state-of-the-art techniques in the field of CAD – CAM
- To equip the graduates, with knowledge and skill to undertake design, analysis, evaluation of systems, processes and components
- To supplement course work through seminars, workshops, case studies, value added programmesand through paper presentation
- To inculcate research culture by way of solving typical problems, Project works from real life situation and innovative assignments
- To develop team spirit, problem solving skill and appreciation for ethical and social relevance of the technologies used

PROGRAMME OUTCOMES:

Graduates will be able to

- Apply the knowledge of mechanical engineering fundamentals, and specialization in CAD-CAM to solve complex engineering problems
- Identify, formulate, review literature, and analyze complex engineering problems to arrive at substantiated conclusions using principles of mathematics and mechanical engineering sciences
- Design solutions for engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health & safety, society, culture and environment
- Use research based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions
- Create, select, and apply appropriate techniques, resources, and modern engineering tools including prediction and modelling to engineering activities with an understanding of the limitations
- Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
- Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
- 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
- Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work to manage projects
- 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:

Graduates will be able to

- Design, analyse and manufacture real life components and systems using latest software in the field of computer aided design and computer aided manufacturing
- Undertake academic and research role to address open ended problems with conceptual knowledge and computational skill in the area of design and manufacturing

B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI – 600 048.

REGULATIONS 2022

M.Tech. / MCA / M.Sc. / M.Com. / M.A. DEGREE PROGRAMMES

(Under Choice Based Credit System)

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires:

i) **"Programme"** means post graduate degree programme (M.Tech. / MCA / M.Sc. / M.Com. / M.A.)

ii) **"Branch"** means specialization or discipline of programme like M.Tech. in Structural Engineering, Food Biotechnology etc., M.Sc. in Physics, Chemistry, Actuarial Science, Biotechnology etc.

iii) **"Course"** means a theory / practical / laboratory integrated theory / mini project / seminar / internship / project and any other subject that is normally studied in a semester like Advanced Concrete Technology, Electro Optic Systems, Financial Reporting and Accounting, Analytical Chemistry, etc.

iv) **"Institution"** means B.S. Abdur Rahman Crescent Institute of Science and Technology.

v) **“Academic Council”** means the Academic Council, which is the apex body on all academic matters of this Institute.

vi) **"Dean (Academic Affairs)"** means the Dean (Academic Affairs) of the Institution who is responsible for the implementation of relevant rules and regulations for all the academic activities.

vii) **"Dean (Student Affairs**)" means the Dean (Students Affairs) of the Institution who is responsible for activities related to student welfare and discipline in the campus.

viii) **"Controller of Examinations"** means the Controller of Examinations of the Institution who is responsible for the conduct of examinations and declaration of results.

ix) **“Dean of the School”** means the Dean of the School of the department concerned.

x) **“Head of the Department”** means the Head of the Department concerned.

2.0 PROGRAMMES OFFERED AND ADMISSION REQUIREMENTS

2.1 Programmes Offered

The various programmes and their mode of study are as follows:

Degree	Mode of Study
M.Tech.	Full Time
MCA	
M.Sc.	
M.Com.	
M.A.	

2.2 ADMISSION REQUIREMENTS

2.2.1 Students for admission to the first semester of the Master's Degree Programme shall be required to have passed the appropriate degree examination as specified in the clause 3.2 [Eligible entry qualifications for admission to programmes] of this Institution or any other University or authority accepted by this Institution.

2.2.2 The other conditions for admission such as class obtained, number of attempts in the qualifying examination and physical fitness will be as prescribed by the Institution from time to time.

3.0 DURATION, ELIGIBILITY AND STRUCTURE OF THE PROGRAMME

3.1. The minimum and maximum period for completion of the programmes are given below:

Programme	Min. No. of Semesters	Max. No. of Semesters
M.Tech.	4	8
MCA	4	8
M.Sc.	4	8
M.Com.	4	8
M.A.	4	8

3.1.1 Each academic semester shall normally comprise of 90 working days. Semester end examinations shall follow within 10 days of the last Instructional day.

3.1.2 Medium of instruction, examinations and project report shall be in English.

3.2 ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO PROGRAMMES

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
1.	Aeronautical Engineering	M.Tech. (Avionics)	B.E. / B.Tech. in Aeronautical Engineering / Aerospace Engineering / Mechanical Engineering / Mechatronics / EEE / ECE / EIE / or Equivalent degree in relevant field.
2.	Civil Engineering	M.Tech. (Structural Engineering)	B.E. / B.Tech. in Civil Engineering / Structural Engineering or Equivalent degree in relevant field.
		M. Tech. (Construction Engineering and Project Management)	B.E. / B.Tech. in Civil Engineering / Structural Engineering / B.Arch. or Equivalent degree in relevant field.
3.	Mechanical Engineering	M.Tech. (CAD/CAM)	B.E. / B.Tech. in Mechanical / Automobile / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace / Aeronautical / Material Science / Polymer / Plastics / Marine Engineering or Equivalent degree in relevant field.
4.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engineering)	B.E. / B.Tech. in EEE / ECE / EIE / ICE / Electronics / Instrumentation Engineering or Equivalent degree in relevant field.
5.	Electronics and Communication Engineering	M.Tech. (VLSI and Embedded Systems)	B.E. / B.Tech. in ECE / EIE / ICE / EEE / IT or Equivalent degree in relevant field.
6.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
		M.Tech. (Artificial Intelligence and Data Science)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
7.	Information Technology	M.Tech. (Information Technology)	B.E. / B.Tech. in IT / CSE / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
8.	Computer Applications	MCA	BCA / B.Sc. Computer Science / B.E. / B.Tech. / B.Sc. Mathematics, B.Sc. Physics / Chemistry / B.Com. / BBA / B.A. with Mathematics at graduation level or at 10 + 2level or equivalent degree in relevant field.
9.	Mathematics	M.Sc. (Actuarial Science)	Any under graduate degree with Mathematics / Statistics as one of the subjects of study at 10 + 2 level.
10.	Physics	M.Sc.(Physics)	B.Sc. in Physics / Applied Science / Electronics /Electronics Science / Electronics & Instrumentation or Equivalent degree in relevant field.
11.	Chemistry	M.Sc.(Chemistry)	B.Sc. in Chemistry / Applied Science or Equivalent degree in relevant field.
12.	Life Sciences	M.Sc. Biochemistry & Molecular Biology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
		M.Sc. Biotechnology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
		M.Sc. Microbiology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
		M.Tech. Biotechnology	B.Tech. / B.E. in Biotechnology or Equivalent degree in relevant field.
		M.Tech. Food Biotechnology	B.E. / B.Tech. in Biotechnology / Food Biotechnology / Chemical Engineering / Biochemical Engineering / Industrial Biotechnology or Equivalent degree in

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
			relevant field.
13.	Commerce	M.Com	B.Com. / BBA
14.	Arabic and Islamic Studies	M.A. Islamic Studies	B.A. in Islamic Studies / Arabic (or) Afzal-ul-Ulama (or) Any under graduate degree with Part 1 Arabic (or) Any under graduate degree with AalimSanad / Diploma / Certificate in Arabic or Islamic Studies.

3.3. STRUCTURE OF THE PROGRAMME

3.3.1 The PG. programmes consist of the following components as prescribed in the respective curriculum:

i. Core courses
ii. Elective courses
iii. Laboratory integrated theory courses
iv. Project work
v. Laboratory courses
vi. Open elective courses
vii. Seminar
viii. Mini Project
ix. Industry Internship
x. MOOC courses (NPTEL- Swayam, Coursera etc.)
xi. Value added courses

3.3.2 The curriculum and syllabi of all programmes shall be approved by the Academic Council of this Institution.

3.3.3 For the award of the degree, the student has to earn a minimum total credits specified in the curriculum of the respective specialization of the programme.

3.3.4 The curriculum of programmes shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below:

Programme	Range of credits
M.Tech.	76 - 80
MCA	86
M.Sc.	77 - 85
M.Com.	88
M.A.	72

3.3.5 Credits will be assigned to the courses for all programmes as given below:

- ❖ One credit for one lecture period per week or 15 periods of lecture per semester.
- ❖ One credit for one tutorial period per week or 15 periods per semester.
- ❖ One credit each for seminar/practical session/project of two or three periods per week or 30 periods per semester.
- ❖ One credit for 160 hours of industry internship per semester for all programmes (except M.Com.)
- ❖ Four credits for 160 hours of industry internship per semester for M.Com.

3.3.6 The number of credits the student shall enroll in a non-project semester and project semester is as specified below to facilitate implementation of Choice Based Credit System.

Programme	Non-project semester	Project semester
M.Tech.	9 to 32	18 to 26
MCA	9 to 32	18 to 26
M.Sc.	9 to 32	10 to 26
M.Com.	9 to 32	16 to 28
M.A.	9 to 32	NA

3.3.7 The student may choose a course prescribed in the curriculum from any department offering that course without affecting regular class schedule. The attendance will be maintained course wise only.

3.3.8 The students shall choose the electives from the curriculum with the approval of the Head of the Department / Dean of School.

3.3.9 Apart from the various elective courses listed in the curriculum for each specialization of programme, the student can choose a maximum of two electives from any other similar programmes across departments, aliter to open electives, during the entire period of study, with approval of Head of the department offering the course and parent department.

3.4. ONLINE COURSES

3.4.1 Students are permitted to undergo department approved online courses under SWAYAM up to 40% of credits of courses in a semester excluding project semester (in case of M.Tech. M.Sc. & MCA programmes) with the recommendation of the Head of the Department / Dean of School and with the prior approval of Dean Academic Affairs during his/ her period of study. The credits earned through online courses shall be transferred following the due approval procedures. The online courses can be considered in lieu of core courses and elective courses.

3.4.2 Students shall undergo project related online course on their own with the mentoring of the project supervisor.

3.5 PROJECT WORK

3.5.1 Project work shall be carried out by the student under the supervision of a faculty member in the department with similar specialization.

3.5.2 A student may however, in certain cases, be permitted to work for the project in an Industry / Research organization, with the approval of the Head of the Department/ Dean of School. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist / Competent authority from the organization and the student shall be instructed to meet the faculty periodically and to attend the review meetings for evaluating the progress.

3.5.3 The timeline for submission of final project report / dissertation is within 30 calendar days from the last instructional day of the semester in which project is done.

3.5.4 If a student does not comply with the submission of project report / dissertation on or before the specified timeline he / she is

deemed to have not completed the project work and shall re-register in the subsequent semester.

4.0 CLASS ADVISOR AND FACULTY ADVISOR

4.1 CLASS ADVISOR

A faculty member shall be nominated by the HOD/ Dean of School as Class Advisor for the class throughout their period of study.

The class advisor shall be responsible for maintaining the academic, curricular and co-curricular records of students of the class throughout their period of study.

4.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counseling, the Head of the Department / Dean of School of the students shall attach a maximum of 20 students to a faculty member of the department who shall function as faculty advisor for the students throughout their period of study. Such faculty advisor shall guide the students in taking up the elective courses for registration and enrolment in every semester and also offer advice to the students on academic and related personal matters.

5.0 COURSE COMMITTEE

5.1 Each common theory / laboratory course offered to more than one group of students 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 Head of the Department / Dean (Academic Affairs) depending upon whether all the teachers handling the common course belong to a single department or from several departments. The Course Committee shall meet as often as possible to prepare a common question paper, scheme of evaluation and ensure uniform evaluation of the assessment tests and semester end examination.

6.0 CLASS COMMITTEE

6.1 A class committee comprising faculty members handling the classes, student representatives and a senior faculty member not handling the courses as chairman will be constituted in every semester:

6.2 The composition of the class committee will be as follows:

i) One senior faculty member preferably not handling courses for the concerned semester, appointed as chairman by the Head of the Department
ii) Faculty members of all courses of the semester
iii) All the students of the class
iv) Faculty advisor and class advisor
v) Head of the Department – Ex officio member

6.3 The class committee shall meet at least three times during the semester. The first meeting shall be held within two weeks from the date of commencement of classes, in which the nature of continuous assessment for various courses and the weightages for each component of assessment shall be decided for the first and second assessment. The second meeting shall be held within a week after the date of first assessment report, to review the students' performance and for follow up action.

6.4 During these two meetings the student members, shall meaningfully interact and express opinions and suggestions to improve the effectiveness of the teaching-learning process, curriculum and syllabi of courses.

6.5 The third meeting of the class committee, excluding the student members, shall meet within 5 days from the last day of the semester end examination to analyze the performance of the students in all the components of assessments and decide their grades in each course. The grades for a common course shall be decided by the concerned course committee and shall be presented to the class committee(s) by the concerned course coordinator.

7.0 REGISTRATION AND ENROLLMENT

7.1 The students of first semester shall register and enroll at the time of admission by paying the prescribed fees. For the subsequent semesters registration for the courses shall be done by the student one week before the last working day of the previous semester.

7.2 Change of a Course

A student can change an enrolled course within 10 working days from the commencement of the course, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

7.3 Withdrawal from a Course

A student can withdraw from an enrolled course at any time before the first continuous assessment test for genuine reasons, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

7.4 A student can enroll for a maximum of 32 credits during a semester including Redo / Predo courses.

8.0 BREAK OF STUDY FROM PROGRAMME

8.1 A student may be allowed / enforced to take a break of study for two semesters from the programme with the approval of Dean (Academic Affairs) for the following reasons:

8.1.1 Medical or other valid grounds

8.1.2 Award of 'I' grade in all the courses in a semester due to lack of attendance

8.1.3 Debarred due to any act of indiscipline

8.2 The total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1).

8.3 A student who has availed a break of study in the current semester (odd/even) can rejoin only in the subsequent corresponding (odd/even) semester in the next academic year on approval from the Dean (Academic affairs).

8.4 During the break of study, the student shall not be allowed to attend any regular classes or participate in any activities of the

Institution. However, he / she shall be permitted to enroll for the 'I' grade courses and appear for the arrear examinations.

9.0 MINIMUM REQUIREMENTS TO REGISTER FOR PROJECT WORK

9.1 A student is permitted to register for project semester, if he/she has earned the minimum number of credits specified below:

Programme	Minimum no. of credits to be earned to enroll for project semester
M.Tech.	18
MCA	22
M.Sc.	18
M.Com	NA
M.A.	NA

9.2 If the student has not earned minimum number of credits specified, he/she has to earn the required credits, at least to the extent of minimum credits specified in clause 9.1 and then register for the project semester.

10.0 ATTENDANCE REQUIREMENT AND SEMESTER / COURSE REPETITION

10.1 A student shall earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% to become eligible to appear for the semester end examination in that course, failing which the student shall be awarded "I" grade in that course.

10.2 The faculty member of each course shall cumulate the attendance details for the semester and furnish the names of the students who have not earned the required attendance in the concerned course to the class advisor. The class advisor shall consolidate and furnish the list of students who have earned less than 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department / Dean of the School. Thereupon, the Dean (Academic Affairs) shall officially notify the names of such students prevented from writing the semester end examination in each course.

10.3 If a student secures attendance between 65% and less than 75% in any course in a semester, due to medical reasons (hospitalization / accident / specific illness) or due to participation in the institution approved events, the student shall be given exemption from the prescribed attendance requirement and the student shall be permitted to appear for the semester end examination of that course. In all such cases, the students shall submit the required documents immediately after joining the classes to the class advisor, which shall be approved by the Head of the Department / Dean of the School. The Vice Chancellor, based on the recommendation of the Dean (Academic Affairs) may approve the condonation of attendance.

10.4 A student who has obtained an “I” grade in all the courses in a semester is not permitted to move to the next higher semester. Such students shall repeat all the courses of the semester in the subsequent academic year. However, he / she is permitted to redo the courses awarded with 'I' grade / arrear in previous semesters. They shall also be permitted to write arrear examinations by paying the prescribed fee.

10.5 The student awarded “I” grade, shall enroll and repeat the course when it is offered next. In case of “I” grade in an elective course either the same elective course may be repeated or a new elective course may be taken with the approval of the Head of the Department / Dean of the School.

10.6 A student who is awarded “U” grade in a course shall have the option to either write the semester end arrear examination at the end of the subsequent semesters, or to redo the course when the course is offered by the department. Marks scored in the continuous assessment in the redo course shall be considered for grading along with the marks scored in the semester end (redo) examination. If any student obtains “U” grade in the redo course, the marks scored in the continuous assessment test (redo) for that course shall be considered as internal mark for further appearance of arrear examination.

10.7 If a student with “U” grade, who prefers to redo any particular course, fails to earn the minimum 75% attendance while doing

that course, then he / she is not permitted to write the semester end examination and his / her earlier “U” grade and continuous assessment marks shall continue.

11.0 REDO COURSES

11.1 A student can register for a maximum of two redo courses per semester without affecting the regular semester classes, whenever such courses are offered by the department concerned, based on the availability of faculty members, and subject to a specified minimum number of students registering for each of such courses.

11.2 The number of contact hours and the assessment procedure for any redo course shall be the same as regular courses, except there is no provision for any substitute examination and withdrawal from a redo course.

12.0 ASSESSMENT PROCEDURE AND PERCENTAGE WEIGHTAGE OF MARKS

12.1 Every theory course shall have a total of three assessments during a semester as given below:

Assessments	Weightage of Marks
Continuous Assessment 1	25%
Continuous Assessment 2	25%
Semester End Examination	50%

12.2 Theory Course

Appearing for semester end theory examination for each course is mandatory and a student shall secure a minimum of 40% marks in each course in semester end examination for the successful completion of the course.

12.3 Laboratory Course

Every practical course shall have 75% weightage for continuous assessments and 25% for semester end examination. However, a

student shall have secured a minimum of 50% marks in the semester end practical examination for the award of pass grade.

12.4 Laboratory Integrated Theory Courses

For laboratory integrated theory courses, the theory and practical components shall be assessed separately for 100 marks each and consolidated by assigning a weightage of 75% for theory component and 25% for practical component. Grading shall be done for this consolidated mark. Assessment of theory components shall have a total of three assessments with two continuous assessments carrying 25% weightage each and semester end examination carrying 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination. The evaluation of practical components shall be through continuous assessment.

12.5 The components of continuous assessment for theory/practical/laboratory integrated theory courses shall be finalized in the first class committee meeting.

12.6 Industry Internship

In the case of industry internship, the student shall submit a report, which shall be evaluated along with an oral examination by a committee of faculty members constituted by the Head of the Department. The student shall also submit an internship completion certificate issued by the industry / research / academic organisation. The weightage of marks for industry internship report and viva voce examination shall be 60% and 40% respectively.

12.7 Project Work

In the case of project work, a committee of faculty members constituted by the Head of the Department / Dean of the School will carry out three periodic reviews. Based on the project report submitted by the students, an oral examination (viva voce) shall be conducted as semester end examination by an external examiner approved by the Controller of Examinations. The weightage for periodic reviews shall be 50%. Of the remaining 50%, 20% shall be for the project report and 30% for the viva voce examination.

12.8 The assessment of seminar course including its component and its weightage shall be decided by a committee of faculty members constituted by the Head of the Department. This committee shall ensure the conduct of assessment of components and award marks accordingly.

12.9 For the first attempt of the arrear theory examination, the internal assessment marks scored for a course during first appearance shall be used for grading along with the marks scored in the arrear examination. From the subsequent appearance onwards, full weightage shall be assigned to the marks scored in the semester end examination and the internal assessment marks secured during the course of study shall become invalid.

In case of laboratory integrated theory courses, after one regular and one arrear appearance, the internal mark of theory component is invalid and full weightage shall be assigned to the marks scored in the semester end examination for theory component. There shall be no arrear or improvement examination for lab components.

13.0 SUBSTITUTE EXAMINATIONS

13.1 A student who is absent, for genuine reasons, may be permitted to write a substitute examination for any one of the two continuous assessment tests of a course by paying the prescribed substitute examination fee. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accidents, admission to a hospital due to illness, etc. by a committee constituted by the Head of the Department / Dean of School for that purpose. However, there is no substitute examination for semester end examination.

13.2 A student shall apply for substitute exam in the prescribed form to the Head of the Department / Dean of School within a week from the date of assessment test. However, the substitute examination will be conducted only after the last working day of the semester and before the semester end examination.

14.0 SUPPLEMENTARY EXAMINATION

14.1 Final Year students can apply for supplementary examination for a maximum of three courses thus providing an opportunity to complete their degree programme. Likewise, students with less credit can also apply for supplementary examination for a maximum of three courses to enable them to earn minimum credits to move to higher semester. The students can apply for supplementary examination within three weeks of the declaration of results in both odd and even semesters.

15. PASSING, DECLARATION OF RESULTS AND GRADE SHEET

15.1 All assessments of a course shall be made on absolute marks basis. However, the Class Committee without the student members shall preferably meet within 5 days after the semester end examination and analyze the performance of students in all assessments of a course and award letter grades. The letter grades and the corresponding grade points are as follows:

Letter Grade	Grade Points
S	10
A	9
B	8
C	7
D	6
E	5
U	0
I	0

"I" denotes inadequate attendance and hence prevented from appearing for semester end examination

"U" denotes unsuccessful performance in the course.

15.2 A student who earns a minimum of five grade points ('E' grade) in a course is declared to have successfully completed the course. Such a course cannot be repeated by the student for improvement of grade.

15.3 The results, after awarding of grades, shall be signed by the Chairman of the Class Committee and Head of the Department/Dean of School and it shall be declared by the Controller of Examinations.

15.4 Within one week from the date of declaration of result, a student can apply for revaluation of his / her semester end theory examination answer scripts of one or more courses, on payment of prescribed fees tothe Controller of Examinations. Subsequently the Head of the Department/ Dean of School offered the course shall constitute a revaluation committee consisting of Chairman of the Class Committee as convener, the faculty member of the course and a senior faculty member knowledgeable in that course as members. The committee shall meet within a week to re-evaluate the answer scripts and submit its report to the Controller of Examinations for consideration and decision.

15.5 After results are declared, grade sheets shall be issued to each student, which contains the following details: a) list of courses enrolled during the semester including redo courses / arrear courses, if any; b) grades scored; c) Grade Point Average (GPA) for the semester and d) 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 of courses registered and the grade points 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.

If C_i, is the number of credits assigned for the i^{th} course and GP_i is the Grade Point in the i^{th} course

$$GPA = \frac{\sum_{i=1}^{n}(C_i)(GPi)}{\sum_{i=1}^{n} C_i}$$

Where n = number of courses

The Cumulative Grade Point Average (CGPA) is calculated in a similar manner, considering all the courses enrolled from first semester.

"I" grade is excluded for calculating GPA.

"U" and **"I"** grades are excluded for calculating CGPA.

The formula for the conversion of CGPA to equivalent percentage of marks is as follows:

Percentage Equivalent of Marks = CGPA X 10

15.6 After successful completion of the programme, the Degree shall be awarded upon fulfillment of curriculum requirements and classification based on CGPA as follows:

Classification	CGPA
First Class with Distinction	8.50 and above and passing all the courses in first appearance and completing the programme within the minimum prescribed period.
First Class	6.50 and above and completing the programme within a minimum prescribed period plus two semesters.
Second Class	Others

15.6.1 Eligibility for First Class with Distinction

- A student should not have obtained 'U' or 'I' grade in any course during his/her study
- A student should have completed the PG programme within the minimum prescribed period of study (except clause 8.1.1)

15.6.2 Eligibility for First Class

A student should have passed the examination in all the courses not more than two semesters beyond the minimum prescribed period of study (except clause 8.1.1)

15.6.3 The students who do not satisfy clause 15.6.1 and clause 15.6.2 shall be classified as second class.

15.6.4 The CGPA shall be rounded to two decimal places for the purpose of classification. The CGPA shall be considered up to three decimal places for the purpose of comparison of performance of students and ranking.

16.0 DISCIPLINE

16.1 Every student is expected to observe discipline and decorum both inside and outside the campus and not to indulge in any activity which tends to affect the reputation of the Institution.

16.2 Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the HOD / Dean shall be referred to a Discipline and Welfare Committee constituted by the Registrar for taking appropriate action.

17.0 ELIGIBILITY FOR THE AWARD OF THE MASTER'S DEGREE

17.1 A student shall be declared to be eligible for the award of the Master's Degree, if he/she has:

i. Successfully acquired the required credits as specified in the curriculum corresponding to his/her programme within the stipulated time.
ii. No disciplinary action is pending against him/her.
iii. Enrolled and completed at least one value added course.
iv. Enrollment in at least one MOOC / SWAYAM course (non-credit) before the final semester.

17.2 The award of the degree must have been approved by the Institute.

18.0 POWER TO MODIFY

Notwithstanding all that have been stated above, the Academic Council has the right to modify any of the above regulations from time to time.

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B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY

M.TECH. (CAD-CAM)

CURRICULUM & SYLLABUS, REGULATIONS 2022

SEMESTER I

Sl. No.	Course Code	Course Title	L	T	P	C
1	MAE 6182	Differential Equations and Numerical Methods	3	1	0	4
2	MEE 6101	Applied Materials Engineering	3	0	0	3
3	MEE 6102	Computer Graphics and Geometric Modeling (Integrated Laboratory)	3	0	2	4
4	MEE 6103	Mechatronics and Automation (Integrated Laboratory)	3	0	2	4
5	MEE 6104	Additive Manufacturing	2	0	0	2
6		Professional Elective Course(s) #	3	0	0	3
7	ENE 6181	English for Career Development	1	0	2	2
		Credits				**22**

SEMESTER II

Sl.No.	Course Code	Course Title	L	T	P	C
1	GEE 6201	Research Methodology and IPR	2	0	0	2
2	MEE 6201	Integrated Product Development (Integrated Laboratory)	2	0	2	3
3	MEE 6202	Advanced Finite Element Analysis(Integrated Laboratory)	2	1	2	4
4	MEE 6203	Digital Manufacturing	2	0	0	2
5	MEE 6204	Advanced Computing Laboratory	0	0	2	1
6		Professional Elective Course(s)##				9
		Credits				**21**

SEMESTER III

Sl. No.	Course Code	Course Title	L	T	P	C
1		Open Elective*	3	0	0	3
2		Professional Elective Course(s)###				6
3	MEE 7101	Project Work - Phase I	0	0	18	6**
4	MEE 7102	Industry Internship	0	0	0	2
5		MOOC (Related to project)	0	0	0	0
		Credits				**11**

SEMESTER IV

Sl. No.	Course Code	Course Title	L	T	P	C
1	MEE 7101	Project Work - Phase II	0	0	36	18**
		Credits				**6+18=24**

Overall Total Credits – 78

\# Professional Electives can be chosen from the list, provided that the cumulative credits should not be less than 3

Professional Electives can be chosen from the list, provided that the cumulative credits should not be less than 9.

Professional Electives can be chosen from the list, provided that the cumulative credits should not be less than 6.

***** Open Electives can be chosen from the list, provided that the cumulative credits should not be less than 3.

****** Credits for project work phase I in III semester to be accounted along with project work phase II in IV semester

LIST OF PROFESSIONAL ELECTIVES

Sl. No.	Course Code	Course Title	L	T	P	C
		PROFESSIONAL ELECTIVES ON CAD				
1	MEEY 001	Advanced Mechanisms Design and Simulation	3	0	0	3
2	MEEY 002	Advanced Strength of Materials	3	0	0	3
3	MEEY 003	Advanced Tool Design	3	0	0	3
4	MEEY 004	Computational Fluid Dynamics	3	0	0	3
5	MEEY 005	Computer Aided Process Planning	3	0	0	3
6	MEEY 006	Design of Hydraulic and Pneumatic Systems	3	0	0	3
7	MEEY 007	Design of Material Handling Equipment	3	0	0	3
8	MEEY 008	Industrial Robotics and Flexible Automation	3	0	0	3
9	MEEY 009	Mechanical Vibrations	3	0	0	3
10	MEEY 010	Optimization Techniques in Design	3	0	0	3
11	MEEY 011	Tribology	3	0	0	3
12	MEEY 012	Measurements and NDT (Integrated Laboratory)	2	0	2	3
13	MEEY 013	Artificial Intelligenceand Machine Learning	3	0	0	3
14	MEEY 014	Mechanics of Composite Materials	2	0	0	2
15	MEEY 015	Design for Sustainability	2	0	0	2
16	MEEY 016	Geometric Dimensioning and Tolerance	1	0	0	1
17	MEEY 017	Topology Optimization	1	0	0	1
		PROFESSIONAL ELECTIVES ON CAM				
18	MEEY 021	Advances in Manufacturing Technology	3	0	0	3
19	MEEY 022	CNC Machines and Computer Aided Manufacturing	3	0	0	3
20	MEEY 023	Processing of Polymers and	3	0	0	3

Sl. No.	Course Code	Course Title	L	T	P	C
		Composites				
21	MEEY 024	Precision Engineering and Nano Technology	3	0	0	3
22	MEEY 025	Newer Materials	2	0	0	2
23	MEEY 026	Automotive Manufacturing	1	0	0	1
24	MEEY 027	Virtual Manufacturing	1	0	0	1
		PROFESSIONAL ELECTIVES ON CAD/CAM MANAGEMENT				
25	MEEY 031	Data Communication in CAD/CAM	3	0	0	3
26	MEEY 032	Industrial Safety Management	3	0	0	3
27	MEEY 033	Integrated Manufacturing Systems and Management	3	0	0	3
28	MEEY 034	Manufacturing Information Systems	3	0	0	3
29	MEEY 035	Reliability and Total Productive Maintenance	3	0	0	3
30	MEEY 036	Product Life Cycle Management	1	0	0	1
31	MEEY 037	Augmented Reality / Virtual Reality	1	0	0	1
32	MEEY 038	Industry 4.0	1	0	0	1

LIST OF OPEN ELECTIVE COURSES – III SEMESTER

Sl. No.	Course Code	Course Title	L	T	P	C	Offering Department / School
1.	OEEY 701	Analytical Techniques	3	0	0	3	Chemistry
2.	OEEY 702	Artificial Intelligence and IoT	3	0	0	3	CSE
3.	OEEY 703	Biomaterials	3	0	0	3	Physics
4.	OEEY 704	Biomedical Instrumentation	3	0	0	3	Physics
5.	OEEY 705	Biophotonics	3	0	0	3	Physics
6.	OEEY 706	Data Science and Machine Learning	3	0	0	3	IT
7.	OEEY 707	Electric Vehicle and Battery Storage Technology	3	0	0	3	EEE
8.	OEEY 708	Green Building and Energy Management	3	0	0	3	Civil Engineering
9.	OEEY 709	Industry 4.0 and Applications	3	0	0	3	ECE
10.	OEEY 710	Nanotechnology and Catalysis	3	0	0	3	Chemistry
11.	OEEY 711	Project Management	3	0	0	3	Mechanical
12.	OEEY 712	Real Time Embedded Systems	3	0	0	3	ECE
13.	OEEY 713	Robotic Technology	3	0	0	3	Mechanical
14.	OEEY 714	Soft Computing Techniques	3	0	0	3	EEE
15.	OEEY 715	Structural Interpretation of Materials	3	0	0	3	Chemistry

SEMESTER I

		L	T	P	C
MAE 6182	**DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS**				
SDG: 4		**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

The aim of this course is to

COB1: familiarize the students with boundary value problems of partial differential equations in engineering.

COB2: knowledge of the variational problems.

COB3: expose the students to interpolation and numerical integration techniques.

COB4: expose the students to implicit and explicit techniques.

COB5: impart the applications of conformal mapping.

MODULE I ONE DIMENSIONAL WAVE AND HEAT EQUATIONS 9+3

Laplace transformation for one dimensional wave equation – displacements in a line string – longitudinal vibration of an elastic bar – Fourier transformation for one dimensional heat conduction problems in infinite and semi-infinite rods.

MODULE II CALCULUS OF VARIATIONS 9+3

Variation and its properties – Euler's equation – functional dependant on first and higher order derivatives – functional dependant on functions of several independent variables – variational problems with moving boundaries – Isoperimetric Problems – Ritz and Kantorovich methods.

MODULE III INTERPOLATION AND NUMERICAL INTEGRATION 9+3

Cubic Spline Interpolation - Newton - Cotes formula - Trapezoidal, Simpson's one third and three eighth rules - Gauss Quadrature formulae.

MODULE IV NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

Solution of Laplace and Poisson equations on a region by Liebmann's method - diffusion equation by the explicit and Crank Nicolson - implicit methods - stability and convergence criterion - solution of wave equation by explicit scheme.

MODULE V CONFORMAL MAPPING AND APPLICATIONS 9+3

The Schwarz – Christoffel transformation – transformation of boundaries in parametric form – physical applications – fluid flow and heat flow problems.

L –45 ; T-15; TOTAL HOURS – 60

TEXT BOOKS:

1. Curtis F. Gerald and Patrick O. Wheatley, Applied Numerical Analysis, 7thedition, Pearson Publications, USA, 2004.
2. S.K. Gupta, Numerical methods for Engineers, New Age Intl. Publishers (Earlier: Wiley Eastern, New Delhi), 1995, Second Edition, 2010 (from IITB).
3. Sankar Rao, Introduction to Partial Differential Equations, PHI Learning Pvt.Ltd., 2010.

REFERENCES:

1. Sneddon, I.N., “Elements of Partial Differential Equations”, Mc Graw-Hill,1986.
2. Gupta, A.S., “Calculus of Variations with Applications”, Prentice Hall of IndiaPvt. Ltd, New Delhi, 1997.
3. Kreyszig, E., “Advanced Engineering Mathematics”, 8th Edition, John Wiley &Sons, Inc., Singapore, 2002.
4. L.E. Elsgolts, “Differential equations and calculus of variations”, UniversityPress of the Pacific, 2003.

COURSE OUTCOMES:

At the end of the course students will be able to

CO1: solve problems using the concepts of Fourier transform.
CO2: analyze problems on calculus of variation.
CO3: solving problems on interpolation and numerical integrations.
CO4: apply the knowledge heat flow problems of one and two dimensional conditions using numericalmethods.
CO5: analyze the concept of conformal mapping.

Board of Studies (BoS):
14th BOS of Mathematics & AS held on 30.06.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	H													
CO2	M	H													
CO3	M	H													
CO4	H	M													
CO5			L	M			H								

SDG 4 : Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

Learning of Fourier transform, Numerical Methods and calculus of variations will lead to knowledge of applications in CAD-CAM.

MEE 6101	APPLIED MATERIALS ENGINERING	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To gain knowledge on the basics of material science

COB2: To acquire knowledge on the micro structural science

COB3: To study about the electrical, optical, and magnetic materials

COB4: To learn about the polymer science

COB5: To familiarize with biomaterial science

MODULE I BASICS OF MATERIAL SCIENCE L:9

Types of bonding - Types of materials - Basics of crystal structures and crystallography – Defects - Methods of structural characterization - Thermodynamics of solid solutions - Phase diagrams – Diffusion – Solidification - Mechanical behaviour: elasticity, plasticity, fracture - Electrochemistry and corrosion – Selection of materials

MODULE II MICROSTRUCTURAL SCIENCE L:9

Elements of microstructure - Role of microstructure on properties - Methods of controlling microstructures: materials processing routes, heat treatments, phase transformations and mechanisms - Processing of cast and wrought alloys - Processing of nanostructured materials - Processing of single crystals, Introduction: Light metal alloys (Al-based, Mg-based and Ti-based), high temperature super alloys and high entropy alloys.

MODULE III ELECTRICAL, OPTICAL, AND MAGNETIC MATERIALS L:9

Free electron theory - Band theory: Energy levels in solids - Semiconductors: Doping, P-N junctions, field-effect transistors, and solar cells - Dielectrics and polarization: Dielectric materials, index of refraction, light-matter interactions, dielectric breakdown, piezoelectricity, ferroelectricity and pyroelectricity - Magnetism: Field intensity, permeability, exchange interaction, saturation magnetization, magnetic domains and anisotropy, hysteresis loop.

MODULE IV POLYMER SCIENCE L:9

Fundamentals of polymer science: Polymer nomenclature and classification

- Synthesis of monomers and polymers - Mechanisms of polymerization reactions - Introduction to polymer compounding and processing (for thermoplastic/thermosets) - Structure, property relationships of polymers- Instrumental methods to analyze the polymer structure and properties : Thermal (DSC, TGA, DMA), Electrical (conductivity, dielectric), and spectroscopic (IR, Raman) analysis.

MODULE V BIOMATERIAL SCIENCE L:9

Surface engineering for biocompatibility - Protein adsorption to materials surfaces - Blood compatibility of materials - Immune response to materials: Corrosion and wear of implanted medical devices - Scaffolds for tissue engineering and regenerative medicine - Concepts in drug delivery - Regulatory issues and ethics.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. W.D. Callister, Materials Science & Engineering: An Introduction, 10th Edition, John Wiley & Sons, Inc, 2018.
2. R. E. Reed-Hill and R. Abbaschian: Physical Metallurgy Principles, Fourth Edition, Cengage Learning, 2009.
3. R. E. Hummel, Electronic Properties of Materials, Springer; 4th ed. 2011.
4. F. W. Bilmeyer, Textbook of Polymer Science, Wiley; Third edition, John Wiley and Sons, 2007.
5. Ratner et al: Biomaterials science: An introduction to materials in medicine, 3rd edition, Elsevier Academic Press, 2012.

REFERENCES:

1. Ian Polmear, Light Alloys, 4th edition, Butterworth-Heinemann, 2006.
2. Roger C. Reed, The Superalloys: Fundamentals and applications, Cambrige university press, 2006.
3. B. S. Murthy, J. W. Yeh, S. Ranganathan, P. P. Bhattacharjee, High entropy alloys, 2nd Edition, Elsevier, 2019.
4. D. Jiles, Introduction to the electronic properties of materials, 2nd Edition, 2017.
5. A. Rudin and P. Choi, The Elements of Polymer Science and Engineering, Academic Press, 3rd edition, 2012.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basics of material science

CO2: Describe the micro structural science

CO3: Illustrate the electrical, optical, and magnetic materials

CO4: Elucidate about the polymer science

CO5: Explain about the biomaterial science

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		L	H			L				M	L	M	H
CO2	H		L	H			L				M	L	M	H
CO3	H		L	H			L				M	L	M	H
CO4	H		L	H			L				M	L	M	H
CO5	H		L	H			L				M	L	M	H

Note: L - Low Correlation M - Medium Correlation H -High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Understanding of applied materials helps to develop advanced components for the sustainable development of industries.

MEE 6102	COMPUTER GRAPHICS AND GEOMETRIC MODELING (INTEGRATED LABORATORY)	L	T	P	C
SDG: 9		3	0	2	4

COURSE OBJECTIVES:

COB1: To acquire knowledge on primitive generation and manipulations

COB2: To learn about the concepts of modelling curves and surfaces

COB3: To gain knowledge on modelling of solids

COB4: To familiarize with image enhancement and graphics standards

COB5: To study about computer aided engineering

MODULE I PRIMITIVE GENERATION AND MANIPULATION **L:10 P:6**

Overview of display devices and systems – Generation of primitives: line, circle, ellipse generation algorithms – 2D and 3D transformation –Viewing transformation – Projections.

MODULE II MODELLING OF CURVES AND SURFACES **L:10 P:8**

Curves: Parametric representation – Analytic curves -Synthetic curves: Bicubic, Bezier, B-spline, NURBS, Continuity conditions -Surfaces: surface patches, Bicubic, Bezier, B-spline, Coons patch - Sweep surfaces - Manipulation of curves and surfaces: Evaluating points, Blending, segmentation, Trimming, Intersection, Transformation.

MODULE III MODELLING OF SOLIDS **L:9 P:6**

Fundamentals of Solid modelling- Geometry and topology -Half-spaces - Boundary representation (B-rep.) – Constructive Solid Geometry (CSG) - Sweeps - Feature representation - Constraints – Parametric relations - Feature manipulations - Data associativity - Features of solid modelling packages – Latest trends in modelling.

MODULE IV IMAGE ENHANCEMENT AND GRAPHICS STANDARDS **L:8 P:6**

Clipping-Hidden line/surface removal: Visibility, Sorting, Coherence, Z Buffer algorithm- Shading and rendering - Graphic standards – Computing shades

– Data exchange standards: IGES, STEP, DXF and other standards – Computer Graphics in Augmented Reality (AR)and Virtual Reality (VR).

MODULE V COMPUTER AIDED ENGINEERING **L:8 P:4**

Collaborative design – Product lifecycle management - Mass property calculation - Assembly modelling – Mesh generation techniques - Animation techniques – Tool path generation

L – 45; P – 30; TOTAL HOURS – 75

PRACTICALS:

LIST OF EXPERIMENTS:

1. Surface Model of a water bottle.
2. Modelling using control points.
3. Modeling of a real life product.
4. Modeling of sheet metals.
5. Assembly of a real life product.
6. Detail drawing of a real life product.
7. Data associativity between CAD model, drawing & assembly.
8. Modelling of a solid using B.rep. and CSG techniques.
9. Parametric Modelling of standard components like Bolt and Nut.
10. Exporting CAD model to another software using standards.
11. Shading and Rendering of a real life component.
12. Visualization of product in real world environment with AR.
13. Simulate a product using VR.
14. Meshing a model with different techniques.
15. Extracting Mass property of a real life component.
16. Creating tool path for machining a simple component.

TEXT BOOKS:

1. Ibrahim Zeid, Mastering CAD / CAM, McGraw Hill Education Pvt. Limited, 2007.

REFERENCES:

1. Chris Mc Mahon and Jimmie Browne, CAD CAM – Principles, Practice and Manufacturing Management, 2nd edition, Pearson Education Asia LN, 2005.
2. Donald Hearn and Pauline Baker, Computer Graphics Prentice Hall Inc.
3. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles

& practice" Pearson Education -2003

4. P.N. Rao, “CAD / CAM Principles and Applications” - 2nd edition, Tata Mc.Graw Hill

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Compute basic primitives and its manipulations

CO2: Illustratevarious techniques for modelling of curves and surfaces

CO3: Describe about modelling of solids

CO4: Elucidate image enhancement and graphics standards

CO5: Explain about computer aided engineering

Board of Studies (BoS):

20th BOS held on 08.08.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		M		M		L			L	L	L	H	L
CO2	H		M		M		L			L	L	L	H	L
CO3	H		M		M		L			L	L	L	H	L
CO4	H		M		M		L			L	L	L	H	L
CO5	H		M		M		L			L	L	L	H	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The knowledge of Computer Aided Modelling and Graphics generation shall promote development of product through creativity and innovation, presentation of ideas and documents leads to sustainable and quality manufacturing of product for the benefit of society and industry.

MEE 6103	MECHATRONICS AND AUTOMATION	L	T	P	C
SDG: 9	(INTEGRATED LABORATORY)	3	0	2	4

COURSE OBJECTIVES:

COB1: To gain knowledge about the basics and application of mechatronics systems.

COB2: To familiarize with sensors and transducers

COB3: To acquire knowledge about various actuators.

COB4: To learn about adaptive and predictive control systems

COB5: To study about industrial automation and PLC.

MODULE I MECHATRONICS AND ITS APPLICATION L:11 P:6

Mechatronics definition – Systems -Measurement Systems - Control Systems: Traditional and Mechatronics design concepts -Mechatronic control in automated manufacturing- Case studies: Pick and place Robot, Conveyor based material handling system, PC based CNC drilling machine.

MODULE II SENSORS AND TRANSDUCERS L:7 P:6

Introduction - Performance Terminology – Potentiometers - LVDT-Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors - Piezoelectric –magneto strictive – Shape memory alloy – Selection of sensors - Signal processing - Applications

MODULE III ACTUATORS L:10 P:6

Actuators: Review of Mechanical and Fluid Power actuators, Electrical actuators - DC Motors: Construction, working principle, torque equation, classification, electrical and mechanical characteristics, speed control techniques, Applications -AC Motors -3-phase induction motors: Construction, working principle, classification, torque equation, electrical and mechanical characteristics, speed control techniques, applications - Synchronous motors: Construction, working principle, torque equation, speed control techniques, applications– Concept of stepper and servo motors- selection of actuators

MODULE IV ADAPTIVE AND PREDICTIVE CONTROL OF MECHATRONICS SYSTEMS L:8 P:6

Introduction to adaptive control – Effects of process variations –Adaptive control schemes – Adaptive control problem – Non-parametric identification: Step response method, Impulse response method and Frequency response method - Case Studies: Robotics, Industrial Automation and Intelligent Vehicle Systems.

MODULE V INDUSTRIAL AUTOMATION AND PLC L:9 P:6

Automation in Production System: Automation principles and strategies, Architecture, Basic Elements of an Automated System - Levels of Automations - Advanced Automation Functions - Fundamentals of programmable logic controller (PLC) - Functions of PLCs - Features of PLC - Selection of PLC - Architecture - Types of PLC - PLC modules- PLC programming - Logic ladder diagrams - Programming in Timers, Counters, and Internal Relays - Auxiliary commands and functions- Data Handling - Applications.

PRACTICALS:

LIST OF EXPERIMENTS:

1. DC motor control using microcontrollers.
2. Stepper motor control using microcontrollers.
3. Modelling and analysis of basic mechanical, electrical, hydraulic and pneumatic systems using Lab VIEW.
4. Characterization of sensors like strain, LVDT, and thermocouple.
5. Interfacing DAC for Control application using Lab VIEW.
6. Timing and counting operations using PLC.
7. PLC programming for bottling plant automation.
8. Control design for Inverted pendulum system.
9. Development of an automated production system with simulation package.
10. Fault diagnosis of machine elements like, bearing, gear box, and pumps.
11. Modelling and control of Anti-lock braking system using MATLAB/ Simulink.

L – 45; P – 30; TOTAL HOURS: 75

TEXT BOOKS:

1. Bolton, “Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering”, 6th Edition, Pearson Education, 2015.
2. Smaili. A and Mrad. F, "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008.
3. Stamatios Manesis and George, Nikolakopoulos, Introduction to Industrial Automation, CRC Press, 2020.

REFERENCES:

1. Milan Sonka, Vaclav Hlavac and Roger Boyle, “Image Processing, Analysis and Machine Vision”, Third Edition, Cengage Learning, 2007
2. Robert H. Bishop, The Mechatronics Handbook, 2nd edition, CRC Press, 2008.
3. Frank D. Petruzella, Programmable Logic Controllers, 5th edition, McGraw Hill,2019.
4. Patrick O.J. Kaltjob, Mechatronic Systems and Process Automation, 1st edition, CRC Press, 2020.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain basics and applications of mechatronics systems

CO2: Describe various sensors and transducers

CO3: Elucidate various actuating systems.

CO4: Discuss various adaptive and predictive control systems.

CO5: Explain the concepts of industrial automation and PLC.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M										L	L	L	L
CO2	M										L	L	L	L
CO3	M										L	L	L	L
CO4	M						M				M	M	M	M
CO5	M		H				M				M	M	M	M

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The multidisciplinary nature of Mechatronics and automation aims at reducing the ecological impact and utilizing optimum resources for the sustainable development.

MEE 6104	ADDITIVE MANUFACTURING	L	T	P	C
SDG: 9		2	0	0	2

COURSE OBJECTIVES:

COB1: To learn the basics of Additive Manufacturing (AM).

COB2: To familiarize with design for additive manufacturing process.

COB3: To acquire knowledge about liquid and solid based systems in AM.

COB4: To gain knowledge on powder based systems in AM.

MODULE I BASICS OF ADDITIVE MANUFACTURING L: 5

Introduction to Additive Manufacturing (AM) – Classifications of AM - Generic AM Process: Steps- Reverse Engineering for AM - Difference between AM and subtractive manufacturing - Benefits of AM –Applications.

MODULE II DESIGN FOR ADDITIVE MAUFACTURING L: 7

CAD Modeling -Data Formats - STL file generation, file verification and Repair for AM - Data Interfacing-Part orientation- Support structure design and support structure generation - Model slicing- Tool path generation.

MODULE III LIQUID AND SOLID BASED SYSTEM L:9

Principle, process parameters, advantages, limitations and applications: Extrusion Based Additive Manufacturing Process, Fused Deposition Modeling (FDM), Shape Deposition Manufacturing (SDM), Laminated Object Manufacturing (LOM), Photo-polymer vat Additive Manufacturing Process, Streolithography (SLA), Solid Ground Curing (SGC), Wire arc additive manufacturing Process (WAAM).

MODULE IV POWDER BASED SYSTEM L:9

Principle, process parameters, advantages, limitations and applications of: Powder bed fusion and material jetting Additive Manufacturing Process- Powder bed fusion, Electron Beam Melting (EBM), Laser Engineered Net Shaping (LENS), and Three Dimensional Printing (3DP) -Binder Jetting– Ceramic - Hybrid Additive Manufacturing Process–Issues with additive manufacturing.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. Ginson. D.W. Rosen and B. Stucker, “Additive Manufacturing Technologies - Rapid prototyping to Direct Digital Manufacturing, Springer, 2015
2. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: principles and applications, Second edition, World Scientific publishers, 2003.

REFERENCES:

1. Andreas Gebhardt, HanserGarener, Rapid prototyping, Publications, 2003
2. Liou W. Liou, Frank W. Liou, Rapid prototyping and Engineering applications: A tool box for prototype development, CRC press, 2007
3. Ali k. Kamrani, EmadAbouel Nasr, Rapid Prototyping: Theory and Practice, Springer, 2006
4. Peter D. Hilton / Jacobs, Paul F. Jacobs, Rapid Tooling: Technologies and industrial Applications, CRC Press, 2000.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basic concepts of AM process.

CO2: Apply design concepts for making components by AM process.

CO3: Explain procedures involved in liquid and solid based system in AM.

CO4: Describe procedures involved in powder based systems in AM.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		L		M		M			L	L		H	H
CO2	H		H		M		M			L	L		H	H
CO3	H		H		M		M			L	L		H	H
CO4	H		L		M		M			L	L		H	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Understanding the concepts of additive manufacturing helps to produce complex engineering shapes to launch the new product at faster rate.

ENE 6181	ENGLISH FOR CAREER DEVELOPMENT	L	T	P	C
SDG: 4 and 8		1	0	2	2

COURSE OBJECTIVES:

COB1: To enable students to learn about the job search, application, and interview process

COB2: To give them an opportunity to explore their global career path, build vocabulary and improve language skills to achieve professional goals

COB3: To produce a professional-looking resume

COB4: To understand networking and interview skills

COB5: To understand the key skills and behaviours required to facilitate a group discussion

MODULE I ENTERING THE JOB MARKET 3+6

(This module focuses more on the practical aspects of communication for career development.)

Introduction to the Career Development - Job Search Overview - Identifying Your Interests and Skills

Language Focus: Vocabulary and Word Forms Related to Jobs - Choosing the Job that's the Best Fit

Language Focus: Verb Tenses (Present vs. Present Progressive)

Understanding Job Descriptions: Reading a Job Advertisement

Language Focus: Phrases to Compare Similarities

Online Learning Opportunities to Extend Your Skills

MODULE II RESUMES 3+2

What is a resume? Why do you need one?

Parts of a Resume-Writing a Resume, Part 1: Name and Contact Information

Listening: Connecting Employers with Job Seekers in Today's Economy

Language Focus: Key Words

Writing a Resume, Part 2: Headline and Summary

Writing a Resume, Part 3: Work Experience

Writing a Resume, Part 4: Education

Language Focus: Action Verbs

Writing a Resume, Part 5: Complete your Resume

MODULE III WRITING A COVER LETTER 3+2

What is a Cover Letter?

Professional Writing: Letter Format

Cover Letter: Paragraph 1- Introducing Yourself
Cover Letter: Paragraph 2- Highlighting Your Skills in the Cover letter
Cover Letter: Paragraph 3- Closing
Language Focus – Present Perfect vs. Past Tense
Professional Writing: Level of Formality
Language Focus: Using Modal Verbs to Write politely
Writing a Cover Letter for a Specific Job

MODULE IV INTERVIEWING FOR A JOB 3+10

(This module focuses more on the practical aspects of communication for career development.)
Overview of the Job Interview: Answering Typical Interview Questions
Language Focus: Asking for Clarification in an Interview-
Sample Interview: Do's and Don'ts Part 1
Sample Interview: Do's and Don'ts Part 2
Sample Video: Responding to an Interview Question

MODULE V GROUP DISCUSSION 3+10

(This module focuses more on the practical aspects of communication for career development.)
Introduction to Group Discussion - Participating in group discussions – understanding group dynamics - brainstorming the topic - questioning and clarifying - GD strategies - activities to improve GD skills

L-15, P-30; TOTAL HOURS - 45

REFERENCES:

1. R. Byrne, D. *Teaching Oral Skill.* London: Longman. 1975.
2. Byrne, D. *Teaching Writing*, London: Longman. 1975.
3. Rani Asoka, Devi Vimala. *English for Career development: A Course in Functional English.* Orient Longman Pvt. Ltd., India, 2004.
4. Anderson, K., Maclean, J. & Lynch, T. *Study speaking: A Course in Spoken English for Academic Purposes*. Cambridge University Press, UK, 2004.
5. Withrow, J., Brookes, G. & Cummings, M.C. *Inspired to write. Reading and Tasks to Develop Writing Skills*. Cambridge University Press, U.K., 2004.

COURSE OUTCOMES:

CO1: Identify the steps in the job search process

CO2: Describe themselves and their experiences in a résumé

CO3: Build their job-related vocabulary

CO4: Write a clear cover letter that tells employers why they are the right person for the job

CO5: Take part in Group discussion confidently.

Board of Studies (BoS) :	**Academic Council:**
15th BoS of the Department of English held on 14.6.2022	19th Meeting of the Academic Council held on 29.09.2022

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Statement: This course ensures that the students acquire quality education and are also made eligible to obtain productive and decent employment.

SEMESTER II

GEE 6201	**RESEARCH METHODOLOGY AND IPR**	**L**	**T**	**P**	**C**
SDG: 4, 8, 9		**2**	**0**	**0**	**2**

COURSE OBJECTIVES:

COB1: To apply a perspective on research

COB2: To analyze the research design, information retrieval and problem formulation techniques.

COB3: To select the appropriate statistical techniques for hypothesis construction and methods of data analysis and interpretation

COB4: To execute the effective communications of research findings and apply the ethics in research.

COB5: To describe the research findings as research reports, publications, copyrights Patenting and Intellectual Property Rights.

PREREQUISITES:

- Basics of core engineering, probability and statistics.
- Basics of flowchart and algorithm techniques.

MODULE I RESEARCH PROBLEM FORMULATION AND RESEARCH DESIGN **6**

Research - objectives – types - Research process, solving engineering problems - Identification of research topic - Formulation of research problem, literature survey and review. Research design - meaning and need - basic concepts - Different research designs, Experimental design - principle, Design of experimental setup, Mathematical modeling - Simulation, validation and experimentation.

MODULE II DATA COLLECTION, ANALYSIS AND INTERPRETATION OF DATA **8**

Sources of Data, Use of Internet in Research, Types of Data - Research Data Processing and analysis - Interpretation of results- Correlation with scientific facts - repeatability and reproducibility of results - Accuracy and precision – limitations, Application of Computer in Research- Spreadsheet tool-Basic principles of Statistical Computation. Importance of statistics in research - Concept of probability - Popular distributions - Sample design. Hypothesis testing, ANOVA, Design of experiments - Factorial designs - Orthogonal arrays.

MODULE III OPTIMIZATION TECHNIQUES 8

Use of optimization techniques - Traditional methods – Evolutionary Optimization Techniques. Multivariate analysis Techniques, Classifications, Characteristics, Applications - correlation and regression, Curve fitting.

MODULE IV INTELLECTUAL PROPERTY RIGHTS 8

The Research Report - Purpose of written report - Synopsis writing - preparing papers for International Journals, Software for paper formatting like LaTeX/MS Office, Reference Management Software, Software for detection of Plagiarism –Thesis writing, - Organization of contents - style of writing- graphs, charts and Presentation tool - Referencing, Oral presentation and defense - Ethics in research - Patenting, Intellectual Property Rights - Patents, Industrial Designs, Copyrights, Trade Marks, Geographical Indications-Validity of IPR, Method of Patenting, procedures, Patent Search.

L –30 ; TOTAL HOURS – 30

TEXT BOOKS:

1. Ganesan R., “Research Methodology for Engineers”, MJP Publishers, Chennai, 2011.
2. George E. Dieter., “Engineering Design”, McGraw Hill – International edition, 2020.
3. Kothari C.R., “Research Methodology” – Methods and Techniques, New Age International (P) Ltd, New Delhi, 2020.
4. Kalyanmoy Deb., “Genetic Algorithms for optimization”, Kangal report, No.2001002.
5. Rajkumar S. Adukia, “Handbook on Intellectual Property Rights in India”, TMH Publishers, 2020.
6. Prabhuddha Ganguli. ”Intellectual Property Rights”. 1st Edition, TMH Publishers, 2012.

REFERENCES:

1. Holeman, J.P., ”Experimental methods for Engineers, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2017.
2. Govt. of India, ”Intellectual Property Laws; Acts, Rules & Regulations”, Universal Law Publishing Co. Pvt. Ltd., New Delhi 2020.
3. R Radha Krishnan & S Balasubramanian, ”Intellectual Property Rights”. 1st Edition, Excel Books, 2012.
4. Derek Bosworth and Elizabeth Webster. ”The Management of Intellectual Property”, Edward Elgar Publishing Ltd., 2013.

COURSE OUTCOMES:

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

CO1: Formulate the research problem

CO2: Design and Analyze the research methodology

CO3: Apply statistical techniques for hypothesis construction

CO4: Analyze and interpret the data to construct and optimize the research hypothesis

CO5: Report the research findings as publications, copyright, trademarks and IPR

Board of Studies (BoS) :
23rd BOS of ECE held on 13.07.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	H	H	H	M	L	L	L	L	L	L	L	H	H	H
CO2	H	H	H	H	M	-	-	-	-	-	-	-	H	H	H
CO3	H	H	H	H	M	L	L	L	L	L	L	-	H	H	H
CO4	H	H	H	H	M	-	M	M	M	M	M	-	H	H	H
CO5	H	H	H	H	M	-	M	M	M	M	M	-	H	H	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 4: Analysis and design of core field design promotes engineering skills and quality education.

Statement: This course enables the student to analyze the existing technology for further solution and its qualitative measures in terms of societal requirements.

SDG 8: Development of new technologies with core field design provides sustainable economic growth and productive employment.

Statement: To apply the hybrid techniques and concepts for different applications provides sustainable economic growth and productive employment.

SDG 9: Creative and curiosity of core field design fosters innovation and sustainable industrialization.

Statement: This course plays major roles through innovative ideas in industry towards modern infrastructures and sustainability.

MEE 6201	INTEGRATED PRODUCT DEVELOPMENT (INTEGRATED LABORATORY)	L	T	P	C
SDG: 9		2	0	2	3

COURSE OBJECTIVES:

COB1: To gain knowledge about product planning process.

COB2: To familiarize with concept development process for new product.

COB3: To study about product architecture design for developing a product.

COB4: To learn about prototyping, design for X and design documentation.

MODULE I PRODUCT PLANNING L:8 P:8

Strategic importance -Characteristics and challenges of product design – Role of innovation in product design - Generic product development process - Plan for products –Understanding the market opportunity - Identifying customer needs - Establishing product specifications - Competitive benchmarking analysis - House of quality.

MODULE II CONCEPT DEVELOPMENT L:8 P:10

Need for creative thinking and innovation - Value engineering and functional analysis - Concept generation: Clarify the problem, Search externally, Search internally, Explore systematically and Reflect on the solutions and process -Concept selection: Concept screening and Concept scoring - Concept testing - Protocol of concept testing.

MODULE III DETAILED DESIGN L:7 P:6

Concept embodiment design - Product architecture - Types of modular architecture - Implications of the architecture - Establishing the product architecture –Platform planning - Portfolio architecture - Industrial design: Need and Impact – Technology driven and User driven products – Industrial design process.

MODULE IV PRODUCT PROTOTYPING AND DOCUMENTATION L:7 P:6

Prototyping: Principles of prototyping, Types of prototypes and Planning for

prototypes -Design for 'X' (DFX): Design for Manufacturing, Assembly, Quality, Cost, Environment, Sustainability and reuse/recycle -Design optimization – Design Documentation - Patents and IP – Product commercialization.

PRACTICALS:

LIST OF EXPERIMENTS:

1. Product Selection.
2. Product Planning.
3. Market Survey.
4. Product Specification.
5. Problem Decomposition.
6. Concept Generation.
7. Concept Selection.
8. Concept Testing.
9. Product Architecture.
10. Physical Prototype.
11. Design Documentation.

L – 30; P – 30; TOTAL HOURS – 60

TEXT BOOKS:

1. Karl TUlrich and Steven D Eppinger, "Product Design and Development", McGraw-Hill Education, 5th Edition, 2017.

REFERENCES:

1. Clive L. Dym, Patrick Little, and Elizabeth J. Orwin, "Engineering Design: A Project Based Introduction", 4th Edition, Wiley, 2014.
2. YousefHaik, T. M. M. Shahin, "Engineering Design Process", Cengage Learning Inc, 2nd Edition, 2010.
3. Chitale A K, Gupta R C, "Product Design and Manufacturing", Prentice Hall India Learning Private Limited, 6th Edition, 2014.
4. Kevin Otto, Kristin Wood, "Product Design", Pearson Education, New Delhi, 2001.
5. Magrab, E.B., Gupta, S.K., McCluskey, F.P. and Sandborn, P., Integrated product and process design and development: The product realization process, CRC Press, 2009.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe the basic concepts of product planning process.

CO2: Discussthe concept development process for new product.

CO3: Elucidate the product architecture design for developing a new product.

CO4: Explain theprinciples for developing prototype, design for X and design documentation.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	H		M		M					L	H	H
CO2	L	L	H		M		M					L	H	H
CO3	L	L	H		M		M					L	H	H
CO4	L	L	H		M		M			M		L	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The knowledge of new product design through creativity and innovation techniques leads to development of quality and sustainable product for the benefit of the society and foster industrialization.

MEE 6202	ADVANCED FINITE ELEMENT ANALYSIS (INTEGRATED LABORATORY)	L	T	P	C
SDG: 9		2	1	2	4

COURSE OBJECTIVES:

COB1: To gain knowledge about basics of finite element method

COB2: To familiarize with structural dynamics.

COB3: To learn about error estimates and adaptive refinements

COB4: To acquire knowledge on non-linear FEA

COB5: To study about implicit and explicit methods

MODULE I BASICS OF FINITE ELEMENT METHOD **L:9 P:6**

Introduction - Finite element formulation based on weighted residual method and stationary of a functional - Isoparametric formulation - Bending of plate and shells - Thin (Kirchoff) and Thick (Mindlin) plate elements – Finite Element Formulation of Plate and Shell Elements

MODULE II STRUCTURAL DYNAMICS **L:9 P:6**

Dynamical equations of motion - Consistent and Lumped Mass Matrices - Damping matrices - Vibration Analysis - Eigenvalue problems and solution techniques - Transient and structural dynamical problems - Stability issues.

MODULE III ERROR ESTIMATES AND ADAPTIVE REFINEMENT **L:9 P:6**

Classification of errors – Error tests - Convergence rates- Mesh revision and Gradient Recovery – Adaptive meshing - h refinement with adaptivity – adaptive refinement.

MODULE IV NONLINEAR FINITE ELEMENT ANALYSIS **L:9 P:6**

Background of nonlinear FEA - Nonlinear analysis strategy – Geometric nonlinearity - Material nonlinearity – Contact nonlinearity – Buckling analysis

MODULE V IMPLICIT AND EXPLICIT METHODS **L:9 P:6**

Implicit versus explicit FE Analysis methods - Explicit Background – Explicit Examples - Topology optimization with examples.

PRACTICALS:

LIST OF EXPERIMENTS:

1. FEA analysis of Machine elements under steady states.
2. FEA analysis of Machine elements under transient states.
3. Modal analysis of a cantilever beam.
4. Harmonic analysis of a beam structure.
5. FEA analysis of Error estimation.
6. FEA analysis of convergence tests.
7. FEA analysis of buckling rod analysis.
8. FEA analysis of viscoelasticity and hyper elasticity problems.
9. Topology optimisation of cantilever beam
10. Explicit analysis of impact problems.

L – 45; P – 30; TOTAL HOURS – 75

TEXT BOOKS:

1. Reddy J.N. An Introduction to the Finite Element Method, McGraw Hill, International Edition, 2005.

REFERENCES:

1. Cook, Robert Davis et al “Concepts and Applications of Finite Element Analysis”, Wiley, John & Sons, 1999.
2. Nitin S. Gokhale, Sanjay S. Deshpande and Sanjeev V. Bedekar, “Practical Finite Element Analysis”, Amazon India, 2008.
3. J.C. Simo and T.J.R. Hughes (1998), Computational Inelasticity, Springer
4. Zienkiewicz.O.C, Taylor.R.L “The Finite Element Method” McGraw Hill International Editions, Fourth Edition, 1991, Volume 2.
5. Bathe, K.J., “Finite Element Procedures in Engineering Analysis, 1990.
6. Reddy, J. N., An Introduction to Nonlinear Finite Element Analysis, Oxford
7. David V Hutton “Fundamentals of Finite Element Analysis”. McGraw-Hill International Edition, 2004.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain about basics of finite element method

CO2: Perform vibrational and structural dynamics analysis.

CO3: Describe error estimates and adaptive refinements

CO4: Solve problems on non linear FEA

CO5: Perform topology optimization through FEA.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	H	M		M		L					L	H	H
CO2	M	H	M		M		L					L	H	H
CO3	M	H	M	L	M		L					L	H	H
CO4	M	H	M		M		L					L	H	H
CO5	M	H	M		M		L					L	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The understanding of Finite element methods in structural, nonlinear and advanced analysis promote innovation of products to build sustainable industrialization.

MEE 6203	DIGITAL MANUFACTURING	L	T	P	C
SDG: 9		2	0	0	2

COURSE OBJECTIVES:

COB1: To gain knowledge on the basics of manufacturing systems

COB2: To acquire knowledge on the modern manufacturing systems

COB3: To study about industry 4.0

COB4: To familiarize with digital twin

MODULE I BASICS OF MANUFACTURING SYSTEMS L:6

Introduction - Components of manufacturing systems: Design, operation, and control of manufacturing systems - CAD / CAPP / CAM System - Group technology and cellular manufacturing - Flexible manufacturing systems - Just-In-Time and lean production.

MODULE II MODERN MANUFACTURING SYSTEMS L:6

Agile/demand driven manufacturing - Computer Integrated Manufacturing: CIM wheel, CAQC (Computer Aided Quality Control) - Enterprise Integration - Digital Manufacturing and Smart manufacturing systems.

MODULE III INDUSTRY 4.0 L:9

Industry 4.0 components: Automation, Data exchanges, Cloud, Cyber-physical systems, Mobile, Robots, Big Data, deep machine learning, IoT, distributed systems and agile methodology - Application Domains: Healthcare, Power Plants, Inventory Management and Quality Control, Plant Safety and Security Facility Management, Oil, chemical and pharmaceutical industry.

MODULE IV DIGITAL TWIN L:9

Background and Concept of Digital Twin – History –Development - Theoretical Definition - Cores of Digital Twin: Models, Data, Connections, and Services - Digital Twin and Related Concepts - Applications of Digital Twin- Future market for Digital Twin - Challenges of Digital Twin Applications.

L – 30; TOTAL HOURS – 30

TEXT BOOKS:

1. M. P. Groover, Automation, Production systems and Computer Integrated Manufacturing. 3rd edition, Pearson Education, 2015.
2. N. Singh, Systems Approach to Computer Integrated Design and Manufacturing,1st edition, Wiley India, 2011
3. Alasdair Gilchris, Industry 4.0: The Industrial Internet of Things, Apress; 1st ed. Edition, 2017.
4. Fei Tao, Meng Zhang, A.Y.C. Nee, Digital Twin Driven Smart Manufacturing, Academic press, 2019.

REFERENCES:

1. G. Chryssolouris, Manufacturing Systems: Theory and Practice. 2nd edition, Springer, 2006.
2. 2. W. J. Hopp, M. L. Spearman, Factory Physics, 3rd edition, Waveland Press, 2011.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basics of manufacturing systems

CO2: Elucidate the modern manufacturing systems

CO3: Describe about industry 4.0

CO4: Explain about the digital twin

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H			L	H		L		M		L	L	H	H
CO2	H			L	H		L		M		L	L	H	H
CO3	H			L	H		L		M		L	L	H	H
CO4	H			L	H		L		M		L	L	H	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Digital technologies helps to increase the production rate, thereby eradicate the poverty through technological advancements.

MEE 6204	ADVANCED COMPUTING LABORATORY	L	T	P	C
SDG: 9		0	0	2	1

COURSE OBJECTIVES:

COB1: To learn the basics operations and plotting functions of MATLAB.

COB2: To get trained in writing programs using MATLAB software to simulate mechanical systems.

COB3: To gain knowledge on Simulink and image processing module of MATLAB software.

COB4: To study the basics of PYTHON programming.

COB5: To familiarize with the functions and programs of PYTHON.

PRACTICALS

MATLAB

Introduction to MATLAB: Introduction, installation of MATLAB, key features, basic commands, assigning and operations with variables, arrays and vectors.

Basic Operations: Arithmetic operations, solving arithmetic equations, matrix operations, solving matrix, trigonometric functions, solving real and complex numbers.

Script files and plotting: Working with script files, creating custom functions, loops, plotting vector and matrix data, plot labelling and editing, creating multiple plots with subplots, controlling the axes, creating 3d plot (mesh and surface).

Programming: Forward kinematics simulator, vibration and dynamics, differential equations, genetic algorithms, examples.

Simulink: Introduction of Simulink, Simulink environment & interface, study of library, multibody dynamics, model-based design, connect call back to subsystem, supervisory control in Hybrid electric vehicle application.

Image Processing: Importing and visualizing images, converting between image types, obtaining pixel intensity values, extracting a region of interest, computing pixel statistics, measuring object sizes, preprocessing images adjusting image contrast and noise.

PYTHON

Introduction to Python: Installation and working with python, understanding python variables, python basic operators, defining functions, data types, declaring and using numeric data types: int, float, complex, use

of tuple data type, branching with if statements, else statement and elif, loops and nested loops,

Python Functions: Modules and packages, working with matplotlib, numpy, scikit and seaborn libraries, data preprocessing, tables, plotting and annotating plots, image processing, segmentation, edge detection, Programs on Mechanical Vibrations.

P – 30; TOTAL HOURS: 30

REFERENCES:

1. E. MikhailovEugeniy, Programming with MATLAB for Scientists: A Beginner Introduction 1st Edition, CRC Press, 2018
2. MATLAB documentation
3. Amir H. Danesh-Yazdi, Yi Wu, Mechanical Vibrations: A State-Space Perspective, Tophatmonocle Corp, 2022
4. Abdelkhalak El-Hami, BouchaibRadi, Optimizations and Programming: Linear, Non-linear, Dynamic, Stochastic and Applications with MATLAB, John Wiley & Sons, Inc, 2021
5. Robert Johansson, Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib, Apress, 2019
6. Steven I. Gordon, Brian Guilfoos, Introduction to Modeling and Simulation with MATLAB® and Python, Taylor & Francis, 2017
7. RavishankarChityala, SrideviPudipeddi, Image Processing and Acquisition using Python, CRC, 2020.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe the basic operations and plotting functions of MATLAB.

CO2: Write programs in MATLAB to simulate mechanical systems.

CO3: Demonstrate the Simulink and image processing module of MATLAB software.

CO4: Explain the basics of PYTHON programming.

CO5: Write PYTHON program using the basic functions.

Board of Studies (BoS):	**Academic Council:**
20th BOS held on 08.08.2022	19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	M		H								H	M
CO2	L	L	M		H								H	M
CO3	L	L	M		H								H	M
CO4	L	L	M		H								H	M
CO5	L	L	M		H								H	M

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Application of software programming skills enables industry towards automation and contribute towards development of industry 4.0

SEMESTER III

MEE 7101	PROJECT WORK - PHASE I	L	T	P	C
		0	0	18	6

COURSE OBJECTIVES:

COB1: To provide opportunity for the students to exhibit their capacity in executing a project work and provide meaningful solution to a research or real-world problem related to CAD-CAM.

GENERAL GUIDELINES

- At post graduate level project work shall be carried out by the student individually
- Student shall select a project topic of his/her interest relevant to CAD-CAM and approach any faculty member of the department with expertise in that field and get his willingness to supervise the project.
- Students are permitted to carry out their project in an Industry / Research organization, with the approval of the Head of the Department. In such cases, the project work shall be jointly supervised by a faculty of the department and an Engineer / Scientist from the organization. Proper permission and approvals should be obtained from the industry and documented.
- The information related to proposed topic and the faculty member willing to act as guide shall be informed to the project co-ordinator within 15 days from the commencement of the semester.
- Supervisor identified by the student shall be approved by the Professor in- charge or Head of the Department considering the guidelines followed in the department to allot supervisor for student projects
- The project co-ordinator in consultation with Professor in-charge or Head of the Department shall give initial approval to start the project work.
- A project review team comprising of minimum two senior faculty members of the department preferably doctorates shall be appointed by the Head of the Department.
- Project review schedules, weightage for each review and rubrics for evaluation will be prepared by the project co-ordinator in line with the academic calendar and informed to the students in advance.

- A minimum of three reviews shall be conducted to evaluate the progress of the students. All the members of the review committee shall evaluate the students individually and the mean value shall be taken for grading.
- Student should meet the supervisor periodically and attend the review committee meetings for evaluating the progress. Proper documents shall be maintained by the supervisor to ensure the attendance and progress of the students.
- In the project phase I, students are expected to identify a suitable topic, draw the need for present study and scope of the investigation, review at least 10 journal papers in the related field, formulate the experimental /analytical methodology and conduct preliminary studies.
- At the end of project work phase I, students should submit a report based on the preliminary studies and the future work to be carried out.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Apply their practical knowledge and skill in Mechanical Engineering with specialization in CAD-CAM to solve real time problems

CO2: Utilize the creative ability and inference capability to prepare an appropriate scientific document and make effective presentations

Board of Studies (BoS):	**Academic Council:**
20th BOS held on 08.08.2022	19th Academic Council held on 29.09.2022

MEE 7102	INDUSTRY INTERNSHIP	L	T	P	C
		0	0	0	2

COURSE OBJECTIVES:

COB1: To expose the activities carried out in typical mechanical industries and enable them gain knowledge on the tasks taken up by professionals in their field.

COB2: To impart hands on practice in facing and solving the problems experiencing in the Industry.

GENERAL GUIDELINES

- The students individually undertake training in reputed mechanical engineering companies in the fields like CAD,CAM, CAE etc.,during the summer vacation for a minimum duration of two weeks.
- The students should submit a certificate and evaluation form filled by concerned authority giving training during that period.
- At the end of training, a detailed report on the work done should be submitted within one month from the commencement of the semester.
- The students will be evaluated through a viva-voce examination by a team of internal staff assigned by the Professor In-charge or Head of the Department.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Face the Industry requirements with more courage and confidence.

CO2: Apply their knowledge in practical real-world problems and get industry ready

Board of Studies (BoS):	**Academic Council:**
20th BOS held on 08.08.2022	19th Academic Council held on 29.09.2022

MOOC (Related to project)	L	T	P	C
	0	0	0	0

COURSE OBJECTIVES:

COB1: To learn the basics principles and concepts of the topic in which a project work is undertaken by the student.

GENERAL GUIDELINES

- Students shall identify a MOOC course related to his/her project topic in consultation with the project supervisor.
- Student shall register for a MOOC course with minimum two credit offered by any recognized organization during the project phase I.
- Selection and completion of MOOC course by the students shall be endorsed by Head of the Department.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Familiarize the basic principles and concepts related to the topic of his/her project work.

CO2: Utilize the knowledge gained in the field of study to perform literature review with ease.

CO3: Formulate the experimental / analytical methodology required for the project work

Board of Studies (BoS):	**Academic Council:**
20th BOS held on 08.08.2022	19th Academic Council held on 29.09.2022

SEMESTER IV

MEE 7101	PROJECT WORK - PHASE II	L	T	P	C
		0	0	36	18

COURSE OBJECTIVES:

COB1: To provide opportunity for the students to exhibit their capacity in executing a project work and provide meaningful solution to a research or real world problem related to CAD-CAM.

GENERAL GUIDELINES

- Project work phase II is a continuation of phase I following the same guidelines.
- The project co-ordinator shall arrange to conduct three reviews to ascertain the progress of the work and award the marks based on the performance.
- Detailed experimental investigation / in-depth analytical study / fabrication of equipment /Development of CAD-CAM Models have to be performed in-line with the scope of investigation.
- The students are expected to analyse the obtained results and discuss the same in an elaborate manner by preparing necessary charts / tables / curves to get an inference.
- The important conclusions need to be drawn and scope for further research also to be highlighted.
- The outcome of project work shall be published in journals / conference of National or International importance.
- At the end, students should submit a report covering the various aspects of Project work.
- The typical components of the project report are Introduction, Need for present study, Scope of the Investigation, Literature review, Methodology / Experimental investigation / development of software packages, Results & discussion of experimental and analytical work, Conclusions, References etc.
- The deadline for submission of final Project Report / Thesis / Dissertation is within 30 calendar days from the last Instructional day of the semester.
- The project co-ordinator in consultation with head of the department and controller of examination shall arrange for an external expert

member to conduct the final viva-voce examination to ascertain the overall performance of the students in Project work.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Apply their practical knowledge and skill in Mechanical Engineering with specialization in CAD-CAM to solve real time problems

CO2: Utilize the creative ability and inference capability to prepare an appropriate scientific document and make effective presentations

Board of Studies (BoS):	**Academic Council:**
20th BOS held on 08.08.2022	19th Academic Council held on 29.09.2022

LIST OF PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVES ON CAD

		L	T	P	C
MEEY 006	**DESIGN OF HYDRAULIC AND**				
SDG: 9	**PNEUMATICSYSTEMS**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To learn about the design of hydraulic circuits.

COB2: To acquire knowledge on design of pneumatic circuits.

COB3: To familiarize with design of Hydro- Pneumatics circuits.

COB4: To gain knowledge on design of Electro- Pneumatics and Electro-Hydraulics circuits.

COB5: To study the design of Programmable Logic Circuits (PLC).

MODULE I DESIGN OF HYDRAULICS CIRCUITS L:9

Properties of hydraulic fluid -Concepts of fluid power - Hydraulic circuit devices- Selection of Devices-Design of circuits: Speed control, Synchronizing, Two handed safety control circuit, Regenerative circuit- Trouble shooting- Case studies.

MODULE II DESIGN OF PNEUMATICS CIRCUITS L:9

Properties of air – Perfect Gas Laws – Components: Compressor, Filters, Regulator, Lubricator, Muffler, Air control Valves and Quick Exhaust Valves-Pneumatic actuators -Selection of devices - Design of sequential multi-actuator circuits: Cascade and step counter methods- Integration of start selection, start restriction and emergency stop modules- Trouble shooting- Case studies.

MODULE III DESIGN OF HYDRO- PNEUMATICS CIRCUITS L:9

Hydro- Pneumatic system-hydro-pneumatic devices-Selection criteria-- Design of Circuits- Hydro-pneumatic breaking system-Pressure boosting water pump system- Trouble shooting- Case studies.

MODULE IV DESIGN OF ELECTRO- PNEUMATICS AND ELECTRO- HYDRAULICS CIRCUITS L:9

Electro- Pneumatic system-Electro-pneumatic devices: Servo valves, Solenoidvalves-Selection criteria- Design of electro-pneumatics circuits-

Trouble shooting- Case studies.

Electro- Hydraulic system-Electro- Hydraulic devices- Selection criteria- Design of electro- Hydraulic circuits- Trouble shooting- Case studies.

MODULE V DESIGN OF PROGRAMMABLE LOGIC CIRCUITS (PLC) **L:9**

PLC Components-Construction-Programming methods- Timers and counters- Programming using ladder logic diagrams-Simulation of PLC- Trouble shooting- Case studies.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Anthony Esposito, “Fluid Power with Application", 7th Edition, Pearson Education, 2013.
2. 2. Srinivasan R, "Hydraulic and Pneumatic Controls", 2nd Edition, Vijay Nicole Imprints Pvt. Ltd, New Delhi, 2010.

REFERENCES:

1. Majumdar, S.R, "Oil Hydraulic Systems: Principles and Maintenance", 28th Edition, McGraw-Hill, 2017.
2. John R. Hackworth, Programmable Logic Controllers: Programming Methods and Applications, Pearson Education India, 2008.
3. Ronald B. Walters, Hydraulic and Electro-Hydraulic Control Systems,Second edition, Springer Netherlands, 2014.
4. JojiParambath, Electro-pneumatics and Automation, Kindle Edition, 2020.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Design the hydraulic circuits.

CO2: Design the pneumatic circuits

CO3: Design the Hydro- Pneumatics circuits.

CO4: Design the Electro- Pneumatics and Electro-Hydraulics circuits.

CO5: Design the Programmable Logic Circuits (PLC).

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		H				L						H	H
CO2	M		H				L						H	H
CO3	M		H				L						H	H
CO4	M		H				L						H	H
CO5	M		H				L						H	H

Note: L - Low Correlation M - Medium Correlation H -High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The understanding the design of hydraulic, pneumatic systems and its components leads to construction of robust circuits and systems.

MEEY 009	MECHANICAL VIBRATIONS	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To learn the fundamentals of vibration

COB2: To acquire knowledge on systems with two degrees of freedom

COB3: To gain knowledge on systems with multi degree of freedom systems

COB4: To study about vibration of continuous systems

COB5: To familiarize with methods for measurement and control of vibration

MODULE I FUNDAMENTALS OF VIBRATION L:8

Review of Single degree system –Periodic and Harmonic motion - Response to arbitrary periodic excitations -Duhamel's Integral – Impulse Response function - Virtual work - Lagrange's equation - Single degree freedom forced vibration with elastically coupled viscous dampers - System Identification from frequency response - Transient Vibration – Laplace transformation formulation.

MODULE II TWO - DEGREE FREEDOM SYSTEMS L:10

Free vibration of spring mass system - Semi definite systems - Mass coupled system - Bending vibration of two degree of freedom system - Forced vibration - Vibration Absorber – Coordinate coupling - Vibration isolation.

MODULE III MULTI-DEGREE FREEDOM SYSTEM L:10

Normal mode of vibration- Influence coefficients - Flexibility Matrix and Stiffness matrix - Eigen values and Eigen vectors – Orthogonal properties - Forced Vibration by matrix inversion - Modal damping in forced vibration – Numerical methods for fundamental frequencies– Torsional vibrations

MODULE IV VIBRATION OF CONTINUOUS SYSTEMS L:8

Systems governed by wave equations - Vibration of strings - Vibration of rods and bars - Euler Equation for Beams - Effect of rotary inertia and shear deformation - Vibration of plates.

MODULE V VIBRATION MEASURMENT AND CONTROL L:9

Measurement of vibration - Free and Forced tests, FFT analyzer, Modal analysis - Methods of vibration control: Excitation reduction at source, balancing of rigid rotors, field balancing, detuning and decoupling

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Singiresu S Rao "Mechanical Vibrations", Prentice Hall, 2010.
2. Thomson W T, "Theory of Vibration with Applications", Ed.5, Prentice Hall of India, 1997.

REFERENCES:

1. Greham Kelly, “Mechanical Vibrations – Theory and Applications”, 2007.
2. V. P. Singh, “Mechanical Vibrations”, Dhanpat Rai & Co (P) Ltd., New Delhi, 2005.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe the fundamentals of vibration

CO2: Solve problems for systems with two degrees of freedom

CO3: Model the system with multi degree of freedom

CO4: Elucidate the vibration in continuous systems

CO5: Explain the methods for measurement and control of vibration

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M			L	L							L	H	L
CO2	M	H		L	L		M					L	H	M
CO3	M	H		L	L		M					L	H	M
CO4	M	H		L	L		M					L	H	L
CO5	M			L	L							L	H	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The understanding of vibrations, methods for measurement and control of vibration leads to construction of robust engineering systems.

MEE 011	TRIBOLOGY	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To learn about different types of surface interactions and friction in components.

COB2: To gain knowledge about different types of wear mechanism and surface treatments.

COB3: To acquire knowledge on the theory of lubrication.

COB4: To learn the design of fluid film bearings.

COB5: To familiarize with design of rolling element bearings.

MODULE I SURFACE INTERACTION AND FRICTION L:9

Surface Topography – Surface features - Properties and measurement – Surface interaction – Laws of friction- Adhesive Theory of Sliding Friction – Static friction -Rolling Friction – Friction in extreme conditions –Thermal considerations in sliding contact.

MODULE II WEAR AND SURFACE TREATMENT L:9

Types of wear mechanism – Laws of wear –Theoretical wear models- Abrasive wear – Adhesive wear – Fatigue wear – fretting wear – Cavitation wear - Wear of Metals and Non-metals - Wear tests– Surface treatments – Surface modifications –Laser processing – Instrumentation – International standards in friction and wear measurements.

MODULE III LUBRICATION THEORY L:9

Lubricants and their physical properties- Lubricants standards – Lubrication Regimes Hydrodynamic lubrication: Reynolds Equation, Thermal, inertia and turbulent effects, elasto, plasto and magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication.

MODULE IV DESIGN OF FLUID FILM BEARINGS L:9

Design and performance analysis of thrust and journal bearings – Full, partial, fixed and pivoted journal bearings design – Lubricant flow and delivery – Power loss, heat and temperature rotating loads and dynamic loads in journal bearings– Hydrostatic bearing design – Special bearings.

MODULE V ROLLING ELEMENT BEARINGS L:9

Geometry and kinematics – Materials and manufacturing processes – contact stresses – Hertzian stress equation – Load divisions – Stresses and deflection – Axial loads and rotational effects, Bearing life capacity and variable loads – ISO standards – Oil films and their effects – Rolling Bearings Failures

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Bharat Bhushan "Introduction to Tribology", Second Edition, John Wiley & Sons, Ltd, 2013.

REFERENCES:

1. G.W. Stachowiak & A.W .Batchelor , Engineering Tribology, Butterworth - Heinemann, UK, 2005.
2. S.K. Basu, S.N. Sengupta& B.B. Ahuja, "Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd, New Delhi, 2005.
3. Phakatkar H G and Ghorpade RR, "Tribology", NiraliPrakashan, 2009.
4. PrasantaSahoo "Engineering Tribology" PHI Learning Pvt. Ltd. 2005.
5. Neale M J, "Tribology Handbook", Elsevier, 1995.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain about different types of surface interactions and friction in components.

CO2: Describe the various types of wear mechanism and surface treatments.

CO3: Elucidate the theory of lubrication.

CO4: Design the fluid film bearings.

CO5: Design of rolling element bearings.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H						L					L	M	L
CO2	H				M		L					L	M	L
CO3	H				M		L					L	M	L
CO4	H		M		M		L					L	M	L
CO5	H		M		M		L					L	M	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The understanding of surface interactions in machine elements and the applications of lubrication leads to the design of robust mechanical system.

MEEY 012	MEASUREMENTS AND NDT	L	T	P	C
SDG: 9	(INTEGRATED LABORATORY)	2	0	2	3

COURSE OBJECTIVES:

COB1: To gain knowledge about advanced metrology

COB2: To familiarise with liquid penetrant, magnetic particle test and radiography

COB3: To study ultrasonic and acoustic emission techniques

COB4: To familiarise with thermography techniques

MODULE I ADVANCED METROLOGY L: 7 P:10

Tool Maker's microscope - Coordinate measuring machine (CMM): Contact and non-contact, Universal measuring machine - Machine vision technology - Surface roughness measurement: Contact and non-contact type – Advancement in machine tool metrology

MODULE II LIQUID PENETRANT, MAGNETIC PARTICLE TEST AND RADIOGRAPHY L:10 P:10

Non-destructive testing: Introduction, Classification and Applications - Liquid penetrant test: Principle, Inspection procedure, Characteristics of liquid penetrates, Different washable systems, Developers and Applications.

Magnetic particle test: Types, Methods of production of magnetic fields, Equipment's, Lighting setup, dry and wet magnetic particle test inspection procedure, Applications, Advantages and limitations.

Radiation sources: X rays and gamma, X-rays production and control methods, detection and measurement - Radiograph: Process of developing film, Film characteristics - Computed Radiography (CR) and Digital Radiography (DR) – X-ray fluorescence (XRF) and X-ray diffraction (XRD), Interpretation of radiograph- Applications.

MODULE III ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES L:7 P:10

Ultrasonic testing: Principle, Production of ultrasonic waves, Different types of waves, General characteristics of waves - Methods of testing: Angle beam testing, Immersion Ultrasonic Testing, Pulse echo method.

Acoustic emission: Principle, Acoustic Emission Signal Features,

Advantages and limitations, Instrumentation and applications.

MODULE IV THERMOGRAPHY L:6

Thermography: Principle, Thermal Energy, Heat Transfer Mechanisms – Emissivity, Thermal Testing Equipment, Thermal Detectors - Quantum Detectors – Thermal Imaging – Interpretation – Applications.

PRACTICALS:

LIST OF EXPERIMENTS

1. Inspection of tool wear using Tool Makers Microscope
2. Inspection of weld defects using Machine Vision system
3. Roughness measurement of a milled component using surface roughness machine.
4. Measurement of complex geometry component using CMM
5. Inspection of welds using Liquid Penetrant Test
6. Inspection of welds by Magnetic Particle Test – dry method
7. Detection and location of simulated emission in a rectangular plate - Acoustic emission test.

L – 30; P – 30; TOTAL HOURS: 60

TEXT BOOKS:

1. Beckwith, Mechanical Measurements, Pearson Education, 2007.
2. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
3. B. Raj, T. Jayakumar and M. Thavasimuthu, Practical Non-Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.
4. Non-Destructive Examination and Quality Control, ASM International, Vol.17, 9th edition, 1989.

REFERENCES:

1. B. D. Cullity, Elements of X-ray Diffraction, Prentice Hall, 3rd edition, 2001.
2. C.U. Grosse, Acoustic Emission Testing, Springer, 2008.
3. C. Hellier, Handbook of Non-Destructive Evluation, McGraw-Hill Professional, 1st edition (2001).
4. C.V. Subramanian, Practical Ultrasonics, Alpha Science International, 2006.
5. R. H. Bossi, F. A. Iddings and G.C. Wheeler, Radiographic Testing, American Society for Non-destructive Testing, 3rd edition, 2002.

6. Wolfgang Osten, NadyaReingand, Optical Imaging and Metrology: Advanced Technologies, Wiley-VCH, 2012.
7. Xavier P. V. Maldague, Non-destructive Evaluation of Materials by Infrared Thermography, Springer-Verlag London, 1993.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain about advanced metrology tools

CO2: Describe liquid penetrant, magnetic particle test and radiography techniques for engineering applications

CO3: Discuss ultrasonic and acoustic emission techniques

CO4: Explain about thermography techniques

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H			L			L		L			L	L	M
CO2	H			L			L		L			L	L	M
CO3	H			L			L		L			L	L	M
CO4	H			L			L		L			L	L	M

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The knowledge of advanced metrology and NDT techniques enables industry to identify flaws and move towards reliable manufacturing process and increases productivity.

MEEY 013	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To learn about the basics and applications of artificial intelligence

COB2: To gain knowledge about various search techniques

COB3: To familiarise with various knowledge base systems

COB4: To study basics of various machine learning models

COB5: To acquire knowledge about various deep learning techniques

MODULE I ARTIFICIAL INTELLIGENCE L:9

Artificial intelligence (AI): Definition, Evolution, Importance and Applications - Classification of AI systems with respect to environment - Intelligent Agents - types of agents - Expert Systems- Stages in the development of an Expert Systems - Difficulties in Developing Expert Systems -Applications of Expert Systems.

MODULE II SEARCH TECHNIQUES L:7

Search Techniques - Breadth-First Search-Depth-First Search -Heuristic Search: Best-First search, A* search and AO* search - Adversarial search

MODULE III KNOWLEDGE REPRESENTATION AND REASONING L:9

Knowledge based expert systems (KBES): Definition and Architecture - Knowledge base: First Order logic-1, First Order Logic-2, Inference of First Order Logic 1 and 2 - Solution extraction - Procedural control of reasoning - Planning and decision making

MODULE IV MACHINE LEARNING L:10

Machine learning (ML): Introduction, pipeline, Classification, Regression - Types of Learning: Supervised, Unsupervised, Reinforcement learning - Data pre-processing -Machine Learning terminologies: Features, Training and testing data, Cross validation, Outliers, Hypothesis -Supervised models: Support vector machine, Decision tree – Unsupervised Models: Measures of Similarity and Dissimilarity – Clustering: K-means - Model Selection - Generalization

MODULE V DEEP LEARNING L:10

Artificial Neural Networks - Need for deep learning -Deep learning models: Recurrent neural networks (RNN), Long Short Term memory (LSTM), Convolution Neural Networks (CNN) - Auto encoder -Generative Adversarial Networks – Bayesian Deep Learning – Deep Reinforcement Learning– Applications

L – 45; TOTAL HOURS: 45

TEXT BOOKS:

1. Stuart J Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach", 3rd Edition, Prentice Hall of India Pearson Education, New Delhi, 2018.
2. Elaine Rich, Kevin Knight and Shivashankar B Nair, "Artificial Intelligence", 3rd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2017.
3. Tom Mitchell, "Machine Learning", McGraw Hill, 2017.
4. Christopher M Bishop, "Pattern Recognition and Machine Learning Learning", Springer, 2011.
5. Thomas Farth, "Deep Learning: A Comprehensive Guide for Beginners", Atlantic Publishers, 2019.

REFERENCES:

1. EthemAlpaydin, "Introduction to Machine Learning", 3rd Edition, PHI Learning, 2015.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical learning", 2nd Edition, Springer, 2017.
3. Kevin Murphy, "Machine Learning - A Probabilistic Perspective", MIT Press, 2012.
4. Eugene Charniak, "Introduction to Deep Learning", MIT Press, London, 2018.
5. Ian Goodfellow, YoshuaBengio, Aaron Courville, "Deep Learning", MIT Press, 2016.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basics and application of artificial intelligence systems

CO2: Select the suitable search technique for a particular application.

CO3: Elucidate the various knowledge based system.

CO4: Describe the basics of various machine learning models

CO5: Explain the concepts of various deep learning techniques

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M			L				M	H	H	H	M	M
CO2	H	H	M		M				M	H	H	M	M	M
CO3	H	H	M		M				M	H	H	M	M	M
CO4	H	H	H		H				M	H	H	H	M	M
CO5	M	M	M		H				H	H	H	M	M	M

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Understanding of artificial intelligence and machine learning systems helps to automate and increases productivity in industries.

PROFESSIONAL ELECTIVES ON CAM

MEEY 021	ADVANCES IN MANUFACTURING	L	T	P	C
SDG: 9	TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES:

COB1: To learn the special machining process and the finishing processes.

COB2: To gain knowledge in various unconventional machining processes

COB3: To be conversant with the micro fabrication technology

COB4: To acquire knowledge on advances in machining process

COB5: To familiarize with the Artificial Intelligence and Expert systems

MODULE I SPECIAL MACHINING AND FINISHING PROCESS L:10

Deep hole drilling - Gun drills - Gun boring - Trepanning - Broaching – Diamond turning–Ultra precision grinding – Binderless wheel - Lapping - Honing – Micro finishing/Super finishing process - Abrasive flow machining – Magnetic abrasive finishing – Polishing.

MODULE II UNCONVENTIONAL MACHINING L:10

Principles, processes, various influencing parameters and applications of: Ultrasonic machining, Electro Discharge Machining, Electro Chemical Machining, Electron and Laser Beam Machining, Plasma Arc Machining, Water Jet Machining, Elastic emission machining and Ion Beam Machining

MODULE III MICRO FABRICATION L:7

Crystal growth and wafer preparation – Monolithic processing – Moulding – Printed circuit board hybrid and multi-chip module technology –Electronic material and processing–Stereolithographic surface acoustic wave (SAW) devices - Surface mount technology.

MODULE IV ADVANCES IN MACHINING PROCESS L:9

Micro machining – Bio-Manufacturing 4.0 – Cryogenic machining process – Minimum Quantity lubrication (MQL) / Minimum Quantity Cooling lubrication (MQCL) assisted machining process - Dry machining – Machining with high pressure cooling – Machining with solid lubricants.

MODULE V ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS **L:9**

Introduction - Pattern recognition - Control strategies - Heuristic search, Forward and Backward reasoning - Search algorithms - Game playing - Knowledge representation - structural representation of knowledge – Expert systems in manufacturing.

L – 45; TOTAL HOURS – 45

REFERENCES:

1. Benedict, G.F., "Non-Traditional manufacturing Processes", CRC press, 2011.
2. Mc Geough, J.A., "Advanced methods of Machining", Springer, 2011.
3. Madou.M.J., Fundamentals of Micro fabrication: The Science of Miniaturization, Second Edition, CRC Press, 2006. (ISBN: 0849308267)
4. SeropeKalpakjian, “Manufacturing Engineering and Technology”, Pearson Education, 2001.
5. A. Fazelfamili, Dana S. Nau and Steven H. Kim, “Artificial Intelligence Applications in Manufacturing”, AAAI Press,1992. (ISBN: 9780262560665)
6. ChanderPrakash, Sunpreet Singh, J. Paulo Davim, “Advanced Manufacturing and Processing Technology, CRC press, 2020. (ISBN 9780367275129)

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe the special machining and finishing processes.

CO2: Elucidate various unconventional machining processes.

CO3: Illustrate the micro fabrication technology

CO4: Explain the advances in machining process

CO5: Describe the Artificial intelligence and expert systems

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		L										M	H
CO2	M			M	L		L						M	H
CO3	M		M		L		L						M	H
CO4	L	M				L							H	H
CO5	M	M	L	M	L		M			M			H	M

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The knowledge of Unconventional machining process along with the Artificial intelligence together can create good surface finish on complex geometries to fulfil any designer’s requirement.

MEEY 022	CNC MACHINES AND COMPUTER AIDED MANUFACTURING	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

The objective of the course is

COB1: To study about basics of CNC machine tools

COB2: To gain knowledge about structure of CNC machine tools

COB3: To familiarize with drives and tooling systems used in CNC machine tools

COB4: To acquire knowledge about feedback and adaptive control of CNC machines

COB5: To learn about programming in CNC turning and machining centres

MODULE I INTRODUCTION TO CNC MACHINE TOOLS L:7

Evolution of CNC Technology: Principles, features, advantages, applications, CNC and DNC concept - Classification of CNC Machines: Turning centre, Machining centre- Features and applications: Automatic tool changers and Multiple pallet system, types of control systems - CNC controllers, characteristics - Interpolators.

MODULE II STRUCTURE OF CNC MACHINE TOOL L:9

CNC Machine building: Structural details, configuration and design - Guide ways: Friction, Anti friction and other types of guide ways -Elements used to convert the rotary motion to linear motion: Screw and nut, recirculating ball screw, rack and pinion, spindle assembly - Torque transmission elements: gears, timing belts, flexible couplings, Bearings -Swarf removal and safety considerations.

MODULE III DRIVES AND TOOLING SYSTEMS L:9

Spindle drives: DC shunt motor, 3 phase AC induction motor - Feed drives: stepper motor, DC and AC servomotors - Open loop and closed loop control - Tooling requirements for turning and machining centres - Introduction to cutting tool materials: Carbides, Ceramics, CBN, PCD inserts – Classification: qualified, semi qualified and preset tooling, coolant fed tooling system - Work holding devices for rotating and fixed work parts, modular fixtures.

MODULE IV FEEDBACK SYSTEMS AND ADAPTIVE CONTROL L:10

Feedback systems - Axis measuring system: Synchro, Synchro-resolver, Gratings, Moiré fringe gratings, Encoders, Inductosyn, Laser interferometer- Adaptive Control :Basic concepts, Adaptive control with constraints (ACC), Adaptive control with optimization (ACO), Geometric adaptive control (GAC) , Examples for ACC, ACO and GAC - Variable gain AC systems: Stability problem, Estimator algorithm, variable gain algorithm - Adaptive control of grinding process: Grinding model, Optimization strategy, Design of adaptive control for grinding - Sensors for adaptive control of CNC machine tools.

MODULE V CNC PROGRAMMING L:10

Coordinate system - Structure of a part program - G & M Codes: Tool length compensation, Cutter radius and tool nose radius compensation, Do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles - Programming for machining centre and turning centre - Generation of CNC codes from CAM packages - Basics of APT

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Rao. P.N, "*CAD/CAM"*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2002.
2. Radhakrishnan. P, "*Computer Numerical Control Machines*", New Central Book Agency, 2002.

REFERENCES:

1. Pabla. B.S &Adithan .M, "*CNC Machines*", New Age Publishers, New Delhi 2005.
2. "*Mechatronics*", HMT, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
3. Warren S. Seames, "*Computer Numerical Control: Concepts and Programming"* 4th edition, Delmar Thomson Learning Inc., 2002.
4. James Madison, "*CNC Machining Hand Book*", Industrial Press Inc., 1996.
5. Peter Smid, "*CNC Programming Hand book*", Industrial Press Inc., 2000.
6. YoramKoren, "*Computer Control of Manufacturing Systems"*, McGraw Hill Book Co, 2005.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Describe the basics of CNC machines

CO2: Explain the structure of CNC machine tools

CO3: Select suitable drives and tooling systems in CNC machine tool

CO4: Explain feedback and adaptive control system of CNC machines

CO5: Write simple programs for CNC turning and machining centres

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		L		L				L				M	L
CO2	H		L		M								H	H
CO3	H		L		M				L				M	M
CO4	H		L		H				L				H	H
CO5	H		L		L								H	M

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Learning CNC machines and computer aided manufacturing support technology development, research and innovation leads to sustainable enhancement in industries.

PROFESSIONAL ELECTIVES ON CAD/CAM MANAGEMENT

MEEY 032	INDUSTRIAL SAFETY MANAGEMENT	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To gain knowledge about the fundamentals of safety management.

COB2: To familiarize with industry operational safety

COB3: To acquire knowledge about industrial safety audit

COB4: To learn about industrial accident investigation and reporting

COB5: To study about the safety performance monitoring and training

MODULE I SAFETY MANAGEMENT L:9

Evaluation of modern safety concepts - Safety management functions:Safety organization, Safety department, Safety committee, Safety audit - Performance measurements and motivation - Employee participation in safety - Safety and productivity

MODULE II INDUSTRY OPERATIONAL SAFETY L:9

Safety in Engineering Industry – Safety in Operations of Hazardous Machines – Safety in welding and gas cutting – Safety in cold forming and hot working of metals – Work Permits for hot Work and Cold Work – Safety of Pressure vessels – Safety in inspection and testing – Safety in radiography.

MODULE III INDUSTRIAL SAFETY AUDIT L:9

Components of safety audit - Types of audits - Audit methodology - Non-conformity reporting (NCR) - Audit checklist and report – Review of inspection - Remarks by government agencies – Consultants and experts - Perusal of accident and safety records - Formats – Implementation of audit indication - Liaison with departments to ensure co-ordination –Check list – Identification of unsafe acts of workers - unsafe conditions in the shop floor-IS 14489: 1998 -Code of practice on occupational safety and health audit.

MODULE IV INDUSTRIAL ACCIDENT INVESTIGATION AND REPORTING L:9

Concept of an accident- Near miss incident - Reportable and non-reportable accidents - Reporting to statutory authorities – Principles of accident prevention – Accident investigation and analysis – Records for accidents - Departmental accident reports - Documentation of accidents – Unsafe act and condition – Domino sequence –Supervisory role – Role of safety committee –Cost of accident.

MODULE V INDUSTRIAL SAFETY PERFORMANCE MONITORING AND SAFETY TRAINING L:9

Calculation of accident indices : Frequency rate, severity rate, frequency severity incidence , incident rate , accident rate - safety “t” score, safety activity rate ,Total Injury illness incidence rate andNumber of lost workdays rate - Problems -Importance of safety training -Identification of training needs- Training methods - Role of government agencies and private consulting agencies in safety training .

L – 45; TOTAL HOURS – 45

TEXTBOOKS:

1. Ray Asfahl. C “Industrial Safety and Health Management” Pearson Prentice Hall, 2010.
2. Philip Hagan, “Accident Prevention Manual for Business and Industry”, N.S.C. Chicago, 13th edition, 2009.

REFERENCES:

1. “Lees, F.P & M. Sam Mannan, “Loss Prevention in Process Industries: Hazard Identification, Assessment and Control”, Butterworth-Heinemann publications, London, 4th edition, 2012.
2. “Occupational Health and Safety Management: A Practical Approach. Charles D. Reese, CRC Press, 2003.
3. Health and Safety: Risk Management Book by Tony Boyle,Routledge; 5th edition, 2018.
4. The Design, Implementation, and Audit of Occupational Health and Safety Management Systems (Workplace Safety, Risk Management, and Industrial Hygiene) Ron C. McKinnon, CRC Press; 1st edition December 2019.
5. Industrial Safety Management: A Practical Approach Book by Jack

E. Daugherty “Government Institutes Inc., 2004.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1. Explain the fundamentals of safety management

CO2: Describe the required safety precautions under various operating conditions.

CO3: Elucidate about safety audit reports.

CO4: Report the industrial accident investigation.

CO5: Discuss the safety performance monitoring and training.

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L					L						L	L	L
CO2	L					L						L	L	L
CO3	L			L	L	L						L	L	L
CO4	L			L		L				M		L	L	L
CO5	L					L				M		L	L	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The comprehensive understanding of Safety management principles and procedure enhance the safety of the manufacturing industries.

MEEY 034	MANUFACTURING INFORMATION SYSTEMS	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To acquire knowledge on manufacturing information systems

COB2: To study about manufacturing database

COB3: To gain knowledge on manufacturing resources planning system

COB4: To learn about manufacturing shop floor control system

COB5: To familiarize with advancements in manufacturing information systems

MODULE I MANUFACTURING INFORMATION SYSTEMS L:8

Introduction - Information needs of manufacturing - Information technology and information systems - Manufacturing information - Agile Manufacturing Information Systems - Manufacturing Database Integration.

MODULE II MANUFACTURING DATA BASES L:9

Database Systems: Database Models, Design and Normalization - General Database Management Issues -Applications of Relational Databases and Future Trends.

MODULE III MANUFACTURING RESOURCE PLANNING SYSTEMS L:7

Materials Requirements Planning - The evolution of order policies from Material Requirement Planning (MRP) to Manufacturing Resources Planning System (MRP II)–Manufacturing Resources Planning System (MRP II): concepts and applications

MODULE IV MANUFACTURING SHOP FLOOR CONTROL SYSTEM L:10

Manufacturing Consideration-Product and its structure, Inventory and Process Flow-Shop Floor Control: Data Structure and Procedure, Various Models- Order Scheduling Module - Input/output Module (IOM)Analysis - IOM Database -Stock Database

MODULE V ADVANCEMENT IN INFORMATION SYSTEM FOR MANUFACTURING **L:11**

Introduction - Concept of Strategic Information Systems, Objectives and function of Manufacturing Information Systems (MIS) -Classification of information system – The Evolution and use of Information Systems (IS) and Information Technology (IT) for competitive advantage -Computerized manufacturing information system - Case study.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Luca G. Sartori, "Manufacturing Information Systems", Addision-Wesley Publishing Company, 2019.

REFERENCES:

1. Franjo Cecelja, "Manufacturing Information and Data Systems Analysis, Design and Practice", Penton Press, 2017.
2. Davendranath G. Jha, "Computer Concepts and Management Information Systems", PHI Learning Pvt. Ltd, 2013.
3. Date. C.J, "An Introduction to Database Systems", Narosa Publishing House, 2004.
4. Orlicky. G, "Material Requirements Planning", McGraw-Hill Publishing & Co., 2016.

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1: Explain about manufacturing information systems

CO2: Describe various types of manufacturing database

CO3: Describe manufacturing resources planning system

CO4: Elucidate about shop floor control system

CO5: Explain the advancements in manufacturing information systems

Board of Studies (BoS):
20th BOS held on 08.08.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L			L					L	M		M	L
CO2	M	L		L	L				L	L	M		M	L
CO3	M	L			M					L	M		M	L
CO4	M	L			M					L	M		M	L
CO5	M	M			M				L	L	M		M	L

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The understanding of manufacturing information systems and its components leads to value addition in manufacturing industries.

OPEN ELECTIVE COURSES

OEEY 701	ANALYTICAL TECHNIQUES	L	T	P	C
SDG: 6, 7		3	0	0	3

COURSE OBJECTIVES:

To make the students to understand the

COB1: basics in data analysis

COB2: basics and principles in volumetric and gravimetric analysis

COB3: types and principles of electro analytical methods

COB4: principles and analysis of spectroscopic techniques

COB5: the principle and methods in chromatography and thermal analysis

MODULE I DATA ANALYSIS 9

Precision and accuracy, Classification of errors, methods of minimization and elimination of errors Mean and standard deviation; absolute and relative errors; students t-test, F-test, linear regression for deriving calibration plots, covariance and correlation coefficient

Statistics for analytical experimentation: Probability, Regression analysis, Data analysis and signal enhancement.

MODULE II VOLUMETRIC METHODS OF ANALYSIS 9

Different methods of expressing concentration terms, Difference between titrimetic and volumetric analysis, Types and roles of indicators - Principle and reactions involved in neutralization, precipitation, complexometric and redox titrations, calculations involving stoichiometry – for all types of systems - Gravimetric analysis (volatilisation and precipitation methods)

MODULE III ELECTROANALYTICAL METHODS 9

Types of electrodes - Conductometric Titrations - Potentiometric titrations - pH-metry and ion-selective electrodes - Amperometric titrations - Coulometric Titrations, DM Electrode - polarography - electrogravimetry - voltammetry, cyclic voltammetry, impedance studies - Electrochemical sensors, ISFETs, CHEMFETs.

MODULE IV SPECTROPHOTOMETRIC TECHNIQUES 9

Quantitative applications of Colorimetric analysis – UV-Visible spectrophotometry – *Atomic absorption spectroscopy* (*AAS*) - atomic

emission spectroscopy (AES), *Flame photometry*, ICP-AES - Fluorescence spectroscopy, Stern Volmer Equation and quantum yield calculation.

MODULE V CHROMATOGRAPHIC TECHNIQUES AND THERMAL METHODS 9

Chromatography**:** Paper, TLC and column Chromatography – Detectors in Chromatography - GC, HPLC, (hyphenated techniques GC/MS, LC/MS) and GPC -– ion exchange chromatography – Electrochromatography**:** Capillary electrophoresis and gel electrophoresis

Thermal analytical techniques: TGA, DTA, DSC, DMA – Chemisorption Techniques – TPD, TPO, TPR, TPS.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Skoog D.A., West D.M., Holler F.J. and Crouch S.R., Fundamentals of Analytical Chemistry, 8th Edition, Thomson Brooks/Cole Publication., Singapore, 2004.
2. Willard H.H., Merritt L.L., Dean J.A. and Settle F.A., Instrumental Methods of Analysis, 7th Edition, CBS Publication, New Delhi Reprint, 2004.
3. Skoog D.A., Holler F.J. and Nieman T.A., Principles of Instrumental Analysis, 5th Edition, Harcourt College Publication., Singapore, 1998.
4. Christian G.D., Analytical Chemistry, 6th Edition, John Wiley, Singapore, 2003.
5. Fifield F.W. and Kealey D., Principles and Practice of Analytical Chemistry, 5th Edition, Blackwell Publication, London, 2000.
6. Settle F. (Editor), Handbook of Instrumental Techniques for Analytical Chemistry, Pearson Education, Singapore, 2004.

COURSE OUTCOMES:

The student will be able to

CO1: analyse the numerical data without error

CO2: perform the volumetric and gravimetric analysis of chemical compounds and interpret the result

CO3: perform the electro analytical titrations and analyse the result

CO4: identify the appropriate spectral technique and do the spectral analysis and interpret the data

CO5: perform the chromatographic techniques and separate the compounds

Board of Studies (BoS):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	M		M											
CO2	H	M		M											
CO3	H	M		M		H									
CO4	H	M		M	M	H									
CO5	H	M		M	M	H									

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 6: Clean Water & Sanitation
SDG 7: Affordable and Clean Energy

Statement: Through various analytical methods, innovative, cheap and affordable materials can be developed and can be employed in the area of clean water, sanitation and energy

OEEY 702 ARTIFICIAL INTELLIGENCE AND IOT L T P C

SDG: 8 3 0 0 3

COURSE OBJECTIVES:

COB1: To learn the working of intelligent agents.

COB2: To study the various search techniques and optimization of search.

COB3: To represent knowledge in first order logic**.**

COB4: To know the fundamentals of IoT.

COB5: To learn the IoT architecture and protocol stack.

MODULE I ARTIFICIAL INTELLIGENCE INTRODUCTION 9

Artificial Intelligence Foundations - Artificial Intelligence History - Agents and Environments - Structure of Agents - Problem-Solving Agents - Search Algorithms - Uninformed Search Strategies - Informed (Heuristic) Search Strategies - Heuristic Functions.

MODULE II SEARCH OPTIMIZATIONS 9

Local Search and Optimization Problem - Continuous Spaces - Nondeterministic Actions - Partially Observable Environments - Online Search Agents and Unknown Environments - Constraint Satisfaction Problems – Backtracking Search – Adversarial Search and Games - Alpha Beta Search.

MODULE III KNOWLEDGE REPRESENTATION 9

Knowledge Based Agents – Propositional Logic – First Order Logic – Inference in First Order Logic – Forward Chaining – Backward Chaining.

MODULE IV IOT FUNDAMENTALS 9

Fundamentals of IoT – Characteristics of IoT – IoT architecture and Components – Logical Design of IoT – Communication Models – IoT Communication APIs.

MODULE V IOT ARCHITECTURE AND PROTOCOLS 9

Structure – Objectives – Three layer and Five Layer Architecture – Cloud and Fog based Architecture – IoT Network Protocol Stack - IoT Technology Stack – Case Study – Applications of AI in IoT.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson, Fourth Edition, 2020. ISBN: 978-0134610993.

2. Dr Kamlesh Lakhwani, Dr Hemant Kumar Gianey, Joseph Kofi Wireko, Kamal Kant Hiran, Internet of Things (IoT): Principles, Paradigms and Applications of IoT, BPB Publications, First Edition, 2020, ISBN: ISBN: 978-9389423365.

REFERENCES:

1. S. Kanimozhi Suguna, M. Dhivya, Sara Paiva, Artificial Intelligence (AI): Recent Trends and Applications, CRC Press, 2021, ISBN: 978-0-367-43136-5.
2. Vlasios Tsiatsis, Stamatis Karnouskos, Jan, Internet of Things: Technologies and Applications for a New Age of Intelligence, 2nd Edition, Academic Press, 2019, ISBN: 978-0-12-814435-0

COURSE OUTCOMES: The student will be able to

- Identify the suitable search algorithms for solving problems.
- Employ AI adversarial game search techniques while evaluating the application of more real world problems.
- Use first order logic for wide variety of applications, from planning and diagnosis to knowledge representation and reasoning.
- Apply the technologies, standards, and protocols that are best suited for low-level sensor nodes.
- Determine the most appropriate IoT Devices and Sensors based on case Studies.

Board of Studies (BoS) :
21st BoS of CSE held on 27.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2
CO1	H	M	H	L	M	-	L	-	-	L	-	M	H	M
CO2	H	H	H	L	M	-	L	-	-	L	-	H	M	H
CO3	H	H	H	L	L	-	-	-	-	L	-	L	M	H
CO4	H	M	H	L	L	-	-	-	-	-	-	M	M	H
CO5	H	H	H	L	L	-	-	-	M	-	M	M	H	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
Statement: The objective of AIoT is to improve human-machine interactions, IoT operations and data management and analytics.

OEEY 703	BIOMATERIALS	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: To enable the students understand importance of and properties of Biomaterials

COB2: To familiarize the students with different orthopaedic materials.

COB3: To understand different cardiovascular materials.

COB4: To help students study about materials in opthalmology

COB5: To make the students understand applications of various biomaterials

MODULE I BIOLOGICAL PERFORMANCE OF MATERIALS 9

Biocompatibility- Introduction to the biological environment – Material response: swelling and leaching, corrosion and dissolution, deformation and failure, friction and wear – Host response: the inflammatory process - coagulation and hemolysis- approaches to thrombo- resistant materials development.

MODULE II ORTHOPAEDIC MATERIALS 9

Bone composition and properties - temporary fixation devices - joint replacement – Biomaterials used in bone and joint replacement: metals and alloys – Stainless steel, cobalt based alloys, titanium based materials – Ceramics: carbon, alumina, zirconia, bioactive calcium phosphates, bioglass and glass ceramics – polymers: PMMA, UHMWPE/HDPE, PTFE – Bone cement – Composites.

MODULE III CARDIOVASCULAR MATERIALS 9

Blood clotting – Blood rheology – Blood vessels – The heart – Aorta and valves – Geometry of blood circulation – The lungs - Vascular implants: vascular graft, cardiac valve prostheses, cardiac pacemakers – Blood substitutes – Extracorporeal blood circulation devices.

probability-internal conversion- nuclear isomerism.

MODULE IV DENTAL MATERIALS 9

Teeth composition and mechanical properties – Impression materials – Bases, liners and varnishes for cavities – Fillings and restoration materials – Materials for oral and maxillofacial surgery – Dental cements and dental amalgams – Dental adhesives.

MODULE V MATERIALS IN OPTHALMOLOGY 9

Biomaterials in ophthalmology – Viscoelastic solutions, contact lenses, intraocular lens materials – Tissue grafts – Skin grafts – Connective tissue grafts – Suture materials – Tissue adhesives – Drug delivery: methods and materials – Selection, performance and adhesion of polymeric encapsulants for implantable sensors- biomemtic materials-Technology from nature.

L – 45; TOTAL HOURS –45

REFERENCES:

1. Sujata V. Bhat. Biomaterials, Narosa Publication House, New Delhi, 2002.
2. Jonathn Black. Biological Performance of Materials: Fundamentals of biocompatibility, Marcel Dekker Inc, New York, 1992.
3. D.F.Williams (editor). Materials Science and Technology: A comprehensive treatment, Volume 14. Medical and Dental Materials, VCH Publishers Inc, New York, 1992.
4. F.Silver and C.Doillon. Biocompatibility: Interactions of Biological and implantable materials. Volume I Polymers, VCH Publishers Inc, New York, 1989.
5. L.L.Hench and E.C.Ethridge. Biomaterials: An Interfacial Approach, Academic Press, 1982.
6. Joon Park, R. S. Lakes, Biomaterials. An Introduction, Springer, third edition, 2010. Springer

COURSE OUTCOMES:

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

CO1: importance and properties of biomaterial..

CO2: different classes of orthopaedic materials

CO3: different types of cardiovascular materials.

CO4: various types of materials used in ophthalmology.

CO5: applications of various biomaterials

Board of Studies (BoS) :	**Academic Council:**
BOS of Physics was held on 30.6.22	19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	L	L	L	M	M	M	M	M
CO2	H	M	M	L	L	M	L	L	L	L	L	M	M	M	M
CO3	H	M	M	L	L	L	L	L	L	L	L	M	M	M	M
CO4	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M
CO5	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 4 : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

OEEY 704	BIOMEDICAL INSTRUMENTATION	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the human physiological systems.

COB2: To know the different aspects of biosignal acquisition.

COB3: To understand the basics in biopotential recorders.

COB4: To know the importance methods, instruments available for biomedical field.

COB5: To analyze the special biomedical instrumentation systems.

MODULE I HUMAN PHYSIOLOGICAL SYSTEMS 9

Cells and their structure – Nature of Cancer cells – Transport of ions through the cell membrane – Resting and action potentials – Bio-electric potentials – Nerve tissues and organs – Different systems of human body. Biopotential Electrodes and Transducers Design of Medical instruments – components of the biomedical instrument system – Electrodes – Transducers.

MODULE II BIOSIGNAL ACQUISITION 9

Physiological signal amplifiers – Isolation amplifiers – Medical preamplifier design – Bridge amplifiers – Line driving amplifier – Current amplifier – Chopper amplifier – Biosignal analysis – Signal recovery and data acquisition – Drift Compensation in operational amplifier – Pattern recognition – Physiological Assist Devices. Pacemakers – Pacemakers batteries – Artificial heart valves – Defibrillators – nerve and muscle stimulators Heart – Lung machine – Kidney machine.

MODULE III BIOPOTENTIAL RECORDERS 9

Characteristics of the recording system – Electrocardiography (ECG) – Electroencephalography (EEG) – Electromyography (EMG) – Electroethinogrphy (ERG) and Electroculography (EOG) – Recorders with high accuracy – recorders for OFF line analysis.

MODULE IV OPERATION THEATRE EQUIPMENT 9

urgical diathermy- shortwave diathermy – Microwave diathermy – Ultrasonic disathermy – Therapeutic effect of heat – Range and area of irritation of different techniques – Ventilators – Anesthesia machine – Blood flowmeter –

Cardiac Output measurements – Pulmonary function analyzers – Gas analyzers – Blood gas analyzers – Oximeters – Elements of intensive care monitoring.

MODULE V SPECIALISED MEDICAL EQUIPMENTS 9

Blood Cell counter – Electron microscope – Radiation detectors – Photometers and colorimeters – digital thermometer – audiometers – X-rays tube – X-ray machine – image intensifiers – Angiography – Application of X-ray examination. Safety instrumentation: Radiation safety instrumentation – Physiological effects due to 50Hz current passage – Microshock and macroshock – electrical accident Hospitals – Devices to protect against electrical hazards – Hospitals architecture.

L – 45; TOTAL HOURS –45

REFERENCES:

1. Arumugam M., Biomedical Instrumentation, Anurada Agencies Publishers, 1992.
2. Khandpur R.S., Handbook of Biomedical Instrumentation, Third Edition, Tata McGraw-Hill Education, 2014.
3. Shakti Chatterjee and Aubert Miller, Biomedical Instrumentation Systems, Cengage Learning Publisher, 2010.
4. Gromwell L., Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Second Edition, Prentice Hall, 1980.

COURSE OUTCOMES:

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

CO1: the human physiological systems.

CO2: the different aspects of biosignal acquisition.

CO3: different biopotential recorders such as EEG, ECG, EMG, EOG

CO4: biomedical instruments involved in advanced operation theatres

CO5: the application of biomaterials towards specialized medical equipment such as electron microscope and radiation detectors

Board of Studies (BoS) :
BOS of Physics was held on 30.6.22

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	L	L	L	M	M	M	M	M
CO2	H	M	M	L	L	M	L	L	L	L	L	M	M	M	M
CO3	H	M	M	L	L	L	L	L	L	L	L	M	M	M	M
CO4	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M
CO5	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 4 : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

OEEY 705	BIOPHOTONICS	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: To know the role of light and its interaction in the cells and tissues.

COB2: To understand the different imaging techniques for the biological systems.

COB3: To know the concepts of spectroscopy in biological applications.

COB4: To understand the optical force spectroscopy.

COB5: To understand the role of Biophotonic materials in applications.

MODULE I INTERACTION OF LIGHT WITH BIOLOGICAL SYSTEMS **9**

Interaction of light with cells, tissues, nonlinear optical processes with intense laser beams, photo-induced effects in biological systems.

MODULE II IMAGING TECHNIQUES **9**

Imaging techniques: Light microscopy, wide-field, laser scanning - confocal, multiphoton, fluorescence lifetime imaging, FRET imaging - Frequency-Domain lifetime imaging. Cellular Imaging - Imaging of soft and hard tissues and other biological structures.

MODULE III SINGLE MOLECULE SPECTROSCOPY **9**

Single molecule spectroscopy: UV-VIS spectroscopy of biological systems, single molecule spectra and characteristics – IR and Raman spectroscopy and Surface Enhanced Raman Spectroscopy for single molecule applications.

MODULE IV OPTICAL FORCE SPECTROSCOPY **9**

Optical Force Spectroscopy: Generation optical forces – Optical trapping and manipulation of single molecules and cells in optical confinement - Laser trapping and dissection for biological systems - single molecule biophysics, DNA protein interactions.

MODULE V BIOSENSORS **9**

Biosensors, Principles- DNA based biosensors – Protein based biosensors–

materials for biosensor applications- fabrication of biosensors.

L – 45; TOTAL HOURS –45

REFERENCES:

1. Prasad. P.N., Introduction to Biophotonics, John Wiley & Sons, 2003
2. Michael P. Sheetz, Laser Tweezers in Cell Biology (Methods in Cell Biology), Vol.55, Academic Press Publishers, 1997.
3. Ranier .W, Nanoelectronics and Information Technology, Wiley Publishers, 2012.
4. Drexler. K.E., Nanosystems: Molecular Machinery, Manufacturing and Computation, Wiley Publishers, 1992.

COURSE OUTCOMES:

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

CO1: Make clear insights into the applications of light interaction with biological systems.

CO2: Compare different imaging techniques

CO3: Understand and analyse the various spectroscopic techniques used in biological system.

CO4: Effectively grasp the usage of the optical force spectroscopy.

CO5: Get clear ideas and communicate about the importance of use of spectroscopy in design of bio-photonic devices.

Board of Studies (BoS) : BOS of Physics was held on 30.6.22

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	L	L	L	M	M	M	M	M
CO2	H	M	M	L	L	M	L	L	L	L	L	M	M	M	M
CO3	H	M	M	L	L	L	L	L	L	L	L	M	M	M	M
CO4	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M
CO5	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 4 : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

OEEY 706 **DATA SCIENCE AND MACHINE LEARNING** **L T P C**

SDG: 8 **3 0 0 3**

COURSE OBJECTIVES:

CO1: To understand the needs of machine learning in Real Time.

CO2: To acquire knowledge about the data science in machine learning.

CO3: To study the Monte Carlo Sampling and processing.

CO4: To explore knowledge about real-time data analysis using various models.

CO5: To understand the deep learning.

MODULE I INTRODUCTION 9

Introduction to Artificial Intelligence - Machine Learning – Types of Machine Learning - Data preprocessing - Noise Removal - Data Transformation - Normalization - Importing, Summarizingand Visualizing Data – Statistics-Visualizing Data-Plotting Qualitative Variables and Quantitative Variables- Data Visualization in a Bivariate Setting

MODULE II MACHINE LEARNING ALGORITHMS 9

Introduction to Supervised and Unsupervised Learning-Linear Regression - Single Variable – Multivariate –Logistic - Naive Bayes - Decision Tree - Neural Network - Single Layer Perceptron - Multilayer BPN- Training and Test Loss-Statistical Learning-Estimating Risk-Modeling Data-Multivariate Normal Models-Bayesian Learning

MODULE III SAMPLING AND UNSUPERVISED LEARNING 9

Unsupervised Learning Algorithm -Clustering - Monte Carlo Sampling-Resampling-Markov Chain Monte Carlo-Monte Carlo Estimation-Monte Carlo for Optimization-Simulated Annealing – Cross-Entropy Method-Splitting for Optimization -Noisy Optimization-Risk and Loss in Unsupervised Learning – Expectation-Maximization (EM) Algorithm-EM Algorithm for Mixture Models-K-Means – KNN - Hierarchical

MODULE IV REGRESSION ANALYSIS AND REGULARIZATION 9

Linear Regression-Analysis via Linear Models-Model Selection and Prediction – Cross-Validation and Predictive Residual Sum of Squares-In-Sample Risk and Akaike Information Criterion-Inference for Normal Linear Models -Nonlinear Regression Models-Modeling Regularization-Reproducing Kernel Hilbert Spaces- Smoothing Cubic Splines- Gaussian Process Regression - Graphical Models - Bayesian Networks

MODULE V ADVANCED LEARNING 9

Semi-supervisory Learning - Reinforcement Learning Algorithm – Feed-Forward Neural Networks -Back-Propagation – QLearning-Methods for Training- Steepest Descent- Levenberg–Marquardt Method - Limited-Memory BFGS Method- Adaptive Gradient Methods-Simple Polynomial Regression -Image Classification

L – 45 ; TOTAL HOURS – 45

REFERENCES:

1. Alex Smola, S.V.N. Vishwanathan, Introduction to Machine Learning, Cambridge University Press, 2008.
2. Stephen Marsland, Machine Learning: An Algorithmic Perspective, Second Edition, Chapman & Hall/CRC, 2014.
3. Kroese, Dirk P., et al. Data science and machine learning: mathematical and statistical methods. Chapman and Hall/CRC, 2019.

COURSE OUTCOMES:

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

CO1: pre process the data

CO2: identify the suitable machine learning algorithm and apply the same to solve the given problem.

CO3: explain risk analysis and optimization algorithms.

CO4: apply the suitable regression method and regularization of data.

CO5: explore the applications of advanced learning.

Board of Studies (BoS): 17th BoS of IT held on 28.02.2023

Academic Council: 20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5
CO1	M	L			L
CO2	M	L		M	
CO3	L	L	L		L
CO4	M	L	L	H	
CO5	L	H	L		H

Note: L - Low Correlation M -Medium Correlation H -High Correlation

SDG 8: Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work.

Statement: The Learning algorithms helps to design and develop solutions for solving real world application in any engineering domain.

OEEY 707	ELECTRIC VEHICLE AND BATTERY STORAGE TECHNOLOGY	L	T	P	C
SDG:8,9		3	0	0	3

COURSE OBJECTIVES:

COB 1: To study the concept of electric vehicles

COB2: To get familiarized with EV and PHEV Energy Storage Systems

COB3: To learn the basics of various electric drive trains

COB4: To study about sensors and electric vehicle control

COB5: To study about electric vehicle and its environmental impact.

MODULE I INTRODUCTION TO ELECTRIC VEHICLE (EV) 9

A Brief History -Technology, benefits and challenges in comparison with IC engine - EV classification and electrification levels - degree of hybridization - Concept of Hybrid Electric Vehicle (HEV) – Working Principle of an HEV drive train - concept of electric, hybrid electric and plug-in hybrid electric vehicles – HEV drive train topologies - plug-in HEV drive train topologies.

MODULE II EV AND PHEV ENERGY STORAGE SYSTEMS 8

Battery parameters - Types of Battery : Lithium – Nickel – Sodium – Zinc – Lead Acid - Coin cell - Rechargeable Battery sealing – Ideal model, Linear model, Thevenin model – Battery Cell Voltage Equalization – Onboard power electronics battery management – Equalizer chaining method. Electrical Modeling of Ultra capacitors, Flywheel Energy Storage Systems and Renewable Fuel Cell Power Sources.

MODULE III FUEL CELL AND HYBRID ELECTRIC VEHICLE DRIVE TRAIN 10

Component Stage Based Efficiency Analysis of Series and Parallel HEV Drive Trains - Varied Driving Patterns and Regenerative Braking Efficiency Analysis - Overall Electric Drive Train Efficiency Analysis - Fuel Cell HEV: Modeling and Control - Power Electronics Interface of Fuel Cell and Traction System - Concept of Fuel Cell Plug-in HEV (FC-PHEV).

MODULE IV SENSORS AND VEHICLE CONTROL 11

Introduction, Basic Sensor Arrangement, Types of Sensors, Oxygen Sensor, Cranking Sensor, Position Sensor, Engine Oil Pressure Sensor, Linear and Angle Sensor, Flow Sensor, Temperature and Humidity Sensor, Gas Sensor, Speed and Acceleration Sensor, Knock Sensor, Torque Sensor, Yaw Rate Sensors, Tire Pressure Sensor,

Actuators.

Protocols: In vehicle Networking (IVN) - Local Interconnect Network(LIN) – Control Area Network (CAN) – Media Oriented System Transport (MOST) and FlexRay - Wireless Access in Vehicular Environment (WAVE).

MODULE V ENVIRONMENTAL IMPACT AND ENERGY MANAGEMENT 6

Vehicle pollution in context - alternative and sustainable energy used via the grid hybridization - V2G, G2V, V2B, V2H - energy consumption in braking and regeneration - brake system of EVs and HEVs.

L – 45; TOTAL HOURS:45

TEXT BOOKS:

1. Sheldon S. Williamson, “Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles”, Springer, 2013.
2. James Larminie and John Lowry, “Electric Vehicle Technology Explained”, John Wiley & Sons Ltd, 2nd edition, 2015.
3. M. Ehsani, Y. Gao, Stefano Lango, K.M.Ebrahimi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 3rd Edition,2018.

REFERENCES:

1. Tariq Muneer and Irene Illescas García, “The automobile, In Electric Vehicles: Prospects and Challenges”, Elsevier, 2017.
2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition, CRC Press, 2016.
3. Tom Denton, “Electric and Hybrid Vehicles” Routledge Publishers, 1st edition, March 2016.

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

CO1: identify the opportunities and challenges of advances in electric vehicles

CO2 : model battery system for any EV

CO3: model and choose a suitable drive scheme suitable for developing an EV

CO4: compute the performance parameter of sensors, actuators and to apply suitable technique for automotive communication

CO5: choose proper energy consumption method to integrate with grid

Board of Studies (BoS) : 18th BoS of EEE held on 10.02.2023

Academic Council: 20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12	PSO 1	PSO 2
CO1	L	H	L	L	M	L	L	H	L	M	M	L	H	L
CO2	H	L	L	L	L	L	H	L	L	L	L	L	L	H
CO3	L	H	M	L	M	L	L	L	M	L	M	L	M	M
CO4	M	L	H	L	L	L	M	L	H	L	L	H	L	L
CO5	L	L	L	L	H	L	L	L	L	L	H	L	L	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas to promote economic growth.

SDG No. 9 Industry, innovation and infrastructure

Statement:

The development of zero emission electric vehicles will meet out the desired needs such as new innovative systems for industry and establishing advanced infrastructure.

OEEY 708	GREEN BUILDING AND ENERGY	L	T	P	C
SDG: 11	MANAGEMENT	3	0	0	3

COURSE OBJECTIVES:

The objectives of the course are to impart knowledge on

COB1: the concept of green design

COB2: the basics of green design strategies

COB3: the elements of green building

COB4: the concept of green building materials

COB5: the concept of energy management.

MODULE I BASIC CONCEPTS 8

Green Design concepts and definitions - sustainability begins with climate - recent upsurge in the green building movement -incentives for building green - incentives and tax deductions-green building programs -defining sustainable communities-emerging directions- liability - spectacular landmarks

MODULE II DESIGN STRATEGIES 9

Conventional versus Green Delivery Systems- green design strategies- The Integrated Design Process (IDP) -the green-building project delivery process- the integrated multidisciplinary project team - design process for high-performance buildings -sustainable site selection-general considerations- site selection - development density and community connectivity –brown field redevelopment - alternative transportation -site development storm water design-heat-island effect - light-pollution reduction

MODULE III ELEMENTS OF GREEN BUILDING 9

Introduction to Green Building- Energy- Water- Materials and Resources - Sustainable Sites and Land Use - Indoor Environmental Quality- Life Cycle Assessment- Energy, water and materials efficiency- Commissioning process – fundamental commissioning –retro commissioning -enhanced commissioning

MODULE IV GREEN COMPOSITES FOR BUILDINGS 9

Concepts of Green Composites-low-emitting materials -adhesives, finishes, and sealants -paints and coatings- flooring systems- earthen building materials- building reuse -materials reuse- construction waste management-recycled materials regional materials- rapidly renewable materials- bamboo-cork - insulation- linoleum

straw-bale construction-wheat board - use and selection of green office equipment -certified wood- life-cycle assessment of building materials and products

MODULE V ENERGY MANAGEMENT 10

Energy Management – Definitions and significance – objectives – Characterising of energy usage – Energy Management program – Energy strategies and energy planning Energy Audit – Types and Procedure – Optimum performance of existing facilities – Energy management control systems- Low Energy Approaches to Water Management. Management of Solid Wastes.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Osman Attmann., “Green Architecture Advanced Technologies and Materials”, McGraw Hill, 2010.
2. Charles Kibert, J., “Sustainable Construction: Green Building Design and Delivery”, 2nd Edition, John Wiley and sons, 2007.
3. Moncef Krarti, “Energy Audit of Building Systems: an Engineering approach” CRC Press, LLC, Florida 2000.
4. “Alternative Building Materials and Technologies”. K.S.Jagadish, B.U. Venkataramareddy and K. S. Nanjundarao New Age International, 2007.

REFERENCES:

1. Doty S. and W. C. Turner, “Energy Management Hand book”, Fairmont Press, 2009.
2. LEED - Practices, Certification and Accreditation Handbook”. Sam Kubba, Butterworth-Heinemann, 2009.

COURSE OUTCOMES:

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

CO1: describe the basics of green design concept.

CO2: explain the concepts of green design strategies.

CO3: illustrate the elements of green building.

CO4: summarize the different green building materials.

CO5: describe the concept of energy management.

Board of Studies (BoS) : Academic Council:

17th BOS of CE held on 10.08.2022 20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	L	-	-	L	H	-	-	-	-	-	L	-	M
CO2	-	-	L	-	-	L	H	-	-	-	-	L	L	-	M
CO3	-	-	L	-	-	L	H	-	-	-	-	-	L	-	M
CO4	-	-	M	-	-	L	H	-	-	-	-	L	L	-	M
CO5	-	-	L	-	-	M	H	-	-	-	-	-	L	-	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

Statement : The understanding of basics of green concepts, materials, energy management and leads to the development of sustainable building

OEEY 709	INDUSTRY 4.0 AND APPLICATIONS	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To describe the concepts, trends and the paradigm of Industry 4.0

COB2:To analyze the IoT technologies for practical IoT applications

COB3: To develop the ability to use Internet of Things related protocols and connectivity methods

COB4:. To elaborate the business issues in Industry 4.0.

COB5: To select the appropriate design concepts of Industrial IoT systems for various application

PREREQUISITES: Basic concepts in automation

MODULE I INTRODUCTION TO INDUSTRY 4.0 9

The Various Industrial Revolutions, Digitalization and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0, The Journey so far: Developments in USA, Europe, China and other countries, Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation

MODULE II ROAD TO INDUSTRY 4.0 & RELATED DISCIPLINES 9

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Smart Manufacturing, Smart Devices and Products, Smart Logistics, Smart Cities, Predictive Analytics, Cyber physical Systems, Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Support System for Industry 4.0, Cyber Security.

MODULE III DATA INFORMATION AND COLLABORATION 9

Resource-based view of a firm, Data as a new resource for organizations, Harnessing and sharing knowledge in organizations, Cloud Computing Basics, Cloud Computing and Industry 4.0

MODULE IV BUSINESS ISSUES IN INDUSTRY 4.0 9

Opportunities and Challenges, Future of Works and Skills for Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world.

MODULE V INDUSTRY 4.0 APPLICATIONS 9

Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security, Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Alp Ustundag and Emre Cevikcan, “Industry 4.0: Managing the Digital Transformation”, Springer, 2017.
2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things" A press, 2017.
3. Deepak Gupta, Victor Hugo C. de Albuquerque, Ashish Khanna, Purnima Lala Mehta, "Smart Sensors for Industrial Internet of Things: Challenges, Solutions and Applications", Springer, 1st Edition, 2021.
4. Francis daCosta, “Rethinking the Internet of things: A Scalable Approach to Connecting Everything”, Apress, 2014.

REFERENCES:

1. Christoph Jan Bartodziej, "The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics", Springer, 2016.
2. Gary Smart, "Practical Python Programming for IoT: Build advanced IoT projects using a Raspberry Pi 4, MQTT, RESTful APIs, Web Sockets, and Python 3", Pckt Publishing, 2020

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: apply the basic concepts and principles of Industry 4.0

CO2:identify, formulate and solve engineering problems using Industrial IoT

CO3:describe basics of cloud computing with IoT capability

CO4:discuss the challenges of the industry through IoT techniques

CO5:develop a domain specific IoT system

Board of Studies (BoS) :
24th BOS of ECE held on 08.02.2023.

Academic Council:
20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12	PSO1	PSO2	PSO3
CO1	H	H	M	M	L	L	L	L	L	L	L	L	H	H	H
CO2	M	H	M	M	L	L	L	L	L	L	L	L	H	H	H
CO3	M	M	L	M	L	L	L	L	L	L	L	L	H	H	H
CO4	H	M	M	M	L	L	L	L	L	L	L	L	H	H	H
CO5	H	H	M	M	L	L	L	L	L	L	L	L	H	H	H

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation,

Statement: Able to apply the theoretical concepts for the various application in Industry 4.0

OEEY 710 NANOTECHNOLOGY AND CATALYSIS L T P C
SDG: 6,7,9,15 3 0 0 3

COURSE OBJECTIVES:

To make the student conversant with

COB1: basic knowledge on nanoscience and nanotechnology which includes the exotic properties of materials at nanoscale including various techniques for the processing of nanomaterials

COB2: various techniques available for the characterization of nanostructured materials

COB3: applications in selected fields and impacts of nanotechnology in ecosystem

COB4: Impart the basic concepts involved in catalytic processes.

COB5: Understand the importance of heterogeneous catalysis.

MODULE I INTRODUCTION AND PREPARATION OF NANOMATERIALS 9

Introduction to nanomaterials, Properties of nanomaterials, Nanostructures: Zero-, One-, Two- and Three-dimensional structures, Surface Plasmon Resonance, Change of bandgap; Methods of preparation of nanomaterials, top-down approach and bottom-up: Chemical precipitation and coprecipitation; Sol-gel synthesis; Ball milling synthesis; lithography, Plasma Laser deposition (PLD) techniques, Thermolysis routes (Solvothermal, Hydrothermal and pyrolysis), Microwave assisted synthesis; Sonochemical synthesis; Electrochemical synthesis.

MODULE II CHARACTERIZATION TECHNIQUES 9

Structural Characterization: X-ray diffraction, Scanning Electron Microscopy (SEM/HR-SEM/FE-SEM) with EDS, TEM (HR-TEM) and SAED analysis, Atomic force Microscopy (AFM). X-ray Photoelectron spectroscopy (XPS), Raman analysis. Introduction to advanced Scanning Probe Microscopy Techniques Scanning Tunnelling Mode (STM), Piezoelectric force microscopy (PFM). DLS and zeta potential analysis. BET surface area analysis, CHNSO micro analysis.

MODULE III APPLICATIONS AND ENVIRONMENTAL IMPACTS 9

Current applications - Short-term Applications - Long - term Applications – Energy filed - solar cells, military battle suits. Biomedical applications –

Photodynamic therapy in targeted drugs - quantum dot technology in cancer treatment, MRI applications. Nanosensors: pH, heat, humidity, gas, toxic chemicals sensors and sensors for aerospace and defence – biosensors – water remediation - Environmental Impacts: toxicological health effects, relevant parameters in nanoparticles toxicology, integrated concept of risk assessment of nanoparticles.

MODULE IV CONCEPTS OF CATALYSIS 9

Acid-base catalysis – catalysis by transition metal ions and their complexes – supported transition metal complexes as catalysts – catalysis by enzymes – phase transfer catalysis - photocatalysis – adsorption – chemisorption on metals, metal oxides and semiconductors - kinetics of unimolecular and bimolecular surface reactions - Contact time - WHSV - time on stream - Catalyst deactivation and regeneration, TOF, TON.

MODULE V HETEROGENEOUS CATALYSTS 9

Metals, metal oxides, mixed metal oxides, supported metals, spinels, perovskites, super acids, hydrotalcites, zeolites and zeotypes (small, medium, large), shape selective catalysts, mesoporous materials (SBA, MCM, KIT, AlPOs, MOFs, COFs) Hydrothermal synthesis, sol-gel process, impregnation method, ion-exchange method - Operations in catalyst manufacture - drying, calcination, spray drying, Reactors- fixed bed and flow reactors.

L – 45; TOTAL HOURS – 45

REFERENCES:

1. T. Pradeep, Nano: The Essentials, Tata McGraw-Hill, New Delhi, 2007.
2. G. Cao, Nanostructures and Nanomaterials –Synthesis, Properties and Applications, Imperial College Press, London, 2004.
3. C. N. R. Rao, A. Muller and A. K. Cheetham, The Chemistry of Nanomaterials, Volume 1, Wiley –VCH Verlag GmbH & Co. KgaA, Weinheim, 2004.
4. G. A. Ozin, A. C. Aresnault, L. Cadematriri, Nanochemistry: A chemical approach to nanomaterials, RSC Publishing, 2008
5. J. Rajaram and J.C. Kuriacose, Kinetics and Mechanisms of Chemical Transformations, Macmillan Publishers India Limited, 2000.
6. B. Viswanathan, S. Sivasanker and A.V. Ramaswamy (Editors), Catalysis

COURSE OUTCOMES:

The students will be able to

CO1: differentiate the nanomaterials based on their dimensions and acquire knowledge of various synthetic methods

CO2: understand the components of instrumental techniques of and characterization techniques for structural and properties of nanomaterials

CO3: select the appropriate nanomaterials for specific applications in the interested arena

CO4: Find the fundamentals of catalysis

CO5: Evaluate significance of heterogeneous catalysts.

Board of Studies (BoS): 12th BoS of Chemistry held on 22.07.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		L		M	H	H									
CO2	M			H	M	H									
CO3					H	M									
CO4															
CO5															

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 6: Clean Water and Sanitation

SDG 7: Affordable & Clean Energy

SDG 9 : Industry and Innovation

SDG 15 : Life on Land

Statement:

SDG 6, 7 & 9: Foundation to work in R&D of renewable energy and sensors sector and for teaching career.

SDG 15: R&D labs in API labs in the production novel materials for various applications

OEEY 711	PROJECT MANAGEMENT	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To learn the concepts of organizational project management.

COB2: To acquire knowledge on leadership in project management.

COB3: To gain knowledge in stakeholder management and program management

COB4: To familiarize with the project scope and time management

COB5: To be conversant with project execution, monitoring and closing.

MODULE I INTRODUCTION – ORGANIZATIONAL PROJECT MANAGEMENT L:9

Introduction to Organizational Project Management- Organizational Project Management Framework- Project Linkages to Strategic Management - Relationships between Portfolio, Program, and Project Management - Organizational Issues and Project Management.

MODULE II PROJECT MANAGEMENT - LEADERSHIP L:9

Importance of Leadership in Project Management-Roles and Responsibilities of a Project Manager-Leadership vs. Management-Project Management Leader's Portfolio-Technical Management skills -Project Entrepreneurship skills- Project Leadership skills

MODULE III PROJECT STAKE HOLDER MANAGEMENT AND PROGRAM MANAGEMENT L:9

Project Stakeholder Management-Stakeholders Identification and Assessment - Stakeholders vs. Project Lifecycle - Stakeholders and Interested Parties- Program Management - Program Characteristics - Programs vs Projects - Programs vs Portfolios

MODULE IV PROJECT SCOPEAND TIME MANAGEMENT L:9

Project Scope: Planning, Defining, Verification and Change control -Project Activity sequencing -Precedence diagram method- Arrow diagram method – Project Activity Time Estimation -Tools for Activity Time Estimation -Schedule development – Resource levelling heuristics

MODULE V PROJECT EXECUTION,MONITORING AND L:9

CLOSING

Execution phase overview-Delegating tasks -Assessing project status - Foreseeing future challenges - Managing progress and timeline adjustments Project execution guidelines - Monitoring phase overview - Key Performance Indicators -Evaluating progress-Assessing work quality -Setting quality assurance procedures -Monitoring risks -Closing phase overview -Obstacles in the closing phase -Evaluating project performance-Final reports and managing records -Project closing guidelines

L – 45; TOTAL HOURS – 45

TEXTBOOKS:

1. Projects: Planning, Analysis, Financing, Implementation and Review, Prasanna Chandra, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
2. Jack. R. Meredith, Samuel. J. Mantel & Scott. M. Shafer, Project Management in Practice, Fifth Edition, Bangalore: Wiley, 2015

REFERENCES:

1. Project Management and Control, Narendra Singh, Himalaya Publishing, New Delhi, 2015.
2. Bob Hughes, Mike Cotterrel “Software Project Management”, Tata McGraw-Hill, 2009
3. A Guide to the Project Management Body of Knowledge (PMBOK® Guide)–Sixth Edition, Author& publisher - Project Management Institute 2017
4. Lean Project Management: Philip Small, Arkham Publishing Limited, March 2020

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1:Explain the concepts of organizational project management

CO2: Discuss the leadership in project management.

CO3: Elucidate the stakeholder management and program management

CO4: Explain project scope and time management

CO5: Describe project execution, monitoring and closing

Board of Studies (BoS) :
21st BOS of Mechanical Engg. held on 10.02.2023.

Academic Council:
20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L		L	M		H							M	L
CO2	L		M	L		L							L	H
CO3	M		M	H		L							H	M
CO4	L		L	L		M							L	M
CO5	L		M	L		L							H	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The comprehensive understanding of Project management principles and techniques brings prosperity, create jobs, and build prosperous equitable societies across the country

OEEY 712	REAL TIME EMBEDDED SYSTEMS	L	T	P	C
SDG: 4,9		3	0	0	3

COURSE OBJECTIVES:

COB1: To define the fundamental concepts of real time systems

COB2: To analyze the various uniprocessor and multiprocessor scheduling mechanisms

COB3: To develop knowledge on programming languages and tools for real time systems.

COB4: To discuss the overview of real time data bases

COB5: To classify the fault tolerance and evaluation techniques in real time systems.

PREREQUISITES: Embedded Systems, Operating Systems

MODULE I INTRODUCTION : EMBEDDED SYSTEMS & REAL TIME SYSTEMS **9**

Introduction –Embedded system - characterizing real time system -Performance Measures for Real Time Systems – Estimating Program Run Times – Task Assignment and Scheduling.

MODULE II PROGRAMMING LANGUAGES AND TOOLS **9**

Desired language characteristics – ADA language - Data typing – Control structures – Facilitating Hierarchical Decomposition- Packages- Run time Error handling – Overloading and Generics – Multitasking – Timing Specifications – Programming Environments – Run time support.

MODULE III REAL TIME DATABASES **9**

Basic Definition, Real time Vs General Purpose Databases- Main Memory Databases- Transaction priorities-Transaction Aborts-Concurrency control issues-Disk Scheduling Algorithms-Two – phase Approach to improve Predictability – Maintaining Serialization Consistency – Databases for Hard Real Time Systems.

MODULE IV REAL TIME COMMUNICATION **9**

Communications media, Network Topologies, Protocols- contention based, Token based, Stop-and-Go multihop, Polled Bus, Hierarchical Round Robin Protocol, Deadline-Based Protocols, Fault Tolerant Routing.

MODULE V FAULT TOLERANT AND EVALUATION TECHNIQUES 9

Fault Tolerance Techniques – Fault Types – Fault Detection-Fault and Error containment- Redundancy- Reliability Evaluation Techniques – Software error models.

L –45 ; TOTAL HOURS –45

TEXT BOOKS:

1. C.M. Krishna, Kang G. Shin, “Real – Time Systems”, McGraw – Hill International Editions, 2010.
2. Rajib Mall,”Real-time systems: theory and practice”, Pearson Education, 2007.

REFERENCES:

1. Xiaocong Fan, “Real-Time Embedded Systems: Design Principles and Engineering Practices”, Elsevier, 2015.
2. Albert M. K. Cheng, “Real-Time Systems: Scheduling, Analysis, and Verification“, Wiley publishers, 2003.
3. P. A. Laplante," Real-Time Systems Design & Analysis", Willey, 2011.
4. Qing Li, "Real Time Concepts for Embedded Systems", Elsevier, 2011.

COURSE OUTCOMES:

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

CO1: describe the characteristics of real time system.

CO2: apply scheduling algorithms based on the application.

CO3: discuss about the programming language characteristics and tools of real time systems.

CO4: choose the appropriate real time communication protocols.

CO5: analyze the fault tolerance and evaluation techniques in real time systems.

Board of Studies (BoS) :
24th BOS of ECE held on 08.02.2023.

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO 3

CO1	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H
CO2	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H
CO3	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H
CO4	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H
CO5	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
Statement: Understanding of the real time systems will bring practical knowledge on quality education.

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation
Statement: capable of promoting industrialization through the application of real-time system design principles.

OEEY 713	ROBOTIC TECHNOLOGY	L	T	P	C
SDG: 9		3	0	0	3

OBJECTIVES:

COB1: To study the basics of robotics technology.

COB2: To acquire knowledge about robot operating system.

COB3: To familiarize with robot assembly and aerial robots.

COB4: To learn about futuristic robots.

COB5: To know about the application of robots in various fields.

MODULE I INTRODUCTION L:6

Robot – Definition – Robot Anatomy – Co-ordinate Systems - Work envelope: Types and classification – Specifications – Pitch, Yaw, Roll, and Joint notations - Speed of motion - Pay load – Robot Parts and their functions – Need for robots.

MODULE II ROBOT OPERATING SYSTEM L:10

Master – Node – Topic – Messages – Subscriber – Publisher – Robot Operating System (ROS) packages – ROS file system – Services and actions – Custom publisher – Custom subscriber – ROS topic list and ROS topic information -ROS topic echo – ROS topic pub – Custom messages.

MODULE III ROBOT ASSEMBLY AND AERIAL ROBOTS L:12

Robotic assembly automation - Parts presentation methods - Assembly operations - Assembly system configurations - Design for robot assembly - Basics of aerial robots - Modelling and control of small Unmanned Aerial vehicles - Guidance and navigation of small range aerial robots.

MODULE IV FUTURE TECHNOLOGY L:9

Wheeled and legged Robot – Legged locomotion and balance – Arm movement, Gaze and auditory orientation control – Facial expression – Hands and manipulation – Sound and speech generation – Motion capture/Learning from demonstration.

MODULE V APPLICATIONS L:8

Implementation of Robots in Industries - Industrial application for material handling: machine loading and unloading, assembly, and inspection– Applications of robot in Arc welding, Spot welding, and Spray painting - Robots

in Assembly operation, Cleaning and underwater applications –Applications of Robots in Agriculture, Mining, Defense, Nuclear, Medical, and Space.

L – 45; TOTAL HOURS – 45

TEXTBOOKS:

1. Robert J. Schilling, “Fundamentals of Robotics Analysis and Control”, PHI Learning.,2009.
2. Richard D. Klafter, Thomas. A, ChriElewski, Michael Negin, “Robotics Engineering an Integrated Approach”, Phi Learning.,2009
3. YoonSeokPyo, HanCheol Cho, RyuWoon Jung, TaeHoon Lim, ROS Robot Programming.
4. M.P.Groover, “Industrial Robotics – Technology, Programming and Applications”, McGraw Hill, 2001.

REFERENCES:

1. Bernard Hodges, “Industrial Robotics”, Second Edition, Jaico Publishing house, 1993.
2. Tsuneo Yohikwa, “Foundations of Robotics Analysis and Control”, MIT Press., 2003.
3. John J. Craig, “Introduction to Robotics Mechanics and Control”, Third Edition, Pearson,2008.
4. Craig.J. J, “Introduction to Robotics Mechanics and Control”, Addison-Wesley, 1999.Robotics Lab manual, 2007.

COURSEOUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basics of robots.

CO2: Elucidate robot operating system.

CO3: Discuss about robot assembly and aerial robots.

CO4: Describe the future robot technology.

CO5: Explain the applications of robots.

Board of Studies (BoS) :
21st BOS of Mechanical Engg. held on 10.02.2023.

Academic Council:
20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		M			M					L	L	H	M
CO2	M		M			M					L	L	H	M
CO3	M		M			M					L	L	H	M
CO4	M		M			M					L	L	H	M
CO5	M		M			M					L	L	H	M

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The holistic knowledge of robot technology, its operating system, and future robot helps in developing robots for various applications.

OEEY 714 SOFT COMPUTING TECHNIQUES L T P C
SDG:8,9 3 0 0 3

COURSE OBJECTIVES:

COB 1: To enumerate the strengths and weakness of soft computing
COB2 To focus on the basics of neural networks
COB3: To learn the basics of fuzzy systems and hybrid Neurofuzzy systems
COB4: To emphasize the role of evolutionary computing algorithms
COB5: To learn the ANN, FIS and GA tool boxes for various soft computing applications.

MODULE I BASICS OF SOFT COMPUTING 8

Soft computing – Hard Computing – Artificial Intelligence as the basis of soft computing – Relation with logic driven and statistical method driven approaches- Expert systems – Types of problems: Classification, Functional approximation, Optimizations – Modeling the problem – Machine Learning – Hazards of Soft Computing – Current and future areas of research.

MODULE II ARTIFICIAL NEURAL NETWORK 10

Artificial Neuron – Multilayer perceptron – Supervised learning – Back propagation network –Types of Artificial Neural Network: Supervised Vs Un Supervised Network – Radial basis function Network – Self Organizing Maps – Recurrent Network – Hopfield Neural Network – Adaptive Resonance Theory – Issues in Artificial Neural Network – Applications.

MODULE III FUZZY SYSTEMS 10

Fuzzy Logic – Membership functions – Operators – Fuzzy Inference systems – Other sets: Rough sets, Vague Sets – Fuzzy controllers - Cooperative Neuro fuzzy systems – Neural network driven fuzzy reasoning – Hybrid Neuro fuzzy systems – Construction of Neuro Fuzzy systems: Structure Identification phase, Parameter learning phase – Applications.

MODULE IV EVOLUTIONARY COMPUTING & ALGORITHMS 7

Overview of evolutionary computing – Genetic Algorithms and optimization – Genetic Algorithm operators – Genetic algorithms with Neural/Fuzzy systems – Variants of Genetic Algorithms– Population based incremental learning – Meta heuristic algorithms - Evolutionary strategies and applications.

MODULE V MATLAB TOOL BOX FOR SOFT COMPUTING 10

Artificial Neural Network (ANN) Toolbox - training and testing with different activation

functions- controller design using ANN toolbox Fuzzy Inference System (FIS) Editor and tool box- fuzzy controller design - Genetic Algorithm Toolbox - Application of ANN, FIS and GA tool box to various power system and control applications.

L – 45; TOTAL HOURS – 45

TEXT BOOK:

1. Samir Roy, “Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms”, Pearson, 2013

REFERENCES:

1. Anupam Shukla, Ritu Tiwari and Rahul Kala, “Real life applications of Soft Computing”, CRC press, 2010.
2. Fakhreddine O. Karray, “Soft Computing and Intelligent Systems Design: Theory, Tools and Applications”, Pearson, 2009
3. Matlab Simulink Manual

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

CO1: enumerate the theoretical basis of soft computing

CO2 : explain the Neural network architecture and different learning rules

CO3: apply the fuzzy systems and hybrid Neurofuzzy systems

CO4: demonstrate the different evolutionary and metaheuristic algorithms

CO5: demonstrate the most appropriate soft computing technique for a given situation using MATLAB tool box.

Board of Studies (BoS) :
18th BoS of EEE held on 10.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12	PSO 1	PSO 2
CO1	L	H	L	L	M	L	L	H	L	M	M	L	H	L
CO2	H	L	L	L	L	L	H	L	L	L	L	L	L	H
CO3	L	H	M	L	M	L	L	L	M	L	M	L	M	M
CO4	M	L	H	L	L	L	M	L	H	L	L	H	L	L
CO5	L	L	L	L	H	L	L	L	L	L	H	L	L	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas to promote economic growth.

SDG No. 9 Industry, innovation and infrastructure

Statement:

The development of soft computing techniques will meet out the desired needs such as new innovative systems for industry and establishing advanced infrastructure.

OEEY 715	STRUCTURAL INTERPRETATION OF	L	T	P	C
SDG: 4, 9	MATERIALS	3	0	0	3

COURSE OBJECTIVES:

To use the concepts (basic and advanced level) of analytical methods for structure elucidation of materials and the students will be trained for the

COB1: Interpretation of electronic spectral data of materials

COB2: Interpretation of magnetic spectral data of materials

COB3: Interpretation of structural and morphological data of materials

COB4: Interpretation of thermoanalytical data of materials

COB5: Interpretation of electrochemical and XPS data of materials

MODULE I ELECTRONIC DATA 9

UV-visible, fluorescence and phosphorescence: Characteristic absorption of simple chromophoric groups, conjugated/ aromatic/ ligand systems, metal complexes and materials. FT-IR and Raman: Characteristic group frequencies of organic, inorganic molecules and various materials (polymer, nano, semiconducting) Interpretation of organic and inorganic and hybrid materials using combination of the spectral data.

MODULE II MAGNETIC AND MASS DATA 9

Solid-state nuclear magnetic resonance spectroscopy: Compounds containing ^{1}H, ^{13}C, ^{19}F,^{27}Al, ^{29}Si, and ^{31}P nuclei. Electron spin resonance (ESR): Simulation of ESR spectra of paramagnetic species, spin dynamics in solid and liquid. Mass spectrometry: The production and analysis of positive ions, molecular ions, application of isotopic abundance measurements, fragmentation modes and rearrangement of ions. Interpretation of organic, inorganic compounds and materials using combination of the spectral data.

MODULE III STRUCTURAL AND MORPHOLOGICAL DATA 9

Fundamental theoretical framework for diffraction (XRD) and imaging methods (SEM, TEM and AFM) used in structural and compositional characterization of materials in solid, film state etc.

MODULE IV THERMOANALYTICAL DATA AND SURFACE AREA 9

Interpretation of Differential Thermal Analysis (DTA), Thermo-gravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC) data of various materials including inorganic complex, organic polymeric materials, composite, nano-composites etc; Surface area analysis; isotherms, types, BET surface area,

pore dimensions, pore volume, etc.

MODULE V ELECTROCHEMICAL AND XPS DATA 9

Cyclic voltammetry for oxidation and reduction potentials, TAFEL polarization and Impedance spectroscopy for corrosion inhibitor behavior, chronoamperometry for charge or discharge of battery. X-ray photoelectron spectroscopy: Study the chemical composition and oxidation state of elements at the surface and interface. Applications of XPS in various arenas.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. R. S. Drago, Physical Methods for Chemists, W. B. Saunders,1992.
2. R. M. Silverstein, C. G. Bassler and T. C. Morril, Spectrophotometric Identification of Organic Compounds, 5th edition, Wiley, 1991.
3. D. H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, 3rd edition, McGraw Hill, 1980.
4. W. Kemp, Organic Spectroscopy, ELBS, 1979.
5. W. L. Jolly, The synthesis and characterization of inorganic compounds, Prentice-Hall, 1970.
6. John Wertz, Electron Spin Resonance: Elementary Theory and Practical Applications, Springer Science & Business Media, 2012.
7. R. F. Speyer, Thermal Analysis of Materials, CRC Press, 1994.
8. P.J. Goodhew, J. Humphreys and R. Beanland, Electron Microscopy and Analysis, Taylor & Francis, 2001.
9. John F Watts, John Woistenhoime, An introduction to surface analysis by XPS and AES, John Wiley and Sons, 2nd edition, 2003.
10. James, B. Condon, Surface Area and Porosity Determinations by Physisorption Measurement and Theory, Elsevier, 1st edition, 2006.

COURSE OUTCOMES:

The students will be able to

CO1: Interpret electronic spectral data of materials

CO2: Interpret magnetic spectral data of materials

CO3: Interpret structural and morphological data of materials

CO4: Interpret thermo analytical data and porous nature of materials

CO5: Interpret electrochemical and XPS data of materials

Board of Studies (BoS): 12th BoS of Chemistry held on 2207.2022

Academic Council: 19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	H	M		H	M	H									
CO2	H	M		H	M	L									
CO3	H	L		H	M	M									
CO4	H	L		H	M	H									
CO5	H	L		H	M	L									

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 4: Quality Education
SDG 9: Industry and Innovation

Statement:
SDG9: Foundation to work in R&D laboratory, chemical industry, independent researcher and for teaching career.
SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities.