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
(Updated upto December 2023, as per 21st Academic Council)

M.Tech.
(Structural Engineering)

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
(Updated upto December 2023
as per 21st Academic Council)

M.TECH. STRUCTURAL ENGINEERING

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 globalchallenges.
- 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 CIVIL ENGINEERING

SCHOOL OF INFRASTRUCTURE

VISION AND MISSION

VISION

To be a leading School for Education, Training and Research in Civil Engineering for a better future and over-all Socio-Economic progress of the Country in a sustainable manner

MISSION

- To offer world-class undergraduate, postgraduate and research programs of industrial and societal relevance in civil engineering.
- To nurture ethically strong civil engineers to address global challenges through quality education and application-oriented research.
- To educate our students on design, construction, maintenance and advancements in civil engineering for providing solutions to the betterment of the society.
- To prepare competitive and responsible citizens with good communication, leadership and managerial skills.
- To enrich and enhance the knowledge base for the best practices in various areas of Civil & allied Engineering through collaborations with Global Institutions of Excellence, Industries and Research Organizations.
- To provide a healthy ambience for teaching, research, consultancy and extension activities.

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES
M.TECH STRUCTURAL ENGINEERINGPROGRAMME

EDUCATIONAL OBJECTIVES

PEO 1: Exhibit expertise in analysis and design of Reinforced Concrete, Steel structures as per codal provisions with an emphasize on economy and sustainability.

PEO 2: Develop and practice cost effective and sustainable cementitious composites in real time projects with care for environment

PEO 3: Evaluate the performance of new or distressed structures with scientific approach by using state of the art software tools.

PEO 4: Pursue innovative research in the field of Structural Engineering to cater the changing needs of society.

PEO 5: Demonstrate leadership in a team by exhibiting ethical approach, good communication skills and time management.

PROGRAMME OUTCOMES

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level of higher than the requirements in the appropriate bachelor program.

PO4: An ability to apply engineering techniques and relevant software to offer solution to structural engineering problems with emphasize on sustainability.

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.
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.

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
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 relevant field.
13.	Commerce	M.Com	B.Com. / BBA

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
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.

****

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

CURRICULUM & SYLLABI FOR
M. TECH. (STRUCTURAL ENGINEERING)

Regulations 2022

SEMESTER I

Sl. No.	Course Code	Course Title	L	T	P	C
1.	MAE 6184	Probability and Matrix Theory	3	1	0	4
2.	CEE 6101	Advanced Design of Concrete Structures	3	1	0	4
3.	CEE 6102	Dynamics of Structures	3	1	0	4
4.	CEE 6103	Condition Assessment and Rehabilitation of Structures	3	0	0	3
5.	CEE 6104	Destructive and Non-Destructive Testing of Concrete Laboratory	0	0	2	1
6.	ENE 6181	English for Career Development	1	1	0	2
7.		Professional Electives				**3**
		Credits				**21**

SEMESTER II

Sl. No.	Course Code	Course Title	L	T	P	C
1.	CEE 6211	Finite Element Analysis in Structural Engineering	3	0	0	3
2.	CEE 6212	Earthquake Resistant Design of Structures	3	0	0	3
3.	GEE 6201	Research Methodology and IPR	2	0	0	2
4.	CEE 6213	Advanced Design of Steel Structures	3	1	0	4
5.	CEE 6214	Structural Modeling and Analysis Laboratory	0	0	2	1
6.		Professional Electives				**9**
		Credits				**22**

SEMESTER III

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

SEMESTER IV

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

Overall Total Credits - 78

* Industrial training will be undertaken during the first-year of summer vacationfor 30 days. The credit will be awarded in the 3rd Semester.

\# Credits for Project Work Phase I to be accounted along with Project Work Phase II in IV Semester

PROFESSIONAL ELECTIVES LIST OF ODD SEMESTER ELECTIVES

Sl. No.	Course Code	Course Title	L	T	P	C
1.	CEEY 101	Advanced Concrete Technology	**3**	**0**	**0**	**3**
2.	CEEY 102	Design of Bridges	**3**	**0**	**0**	**3**
3.	CEEY 103	Design of Steel Concrete Composite Structures	**3**	**0**	**0**	**3**
4.	CEEY 104	Experimental Methods in Structural Engineering	**3**	**0**	**0**	**3**
5.	CEEY 105	Ground Improvement Techniques	**3**	**0**	**0**	**3**
6.	CEEY 106	Matrix Methods of Structural Analysis	**3**	**0**	**0**	**3**
7.	CEEY 107	Theory of Elasticity and Plasticity	**3**	**0**	**0**	**3**
8.	CEEY 108	Water Proofing of Concrete and Masonry Structures	**3**	**0**	**0**	**3**
9.	CEEY 109	Prefabricated Structures	**2**	**0**	**0**	**2**
10.	CEEY 110	Subsurface Exploration Techniques	**2**	**0**	**0**	**2**
11.	CEEY 111	3D Printing Concrete Technology	**1**	**0**	**0**	**1**

LIST OF EVEN SEMESTER ELECTIVES

Sl. No.	Course Code	Course Title	L	T	P	C
1.	CEEY 201	Advanced Foundation Design	**3**	**0**	**0**	**3**
2.	CEEY 202	Corrosion Prevention and Control in RC Structures	**2**	**0**	**2**	**3**
3.	CEEY 203	Design of Industrial Structures	**3**	**0**	**0**	**3**
4.	CEEY 204	Optimization in Structural Design	**3**	**0**	**0**	**3**
5.	CEEY 205	Prestressed Concrete Structures	**3**	**0**	**0**	**3**
6.	CEEY 206	Stability of Structures	**3**	**0**	**0**	**3**
7.	CEEY 207	Structural Safety and Reliability	**3**	**0**	**0**	**3**
8.	CEEY 208	Tall Structures	**3**	**0**	**0**	**3**
9.	CEEY 209	Theory of Plates and Shells	**3**	**0**	**0**	**3**
10.	CEEY 210	Wind and Cyclone Effects on Structures	**2**	**0**	**0**	**2**
11.	CEEY 211	Fire Protection of Structures	**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 EmbeddedSystems	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

MAE 6184	PROBABILITY AND MATRIX THEORY	L	T	P	C
SDG: 4		3	1	0	4

COURSE OBJECTIVES:

COB1: To provide comprehensive knowledge on the theory of probability and random variables.

COB2: To familiarize with the various techniques to carry out the probability calculations and identify probability distributions.

COB3: To impart knowledge on the multidimensional random variables.

COB4: To enable the students to understand the concepts in advanced matrix theory.

COB5: To provide sufficient knowledge on the importance of variationalproblems.

MODULE I PROBABILITY AND RANDOM VARIABLE 9+3

Axioms of probability – Addition and Multiplication theorem – conditional probability –Total Probability – Baye's theorem - Random variable – Probability mass function – Probability density functions – Properties – Expectation - Moments – Moments generating functions and their properties.

MODULE II STANDARD DISTRIBUTIONS 9+3

Binomial, Poisson, Geometric, Negative Binomial, Uniform, Exponential,Gamma, Weibull and Normal distributions.

MODULE III MULTIDIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Regression - Partial, Multiple correlations and regressions.

MODULE IV ADVANCED MATRIX THEORY 9+3

Matrix norms – singular value decomposition – QR algorithm – pseudoinverse – least square approximations.

MODULE V CALCULUS OF VARIATIONS 9+3

Variation and its properties – Euler's equation – functional dependent on first and higher order derivatives – functional dependent on functions of several independent variables – variational problems with moving boundaries – isoperimetric problems.

L – 45;T- 15;TOTAL HOURS –60

TEXT BOOKS:

1. Sheldon M. Ross, “Introduction to Probability and Statistics for Engineers and Scientists”, Fifth Edition, Elesvier 2016.
2. Richard A. Johnson, “Probability and Statistics for Engineers”, 8th Edition, Pearson Education, 2017.
3. T. Veerarajan, “Probability, Statistics and Random Processes”, 3rd edition, Tata McGraw-Hill Publishing Company Limited, 2008.
4. Lewis D W, “Matrix Theory”, Allied Publishers, Chennai 1995.
A. S. Gupta, “Calculus of variations with applications”, PHI Pvt. Ltd. NewDelhi 2011.

REFERENCES:

1. Cramer.H., “Random Variables and Probability Distributions”, Cambridge University Press, (2004).
2. Elsgolts, “Differential Equations and Calculus of Variations”, University Press of the Pacific (2003).
3. Gupta S.C. and V. K. Kapoor, “Fundamentals of Mathematical Statistics”, 12th Edition, Sultan Chand and Sons, 2014.
4. Roger A. Horn, Charles R Johnson, “Matrix Analysis”, Cambridge University Press, 2nd edition (2012).

COURSE OUTCOMES:

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

CO1: Solve fundamental problems on probability

CO2: Solve the probability problems using appropriate distributions.

CO3: Derive the probability mass / density function of a random variable and multiple correlations and regressions.

CO4: Find eigen values and eigenvectors of a higher-order matrix.

CO5: Solve problems of calculus of variations by direct method and using Euler’s formulae.

Board of Studies (BoS):	**Academic Council:**
14th BOS of Mathematics held on 30.06.2022	*19th AC held on 29.09.2022*

	PO1	PO2	PO3	PO4
CO1	2	1	-	-
CO2	2	1	-	-
CO3	2	2	-	-
CO4	1	1	-	-
CO5	2	2	-	-

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG — 4: Ensure inclusive and equitable quality education and promote life long opportunities for all.

Statement: Learning probability distributions and calculus of variations will lead to knowledge of applications in Structural Engineering.

CEE 6101	ADVANCED DESIGN OF CONCRETE STRUCTURES	L	T	P	C
SDG: 9 & 11		3	1	0	4

COURSE OBJECTIVES:

COB1: To impart knowledge on the design of RCC beams under combined shear, torsion and bending and limit the state of serviceability for the structural members.

COB2: To provide exposure to the design of slender columns, RC walls, deep beams and corbels.

COB3: To understand the concept of yield line analysis and gain knowledge on the design of flat slabs and grid floors.

COB4: To expand the knowledge on the inelastic response of reinforced concrete beams.

MODULE I TORSION IN BEAMS & LIMIT STATE OF SERVICEABILITY 9+3

Review on the basic concepts - Strength and deformation of members with combined bending, shear and torsion - Serviceability limit states: Estimation of deflection and crack widths in RC members.

MODULE II DESIGN OF SLENDER RC COLUMNS 9+3

Behaviour of slender RCC Columns - Failure modes - Design moments for braced and unbraced columns - Design of slender columns as per IS 456.

MODULE III DESIGN OF SPECIAL STRUCTURAL ELEMENTS 9+3

Design of plain and R.C walls - Strut and tie method of analysis & design of corbels - Design of deep beams.

MODULE IV DESIGN OF STRUCTURAL SLAB SYSTEMS 9+3

Design of grid floor - Design of flat slabs and flat plates – Check for shear - Yieldline theory of slabs.

MODULE V INELASTIC ANALYSIS OF CONCRETE BEAMS 9+3

Inelastic behaviour of reinforced concrete – Moment curvature relationship - Strength and ductility of concrete beams - Plastic hinge formation - Redistribution of moments - Moment redistribution for a single span and two span continuous beam.

L – 45;T- 15;TOTAL HOURS –60

REFERENCES:

1. Krishna Raju, N. “Advanced Reinforced Concrete Design (IS 456-2000)”, CBS Publishers & Distributors, New Delhi, 2010
2. Park. R., & Paulay .T., “Reinforced Concrete Structures”, John Wiley & Sons,1975.
3. Purushothaman, P, “Reinforced Concrete Structural Elements: Behaviour Analysis and Design”, Tata McGraw-Hill, 1986.
4. Subramanian. N, “Design of Reinforced Concrete Structures”, Oxford University Press, 2013.
5. Unnikrishna Pillai and Devdas Menon, “Reinforced Concrete Design”, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2006.
6. Varghese, P.C. “Advanced Reinforced Concrete Design”, Prentice Hall ofIndia, 2005.

COURSE OUTCOMES:

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

CO1: Describe the behaviour of beams under combined bending, shear & torsion and compute the deflection & crack width for RC members as per codal provisions.

CO2: Employ the Indian standard code of practice for the design of slender RC columns.

CO3: Design the special structural elements such as RC walls, deep beams, and corbels.

CO4: Appropriately choose and design the structural slab systems for buildings.

CO5: Critically describe the inelastic behaviour of reinforced concrete beams.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	2	3	3
CO2	2	2	3	3
CO3	2	2	3	3
CO4	2	2	3	3
CO5	2	2	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: Design of concrete structures is imperative for safe andsustainable construction.

CEE 6102	DYNAMICS OF STRUCTURES	L	T	P	C
SDG: 9 &11		3	1	0	4

COURSE OBJECTIVES:

COB1: To impart knowledge on the theory of vibrations and vibration parameters.

COB2: To analyze the dynamic forces caused by an earthquake.

COB3: To understand the design concepts of buildings for blast and impact forces as per BIS codes of practice.

MODULE I INTRODUCTION TO VIBRATION AND DAMPING 9+3

Simple harmonic motion - Longitudinal vibrations equation of motion - Dynamic equation of motion - D'Alembert's principle - Equivalent stiffness - Springs connected in series and parallel – Natural frequency and time period - Amplitude of motion - Nature of exciting forces, mathematical modelling of dynamic systems.

MODULE II SINGLE DEGREE OF FREEDOM SYSTEM 9+3

Free and Forced Vibration with and without Damping - Response to Harmonic Loading - Underdamped, overdamped and critically damped- Logarithmic decrement.

MODULE III TWO DEGREE OF FREEDOM SYSTEM 9+3

Introduction - Concept of shear building - Free vibration with and without damping - Forced Vibration with and without damping - Response to general dynamic loading using Duhamel's Integral.

MODULE IV MULTIPLE DEGREE OF FREEDOM SYSTEM 9+3

Multiple degrees of freedom system - Orthogonality principle - Equation of motion of multiple degrees of freedom with lumped and distributed mass - Stiffness, mass and damping matrices – Decoupling of equations - Superposition method.

MODULE V DESIGN CONCEPTS AGAINST BLAST AND IMPACT 9+3

Characteristics of internal and external blast - Impact and impulse loads - Pressure distribution on buildings above ground due to external blast - Underground explosion - Design principles of buildings for blast and impact as per BIS codes of practice.

L – 45;T- 15;TOTAL HOURS –60

REFERENCES:

1. Anil K. Chopra, “Dynamics of Structures: Theory and Applications to Earthquake Engineering”, Prentice Hall, Englewood Cliffs, New Jersy, Second Edition, 2001.
2. Cheng, F.Y., “Matrix Analysis of Structural Dynamics”, CRC Press, New York, 2001.
3. Clough, R.W. and Penzien. J., “ Dynamics of Structures”, Computers and Structures, Incorporated, 2003, 2nd Edition, 2003.
4. Hurty.W.C, Rubinstein. M.F, ”Dynamic of Structures”, Prentice Hall of India Pvt Ltd. New Delhi, 2002.
5. M. Y. H. Bangash, T. Bangash, “Explosion-Resistant Buildings: Design, Analysis, and Case Studies”, Springer –Verlag Berlin Heidelberg, Germany, 2006.
6. Donald O. Dusenberry, “Handbook For Blast-Resistant Design of Buildings”, John Wiley & Sons, Inc, 2010.

COURSE OUTCOMES:

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

CO1: Develop the mathematical modelling systems using fundamental theory and equation of motion.

CO2 : Develop the equation of motion for single-degree-of-freedom systems.

CO3 : Analyse the response of two-degree freedom systems.

CO4 : Find the dynamic response of multiple degrees of freedom systems.

CO5 : Apply the design principles against blast and impact forces on buildings using BIS codes of practice.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	2	3	3
CO2	2	2	3	3
CO3	2	2	3	3
CO4	2	2	3	3
CO5	2	2	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: Dynamic analysis of structures is more essential to ensure safe and sustainable building.

		L	T	P	C
CEE 6103	**CONDITION ASSESSMENT AND**				
SDG: 11	**REHABILITATION OF STRUCTURES**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

The objective of the course is to impart adequate knowledge on

COB1: Physical and chemical deterioration mechanisms acting on reinforced concrete (RC) structures in real-time conditions.

COB2: Condition assessment of distressed RC structures using NDT techniques.

COB3: Materials used in RC repair works.

COB4: Techniques used for rehabilitation of RC structures.

COB5: Seismic retrofitting cum rehabilitation of RC structures.

MODULE I PHYSICAL AND CHEMICAL DETERIORATING MECHANISMS **9**

Durability of concrete – Influencing parameters - Life cycle cost and sustainability - Physical deteriorating mechanisms: shrinkage & creep, abrasion, erosion, cavitation - Freeze and thaw — Thermal incompatibility: high-temperature variations - Chemical deteriorating mechanisms: alkali-silica reaction – Leaching - acid attack – Sulphate attack – Corrosion of steel rebar in RC (chloride penetration and carbonation) – Microbial induced corrosion – Effluent gases from industries.

MODULE II CONDITION ASSESSMENT OF RC STRUCTURES USING NDT **9**

Condition assessment: significance and objectives, various stages – Preliminary inspection – Planning – Visual inspection – Laboratory and field testing. Non-Destructive techniques for condition assessment: overview – Rebound hammer test, ultrasonic pulse velocity test, concrete resistivity, cover meter, concrete core test, half-cell potential test, tests for carbonation, chemical analysis (chloride and sulphate content), tests for assessing fire damage in concrete structures. Condition assessment of distressed building: case study – report preparation.

MODULE III MATERIALS FOR REPAIR **9**

Repair materials – Factors influencing selection of repair materials – Various stages of concrete repair – Importance of surface preparation – Bond coat – Rust convertors – Rust removers - Protective coating to steel rebars – Superplasticizers – Corrosion inhibitor admixed concrete – Micro concrete - Polymer modified mortar / concrete – Carbon fiber sheets – Grouting agents - Concrete coatings - Sacrificial anodes.

MODULE IV TECHNIQUES FOR REHABILITATION OF RC ELEMENTS **9**

Rehabilitation techniques: overview, significance and selection methods – Dry pack method – Overlays – Preplaced aggregate concrete - Pressure grouting – RC jacketing technique – Plate bonding technique – FRP jacketing technique – Prestressing technique - Ferrocement – Guniting and shotcrete – Techniques for repairing cracks – Sacrificial anode cathodic protection.

MODULE V CASE STUDIES ON RETROFITTING AND REHABILITATION OF RC STRUCTURES **9**

Seismic retrofitting of G+4 building: analysis for higher seismic level — Revised member dimensions and steel requirement – Retrofitting strategy - Case study on rehabilitation of: dampness in buildings, leaky sunken slab, distressed roof slab, overhead RC water tank, corrosion damaged RC bridge, fire damaged building, damaged industrial floors etc.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Perkins, P.H., “Repair, Protection and Waterproofing of ConcreteStructures”, 3rd edition, E & FN Spon, 1997.
2. Emmons, P.H., “Concrete Repair and Maintenance Illustrated: Problem Analysis; Repair Strategy; Techniques”, RS Means Publishers, 2002.

REFERENCES:

1. Santha Kumar, A.R., “Concrete Technology”, Oxford University Press, New Delhi, 2007.
2. Shetty. M.S., and A.K. Jain “Concrete Technology (Theory and Practice)”, S. Chand and Company Ltd.,2010.
3. Brooks, J.J. and Neville, A.M., “Concrete Technology”, Pearson, 2019.
4. Kumar Mehta. P. and Paulo J.M. Monteiro., “Concrete: Microstructure, Properties, and Materials” 4th Edition, McGraw Hill Education (India) Pvt. Ltd., 2014.
5. Hand Book on “Repair and Rehabilitation of RCC Buildings”, Central Public Works Department, Government of India, 2002.
6. Malhotra, V.M. and Carino, N.J., “Handbook on Non-destructive Testing of Concrete”, CRC Press, 2004.
7. John Broomfield, “Corrosion of Steel in Concrete – Understanding, Investigation and Repair”, CRC Press, London, 2003.

8. Yoshihiko Ohama, “Hand Book of Polymer Modified Concrete andMortars”, Noyes Publications, U.K., 3rd Edition, 2013.
9. FEMA 273; NEHRP Guidelines for the Seismic Rehabilitation of Buildings, 2005.
10. ATC – 40: Seismic Evaluation and Retrofit of Concrete Buildings, Vol. 1 &2, 2005.

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

CO1: Understand the physical and chemical deteriorating mechanisms detrimental to the RC structures.

CO2: Perform conditions assessment of distressed building using NDT

CO3: Suggest materials for different repair works

CO4: Identify the suitable repair techniques for the rehabilitation of RC elements.

CO5: Suggest procedure for rehabilitation and retrofitting of RC structures.

Board of Studies (BoS) :
17th BoS of Civil held on 10.08.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	3	3	2
CO2	2	3	3	2
CO3	2	3	3	2
CO4	2	3	3	2
CO5	2	3	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

1. Development of sustainable infrastructure by understanding the physical and chemical deteriorating mechanisms during its life time.
2. Make the existing human settlements safe and resilient by performing condition assessment using NDT and by adopting suitable repairtechniques for its rehabilitation including seismic retrofitting.

CEE 6104	DESTRUCTIVE AND NON- DESTRUCTIVE	L	T	P	C
SDG: 9 & 11	TESTING OFCONCRETE LABORATORY	0	0	2	1

COURSE OBJECTIVES:

COB1: To enable the students to understand the design of concrete mix by various codal provisions and conduct the tests on fresh concreteproperties

COB2: To gain knowledge on the strength and durability properties of concrete by conducting various tests.

COB3: To expand the knowledge on the non-destructive tests of concrete.

COB4: To examine the behaviour of concrete beams under flexural loading.

MODULE I MIX DESIGN OF CONCRETE & FRESH CONCRETE PROPERTIES **5**

Mix design of various grades of concrete as per Codal Provisions - Fresh concrete properties.

MODULE II STRENGTH & DURABILITY TESTS OF CONCRETE **10**

Correlation between cube strength, cylinder strength, splitting tensile strength and modulus of rupture - Study of stress-strain curve for concrete & steel - Determination of Young's modulus - Durability tests of concrete — RCPT, sorptivity test, permeability test.

MODULE III NON-DESTRUCTIVE TESTS OF CONCRETE **7**

Rebound hammer method – Ultrasonic pulse velocity method.

MODULE IV TESTING OF REINFORCED CONCRETE BEAMS **8**

Behavior of reinforced concrete beams under flexure loading using data logger, LVDT, strain gauges and load cell.

P – 30; TOTAL HOURS – 30

REFERENCES:

1. Lea, "Chemistry of Cement and Concrete", Butterworth-Heinemann Ltd, 5th edition, 2017.
2. Mehta and Monteiro, "Concrete- Micro Structure, Properties and Materials", McGraw Hill Professional, 2017.
3. Neville A. M. and Brooks J. J., "Concrete Technology", Pearson Education, 2019.
4. Neville A.M., "Properties of Concrete", Trans-Atlantic Publications, Inc.; 5th edition, 2016
5. Santhakumar.A.R. "Concrete Technology", Oxford Universities Press, 2018.

6. Shetty, M. S., “Concrete Technology”, S. Chand & Co., 2018.

COURSE OUTCOMES:

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

CO1: Perform the mix design of normal & high strength grade concrete and investigate the fresh concrete properties.

CO2: Assess the various properties of hardened concrete by conducting the strength and durability tests.

CO3: Evaluate the concrete structure by conducting the non-destructive tests.

CO4: Apply the engineering techniques to test & study the behaviour of concrete beams.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	3	2
CO3	3	3	3	2
CO4	3	3	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: Designing durable concrete by properly understanding the properties of concrete constituent materials, expected strength, exposure conditions and application.

ENE 6181	ENGLISH FOR CAREER DEVELOPMENT	L	T	P	C
SDG: 4 & 8		1	1	0	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 behaviors required to facilitate a group discussion

MODULE I ENTERING THE JOB MARKET 3+2

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 SummaryWriting 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 TenseProfessional Writing: Level of Formality
Language Focus: Using Modal Verbs to Write politelyWriting a Cover Letter for a Specific Job

MODULE IV INTERVIEWING FOR A JOB 3+5

Overview of the Job Interview: Answering Typical Interview QuestionsLanguage Focus: Asking for Clarification in an Interview-
Sample Interview: Do's and Don'ts Part 1Sample Interview: Do's and Don'ts Part 2
Sample Video: Responding to an Interview Question

MODULE V GROUP DISCUSSION 3+4

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, T - 15; TOTAL HOURS - 30

REFERENCES:

1. R. Byrne, D. Teaching Oral Skill. London: Longman. 1975.
2. Byrne, D.Teaching Writing, London: Longman. 1975.
3. Rani Asoka, DeviVimala. 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
5. English for Academic Purposes. Cambridge University Press, UK, 2004.
6. Withrow, J., Brookes, G.& Cummings, M.C.Inspired to write. Reading and Tasks to Develop Writing Skills. Cambridge University Press, U.K., 2004.
7. Shinde, Maithry et al. Life Skills & Personality Development, Cambridge University Press India Pvt. Ltd, New Delhi
8. Fernandez, Agna Generic Skills for Employability, Cambridge University Press India Pvt. Ltd, New Delhi

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) :
15thBoS of the Department of English held on 14.6.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	3	-	-	-
CO2	-	2	-	-
CO3	-	2	-	-
CO4	1	2	-	-
CO5	-	2	-	-

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

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

SEMESTER – II

		L	T	P	C
CEE 6211	**FINITE ELEMENT ANALYSIS IN**				
SDG: 9 & 11	**STRUCTURAL ENGINEERING**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To introduce the fundamental concepts of finite element method.

COB2: To impart knowledge on the matrix techniques and concepts of one, two and higher order elements.

COB3: To understand the concepts of mesh generation and providingsolutions to the critical problems.

MODULE I FUNDAMENTAL CONCEPTS 9

Stresses and equilibrium – Boundary conditions – strain displacement relations – stress-strain relations – Potential energy and equilibrium – Weighted integral and weak formulation – Variational approach – Rayleigh-Ritz method – Galerkin method**.**

MODULE II ONE DIMENSIONAL ELEMENT FORMULATION 9

Types of an element – Convergence criteria- Derivation of elemental equations – Coordinates and shape functions – Assembly of global stiffness matrix and global load vector – Treatment of boundary conditions.

MODULE III TWO DIMENSIONAL ELEMENT FORMULATION 9

Types of triangular element - Constant strain triangle – Linear strain triangle - Geometry invariance - Stress calculations.

MODULE IV HIGHER ORDER ELEMENT FORMULATION 9

Rectangular elements -Isoparametric elements - Lagrange and serendipityelements - Introduction to finite element software.

MODULE V MESHING AND SOLUTION PROBLEMS 9

Pre and post-processor interpretations - p and h methods of refinement - Ill-conditioned elements - Discretization errors — Patch test - Auto and adaptive mesh generation techniques - Gaussian Formulation - Static Condensation.

L- 45;TOTAL HOURS – 45

REFERENCES:

1. Cook Robert. D., Plesha, Michael. E & Witt, Robert.J. "Concepts andApplications of Finite Element Analysis", Wiley Students Edition, 2004.
2. David V. Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw-Hill 1st edition, 2005.
3. Krishnamoorthy, C.S, "Finite Element Analysis Theory and Programming", Tata McGraw Hill Publishing Co.Ltd. New Delhi, 2004.
4. Reddy, J.N, "An Introduction to the Finite Element Method", McGraw Hill International Edition, New York, 3rd edition, 2008.
5. Seshu, P., "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
6. Tirupathi R. Chandrupatla, Ashok D. Belegundu, "Introduction toFinite Elements in Engineering", Prentice Hall of India, New Delhi, 2007.

COURSE OUTCOMES:

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

CO1: Solve the boundary value problems using approximate methods**.**

CO2: Derive the elemental equations and shape functions for one and two-dimensional elements.

CO3: Derive the elemental equations and shape function for two-dimensional elements.

CO4: Generate the iso-parametric functions for various elements.

CO5: Describe the mesh refinement and Gaussian formulation.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	3
CO2	1	1	3	3
CO3	1	1	3	3
CO4	1	1	3	3
CO5	1	1	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: Finite Element analysis of structures is essential to ensure safe and sustainable building.

CEE 6212	EARTHQUAKE RESISTANT DESIGN OF STRUCTURES	L	T	P	C
SDG: 9 & 11		3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce the phenomena of earthquake and its measurements and factors that affect the design of structures in seismic areas.

COB2: To impart knowledge on the fundamentals of load calculation for various structural systems, design and detailing aspects of structures subjected to earthquake loading.

COB3: To provide insight knowledge on the seismic retrofitting techniques and response control system of structures.

MODULE I ENGINEERING SEISMOLOGY **9**

Introduction to engineering seismology – Plate tectonics – Faults - Causes of earthquake - Seismic waves - Liquefaction – Evaluations & its mitigation - Seismic bearing capacity of foundations - Magnitude of earthquake – Intensity measurement – Seismographs – Characteristics of strong ground motions - Seismic zones of India.

MODULE II SEISMIC DESIGN CONCEPTS **9**

Earthquake load on simple buildings – Load path – Floor and roof diaphragms – Seismic resistant building architecture – Plan configuration – Vertical configuration – Pounding effects – Mass and stiffness irregularities – Flexible building and rigid building systems - Torsion in structural system.

MODULE III SEISMIC METHODS OF ANALYSIS **9**

Philosophy and principles of earthquake resistant design - Design earthquake loads - Seismic methods of analysis – Seismic co-efficient method – Response spectrum analysis - Factors in seismic analysis – Modal Analysis – Time history method.

MODULE IV SEISMIC BEHAVIOUR & DESIGN OF STRUCTURES **9**

Behaviour of unreinforced and reinforced masonry walls – Behaviour of infill walls – Improving seismic behaviour of masonry buildings – Earthquake resistant design of RC members: beams, columns, joints of frames, slabs and staircases - Behavior and design of shear walls – Steel frames – Steel panel zones – Bracing members – Connection design and joint behaviour.

MODULE V SEISMIC RESTORATION & RESPONSE CONTROL SYSTEMS **9**

Seismic restoration techniques - Damages in structures - Repair materials for seismic strengthening - Retrofitting techniques - Response control systems - Base isolation - Active, passive, semi-active & hybrid systems.

L- 45; TOTAL HOURS – 45

REFERENCES:

1. Anil K.Chopra, "Dynamics of Structures Theory and Applications to Earthquake Engineering", Prentice Hall of India (P) Ltd., New Delhi, 2nd Edition, 2015.
2. Datta T.K., "Seismic Analysis of Structures", John Wiley & Sons, 2010.
3. Duggal S.K., "Earthquake Resistant Design of Structures", Oxford University Press, 2007.
4. Paulay.T and Priestly. M.N.J., "Aseismic Design of Reinforced Concrete and Masonry Building", John Wiley and Sons, 2007.

COURSE OUTCOMES:

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

CO1: Identify the types of seismic waves, measure the magnitude of earthquakes and describe the characteristics of ground motion.

CO2: Describe the conceptual design of the structural systems against earthquake

CO3: Perform seismic analysis of structures by using various methods.

CO4: Describe the seismic behaviour and design the masonry, RC and steel buildings.

CO5: Suggest suitable retrofitting and strengthening methods for structural members and describe the seismic base isolation & passive energy dissipation for seismic response control of civil engineering structures.

Board of Studies (BoS) :
17th BoS of Civil held on 10.08.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	2	3	2
CO2	2	2	3	2
CO3	2	2	3	2
CO4	2	2	3	2
CO5	2	2	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG — 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
SDG - 11: Make cities and human settlements inclusive, safe, resilient and sustainable.

Statement: Earthquake Resistant Design of structures is more essential to ensure safe and sustainable building.

GEE 6201	RESEARCH METHODOLOGY AND IPR	L	T	P	C
SDG: 4 & 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 communication of research findings and apply the ethics in research.

COB5: To describe the research findings as research reports, publications, copyright patenting and intellectual property rights.

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 will be able to:

CO1: Formulate the research problem.

CO2: Design and Analyze the research methodology.

CO3: Analyze and interpret the data to construct and optimize the research Hypothesis.
CO4: 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
CO1	3	2	2	3
CO2	3	2	2	3
CO3	3	2	2	3
CO4	3	2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
SDG — 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement: This course enables the student to analyze the existing technology for further solutions and its qualitative measures in terms of societal requirements. It plays major roles through innovative ideas in industry towards modern infrastructure and sustainability.

CEE 6213	ADVANCED DESIGN OF STEEL STRUCTURES	L	T	P	C
SDG: 9 &11		3	1	0	4

COURSE OBJECTIVES:

COB1: Various codal provisions for steel structural design.

COB2: The design of structural components of industrial buildings.

COB3: The behaviour and design of various types of connections.

COB4: The design of cold-formed steel structural members.

COB5: The design of special structures (chimney).

MODULE I DESIGN OF INDUSTRIAL BUILDINGS 9+3

Planning – selection of materials – structural framing – types of roof trusses and configurations – codal provisions of IS 875 – loading on roof truss – load combination for design – wind load calculation – design of industrial buildings: truss, purlin, stanchion.

MODULE II BEHAVIOUR AND DESIGN OF CONNECTIONS 9+3

Types of connection - importance and behaviour - codal provisions as per IS: 800 - design of bracket connection - unstiffened and stiffened seated connections – framed connections - connections for force and moment transmission – tee stub and end plate connections - stiffeners and other reinforcement.

MODULE III DESIGN OF COLD-FORMED STEEL COMPRESSION MEMBERS 9+3

Introduction to cold-formed steel, types of cross section, unstiffened and stiffened compression members, multiple stiffened compression members, codal provisions as per IS 801, design of compression members - behaviour of compression elements - concept of local buckling and effective width - analysis and design of stiffened and unstiffened compression elements.

MODULE IV DESIGN OF COLD-FORMED STEEL FLEXURAL MEMBERS 9+3

Design of web of beams - web crippling – degree of restraint against rotation of the web – single unreinforced web, design of flexural members - economic design for beam strength - concept of lateral buckling of beams – bracing requirements for beams – concept of shear lag and flange curling, design of wall studs and connection details.

MODULE V ANALYSIS AND DESIGN OF SPECIAL STRUCTURES - 9+3

CHIMNEY

Design of self-supporting chimney (lined and unlined) - codal provisions of IS 6533 - stresses due to wind and earthquake forces – design of base plate, anchor bolts and foundation - check for deflection - design for dynamic effects - wind effects on chimney - gust factor method - Design of guyed chimneys.

L – 45 T- 15;TOTAL HOURS –60

REFERENCES:

1. Bhavikatti, S.S., Design of Steel Structures: By Limit State Method as Per IS: 800 – 2007, I.K. International Pvt. Ltd. 2017.
2. BIS 6533 (Part 1), Design and construction of steel chimney - Code of practice, Part I Mechanical Aspect, Bureau of Indian Standards.
3. BIS 6533 (Part 2), Design and construction of steel chimney - Code of practice, Part 2 Structural Aspect, Bureau of Indian Standards.
4. BIS 801, Indian standard code of practice for use of cold-formed light gauge steel structural member's in general building construction, Bureau of Indian Standards.
5. BIS 800, Indian standard code of practice for general construction in steel, Bureau of Indian Standards.
6. BIS 875, Design loads (other than earthquake) for Buildings and Structures – Code of Practice, Bureau of Indian Standards.
7. Dayaratnam, P., Design of Steel Structures, S Chand Publishing, 2012.
8. Duggal, S.K., "Design of Steel Structures", Tata McGraw-Hill Publishers, New Delhi, 2009.
9. N. Subramanian, Steel Structures - Design and practice, Oxford University Press, 2011.
10. Ram Chandra, Design of Steel Structures, Vol.-II, Standard Book House, New Delhi, 2016.
11. Rhodes, J, Design of Cold-Formed Steel Members, Elsevier Science Publishers, 2014.
12. Salmon, C.G., Johnson, J.E., and Malhas F.A., Steel Structures-Design and Behaviour, Harper and Row, 2009.
13. Shah, V.L. and Veena Gore, "Limit State Design of Steel Structures", Structures Publications, Pune, 2010.
14. SP 6 (1) – Hand book for structural Engineers, 1. Structural Steel Sections, Indian Standards Institution.
15. SP 6 (5) – Hand book for structural Engineers, 5. Cold formed, Light- gauge steel structures, Bureau of Indian Standards.
16. Teaching Resource for Structural Steel Design, INSDAG, Kolkatta, 2010.
17. Wie - Wen Yu., Cold-formed Steel Structures, John Wiley & Sons, 2010.

COURSE OUTCOMES:

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

CO1: Describe the codal provisions for design of connections, industrial buildings, cold formed structural members and chimney

CO2: Design roof truss of an industrial building

CO3: Design different types of connections for the expected shear force and bending moment

CO4: Design cold-formed steel compression and flexure members

CO5: Design self-supporting and guyed chimneys for the various loading conditions

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	2	3	2
CO2	1	1	3	2
CO3	2	2	3	2
CO4	2	2	3	2
CO5	2	2	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: The design of steel structures as per codal provisions ensure construction of safe and resilient infrastructure by giving emphasis to sustainability and innovation.

CEE 6214	**STRUCTURAL MODELLING AND ANALYSIS LABORATORY**	**L**	**T**	**P**	**C**
SDG: 9 &11		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

COB1: To gain knowledge on the analysis of concrete and steel structures using STAAD Pro software.

COB2: To impart knowledge on the modelling of a residential building using BIM and analyse it through STAAD Pro software.

MODULE I ANALYSIS OF RC BUILDING USING STAAD PRO SOFTWARE **7**

Analysis of RC building - Design of foundation for the RC building.

MODULE II ANALYSIS OF STEEL STRUCTURES USING STAAD PRO SOFTWARE **7**

Analysis of steel structure - Design of foundation for the structure

MODULE III INTRODUCTION TO BUILDING INFORMATION MODELLING (BIM) **7**

Introduction to Building Information Modelling - Roles and Impacts of BIM in the Design, Construction Engineering and Management, Infrastructure Engineering, and Facility Management - BIM 3D, 4D, 5D, 6D & 7D.

MODULE IV DESIGN OF A RESIDENTIAL BUILDING **9**

Annotate the model with 2D drafting elements and access building information from the building model's database - Creating and editing architectural & structural floor - Creating new material - Developing ceiling plan, adding ceiling, hosted components, interior space planning, developing interior 3D image using camera & rendering.

P -30; TOTAL HOURS –30

REFERENCES:

1. T.S.Sarma, Staad Pro v8i for beginners, Notion Press, 2014

2. Hardin, B., & McCool, D., BIM and construction management: proven tools, methods, and workflows.John Wiley & Sons, 2015

3. Issa, R. R., & Olbina, S. (Eds.)., Building Information Modeling: Applications and Practices, American Society of Civil Engineers,2015

4. Krygiel, E., & Nies, B., Green BIM: successful sustainable design with building information modeling, John Wiley & Sons, 2008.

COURSE OUTCOMES:

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

CO1: Analyse the reinforced concrete buildings using STAAD Pro software.

CO2: Analyse the steel buildings using STAAD Pro software.

CO3: Understand concepts of Building Information Modeling.

CO4: Design a residential building using software.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	3	3	3
CO2	2	3	3	3
CO3	1	1	3	1
CO4	2	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: Holistic Understanding of structural modelling and analysis is more essential to ensure safe and sustainable building.

CEE 7102	INTERNSHIP	L	T	P	C
SDG: 9 &11		0	0	4	2

GENERAL GUIDELINES:

- The course carries two credits with a minimum duration of 30 days.
- The students are encouraged to pursue Internship in Industry (Government departments / Private Constructions Companies / Private consulting firms etc.,) / Research organizations (SERC, PMI, CBRI etc.,) / Eminent Academic Institutions (IIT/ NIT/ Government or Private Universities) in the summer vacation after first year of study.
- The students shall obtain permission from Head of the Department / Dean of School by submitting an 'induction to internship certificate' provided by the organization (as per the given template) before commencement of Internship.
- The students shall submit a report of internship elaborating knowledge acquired during the internship period at the beginning of III Semester.
- The student shall also submit the internship completion certificate issued by the Industry/ Research Organization / Academic Institution along with confidential feedback provided by them (in a specified format) in a sealed cover to the Class Advisor.
- A committee comprising of faculty members constituted by the Head of the Department / Dean of School shall evaluate the Internship report, and shall conduct internship midterm reviews in the III semester of study followed by semester end oral examination.
- The weightage of marks for internship report and viva-voce examination are 60 % and 40% respectively.
- Based on the assessment of internship report, and performance of the students in end semester oral examination, relative grade is awarded.

COURSE OUTCOMES:

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

CO1: Understand salient activities of Industry/ Research organization to provide feasible solution for a problem.

CO2: Correlate the application of theoretical knowledge in day to day activities of Industry, research organization.

CO3: Offer suggestions/ remarks for solving a Industry / research problem.

CO4: Exhibit good communication and report writing skills.

Board of Studies (BoS) : 19th BoS of Civil held on 29.09.2023

Academic Council: 21st AC held on 20.12.2023

	PO1	PO2	PO3	PO4
CO1	1	-	2	1
CO2	2	-	3	1
CO3	1	-	2	2
CO4	-	3	1	-

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: The industry internship shall impart the students a holistic understanding of structural Engineering domain with the skills to integrate sustainability principles into the design and construction of structures.

CEE 7101	PROJECT WORK (PHASE I)	L	T	P	C
SDG: 11		0	0	18	6

COURSE OBJECTIVE:

The Project work aims to provide opportunity for the students to exhibit their capacity in executing a project work which deals with study on materials / analysis / design / experimental works related to structural engineering domain.

GENERAL GUIDELINES:

- At post-graduate level, project work shall be carried out by the student individually.
- The students are encouraged to execute their project work (Phase I & II) in collaboration with Industry, R&D organization, Eminent Academic Institutions etc.
- The students will be given opportunity to select a project topic of his/her interest and are advised to interact with potential faculty members to discuss their project ideas for better understanding.
- A project coordinator is identified in the beginning of III semester for every batch who coordinates various activities viz. dissemination of research thrust areas of structural engineering domain, faculty expertise, allocation of project guides, conduct of periodic reviews and monitoring the performance of the students throughout the project period.
- The project guide is nominated based on the preference of students and consent of the faculty concerned.
- The Project work Phase – I, shall be carried out by the students under the guidance of allotted Guide.
- In case, the students pursuing their project in the Industry / R & D organization / Eminent academia, a competent person from the project offering organization is assigned as co-guide as per the discretion of the head of the firm, in addition to the Department allotted guide.
- In the Project work – Phase I, the students are expected to identify the project topic, refer related literatures / data / information to identify the research problem (i.e., need for the present study). The students shall conduct meticulous literature review to identify the research gap, and frame the

objectives to address the same.

- The students are encouraged (i) to frame the methodology to achieve the desired objectives, (ii) to conduct study on properties of various materials used in the study as per relevant codal provisions, (iii) to acquire knowledge on relevant software (if applicable) to conduct analytical investigation, (iv) to acquire knowledge on various experiments / techniques to conduct experimental experimentation etc.
- The Head of the Department / Dean of School shall constitute a project progress review committee comprising competent senior faculty members as members to continuously monitor the progress made by students during the Project Phase I.
- The project coordinator shall arrange to conduct three progress review meetings to ascertain the progress of the work and award the marks based on the performance on expected metrics.
- At the end of phase –I period, students shall submit a project report covering the various aspects of project work. The typical components of the project report in Phase I shall objectives, include Introduction, Need for the present study, scope for investigation, literature review and methodology.
- An oral examination (viva voce) shall be conducted as semester end examination. 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.
- The project co-ordinator shall arrange for final viva-voce examination to ascertain the overall performance in Project work.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Able to identify research problem in the area of Structural Engineering, conduct review of literature, frame objectives and methodology to address the research gap.

CO2: Exhibit competency to conduct core scientific/ application oriented research in the field of Structural Engineering by employing relevant software tools/ experimental investigation as per codal provisions.

CO3: Exhibit good communication and report writing skills.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	-	3	1
CO2	2	-	3	2
CO3	-	3	-	-

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

Statement: Holistic Understanding (materials and behavior of structural elements supported by analytical investigation) is more essential to ensure safe and sustainable building.

CEE 7101	PROJECT WORK (PHASE II)	L	T	P	C
SDG: 11		0	0	36	18

COURSE OBJECTIVE:

The Project aims to provide an opportunity for the students to exhibit their capacity in executing a project work which deals with the study of materials/analysis/design/experimental works related to the structural engineering domain.

GENERAL GUIDELINES:

- Project work phase II is a continuation of phase I following the same guidelines.
- The project co-coordinator shall arrange to conduct three reviews to ascertain the progress of the work and award the marks based on the performance of students on desired metrices.
- Detailed experimental investigation and in-depth analytical study shall be performed in line with the objectives of the investigation.
- The students are expected to analyze 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 the scope for further research also to be highlighted.
- The outcome of project work shall preferably be published in journals/conference of National or International importance.
- At the end of project phase II, students shall submit a detailed report and it shall include Experimental investigation and analytical study, Results & Discussion of experimental/analytical work, Conclusions, References etc., in addition to work completed in Phase –I viz. Introduction, Literature and methodology.
- The project co-ordinator in consultation with Dean/ Head of the department and Controller of Examination shall arrange for a semester end oral examination by following SOP of the Institution to ascertain the overall performance of the students in Project work.
- 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.

COURSE OUTCOMES: On completion of the course, students will be able to

CO1: Able to interpret analytical / experimental data by applying critical thinking, scientific principles/ context etc.

CO2: Able to provide conclusions and recommendations to a problem with emphasis on professional ethics, care for safety and society and environment and sustainability.

CO3: Exhibit good communication and report writing skills.

Board of Studies (BoS):

17th BoS of Civil held on 10.08.2022

Academic Council:

19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	3	-	3	3
CO2	2	-	2	2
CO3	-	3	-	-

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

Statement: Holistic Understanding of materials and behavior of structural elements supported by analytical study is more essential to ensure safe and sustainable building.

PROFESSIONAL ELECTIVES - ODD SEMESTER

CEEY 101	ADVANCED CONCRETE TECHNOLOGY	L	T	P	C
SDG: 11		3	0	0	3

COURSE OBJECTIVES:

The objective of the course is to impart adequate knowledge on

COB1: Usage of mineral and chemical admixtures in concrete.

COB2: Mechanism of corrosion of steel rebar in concrete and protection methods.

COB3: Ready-mix concrete and self-compacting concrete.

COB4: Polymer modified concrete, fiber reinforced concrete and pervious concrete.

MODULE I MINERAL ADMIXTURES IN CONCRETE 9

Supplementary cementitious materials: source, significance and overview - Fly ash (different classes), silica fume, metakaolin, blast furnace slag, rice husk, titanium- di-oxide: properties — Influence on fresh concrete, Hardened concrete, microstructure and durability properties of concrete.

MODULE II CHEMICAL ADMIXTURES IN CONCRETE 9

Chemical admixtures for concrete: overview and significance - Water reducers/plasticizers: types, working mechanism, optimum dosage, influence on workability and application areas - Viscosity modifying agents, retarders, set accelerators, air entraining agents, damp-proofers, water repelling admixtures - Shrinkage reducing admixtures: types, brief working mechanism and application areas - Influence of chemical admixtures on fresh concrete, hardened concrete, microstructure and durability properties of concrete.

MODULE III CORROSION OF STEEL REBARS IN REINFORCED CONCRETE 9

Mechanism of corrosion of steel in concrete – Causes and influencing parameters: carbonation, chloride attack, microbial induced corrosion and acid attack - Deteriorating mechanism - Consequences of corrosion in reinforced concrete and pre-stressed concrete structures - Corrosion protection methods: overview - Protective coating to steel rebars: fusion bonded epoxy coating, galvanization andcement polymer anticorrosive coating — Sacrificial anode cathodic protection — concrete coatings: types and materials — Corrosion inhibitors: types, working mechanism.

MODULE IV READY MIX CONCRETE AND SELF COMPACTING CONCRETE **9**

Ready mix concrete: ingredients, mix proportion, mix design, manufacturing processand good construction practices - Self-compacting concrete: ingredients, mix design as per EFNARC guidelines, workability requirements of SCC: Abrams cone, J-ring,V-funnel, L-box and U-box, good construction practices and application areas.

MODULE V SPECIAL CONCRETES: POLYMER MODIFIED CONCRETE, FIBER-REINFORCED CONCRETE AND PERVIOUS CONCRETE **9**

Polymer modified mortar/concrete - Types of polymers — Working mechanism in cementitious systems - Influence on fresh mortar/concrete, hardened mortar / concrete, microstructure, transport mechanism and durability properties — Applications areas - Fiber-reinforced concrete: types of fibers – working mechanism - Influence on fresh, hardened and durability properties – Application areas - Pervious concrete: significance, manufacturing, properties and application areas.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Brooks, J.J. and Neville, A.M., “Concrete Technology”, Pearson,2019.
2. Santhakumar, A.R., “Concrete Technology” Oxford University Press,New Delhi, 2007.

REFERENCES:

1. Kumar Mehta. P. and Paulo J.M. Monteiro., “Concrete : Microstructure, Properties, and Materials”4th Edition, McGraw Hill Education (India) Pvt. Ltd., 2014.
2. Shetty.M.S., and A.K. Jain “Concrete Technology (Theory and Practice)”, S. Chand and Company Ltd.,2010.
3. Gambhir.M.L., “Concrete Technology”, 5th Edition, Tata McGraw Hill Education, 2017.
4. Nayak, N.V, and Jain, A.K, Handbook on Advanced Concrete Technology, Narosa Publishing House Pvt. Ltd., New Delhi, 2012.
5. Zongjin Li, “Advanced Concrete Technology”, John Wiley & Sons, 2011.
6. EFNARC (2002), “Specification and Guidelines for Self-compacting Concrete”, Surrey, UK.
7. John Broomfield, “Corrosion of Steel in Concrete – Understanding, Investigation and Repair”, CRC Press, London, 2003.
8. Yoshihiko Ohama, “Hand Book of Polymer Modified Concrete and Mortars”, Noyes Publications, U.K., 3rd Edition, 2013.

COURSE OUTCOMES:

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

CO1: Understand the significance of the addition of mineral admixtures in concrete for various applications.

CO2: Suggest the chemical admixtures in concrete for real-time applications.

CO3: Describe the mechanism of corrosion in concrete and suggest protection measures of reinforced concrete structures.

CO4: Describe the manufacturing process of ready-mix concrete and perform mix design of self-compacting concrete as per EFRAC standards

CO5: Describe procedure for manufacture and properties of polymer-modified concrete, fiber- reinforced concrete and pervious concrete including its application areas.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	2	1	3
CO2	2	2	1	3
CO3	1	3	2	2
CO4	2	2	2	2
CO5	3	2	1	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

Statement : Designing of durable, high performance and sustainable reinforced concrete (i) by using mineral admixtures, chemical admixtures in concrete, (ii) by adopting specialized procedures and methods and (iii) by adopting corrosion protection methods during construction; and make the human settlements safe, resilient and sustainable.

CEEY 102	DESIGN OF BRIDGES	L	T	P	C
SDG: 9 & 11		3	0	0	3

COURSE OBJECTIVES:

COB1: Components of bridges, its types, material requirements, while familiarizing with IRC specification and design standard.

COB2: The skills to design short and long span bridges, incorporating deck slabs, cantilever slabs, longitudinal and cross girders as per IRC.

COB3: Prestressed concrete bridge design principles, its types, cross section, focussing on the design of post-tensioned prestressed concrete deck slab and T-beam.

COB4: The design of plate girder and truss bridges, emphasising codal provisions, loading standards and stiffeners design.

COB4: Types and design of bearings, substructure and foundation for the bridges.

MODULE I INTRODUCTION TO BRIDGE DESIGN 6

Components of bridge - Types of bridges, classification, materials of construction - Need for investigation and planning – Most economical span - Choice of type of bridge - I.R.C. specifications for road bridges and loadings - general design considerations - load distribution theories.

MODULE II DESIGN OF SHORT SPAN AND LONG SPAN BRIDGES 15

Types of culverts, basic features - Methods of design of slabs and girders, effective width method, Pigeaud's method, Courbon's method, approximate method - Impact factor calculation - Design of slab culverts - Design of reinforced concrete T-beam bridges, design of deck slab, cantilever slab, longitudinal and cross girders - Design principles of continuous bridges.

MODULE III PRESTRESSED CONCRETE BRIDGES 8

General aspects - Types of prestressed concrete bridges, pre-tensioned prestressed concrete bridge, post-tensioned prestressed concrete bridge - typical configurations - over view of design principles of prestressed concrete bridges - design of post-tensioned prestressed concrete slab deck and T-beam, significance of end-block.

MODULE IV PLATE GIRDER BRIDGES 8

Plate girder bridges, general features, types, advantages and disadvantages - Design principles, codal provisions and loading standards - Design of plate girder bridges, intermediate stiffeners, end bearing stiffeners - Truss bridges, types,

design of truss bridges.

MODULE V **BEARINGS, SUBSTRUCTURE AND FOUNDATION FOR BRIDGES** **8**

Bridge bearings, general features, types of bearings - Design of steel rocker bearing – Bridge substructure, design of piers and abutments – Bridge foundation, types, design of well and pile foundation.

L-45; TOTAL HOURS – 45

REFERENCES:

1. Edwin H.Gaylord Jr., Charles N.Gaylord, James, E.,Stallmeyer Design of Steel Structures, McGraw Hill Education, 1991.
2. IRC – 78, “Standard code of practice for limit state design for foundations,” New Delhi, India, 2014.
3. IRC – 83 - (Part – I), “Section: IX Bearing’s Part 1 Roller and rocker bearings,” New Delhi, India, 2015.
4. IRC – 83 - (Part – II), “Section: IX Bearings (Elastomeric bearings),” New Delhi, India, 2018.
5. IRC – 83 - (Part – III), “Section IX Bearings Part III (Pot, pin, metallic guide plane, sliding bearings),” New Delhi, India, 2018.
6. IRC – 83 - (Part – IV), “Section IX Section: IX Bearings (Spherical and symmetrical),” New Delhi, India, 2014.
7. IRC 112, “Code of practice for concrete road bridges,” New Delhi, India, 2020.
8. IRC 22, “Section: IV Composite construction (Limit state design),” New Delhi, India, 2015.
9. IRC 24, “Section V: Steel road bridges (Limit state method),” New Delhi, India, 2010.
10. IRC 6, “Section: II Loads and load combinations,” New Delhi, India, 2017.
11. Krishnaraju, N., Design of Bridges, Oxford and IBH Publishing Co., New Delhi, 2019.
12. Petros P. Xanthakos, Theory and Design of Bridges, .John Wiley & Sons, 1994.
13. Ponnuswamy, S., Bridge Engineering, Tata McGraw Hill Publishing Company, New Delhi, 2017.
14. Raina V.K. Concrete Bridge Practice: Analysis, design and Economics, Shroff Publishers, 2014.

COURSE OUTCOMES:

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

CO1: Identify the components and types of bridges, assess the material requirements and apply IRC specifications to bridge design.

CO2: Design of short span and long span bridges incorporating deck slab, cantilever slab, longitudinal and cross girders as per IRC specifications.

CO3: Design post tensioned prestressed concrete bridge superstructure, deck slab and T-beam for the IRC loading.

CO4: Design steel plate girder bridge and truss bridge based on IRC loading conditions.

CO5: Design of bearing, substructure for foundation, pile foundation and well foundation as per IRC.

Board of Studies (BoS) :
17th BoS of Civil held on 10.08.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	2	3	2
CO2	3	2	3	2
CO3	3	2	3	2
CO4	3	2	3	2
CO5	2	2	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG – 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
SDG - 11: Make cities and human settlements inclusive, safe, resilient and sustainable

Statement: The knowledge on the design of bridges shall lead to construction of smart and resilient infrastructure in line with the needs of industrialization and innovation.

CEEY 103	**DESIGN OF STEEL CONCRETE**	**L**	**T**	**P**	**C**
SDG: 9 & 11	**COMPOSITE STRUCTURES**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To impart knowledge on the behaviour of composite beams, columns and connections.

COB2: To understand the behaviour and design concepts of composite boxgirder bridges and composite trusses.

MODULE I CONCEPTS OF STEEL CONCRETE COMPOSITE CONSTRUCTION **9**

Introduction to steel-concrete composite construction - Theory of composite structures - Introduction to steel-concrete - Steel sandwich construction.

MODULE II DESIGN OF COMPOSITE MEMBERS **9**

Behaviour of composite beams - Columns - Design of composite beams – Steel-concrete composite columns - Design of composite trusses.

MODULE III DESIGN OF CONNECTIONS **9**

Types of connections - Design of connections in the composite structures - Shear connections - Design of connections in composite trusses.

MODULE IV COMPOSITE BOX GIRDER BRIDGES **9**

Introduction - Behaviour of box girder bridges - Design concepts.

MODULE V CASE STUDIES ON STEEL CONCRETE COMPOSITE CONSTRUCTION **9**

Case studies on steel–concrete composite construction in buildings – Seismic behaviour of composite structures.

L - 45; TOTAL HOURS –45

REFERENCES:

1. Johnson R.P., “Composite Structures of Steel and Concrete”, Blackwell Scientific Publications (Second Edition), UK, 2005.
2. Owens, G.W. and Knowels. P., “Steel Designers Manual”, Steel Concrete Institute (UK), Oxford Blackwell Scientific Publications, 5th Edition, 2002.

COURSE OUTCOMES:

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

CO1: Describe the composite structures using various theories.

CO2: Design the composite beams and columns.

CO3: Analyse and design the connections in composite structures

CO4: Design composite box girder bridges.

CO5: Describe the steel concrete composite construction in buildings through case studies

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	1
CO2	2	1	3	1
CO3	2	1	3	1
CO4	2	1	3	1
CO5	1	1	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: A holistic understanding of design concepts of steel and concrete composite structures are more essential to ensure safe and sustainable buildings.

CEEY 104	EXPERIMENTAL METHODS IN	L	T	P	C
SDG: 9 & 11	STRUCTURAL ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

The objectives of the course are :

COB1: To impart knowledge on the similitude principles and model analysis that governs the design, testing and interpretation of models.

COB2: To provide sufficient knowledge on the various aspects of elastic and inelastic models of various materials.

COB3: To impart sound knowledge on the various model fabrication techniques and emphasis on instrumentation techniques.

CO4: To impart sound knowledge on the various types of loads acting onthe structures.

MODULE I THEORY OF STRUCTURAL MODELS 7

Dimensions and dimension homogeneity - Dimensional analysis - Structural models - Similitude requirements - Physical modeling and choice of geometric scale - Modeling process - Advantages and limitations of model analysis - Accuracy of structural models.

MODULE II MATERIALS FOR ELASTIC AND INELASTIC MODELS 9

Materials for elastic models - Plastics-time effects in plastics-effect of loading rate, temperature and environment - Inelastic models – Prototype and model concretes - Design mixes for model concrete - Structural steel models - Reinforcement for small-scale concrete models – Model prestressing reinforcement and techniques - Bond characteristics of model steel - Bond similitude.

MODULE III MODEL FABRICATION TECHNIQUES 9

Basic cutting, shaping and machining operation - Basic fastening and glueing techniques - Construction of structural steel models - Construction of concrete models - Fabrication of concrete masonry models - Construction of plastic models - Size effects, accuracy, and reliability in materials systems.

MODULE IV INSTRUMENTATION- PRINCIPLES AND APPLICATIONS 9

Quantities to be measured – Strain measurements: mechanical strain gauges, electrical strain gauges - Displacement measurements: mechanical dial gauges, Linear Variable Differential Transformer, linear resistance potentiometers - Full-field strain measurement and crack detection methods - Brittle coating - Photo

elastic coating, other crack detection methods - Stress and force measurements - Load cells, embedded stress meters and plugs - Data Acquisition and reduction-types of data recording, various data acquisition systems - Introduction on fibre optic sensors for smart structures.

MODULE V STRUCTURAL MODEL TESTING 11

Types of loads - Discrete vs distributed loads - Flexural and axial test on structural members - Application of NDT for quality assessment and damage detection of structures and materials - Statistical quality control - Materials for dynamic models - Properties of steel and concrete - Loading systems for dynamic modelling - Vibrationand resonant testing, wind tunnel testing, shock tubes and blast chambers, shaking tables, drop hammers and impact pendulums — Case studies - shaking table tests on buildings.

TOTAL HOURS –45

REFERENCES:

1. Bungey, J.H., S.G. Millard, S.G and Grantham, M.G., “Testing of Concrete in Structures”, CRC Press, 4th Edition, 2014.
2. Harry, G. Harris and Gajanan M. Sabnis, “Structural Modeling and Experimental Techniques” Second Edition, CRC Press, 2010.
3. Malhotra and Carino, “Handbook of Nondestructive Testing of Concrete”,CRC Press, 2004.

COURSE OUTCOMES:

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

CO1: Describe the similitude principles and model analysis that govern the design, testing and interpretation of models.

CO2: Prepare the elastic and inelastic model for various types of materials, which facilitate the study of their behaviour.

CO3: Develop the techniques for fabricating small-scale structural models.

CO4: Identify the correct type of instrument and sensor design for a particular experimental measurement application and match this instrument with a signal conditioning and data acquisition system to obtain an integrated measurement.

CO5: Conduct flexural and axial tests on structural members.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	2	3	1
CO2	2	2	3	1
CO3	2	2	3	1
CO4	2	2	3	1
CO5	2	2	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: The holistic understanding of structural model testing through experimental methods is more essential to ensure safe and sustainable buildings

CEEY 105	GROUND IMPROVEMENT TECHNIQUES	L	T	P	C
SDG: 9 & 11		3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce the various ground improvement methods based on soil type.

COB2: To impart knowledge on the selection, design, and construction aspects of ground improvement techniques in problematic soils.

COB3: To understand the methods and properties of reinforced soil.

COB4: To provide sufficient knowledge of the basic concepts of geosynthetics.

MODULE I INTRODUCTION 9

Role of ground improvement in foundation engineering – Methods of ground improvement – Ground Improvement – Potential – Hazardous ground conditions, poor ground conditions, favorable ground conditions, alternative approaches - Geotechnical Processes – Selection of suitable ground improvement techniques based on soil condition.

MODULE II HYDRAULIC MODIFICATION 9

Drainage techniques – Well points – Vaccum and electro osmotic methods – Seepage analysis for two-dimensional flow – Fully and partially penetrating slots inhomogenous deposits (Simple cases only).

MODULE III MECHANICAL MODIFICATION 9

Methods of compaction, shallow compaction, deep compaction techniques — Vibro-floatation, blasting, dynamic consolidation, pre-compression and compaction piles - Field compaction control and geo material replacement concept.

MODULE IV EARTH REINFORCEMENT 9

Reinforce earth - Principles – Components of reinforced earth – Design principles of reinforced earth walls – Stability checks – Soil nailing.

MODULE V GEOSYNTHETICS 9

Geo–synthetics – Geo–textiles, types, functions, properties and applications, Geogrids, geo- membranes and gabions – properties and applications – Grouting objectives of grouting – Grouts and their applications – Methods of grouting - Stage of grouting – Hydraulic fracturing in soils and rocks – Post grout tests.

L - 45; TOTAL HOURS – 45

REFERENCES:

1. Das, B.M, “Principles of Foundation Engineering”, Thomson Brooks Cole, USA. 2003.

R.M. Korner, “Design with Geosynthetics”, Prentice Hall, New Jersy, 3rd Edition 2002.

COURSE OUTCOMES:

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

CO1: Assess the properties of problematic soil and the necessity of different ground improvement.

CO2: Explain the process of dewatering and assess the soil strength.

CO3: Analysis the various available mechanical methods to strengthen soil.

CO4: Effectively utilize different earth reinforcement materials and understand various available methods.

CO5 : Describe the concept of geosynthetics of ground improvement.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	2	3	1
CO2	2	2	3	1
CO3	2	2	3	1
CO4	2	2	3	1
CO5	2	2	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: A holistic understanding of various techniques for ground improvement is essential to ensure safe and sustainable buildings.

CEEY 106	MATRIX METHODS OF	L	T	P	C
SDG: 9 & 11	STRUCTURAL ANALYSIS	3	0	0	3

COURSE OBJECTIVES:

COB1: To impart knowledge on the computation of deflections and forces in statically determinate and indeterminate structures using matrix methods.

COB2: To provide in-depth analytical knowledge on the physicalinterpretation of stiffness matrices to assemble stiffness matrices.

MODULE I FUNDAMENTAL CONCEPTS AND TRANSFORMATION **9**

Introduction — Forces and displacement measurements — Principle of superposition – Methods of structural analysis – Betti's Law – Stiffness and flexibility matrices of the elements - Indeterminate structures – Transformationof system force to element forces – Element flexibility to system flexibility – System displacement to element displacement – Transformation of forces and displacement in general – Normal and orthogonal transformation.

MODULE II FLEXIBILITY METHOD **9**

Choice of redundant – Ill and well-conditioned equations – Automatic choice of redundant – Rank technique – Transformation of one set of redundant to another set – Thermal expansion – Lack of fit – Application to pin jointed plane truss - Continuous beams - Frames and grids.

MODULE III STIFFNESS METHOD **9**

Development of stiffness method – Analogy between flexibility and stiffness – Analysis due to thermal expansion, lack of fit – Application to pin-jointed plane and space trusses – Continuous beams – Frames and grids – Problem solving.

MODULE IV MATRIX DISPLACEMENT METHODS - SPECIAL TOPICS **9**

Static condensation technique – Substructure technique - Transfer matrix method – Symmetry & anti symmetry of structures – Reanalysis technique.

MODULE V DIRECT STIFFNESS METHOD **9**

Discrete system – Direct stiffness approach – Application to two and three dimensional pin-jointed trusses - Plane frames grids – Three dimensional space frames.

L - 45; TOTAL HOURS – 45

REFERENCES:

1. Godbole P.N., Sonparote, R.S., Dhote, S.U., "Matrix Methods Of Structural Analysis", PHI Learning Pvt. Ltd., 2014
2. Mcguire and Gallagher, R.H, "Matrix Structural Analysis", John Wiley, 2001
3. Meek J. L., "Computer Methods in Structural Analysis", Taylor and Francis, 2017.
4. Nelsm J.K., Nelson K James and Mc Cormac J C., "Structural analysis using Classical and Matrix Methods", John Wiley &sons, 2002
5. Rajasekaran, S and Sankara Subramanian. G, "Computational Structural Mechanics", Prentice Hall of India, 2001.

COURSE OUTCOMES:

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

CO1: Transform the system force to element forces and system displacement to element displacement.

CO2: Apply the matrix flexibility method for planar trusses, beams, and frames.

CO3: Compute reactions, internal forces and deflections for planar trusses, beams, and frames using matrix stiffness method.

CO4: Analyse the matrix displacement method for symmetry and anti-symmetry of structures using various techniques.

CO5: Extend the direct stiffness method for three dimensional framed structure.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	2
CO2	1	1	3	2
CO3	1	1	3	2
CO4	1	1	3	2
CO5	1	1	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG – 9: Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.

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

Statement: Matrix methods of Structural analysis is more essential to ensure safe and sustainable buildings.

CEEY 107	THEORY OF ELASTICITY AND PLASTICITY	L	T	P	C
SDG: 9 &11		3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce the general features of elastic systems and analyze two-dimensional state of stresses and strains.

COB2: To familiarize the students to solve the torsion of non-circular cross-sections by various approaches.

COB3: To understand the fundamental concepts to solve problems in structural members by various energy methods.

CO4: To provide sufficient background on the theory of plasticity.

MODULE I ANALYSIS OF STRESS & STRAIN 9

Basic concepts of deformation of deformable bodies, notations for stress and strain intwo and three dimensions - Stress transformation laws - Differential equations of equilibrium in two and three dimensions in cartesian coordinates - Generalized Hooke's law - Lame's constants.

MODULE II TWO DIMENSIONAL PROBLEMS 9

Plane stress and plane strain problems, examples - Airy's stress function — Polynomials - Direct method of determining Airy's stress function - Two-dimensional problems in rectangular coordinates - Bending of a cantilever loaded at the free end - Bending of a beam by uniform load - Equation of Equilibrium in polar coordinates - Two-dimensional problems in polar coordinates for curved beam, thick cylinders and plate with holes.

MODULE III STRAIN ENERGY METHODS 9

Total strain energy - Complementary energy - Principle of virtual work and total potentialenergy - Theorem of minimum potential energy - Betti’s reciprocal theorem - Principle oflinear superposition - Uniqueness of elasticity solution - Theorem of minimum complementary energy - Griffith’s theory of rupture - Castigliano’s theorem - Principle of least work.

MODULE IV TORSION OF VARIOUS SHAPED BARS 9

Torsion of straight bars – Elliptic cross-section - Saint Venant’s theory – Membrane analogy — Narrow rectangular cross-section - Torsion of thin-walled open sections -Torsional stress concentration.

MODULE V PLASTICITY 9

Introduction - Physical assumptions, yield criteria of metals, graphical representation of yield criteria - Flow rule (plastic stress-strain relation) – Prandtl-Reuss equation - Levy Mises equation — Lower bound, upper bound and uniqueness theorems - Application to simple problems in tension-compression - Solution of elastoplastic problems.

L - 45; TOTAL HOURS – 45

REFERENCES:

1. Arthur P Boresi, Ken P.Chong, “Elasticity in Engineering Mechanics”, John Wiley & Sons, 2000.
2. Kachanov L M, “Fundamentals of the Theory of Plasticity”, Dover Publications, 2013.
3. Stuart Antman, “Nonlinear Problems of Elasticity”, Springer Publication, 2nd Edition, 2005.
4. Sadhusingh, “Theory of Elasticity”, Khanna Publishers, New Delhi 2012.

Γimoshenko and Goodier, “Theory of Elasticity”, 3rd Edition, McGraw Hill,2010.

COURSE OUTCOMES:

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

CO1: Critically describe the mathematical and physical foundations of the continuum mechanics of solids, including deformation, stress measures and constitutiverelations.

CO2: Solve the two-dimensional problems in cartesian and polar coordinates.

CO3: Apply the principles to evaluate the problems related to torsion of non-circular cross-sections.

CO4: Analyze the structural members by various energy methods.

CO5: Describe the basic concepts of the theory of plasticity.

Board of Studies (BoS) :
17th BoS of Civil held on 10.08.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	2
CO2	1	1	3	2
CO3	1	1	3	2
CO4	1	1	3	2
CO5	1	1	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG – 9: Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation

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

Statement: A holistic understanding of the theory of elasticity and plasticity is essential to ensure safe and sustainable buildings.

CEEY 108	WATERPROOFING OF CONCRETE AND MASONRY STRUCTURES	L	T	P	C
SDG: 11		3	0	0	3

COURSE OBJECTIVES: The objective of the course is to impart adequate knowledge on

COB1: principles of waterproofing and designing envelope for concrete structures

COB2: below-grade waterproofing, designing and relevant materials

COB3: above-grade waterproofing, designing procedures and relevant materials

COB4: waterproofing problems in residential buildings and protection systems

COB5: remedial waterproofing of distressed concrete structures

MODULE I PRINCIPLES OF WATERPROOFING 9

Introduction to waterproofing and envelope design – water sources – designing to prevent leakages in concrete structures. Basic envelope design – most important waterproofing principles – preventing water infiltration – beyond envelope waterproofing.

MODULE II BELOW-GRADE WATERPROOFING 9

Introduction – surface water control – ground water control – manufactured drainage systems – waterstops – hydrophilic bentonite / asphalts. Capillary action – positive and negative systems – cementitious system – metallic system – acrylic modified system – chemical additive system. Fluid applied systems – urethane – rubber derivatives – polymer asphalt etc. - Case studies.

MODULE III ABOVE-GRADE WATERPROOFING 9

Introduction – difference from below-grade waterproofing systems – vertical applications – horizontal applications – above-grade exposure problems. Materials – clear repellents – film forming sealers – penetrating sealers – choosing appropriate repellents – cementitious coatings – elastomeric coatings – deck coatings. Roof waterproofing – interior waterproofing on masonry elements - applications. Case studies.

MODULE IV RESIDENTIAL WATERPROOFING 9

Introduction – Multiple residents and single family construction. Below-grade waterproofing – substrate – ground water control – positive versus negative waterproofing – basement waterproofing systems. Above-grade waterproofing –

exterior insulate finish systems – terminations and transitions – roof waterproofing systems – masonry waterproofing systems. Case studies.

MODULE V REMEDIAL WATERPROOFING 9

Introduction – remedial applications – visual inspection – non-destructive testing – destructive testing – cause determination and methods of repair. Cleaning surfaces – types. Restoration work – pointing – grouting – epoxy injection – cementitious patching – shotcrete – overlays. Case studies.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

Michael T. Kubal, “Construction Waterproofing : Handbook”, Second edition, Mc Graw Hill Education, 2008.

REFERENCES:

1. Brooks, J.J. and Neville, A.M., “Concrete Technology”, Pearson, 2019.
2. Emmons, P.H., “Concrete Repair and Maintenance Illustrated: Problem Analysis; Repair Strategy; Techniques”, RSMeans Publishers, 2002.
3. Handbook on “Waterproofing of Concrete Structures”, Indian Concrete Institute, 2020.
4. Hand Book on “Repair and Rehabilitation of RCC Buildings”, Central Public Works Department, Government of India, 2002.
5. Kumar Mehta. P. and Paulo J.M. Monteiro., “Concrete: Microstructure, Properties, and Materials” 4th Edition, McGraw Hill Education (India) Pvt. Ltd., 2014.
6. Mahel Al-Jabari, “Integral Waterproofing of Concrete Structures : Advanced Protection Technologies of Concrete by Pore Blocking and Lining”, Elsevier Ltd., 2022.
7. Malhotra, V.M. and Carino, N.J., “Handbook on Non-destructive Testing of Concrete”, CRC Press, 2004.
8. Perkins, P.H., “Repair, Protection and Waterproofing of Concrete Structures”, Third edition, E & FN Spon, 1997.
9. Santha Kumar, A.R., “Concrete Technology”, Oxford University Press, New Delhi, 2007.
10. Yoshihiko Ohama, “Hand Book of Polymer Modified Concrete and Mortars”, Noyes Publications, U.K., 3rd Edition, 2013.

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

CO1: Understand scientific principles involved in design of waterproofing envelope for concrete and masonry structures.

CO2: Identify below-grade waterproofing system for different applications

CO3: Identify above-grade waterproofing system for different applications

CO4: Design waterproofing system for residential application

CO5: Conduct condition assessment on concrete and masonry elements distressed with water leakage and suggests remedial methods.

Board of Studies (BoS) :
17th BoS of Civil held on 10.08.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	2	3	3
CO2	2	2	3	3
CO3	2	2	3	3
CO4	2	2	3	3
CO5	2	2	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

1. Development of sustainable infrastructure by understanding the principles of waterproofing in buildings.

2. Make the existing human settlements safe and resilient by identifying suitable waterproofing materials, and adopting feasible techniques based on application areas.

CEEY 109	PREFABRICATED STRUCTURES	L	T	P	C
SDG: 11		2	0	0	2

COURSE OBJECTIVES:

The course will impart knowledge on

COB1: Design principles of prefabricated structures.

COB 2: Behavior of prefabricated RC structures.

COB 3: The concepts in the construction of prefabricated structural components.

COB 4: Design of elements for industrial buildings.

MODULE I DESIGN PRINCIPLES 7

General civil engineering requirements - Specific requirements for planning and layout of prefabrication plant - IS code specifications - Modular co-ordination, standardization, disuniting of prefabricates, production, transportation, erection, stages of loading and code provisions, safety factors, material properties, deflection control - Lateral load resistance - Location and types of shear walls - Long wall and cross-wall large panel buildings.

MODULE II REINFORCED CONCRETE 8

One-way and two-way prefabricated slabs - Framed buildings with partial and curtainwalls - Connections — Beam to column and column to column - Types of floor slabs, analysis and design example of cored and panel types and two-way systems - Staircase slab design - Types of roof slabs and insulation requirements - Description of joints - Their behaviour and reinforcement requirements - Deflection control for short term and long term loads - Ultimate strength calculations in shear and flexure.

MODULE III WALLS 7

Types of wall panels - Blocks and large panels - Curtain, partition and load bearing walls, load transfer from floor to wall panels, vertical loads, eccentricity and stabilityof wall panels - Design curves - Types of wall joints - Their behaviour and design Leak prevention - Joint sealants - Sandwich wall panels - Approximate design of shear walls.

MODULE IV INDUSTRIAL BUILDINGS AND SHELL ROOFS 8

Components of single-storey industrial sheds with crane gantry systems - R.C. roof trusses, roof panels, corbels and columns, wind bracing design - Cylindrical, folded plate and hyper-prefabricated shells, erection and jointing - Joint design, hand book-based design.

L-30; TOTAL HOURS - 30

REFERENCES:

1. Koncz.T., Manual of Precast Concrete Construction, Vol.I II and III & IV Bauverlag, GMBH, 1971.
2. Laszlo Mokk, Prefabricated Concrete for Industrial and Public Structures, Akademiai Kiado, Budapest, 2007.
3. Lewicki. B, Building with Large Prefabricated, Elsevier Publishing Company, Amsterdam/ London/New York, 1998.
4. Structural Design Manual, Precast Concrete Connection Details, Society for the studies in the use of Precast Concrete, Netherland BetorVerlag, 2009.
5. Warszawski, A., Industrialization and Robotics in Building - A managerial approach, Harper and Row, 1990.

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: Apply the design principles used to construct prefabricated structures.

CO2: Create a panel and framed buildings with their connections of prefabricated RC structures.

CO3: Classify the types of floors, stairs, wall panels and roofs and describe their behaviour of structures

CO4:. Construct a prefabricated structural component for industrial buildings.

Board of Studies (BoS) :
17th BoS of Civil held on 10.08.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	1
CO2	1	1	3	1
CO3	1	1	3	1
CO4	1	1	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG – 9: Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.

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

Statement: A holistic understanding of prefabricated structures is essential to ensure safe and sustainable buildings.

CEEY 110	SUBSURFACE EXPLORATION TECHNIQUES	L	T	P	C
SDG: 9 &11		2	0	0	2

COURSE OBJECTIVES:

COB1: To understand the importance and methods of subsurface exploration.

COB2: To impart knowledge on the various techniques on soil sampling.

COB3: To provide insight knowledge on the various laboratory tests and its interpretation.

COB4: To impart knowledge on the testing of soil in field.

MODULE I INTRODUCTION 7

Introduction — Scope and objectives, planning of exploration program - Methods of exploration - Exploration for preliminary and detailed design, spacing and depth of bore holes, data Interpretation - Methods of boring and drilling, non- displacement and displacement methods, drilling in difficult subsoil conditions.

MODULE II SOIL SAMPLING 6

Sampling Techniques – Quality of samples – Factors influencing sample quality - Disturbed and undisturbed soil sampling, advanced sampling techniques, Offshore sampling, shallow penetration samplers, preservation and handling of samples.

MODULE III LAB TESTING OF SOIL 7

Introduction – Determination of index and engineering properties of soil – Grain size Analysis, Atterberg limits, permeability of soil, shear test – Direct shear, vane shear, tri axial tests - Consolidation measurements- lab procedure – Calculations and interpretation.

MODULE IV INSITU EXPLORATION TECHNIQUES 10

Field tests, penetration tests, field vane shear, insitu shear and bore hole shear test, pressure meter test, dilatometer test - Plate load test–monotonic and cyclic; field permeability tests — Block vibration test - Procedure, limitations, correction and data interpretation of all methods - Indirect method of exploration, seismic method, electrical resistivity, resistivity sounding and profiling, qualitative and quantitative interpretation of test results.

L -30; TOTAL HOURS – 30

REFERENCES:

1. Alam Singh and Chowdhary G. R., “Soil Engineering in Theory andPractice, Volume - 2, Geotechnical Testing And Instrumentation”, CBS Publishers and Distributors, New Delhi, 2006.
2. Muni Budhu, "Soil Mechanics and Foundations", John Wiley and Sons, Inc., New York, 2000.
3. Thomson.D and D. J. Beasley, “Handbook of Marine Geotechnical Engineering”, US Navy, 2012
4. Venkataramiah.C, “Geotechnical Engineering”, New Age International Pvt.Ltd, 2002.

COURSE OUTCOMES:

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

CO1: Implement the concepts of soil tests and boring methods.

CO2: Apply various techniques for soil sampling.

CO3: Determine the soil properties by conducting laboratory tests.

CO4: Demonstrate the various methods of field test.

Board of Studies (BoS) :
17th BoS of Civil held on 10.08.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	3	3	1
CO2	2	3	3	1
CO3	2	3	3	1
CO4	2	3	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: Knowledge on subsurface exploration is more essential to ensuresafe and sustainable building.

CEEY 111	3D PRINTING IN CONCRETE TECHNOLOGY	L	T	P	C
SDG: 9 & 11		1	0	0	1

COURSE OBJECTIVES:

COB1: To introduce the 3D printing for building and construction, including the technologies, materials and applications.

MODULE I GENERAL CONSIDERATIONS AND TECHNOLOGIES 7

Introduction - General considerations for 3D printing and additive fabrication - 3D printing of cement-based materials - Digital and additive fabrication of cement materials - Printed methods using extrusion and deposition - Methods of printing by injection into a particle bed - Alternative printing methods - A classification of 3D printing methods for concrete.

MODULE II TECHNIQUES FOR EXTRUSION/CASTING 8

Introduction Breakdown of the process into stages - Behavior during the fresh state and the printing stage - Rheology of cement-based materials - Pumping - Extrusion - Stability of an elemental layer during deposition - Elastic deformation and accuracy of the deposition - Shrinkage and cracking during drying - Bonding between layers — weakness at the interface between layers.

L – 15; TOTAL HOURS –15

REFERENCES:

1. Jay Sanjayan, Ali Nazari, Behzad Nematollahi, “3D Concrete Printing Technology Construction and Building Applications”, 2019.
2. Arnaud Perrot, “3D Printing of Concrete State of the Art and Challenges ofthe Digital Construction Revolution”, Wiley, New York, 2019.

COURSE OUTCOMES:

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

CO1: Describe the history and classification of 3D printing methods for concrete.

CO2: Elucidate techniques for Extrusion/Casting of 3D printable concrete.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	1
CO2	1	1	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable.
Statement: The holistic understanding of 3D printing for building and Construction, leads to development of sustainable buildings.

PROFESSIONAL ELECTIVES - EVEN SEMESTER

CEEY 201	**ADVANCED FOUNDATION DESIGN**	**L**	**T**	**P**	**C**
SDG: 9 & 11		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

COB1: To impart knowledge on the analysis and design of shallow foundation.

COB2: To design the pile foundations under vertical and lateral loads.

COB3: To understand the components and design methods of well and other types of foundations.

COB4 : To provide in-depth knowledge on the basic concepts of soildynamics and design of machine foundation.

MODULE I SHALLOW FOUNDATIONS 10

Requirements for satisfactory performance of foundations - Methods of estimating, bearing capacity, factors affecting bearing capacity factors influencing selection of depth of foundation - Types of shallow foundations - Settlements of footings and rafts, proportioning of foundations using field test data, pressure — Settlement computation.

MODULE II LATERAL AND UPLIFT LOAD EVALUATION OF PILES 10

Pile Foundations - Methods of estimating load transfer of piles - Settlements of pile foundations - Pile group capacity and settlement - Laterally loaded piles - Pile load tests - Analytical estimation of load - Settlement behaviour of piles - Proportioning of pile foundations - Lateral and uplift capacity of piles.

MODULE III WELL FOUNDATION 10

Types, components, construction methods, design methods (Terzaghi, IS and IRC approaches) - Check for stability - Base pressure - Side pressure and deflection.

MODULE IV MISCELLANEOUS FOUNDATION 8

Sheet Pile Structure - Types, cantilever, anchored sheet pilling - Design by fixed earth method - Anchor braced sheeting cofferdam - Single well cofferdams - Cellular cofferdam Stability of cellular cofferdam.

MODULE V SOIL DYNAMICS & MACHINE FOUNDATIONS 7

Introduction to soil dynamics – Soil behaviour under dynamic loads – Difference between static and dynamic load behaviour of soil – Dynamic soil properties – Free vibrations and forced vibrations – Types of machines – Types of machine foundations – Vibration analysis of a machine foundation – General design criteria for machine foundations.

L -45 ; TOTAL HOURS – 45

REFERENCES:

1. Bowles J E, “Foundation Analysis & Design”, McGraw Hill Education; 5th edition, 2017.
2. Kurian. N.P, “Design of foundation systems: Principles and Practices”, Narosa Publishing House, 2014.
3. Lambe T. W. & R. V. Whitmen, “Soil Mechanics”, Wiley Eastern Ltd.,2000.
4. Murthy, V.N.S., "Advanced Foundation Engineering", CBS Publishers, New Delhi, 2007.
5. Swami saran, “Soil Dynamics and Machine Foundations”, Galgotias, 2012.
6. Varghese P.C., "Design of Reinforced Concrete Foundations”, PHILearning Private Limited, New Delhi, 2009.

COURSE OUTCOMES:

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

CO1: Design the shallow foundations based on the bearing capacity of soil.

CO2: Perform lateral and uplift load analysis and suitably design a pile foundation.

CO3: Analyze and design the well foundation for structure.

CO4: Design the sheet pile and coffer dams.

CO5: Describe the dynamic behaviour of soil and foundations for machines.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	2	3	2
CO2	1	2	3	2
CO3	1	2	3	2
CO4	1	2	3	2
CO5	1	2	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: Knowledge on Advanced Foundation Design is more essential to ensure safe and sustainable building.

.

CEEY 202	CORROSION PREVENTION AND	L	T	P	C
SDG: 9 & 11	CONTROL IN RC STRUCTURES	2	0	2	3

COURSE OBJECTIVES:

COB1: Mechanism of corrosion of steel in concrete, major causes, influencing parameters and consequences in reinforced and pre-stressed concrete structures.

COB2: Techniques and methods for condition assessment, corrosion prevention, and corrosion control in reinforced concrete (RC) structures.

COB3: Types of corrosion and its mechanism, non-destructive and destructive testing techniques for corrosion assessment in distressed concrete elements through hands-on training.

MODULE I **MECHANISM OF CORROSION OF STEEL IN RC STRUCTURES** **8**

Corrosion mechanism – black rust - pits - stray current, causes of corrosion – carbonation - chloride attack – microbial induced corrosion in concrete – influencing parameters – corrosion damage in reinforced concrete and pre-stressed concrete - stress corrosion cracking - hydrogen embrittlement, cost of corrosion - worldwide scenario.

MODULE II **CORROSION PREVENTION IN RC STRUCTURES** **8**

Control of carbonation - control of chlorides - high performance concrete - corrosion inhibitors – anodic, cathodic and mixed inhibitors - protective coatings to steel rebars: fusion bonded epoxy coating, galvanization, cement polymer composite coating and anticorrosive polymer cementitious coatings - stainless steel reinforcement - sealers and membranes – cathodic protection.

MODULE III **CONDITION EVALUATION AND CORROSION RATE MEASUREMENT** **7**

Preliminary survey - visual inspection and detailed survey – delamination survey - cover – half-cell potential measurements - carbonation depth measurement - chloride determination - resistivity measurement, corrosion rate measurement – linear polarization resistance techniques - impedance

studies - macrocell techniques - potential-time behaviour studies - accelerated corrosion studies.

MODULE IV CORROSION CONTROL IN RC STRUCTURES 7

Physical and chemical rehabilitation techniques – coatings - sealers and membranes - corrosion inhibitors - electrochemical repair techniques: basic principles, chloride removal and realkalization - cathodic protection.

LIST OF EXPERIMENTS / CASE STUDIES:

1. Cover meter survey, location of rebar and its spacing and resistivity of concrete
2. Determination of depth of carbonation and chloride penetration
3. Quantitative estimation of chloride in concrete / mortar samples
4. Half-cell potential measurements on corroding RC elements
5. Rapid chloride penetration test on chemical admixed concrete / mortar
6. Corrosion rate measurement - Electrochemical Impedance Spectroscopy (EIS) technique
7. Macrocell corrosion studies on RC prisms
8. Accelerated corrosion studies on RC specimens
9. Bimetallic corrosion of steel rebars in existing buildings - Case study
10. Performance evaluation of coated steel rebars – Case study

L – 30, P - 30 ; TOTAL HOURS – 60

TEXT BOOKS:

1. John P. Broomfield, Corrosion of Steel in Concrete: Understanding, Investigation and Repair, second edition, CRC Press, 2006.

REFERENCES:

1. ACI (American Concrete Institute) 222R-01: Protection of metals in concrete against corrosion. American Concrete Institute, Farmington Hills, MI, USA, 2010.
2. ASTM A 775/A775 M-19, "Standard specification for epoxy-coated steel reinforcing bars", American Society for Testing and Materials, 2019.
3. ASTM C 876, Standard Test Method for Half-Cell Potentials of Uncoated Reinforcing Steel in Concrete, American Society for Testing and Materials, 2015.
4. ASTM G109-07: Standard test method for determining effects of chemical

admixtures on corrosion of embedded steel reinforcement in concrete exposed to chlorides. ASTM International, West Conshohocken, PA, USA, 2013.

5. Baeckmann, W. von, W. Schwenk, and W. Prinz, Handbook of cathodic corrosion protection: Theory and practice of electrochemical protection processes, 3rd ed. Gulf Publishing Company, 1997.
6. Central Public Works Department (CPWD). "Handbook on repair and rehabilitation of RCC buildings." 2002.
7. Chess, P. M. and J. P. Broomfield, Cathodic Protection of Steel in Concrete and Masonry, 2nd Edition. London: CRC Press, 2014.
8. Haji Sheik Mohammed MS, "Performance evaluation of protective coatings on steel rebars", Ph.D. Thesis submitted to Anna University, India, 2008.
9. IS 12594, Hot-Dip Zinc Coating on Structural Steel Bars for Concrete Reinforcement - Specification, Bureau of Indian Standards, 1988.
10. IS 13620, "Fusion bonded epoxy-coated reinforcing bars-Specification", Bureau of Indian Standards, New Delhi, 2020.
11. Jacobson, Gretchen A. "NACE International's IMPACT Study Breaks New Ground in Corrosion Management Research and Practice." The Bridge 46, no. 2, 2016.
12. Javaherdashti, R., Microbiologically Influenced Corrosion (An Engineering Insight), 2nd ed. Springer, Cham, 2017.
13. Luca Bertolini, Bernhard Elsener, Pietro Pedeferri, Elena Redaelli and Rob B. Polder, Corrosion of Steel in Concrete: Prevention, Diagnosis, Repair, 2nd Edition, Wiley, 2013.
14. Mattsson, Einar. "Basic Corrosion Technology for Scientists and Engineers." 1996.
15. Popov, B. N., Corrosion Engineering: Principles and Solved Problems. Elsevier, 2015.

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

CO1: understand scientific principles involved in design of waterproofing envelope for concrete and masonry structures.

CO2: identify below-grade waterproofing system for different applications.

CO3: identify above-grade waterproofing system for different applications

CO4: design waterproofing system for residential application

CO5: conduct condition assessment on concrete and masonry elements distressed with water leakage and suggest remedial methods.

Board of Studies (BoS) :
17th BoS of Civil held on 10.08.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	2	3	2
CO2	2	2	3	2
CO3	2	2	3	2
CO4	2	2	3	2
CO5	2	2	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

Statement: Knowledge on Advanced Foundation Design is more essential toensure safe and sustainable building.

CEEY 203	DESIGN OF INDUSTRIAL STRUCTURES	L	T	P	C
SDG: 9 & 11		3	0	0	3

COURSE OBJECTIVES:

COB1: To provide knowledge on functional requirements of industrial buildings and to design various industrial building components.

COB2: To impart knowledge on the design of various special structuresand transmission line towers.

MODULE I GENERAL REQUIREMENTS OF INDUSTRIAL STRUCTURES **9**

Classification of industries and industrial structures — General requirements of various industries – Engineering, textiles, chemicals etc, - Planning and layout of buildings and components.

MODULE II FUNCTIONAL REQUIREMENTS OF INDUSTRIAL STRUCTURES **9**

Lighting, illumination levels, characteristics of good lighting – Principles of day lighting design – Artificial lighting – Ventilation – Natural and mechanical ventilation – Evaporate cooling design – Measurement – Contaminant control – Installationand operation - Acoustics – Fire safety – Guidelines from factories act.

MODULE III ANALSYSIS & DESIGN OF INDUSTRIAL BUILDINGS **9**

Industrial building frames - Analysis of industrial bents – Design of gable frames - Industrial roofs - Crane girders - Machine foundations.

MODULE IV DESIGN OF SPECIAL STRUCTURES **9**

Design of corbels and nibs - Analysis and design of bunkers and silos – Design of chimneys - Design of cooling towers.

MODULE V ANALYSIS & DESIGN OF POWER TRANSMISSION STRUCTURES **9**

Tower configuration and bracings – Loads acting on towers – Analysis and design of lattice towers – Transmission line towers – Tower foundations.

L - 45; TOTAL HOURS – 45

REFERENCES:

1. Dayaratnam P., “Design of Steel Structures”, Wheeler and Co., New Delhi,1999.

2. Krishna Raju, “Advanced Concrete Structures”, McGraw Hill, New Delhi, 2000.

3. Manohar S.N., Tall Chimneys; “Design and Construction”, Tata McGrawHill, 1985.

4. Ramchandra. V, “Design of Steel Structures”, Standard Book House, New Delhi, 2007.

5. SP 32: 1986, Handbook on Functional Requirements of Industrial buildings.

6. Santhakumar A.R. and Murthy S.S, “Transmission Line Structures”,McGraw-Hill, 1990.

COURSE OUTCOMES:

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

CO1: Plan for general requirements in an industry and prepare a layout on buildings and structural components for various industries.

CO2: Make an appropriate lighting & ventilation and identify suitable measures to control fire as per factories act.

CO3: Analyze & Design an industrial building with bents along with crane girder; describe suitable foundations for the various types of machines/equipment in an industry.

CO4: Analyse and design the special structures such as corbels, bunkers, silos, chimneys and cooling towers for an industry.

CO5: Identify suitable tower configurations and structurally design the tower for power transmission.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	1
CO2	1	1	3	1
CO3	1	2	3	1
CO4	1	2	3	1
CO5	1	2	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: The holistic understanding of design of industrial buildings leads to development of sustainable buildings.

CEEY 204	OPTIMIZATION IN STRUCTURAL DESIGN	L	T	P	C
SDG: 9 & 11		3	0	0	3

COURSE OBJECTIVES:

COB1: To impart sufficient knowledge on basic concepts of optimization and classical methods.

COB2: To impart knowledge on the queuing theory, exposure to various optimization techniques for design of structural elements and linear programming methods for plastic design.

MODULE I BASIC CONCEPTS IN OPTIMIZATION 9

Basic concepts of minimum weight - Minimum cost design - Objective function — Constraints - Classical methods.

MODULE II QUEUING THEORY 9

Queuing model - Poisson and exponential distributions - Queues with combined arrivals and departures - Random and series queues.

MODULE III OPTIMIZATION TECHNIQUES AND ALGORITHMS 9

Linear programming - Integer programming - Quadratic programming - Dynamic programming and geometric programming methods for optimal design of structural elements.

MODULE IV SEARCH METHODS IN OPTIMIZATION 9

Linear programming methods for plastic design of frames - Computer search methods for univariate and multivariate minimization.

MODULE V OPTIMIZATION THEOREMS 9

Optimization by structural theorems – Maxwell - Mitchell and Heyman's Theorems for trusses and frames - Fully stresses - Design with deflection constraints - Optimality criterion methods.

L - 45; TOTAL HOURS – 45

REFERENCES:

1. Iyengar. N.G.R and Gupta.S.K, "Structural Design Optimisation", Affiliated East West Press Ltd, New Delhi, 2002

2. Quang Liang, Q., "Performance-based Optimization of Structures: Theory and Applications", Taylor & Francis, 2005.

3. Ratan Prakash Agarwal, Ravi P. Agarwal, "Recent Trends in Optimization Theory and Applications", World Scientific, 2010

COURSE OUTCOMES:

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

CO1: Describe the various basic concepts in optimization.

CO2: Perform the queuing theory in structural analysis.

CO3: Execute different optimization techniques for the design of structural elements.

CO4: Appropriately use the computer search methods for analysis of structures.

CO5: Describe the various optimization theorems for analysis of structures.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	2
CO2	1	1	3	2
CO3	1	1	3	2
CO4	1	1	3	2
CO5	1	1	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: Optimization in Structural Engineering is more essential to ensuresafe and sustainable building.

CEEY 205	PRESRESSED CONCRETE STRUCTURES	L	T	P	C
SDG: 9 & 11		3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce the fundamental concepts and analysis of stresses of prestressed concrete members.

COB2: To impart knowledge on the analysis and design of various prestressed concrete members.

COB3: To understand the concepts and design the composite structures.

MODULE I BASIC CONCEPTS & ANALYSIS OF STRESSES 9

Basic concepts – Advantages of PSC – Materials required – Systems and methods of prestressing – Analysis of sections – Stress concept – Strength concept – Load balancing concept - Stresses in tendons - Losses of prestress – Deflections of prestressed concrete members - Factors influencing deflections – Effect on tendon profile on deflections - Short term and long term deflections as per codal provisions.

MODULE II DESIGN OF PSC MEMBERS 9

Flexural strength — Simplified procedures as per codes — Shear and principal stresses — Ultimate shear resistance of PSC members - Design of shear reinforcement — Behaviour under torsion — Modes of failure - Design for torsion, shear and bending - Design of PSC sections for flexure - Transmission of prestress in pre-tensioned members – Bond and transmission length — End zone reinforcement — Anchorage zone stresses - Stress distribution - Design of anchorage zone reinforcement - Prestressed concrete slabs: types of prestressed concrete floor slabs - Design of prestressed concrete one way and two way slabs — Design of prestressed concrete simple flat slabs and continuous flat slab floors.

MODULE III STATICALLY INDETERMINATE STRUCTURES 9

Analysis of indeterminate structures – Continuous beams – Concept ofconcordance and linear transformations.

MODULE IV DESIGN OF TENSION AND COMPRESSION MEMBERS 9

Design of tension members - Design of prestressed concrete pipes and cylindrical water tanks - Design of compression members with and without flexure - Design of prestressed concrete piles.

MODULE V DESIGN OF COMPOSITE MEMBERS 9

Analysis and design of composite members – Flexure and shear of composite members - Partial prestressing - Advantages and applications.

L - 45; TOTAL HOURS – 45

REFERENCES:

1. Krishna Raju, N., “Prestressed Concrete”, Tata McGraw Hill Company, New Delhi,2012.
2. Lin.T.Y., “Design of Prestressed Concrete Structures”, John Wiley and Sons, Inc, 2000.
3. RamaswamyG.S., “Modern Prestressed Concrete Design”, Arnold Heinimen, New Delhi,1990.
4. Rajagopal, N, “Prestressed Concrete”, 2nd Edition, Narosa Publications, New Delhi,2007.
5. Sinha, N.C, & S.K.Roy, “Fundamentals of Prestressed Concrete”, S.Chand & Co, New Delhi, 2000.

COURSE OUTCOMES:

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

CO1 : Apply the principles for analysing the prestressed concrete structures; and evaluate the short and long term losses & deflection for PSC members

CO2 : Establish appropriate approaches to calculate the design strength for flexure, shear & torsion and design the PSC members.

CO3 : Analyse the indeterminate PSC structures

CO4: Apply the principles and techniques for the design of Tension and Compression members

CO5: Analyse and design the composite structural members.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	2	1	3	2
CO2	2	1	3	2
CO3	2	1	3	2
CO4	2	1	3	2
CO5	2	1	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: The holistic understanding of analysis and design of prestressed concrete members leads to development of resilient infrastructure.

CEEY 206	STABILITY OF STRUCTURES	L	T	P	C
SDG: 9 & 11		3	0	0	3

COURSE OBJECTIVES:

COB1: To introduce the basic concepts of elastic structural stability, analytical approaches to stability and analysis of inelastic buckling ofcolumns.

COB2: To impart knowledge on the stability analysis of beam columns and frames using FEM and other methods and analysis of buckling of beams & thin plates

MODULE I STABILITY OF COLUMNS 9

Concepts of elastic structural stability - Analytical approaches to stability - Characteristics of stability analysis - Elastic buckling of columns - Equilibrium; energy and imperfection approaches — Non-prismatic columns - Built up columns - Orthogonality of buckling modes - Effect of shear on buckling load - Large deflection theory.

MODULE II METHODS OF ANALYSIS AND INELASTIC BUCKLING 9

Approximate methods – Rayleigh and Galerkin methods – Numerical methods – Finite difference and finite element - Analysis of columns – Experimental study of column behaviour – South well plot - Column curves - Derivation of column design formula - Effective length of columns - Inelastic behaviour - Tangent modulus and double modulus theory.

MODULE III BEAM- COLUMNS AND FRAMES 9

Beam column behaviour - Standard cases - Continuous columns and beam columns – Column on elastic foundation – Buckling of frames – Single storey portal frames with and without side sway – Classical and stiffness methods – Approximate evaluation of critical loads in multistoried frames – Use of wood's charts.

MODULE IV BUCKLING OF BEAMS 9

Lateral buckling of beams – Energy method - Application to symmetric and simply symmetric I beams – Simply supported and cantilever beams - Narrow rectangular cross sections- – Numerical solutions – Torsional buckling – Uniform and non-uniform torsion on open cross section - Flexural torsional buckling – Equilibrium and energy approach.

MODULE V BUCKLING OF THIN PLATES 9

Isotropic rectangular plates - Governing differential equations - Simply supported onall edges – Use of energy methods – Plates with stiffeners – Numerical techniques.

L -45;TOTAL HOURS – 45

REFERENCES:

1. Ashwini Kumar, “Stability of Structures”, Allied Publishers Ltd, 2003.
2. Stephen P. Timoshenko and Gere, “Theory of Elastic Stability”, McGraw-Hill Company, 2000.
3. Iyengar, N.G.R, “Structural Stability of Columns and Plates”, Affiliated East-West Press Pvt. Ltd, 2007.
4. Chai H Yoo, Sung Lee, “Stability of Structures - Principles and Applications”, Elsevier, 2011.
5. Gambhir, M.L, “Stability Analysis and Design of Structures”, Springer,2004.

COURSE OUTCOMES:

A**t** the end of the course, the students will be able to

CO1: Describe the basic concepts of elastic structural stability and identify suitable analytical approaches for the stability of structures.

CO2 : Analyse the inelastic buckling of structures by various approximate methods

CO3: Illustrate the buckling behaviour of various structural components and evaluate under critical loading conditions.

CO4: Perform stability analysis by different approaches for various types of beams**.**

CO5: Establish differential equations for thin plates under different edge conditions.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	1
CO2	1	1	3	1
CO3	1	1	3	1
CO4	1	1	3	1
CO5	1	1	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: The holistic understanding of stability analysis of beam columnsand frames leads to development of sustainable buildings.

CEEY 207	STRUCTURAL SAFETY AND RELIABILITY	L	T	P	C
SDG: 9 & 11		3	0	0	3

COURSE OBJECTIVES:

COB1: To impart adequate knowledge on safety aspects involved in construction industry.

COB2: To impart knowledge on the quantitative estimates of the reliabilityof structures under different limit state conditions.

MODULE I INTRODUCTION TO STRUCTURAL SAFETY 9

Structural safety - Role of safety officers, responsibilities of general employees, safety committee, safety monitoring - Concepts of safety factor - Safety, reliability and risk analysis.

MODULE II PROBABILITY CONCEPTS 9

Fundamentals of set theory and probability - Probability distribution - Regression analysis - Hypothesis testing - Stochastic process and its moments - Probability distributions - Probability of failure - Fatal accident rate - Societal risk - Anatomy of failure - Management of safety.

MODULE III STRUCTURAL RELIABILITY THEORY ANDMETHODS 9

R-S problem in structural design and assessment - Probability of failure and the reliability index - Convolution Integral - Standardized method for normal variables - First order reliability method - Monte carlo simulation - Second order reliability method.

MODULE IV RELIABILITY ANALYSIS 9

Measures of reliability - Factor of safety, safety margin, reliability index, performance function and limiting state - Reliability Methods - First Order Second Moment Method (FOSM) - Point Estimate Method (PEM), and
Advanced First Order Second Moment Method (Hasofer-Lind's method)

MODULE V RELIABILITY BASED DESIGN 9

Specification of characteristic load/resistance values - Design values - Partial Factors - Target reliability - Methods of code calibration - Use of ISO 2394 methodand its significance.

L - 45; TOTAL HOURS – 45

REFERENCES:

1. Tim Howarth, Paul Watson, "Construction Safety Management" Wiley-Blackwell, 2008.

2. Choi S K, Grandhi R V and Canfield R A., “Reliability Based Structural Design”, Springer Verlag, London, UK, 2007.
3. Haldar, A., and Mahadevan, S., “Probability, Reliability and Statistical Methods in Engineering Design”, John Wiley and Sons, New York, 2000.
4. Ranganathan,R., “Structural Reliability Analysis and Design”, Jaico Publishing House, Mumbai, 2006.

COURSE OUTCOMES:

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

CO1: Describe the safety practices to be followed during various construction operations

CO2: Explain the quantifying uncertainties using theories of probability.

CO3: Illustrate the theory of methods of structural reliability based on the conceptof reliability indices.

CO4: Perform the reliability-based limit state design for simple structural elements and recognize the sensitivity of the outcome to the uncertainty in differentvariables.

CO5: Explain the reasons leading to different values of partial safety factors for load and resistance variables in design and assessment standards.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	1
CO2	1	1	3	1
CO3	1	1	3	1
CO4	1	1	3	1
CO5	1	1	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: The holistic understanding of structural safety and reliability of structures leads to development of sustainable buildings.

CEEY 208	TALL STRUCTURES	L	T	P	C
SDG: 9 & 11		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the problems associated with large heights of structures with respect to different loads.

COB2: To impart knowledge on the behaviour, analysis and design of various structural systems.

COB3: To impart knowledge on stability of tall buildings and also on dynamicanalysis of wind and earthquake loadings.

MODULE I DESIGN CRITERIA & LOADING 9

General - Factors affecting growth, height and structural form - Design philosophy – loading, gravity loading, wind loading, earthquake loading - Combinations of loading - Strength and stability - Stiffness and drift limitations - Human comfort criteria - Creep effects - Shrinkage effects - Temperature effects - Fire - Foundation settlement - Soil-structure interaction.

MODULE II STRUCTURAL FORMS 9

Structural forms — Braced frame, rigid frame, infilled frame, shear wall structures, wall - Frame structures, framed tube structures, outrigger braced structures, space structures, hybrid structures, R.C.floor systems - One-way slab on beams and girders - Two-way flat slab - Two-way flat plate - Waffle flat slabs - Two-way slab andbeam - Steel framing floor systems - One-way beam system - Two-way beam system - Three-way beam system - Composite steel - Concrete floor systems.

MODULE III MODELLING, BEHAVIOUR & ANALYSIS OFSTRUCTURAL SYSTEMS 9

Assumptions - Modelling for approximate analyses - Modelling for accurate analysis - Reduction technique. types, behaviour and analysis methods of braced frames - Behaviour and analysis of rigid frame structures - Behaviour, analysis & design of infilled frame structures - Behaviour and analysis of shear wall, coupled shear wall and wall-frame structures - Behaviour of tubular structures, core structures and outrigger - Braced structures.

MODULE IV STABILITY OF TALL BUILDINGS 9

Overall buckling analysis of frames (approximate methods) - Overall buckling analysis of wall frames - Second order effects of gravity loading - Translational - Torsional instability - Out-of-plumb effects - Effects of foundation rotation - Creep and shrinkage effects - Temperature effects.

MODULE V DYNAMIC ANALYSIS 9

Response to wind loading - Along-wind response - Across-wind response - Estimation of natural frequencies & damping - Types of excitation - Design to minimize dynamic response - Response to earthquake motions - Response to ground accelerations - Response spectrum analysis - Estimation of natural frequencies and damping - Human response to building motions.

L - 45; TOTAL HOURS – 45

REFERENCES:

1. Bryan Stafford Smith and AlexCoull, "Tall Building Structures, Analysis Design", John Wiley and Sons, Inc.1991
2. Taranath B.S, "Structural Analysis and Design of Tall Buildings", McGraw Hill Book Co., 2016.
3. Emil Simiu and Dong Hun Yeo, "Wind Effects on Structures - Modern Structural Design for Wind", John Wiley and Sons, Inc. 2019.

COURSE OUTCOMES:

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

CO1: Describe the different types of loads acting on tall structures and identify the different factors affecting the tall structures.

CO2: Classify and use appropriate types of structural systems in tall structures.

CO3: Construct the modelling using various analysis techniques and describe its behaviour for various structural systems.

CO4: Manipulate the second order effects of gravity loading, translational and torsional instability in the analysis of tall structures.

CO5: Analyse the response of wind and seismic motions on tall structures.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	1
CO2	1	1	3	1
CO3	1	1	3	1
CO4	1	1	3	1
CO5	1	1	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: The holistic understanding of behaviour, analysis and design of tall buildings leads to development of sustainable buildings.

CEEY 209	THEORY OF PLATES AND SHELLS	L	T	P	C
SDG: 9 & 11		3	0	0	3

COURSE OBJECTIVES:

COB1: To impart knowledge on the behavior of thin and thick plates in cartesian and polar coordinates

COB2: To understand the behaviour of reinforced concrete plate and shellelements at material level, element level and system level.

MODULE I THIN AND THICK PLATES 9

Plate equation and behaviour of thin plates in cartesian - Polar coordinates - Isotropic and orthotropic plates - Bending and twisting of plates.

MODULE II ANALYSIS & DESIGN OF PLATES 9

Navier's solution and energy method, rectangular, circular plates with various end conditions - Design steps - Minimum thickness and reinforcements as per I.S. specifications for R.C. folded plates.

MODULE III BEHAVIOUR OF SHELLS 9

Shell behaviour - Shell surfaces and characteristics - Classifications of shells - Equilibrium equations in curvilinear coordinates - Force displacement relations.

MODULE IV ANALYSIS OF SHELLS 9

Membrane analysis and bending theory of shells of revolution - Cylindrical shells under different loads - Shallow shells - Solutions for typical problems.

MODULE V DESIGN OF SHELLS 9

Design of spherical, conical, paraboloid, ellipsoid, cylindrical hyperbolic paraboloid, northlight shells – Detailing of shell structures.

L - 45;TOTAL HOURS – 45

REFERENCES:

1. Philip L Gould, “Analysis of Shells and Plates”, Prentice Hall, 2012.
2. Ramaswamy. G.S, “Design and Construction of Concrete Shell Roofs”, CBS Publishers, 2005.
3. Reddy, J.N., “Mechanics of Laminated Composites Plates and Shells”, CRC Publishers, 2nd Edition, 2003.
4. Timoshenko. S and S.W. Krieger, “Theory of Plates & Shells”, McGraw Hill & Co., New York, 2003.

COURSE OUTCOMES:

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

CO1: Describe the behaviour of thin and thick plates.

CO2: Solve and establish classical solutions for various types of plates.

CO3: Illustrate the characteristics on different types of shells and develop equilibrium equations and force displacement relations.

CO4: Analyse the various types of shells under different loading conditions.

CO5: Design the various types of shell structures.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	1
CO2	1	1	3	1
CO3	1	1	3	1
CO4	1	1	3	1
CO5	1	1	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: The holistic understanding of theory of plates and shells leads tothe development of an analytical tool to analyse sustainable buildings.

CEEY 210	WIND AND CYCLONE EFFECTS ON STRUCTURES	L	T	P	C
SDG: 9 & 11		2	0	0	2

COURSE OBJECTIVES:

COB1: To impart sufficient knowledge on the concepts of wind effects on Structures.

COB2: To familiarize on the modeling and designing the structures forwind and cyclone effects as per the codal recommendations**.**

MODULE I INTRODUCTION 7

Types of wind – Characteristics of wind – Wind velocity, method of measurement, variation of speed with height, shape factor, aspect ratio, drag effects - Dynamic nature of wind – Pressure and suctions - Spectral studies - Gust factor.

MODULE II WIND TUNNEL STUDIES 8

Wind tunnel studies - Types of tunnels, prediction of acceleration — Load combination factors – Wind tunnel data analysis – Calculation of period and damping value for wind design - Modeling requirements – Interpretation of results - Aero dynamic and aero-elastic models.

MODULE III WIND EFFECTS ON STRUCTURES 7

Classification of structures - Rigid structures, flexible structures - Static and dynamic effects on tall buildings - chimneys.

MODULE IV CYCLONE EFFECTS ON STRUCTURES 8

Cyclone effect on low rise structures — Sloped roof structures - tall buildings - effect of cyclone on claddings and design of cladding as per codal provisions in cladding design – Procedure and modeling of cladding.

L -30; TOTAL HOURS –30

REFERENCES:

1. John D. Holmes, “Wind Loading on Structures”, Taylor & Francis, 2007.
2. Emil Simiu and Dong Hun Yeo, “Wind Effects on Structures - Modern Structural Design for Wind”, John Wiley and Sons, Inc. 2019.

COURSE OUTCOMES:

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

CO1: Describe the concepts on the wind effects on structures.

CO2: Perform the wind tunnel studies, analyse and compute the various parameters for wind design.

CO3: Critically describe the behavior of various types of structures due to wind loading.

CO4: Describe and perform the design of structures against cyclone.

Board of Studies (BoS) :
17th BoS of Civil held on 10.08.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	1
CO2	1	1	3	1
CO3	1	1	3	1
CO4	1	1	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: Knowledge on wind and cyclone effects on structures is more essential to ensure safe and sustainable building.

CEEY 211	FIRE PROTECTION OF STRUCTURES	L	T	P	C
SDG: 9 &11		1	0	0	1

COURSE OBJECTIVES:

COB1: To introduce the fundamental concepts of fire protection in abuilding.

MODULE I BASIC CONCEPTS OF FIRE PROTECTION 7

Types of construction and classification of buildings - Main building elements - Requirements of buildings - Combustibility and fire resistance - Fire hazard category of production processes - Process of combustion in fire - Effect of fire load & ventilation condition on enclosure fire- growth and decay of fire in enclosure.

MODULE II FIRE RESISTANCE IN BUILDINGS 8

Initial condition for calculating fire resistance of structures - Duration of fire - Temperature of fire - Method of investigating temperature regimes of fires - Simulation of temperature regimes of fires - Determination of fire in residential and public buildings - Determination of duration of fire in industrial buildings and warehouses - Standardization of fire resistance of structures.

L - 15 ; TOTAL HOURS –15

REFERENCES:

1. John A. Purkiss “Fire Safety Engineering Design of Structures”-, Butterworth Heinemann, 2009.
2. Brannigan, F. L. and Corbett, G. P. Brannigan, “Building Construction for the Fire Service”, Sudbury, MA: Jones & Bartlett Publishers, 2008
3. U.S Bendev, “Fire Resistance of Buildings”, Amerind Publishing Co. Pvt. Ltd, 2006.
4. Andrew H. Buchman “Structural Design for Fire Safety, Comprehensive Overview of the Fire Resistance of Building Structures”, John Wiley and Sons, 2001.

COURSE OUTCOMES:

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

CO1: Describe the fundamental concepts of fire protection in buildings.

CO2: Determine the fire load and duration in various types of buildings.

Board of Studies (BoS) : 17th BoS of Civil held on 10.08.2022

Academic Council: 19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	1	1	3	1
CO2	1	1	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

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

Statement: Knowledge on fire protection of structures is more essential to ensure safe and sustainable building.

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
CO1	2	2	3	2
CO2	2	2	3	2
CO3	2	2	3	2
CO4	2	2	3	2
CO5	2	2	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - 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

CO1: Identify the suitable search algorithms for solving problems.

CO2: Employ AI adversarial game search techniques while evaluating the application of more real world problems.

CO3: Use first order logic for wide variety of applications, from planning and diagnosis to knowledge representation and reasoning.

CO4: Apply the technologies, standards, and protocols that are best suited for low-level sensor nodes.

CO5: 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

	PO1	PO2	PO3	PO4
CO1	3	1	-	2
CO2	2	-	-	1
CO3	1	-	1	1
CO4	1	-	1	1
CO5	-	-	1	1

Note: 1- Low Correlation 2 - Medium Correlation 3 -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) :
BOS of Physics was held on 30.6.22

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4
CO1	3	3	2	1
CO2	3	3	2	1
CO3	2	2	2	2

CO4	3	2	2	1
CO5	3	2	3	3

Note: 1- Low Correlation 2 -Medium Correlation 3 -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
CO1	3	3	2	1
CO2	3	2	2	1
CO3	2	2	2	2
CO4	2	2	2	1
CO5	3	3	2	3

Note: 1- Low Correlation 2 -Medium Correlation 3 -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
CO1	2	2	1	1
CO2	2	2	1	1
CO3	3	3	2	2
CO4	3	3	2	1
CO5	3	2	2	3

Note: 1- Low Correlation 2 -Medium Correlation 3 -High Correlation

SDG 4 : Ensuring inclusive and equitable quality education for all personsand 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
CO1	2	-	-	2
CO2	2	1	-	2
CO3	1	-	-	-
CO4	2	-	1	2
CO5	1	-	1	2

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
CO1	2	1	1	-
CO2	-	2	3	1
CO3	3	-	2	3
CO4	1	3	2	-
CO5	2	-	-	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 -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 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

+

	PO1	PO2	PO3	PO4
CO1	1	1	3	3
CO2	1	2	3	3
CO3	1	1	3	3
CO4	2	1	3	3
CO5	1	1	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - 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
CO1	2	1	2	1
CO2	3	2	3	3
CO3	3	2	3	3
CO4	2	3	2	2
CO5	3	2	3	3

Note: 1- Low Correlation 2 -Medium Correlation 3 -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
CO1	3	-	-	-
CO2	3	-	-	2
CO3	-	-	-	-
CO4	-	-	-	-
CO5	2	-	-	-

Note: 1- Low Correlation 2 - Medium Correlation 3 -High Correlation

SDG 6: Clean Water and SanitationSDG 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 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 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 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 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 CLOSING 9

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
CO1	1	3	2	2
CO2	1	2	2	3
CO3	1	1	1	2
CO4	2	2	3	3
CO5	1	1	3	3

Note: 1- Low Correlation 2 - Medium Correlation 3 -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

	PO1	PO2	PO3	PO4
CO1	2	1	2	1
CO2	3	2	3	2
CO3	2	2	3	3
CO4	2	2	2	1
CO5	3	1	2	3

Note: 1- Low Correlation 2 - Medium Correlation 3 -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 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 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 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 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 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) :	**Academic Council:**
21st BOS of Mechanical Engg. held on 10.02.2023.	20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4
CO1	2	1	2	2
CO2	2	2	3	2
CO3	2	2	3	2
CO4	2	3	3	1
CO5	3	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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

Statement : 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:

COB1: 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
CO1	2	-	-	-
CO2	3	-	2	2
CO3	-	-	3	2
CO4	3	-	3	-
CO5	-	2	-	3

Note: 1- Low Correlation 2 - Medium Correlation 3 -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. 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

	PO1	PO2	PO3	PO4
CO1	3	-	-	-
CO2	-	-	-	-
CO3	-	2	-	-
CO4	3	-	-	-
CO5	3	2	-	-

Note: 1- Low Correlation 2 - Medium Correlation 3 -High Correlation

SDG 4: Quality Education

SDG 9: Industry and Innovation

Statement:

Ensure inclusive and equitable quality education and promote lifelong learning opportunities.

Foundation to work in R&D laboratory, chemical industry, independent research and for teaching career.