MAR ATHANASIUS COLLEGE OF ENGINEERING

(Government Aided & Autonomous)

Kothamangalam 686 666

Affiliated to APJ Abdul Kalam Technological University

Thiruvananthapuram

Master of Technology (M. Tech.)

Curriculum - 2024

COLLEGE VISION AND MISSION

VISION

Excellence in education through resource integration.

MISSION

The institution is committed to transform itself into a centre of excellence in Technical Education upholding the motto "Knowledge is Power."

This is to be achieved by imparting quality education to mould technically competent professionals with moral integrity, ethical values and social commitment, and by promoting innovative activities in the thrust areas emerging from time to time.

MAR ATHANASIUS COLLEGE OF ENGINEERING

(GOVT. AIDED & AUTONOMOUS)

M.TECH CURRICULUM AND SCHEME-2024

Department of Civil Engineering

Structural Engineering and Construction Management

PROGRAM OUTCOMES – PO

Outcomes are the attributes that are to be demonstrated by a graduate after completing the programme

PO1: An ability to independently carry out research/investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

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

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-art tool to model, analyse and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development of the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects. Also to develop cognitive skills for project management and finance which focus on Industry and Entrepreneurship.

The departments conducting the M Tech programme shall define their own PSOs, if required and evaluation shall also be done for the same

SEMESTER I

Slot	Course code	Course Name	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
A	M24CE1T101	Numerical methods in Structural Engineering	40	60	4-0-0-4	4	4
B	M24CE1T102	Theory of Elasticity & Plasticity	40	60	4-0-0-4	4	4
C	M24CE1T103	Construction Planning, Scheduling And Control	40	60	4-0-0-4	4	4
D	M24CE1E104A	Programme Elective 1	40	60	3-0-0-3	3	3
E	M24CE1E105A	Programme Elective 2	40	60	3-0-0-3	3	3
J	M24CE1R106	Research Methodology & IPR	40	60	2-0-0-2	2	2
G	M24CE1L107	Advanced Structural Engineering Lab	60	40	0-0-3-3	3	2
	Total		300	400		23	22

Teaching Assistance: 7 hours
Self-study- 23 Hrs

PROGRAM ELECTIVE 1

Slot	Course code	Course Name	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
D	M24CE1E104A	Prestressed Concrete	40	60	3-0-0-3	3	3
	M24CE1E104B	Modern Construction Materials	40	60	3-0-0-3	3	3
	M24CE1E104C	Resilient Structures and Sustainable Construction	40	60	3-0-0-3	3	3
	M24CE1E104D	Construction Contracts, Methods And Equipment	40	60	3-0-0-3	3	3

PROGRAM ELECTIVE 2

Slot	Course Code	Course Name	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
E	M24CE1E105A	Structural Dynamics	40	60	3-0-0-3	3	3
	M24CE1E105B	Advanced Structural Analysis	40	60	3-0-0-3	3	3
	M24CE1E105C	Advanced Design of Steel Structures	40	60	3-0-0-3	3	3
	M24CE1E105D	Construction Management and Engineering Economics	40	60	3-0-0-3	3	3

SEMESTER II

Slot	Course Code	Courses	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
A	M24CE1T201	Advanced Design of Concrete Structures	40	60	4-0-0-4	4	4
B	M24CE1T202	Project Planning and Implementation	40	60	4-0-0-4	4	4
C	M24CE1E203A	Programme Elective 3	40	60	3-0-0-3	3	3
D	M24CE1E204A	Programme Elective 4	40	60	3-0-0-3	3	3
E	M24CE1S205	Building Information Modelling	40	60	3-0-0-3	3	3
G	M24CE1P206	Mini project	100	-	0-0-3-3	3	2
H	M24CE1L207	Structural Design Studio Lab	60	40	0-0-3-3	3	2
	Total		320	380		23	21

Teaching Assistance: 7 hours
Self-study- 23 Hrs

PROGRAM ELECTIVE 3

Slot	Course Code	Course Name	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
C	M24CE1E203A	Design Of Bridges	40	60	3-0-0-3	3	3
	M24CE1E203B	Advanced Concrete Technology	40	60	3-0-0-3	3	3
	M24CE1E203C	Structural Health Monitoring	40	60	3-0-0-3	3	3
	M24CE1E203D	Construction Project Management	40	60	3-0-0-3	3	3

PROGRAM ELECTIVE 4

Slot	Course Code	Course Name	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
D	M24CE1E204A	Finite Element Method	40	60	3-0-0-3	3	3
	M24CE1E204B	Advanced Construction Techniques	40	60	3-0-0-3	3	3
	M24CE1E204C	Forensic Engineering in Civil Engineering Structures	40	60	3-0-0-3	3	3
	M24CE1E204D	Earthquake Resistant Design of Structures	40	60	3-0-0-3	3	3

SEMESTER III

TRACK 1							
Slot	**Course Code**	**Courses**	**Marks**		**L-T-P**	**Hours**	**Credit**
			CIE	ESE			
A	M24CE2M301	*MOOC	To be completed successfully		--	--	2
B	M24CE2E302A	Programme Elective 5	40	60	3-0-0-3	3	3
K	M24CE2I303	**Internship	50	50	--	--	3
P	M24CE2P304	Dissertation Phase 1	100	--	0-0-17	16	11
	TOTAL		190	110		23	19
TRACK 2							
A	M24CE2M305	* MOOC 1	To be completed successfully		--	--	2
B	M24CE2M306	* MOOC 2	To be completed successfully		-	-	2
K	M24CE2I307	## Internship	50	50	--	-	4
P	M24CE2P308	###Dissertation Phase 1	100	--	-	-	11
	TOTAL		150	50			19

Teaching Assistance: 6 hours

*MOOC Course of minimum 8 weeks duration to be successfully completed before the end of fourth semester (starting from semester 1).

**Internship- mandatory internship of 6 to 8 weeks

Internship - mandatory internship of more than 16 weeks

###Dissertation Phase 1 – Should be done in Industry

PROGRAM ELECTIVE 5

Slot	Course Code	Course Name	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
D	M24CE1E302A	Maintenance and Rehabilitation of Structures	40	60	3-0-0-3	3	3
	M24CE1E302B	Structural Stability	40	60	3-0-0-3	3	3
	M24CE1E302C	Artificial Intelligence in Structural Engineering	40	60	3-0-0-3	3	3
	M24CE1E302D	Integrated Construction Logistics	40	60	3-0-0-3	3	3

TRACK 1 / TRACK 2

In second year, the students can choose either of the two tracks: TRACK 1 or TRACK 2. Track 1 is conventional M.Tech programme in which the dissertation Phase 1 is conducted in college. Track 2 is M.Tech programme designed for students who have undergone long term internship (not less than 16 weeks) in industry. An aspirant in track 2 needs to do the dissertation in the industry. The candidates should also be good with performing in-depth research and colluding the conclusions of research led by them. Such students are expected to have the following skills: Technical skills, Research Skills, Communication Skills, Critical Thinking Skills, and Problem-solving Skills.

The eligibility for Track 2:

- Shall have qualified in the GATE or have a SGPA above 8.0 during the first semester, and
- Qualify an interview during the end of second semester by an expert committee constituted by the College.

SEMESTER IV

TRACK 1							
Slot	**Course Code**	**Courses**	**Marks**		**L-T-P-S**	**Hours**	**Credit**
			CIE	**ESE**			
P	M24CE1P401	Dissertation Phase II	100	100	0-0-27-24	27	18
	TOTAL		100	100		27	18
TRACK 2							
P	M24CE1P402	##Dissertation Phase II	100	100			18
	TOTAL		100	100			18
Total credits in all four semesters							80

##Dissertation Phase II- Should be done in Industry

COURSE NUMBERING SCHEME

The course number consists of digits/alphabets. The pattern to be followed is

For General Courses – MYYBBXCSNN

For Elective Courses - MYYBBXCSNNA

- M: MASTERS
- YY: Last two digits of year of regulation
- BB: DEPARTMENT

Sl. No.	Department	Course Prefix
01	Civil Engg	CE
02	Computer Science	CS
03	Electrical & Electronics	EE
04	Electronics & Communication	EC
05	Mechanical Engg	ME
06	Any	GE
07	External (Industry/NPTEL etc)	EX

- X: Specialization number
- C: Course Type
  - T - Core Course
  - E - Elective Course
  - R - Research Methodology & IPR
  - L - Laboratory Course
  - S - Industry Integrated Course
  - I - Internship
  - M - MOOC
  - P - Project/Dissertation
- S:Semester of Study
  1. Semesters 1
  2. Semester 2

3. Semester 3
4. Semester 4

- NN: Course sequence number
- A: Elective sequence number - A/B/C/D/E

It is illustrated below: Examples:

M24CE1T202 is a second core course of first specialization offered by the Civil Department in semester 2

M24EC1R106 is Research Methodology & IPR offered in semester 1

M24EC1E104A is the first subject of Elective 1 of first specialization offered by the EC Department in semester 1

EVALUATION PATTERN

(i) CORE COURSES

Evaluation shall only be based on application, analysis or design based questions (for both internal and end semester examinations).

Continuous Internal Evaluation	**:**	**40 marks**
Micro project/Course based project	:	10 marks
Course based task/Seminar/Quiz	:	10 marks
Test paper 1 (Module 1 and Module 2)	:	10 marks
Test paper 2 (Module 3 and Module 4)	:	10 marks

The micro/course-based project shall be done individually

End Semester Examination: 60marks

The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem-solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

(ii) ELECTIVE COURSES

Evaluation shall only be based on application, analysis or design based questions (for both internal and end semester examinations).

Continuous Internal Evaluation	**:**	**40 marks**
Seminar*	:	10 marks
Course based task/Micro Project//Data collection and interpretation/Case study	:	10 marks
Test paper 1 (Module 1 and Module 2)	:	10 marks
Test paper 2(Module 3 and Module 4)	:	10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination: 60 marks

The end semester examination will be conducted by the College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 4 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

(iii) RESEARCH METHODOLOGY & IPR

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed original publications in the relevant discipline (minimum 10 publications shall be referred)	:	10 marks

Course based task/Seminar/Quiz	:	10 marks
Test paper 1 (Module 1 and Module 2)	:	10 marks
Test paper 2 (Module 3 and Module 4)	:	10 marks
End Semester Examination	**:**	**60 marks**

The end semester examination should be conducted by the college. The time duration will be for 3 Hrs and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

(iv) INTERNSHIP

Internships are educational and career development opportunities, providing practical experience in a field or discipline. They are structured, short-term, supervised placements often focused around particular tasks or projects with defined timescales. An internship may be compensated or non-compensated by the organization providing the internship. The internship has to be meaningful and mutually beneficial to the intern and the organization. It is important that the objectives and the activities of the internship program are clearly defined and understood. The internship offers the students an opportunity to gain hands-on industrial or organizational exposure; to integrate the knowledge and skills acquired through the coursework; interact with professionals and other interns; and to improve their presentation, writing, and communication skills. Internship often acts as a gateway for final placement for many students.

A student shall opt for carrying out the Internship at an Industry/Research Organization or at another institute of higher learning and repute (Academia). The organization for Internship shall be selected/decided by the students on their own with prior approval from the faculty advisor/respective PG Programme Coordinator/Guide/Supervisor. Every student shall be assigned an internship Supervisor/Guide at the beginning of the Internship. The training shall be related to their specialization after the second semester for a minimum duration of six to eight weeks. On completion of the course, the student is expected to be able to develop skills in facing and solving the problems experiencing in the related field.

Objectives

- Exposure to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
- Provide possible opportunities to learn understand and sharpen the real time technical / managerial skills required at the job.
- Exposure to the current technological developments relevant to the subject area of

training.

- Create conducive conditions with quest for knowledge and its applicability on the job.
- Understand the social, environmental, economic and administrative considerations that influence the working environment.
- Expose students to the engineer's responsibilities and ethics.

Benefits of Internship Benefits to Students

- An opportunity to get hired by the Industry/ organization.
- Practical experience in an organizational setting & Industry environment.
- Excellent opportunity to see how the theoretical aspects learned in classes are integrated into the practical world. On-floor experience provides much more professional experience which is often worth more than classroom teaching.
- Helps them decide if the industry and the profession is the best career option to pursue.
- Opportunity to learn new skills and supplement knowledge.
- Opportunity to practice communication and teamwork skills.
- Opportunity to learn strategies like time management, multi-tasking etc in an industrial setup.
- Makes a valuable addition to their resume.
- Enhances their candidacy for higher education/placement.
- Creating network and social circle and developing relationships with industry people.
- Provides opportunity to evaluate the organization before committing to a full time position.

Benefits to the Institute

- Build industry academia relations.
- Makes the placement process easier.
- Improve institutional credibility & branding.
- Helps in retention of the students.
- Curriculum revision can be made based on feedback from Industry/ students.
- Improvement in teaching learning process.

Benefits to the Industry

- Availability of ready to contribute candidates for employment.
- Year round source of highly motivated pre-professionals.
- Students bring new perspectives to problem solving.
- Visibility of the organization is increased on campus.
- Quality candidate's availability for temporary or seasonal positions and projects.
- Freedom for industrial staff to pursue more creative projects.
- Availability of flexible, cost-effective workforce not requiring a long-term employer commitment.
- Proven, cost-effective way to recruit and evaluate potential employees.
- Enhancement of employer's image in the community by contributing to the educational enterprise.

Types of Internships

- Industry Internship with/without Stipend
- Govt / PSU Internship (BARC/Railway/ISRO etc)
- Internship with prominent education/research Institutes
- Internship with Incubation centres /Start-ups

Guidelines

- All the students need to go for internship for minimum duration of 6 to 8 weeks.
- Students can take mini projects, assignments, case studies by discussing it with concerned authority from industry and can work on it during internship.
- All students should compulsorily follow the rules and regulations as laid by industry.
- Every student should take prior permissions from concerned industrial authority if they want to use any drawings, photographs or any other document from industry.
- Student should follow all ethical practices and SOP of industry.
- Students have to take necessary health and safety precautions as laid by the industry.
- Student should contact his /her Guide/Supervisor from college on weekly basis to communicate the progress.
- Each student has to maintain a diary/log book
- After completion of internship, students are required to submit
    - Report of work done
    - Internship certificate copy
    - Feedback from employer / internship mentor

- Stipend proof (in case of paid internship).

Total Marks 100: The marks awarded for the Internship will be on the basis of (i) Evaluation done by the Industry (ii) Students diary (iii) Internship Report and (iv) Comprehensive Viva Voce.

Continuous Internal Evaluation	**:**	**50 marks**
Student's diary	-	25 Marks
Evaluation done by the Industry	-	25 Marks

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor visiting the industry from time to time and got ratified on the day of his visit. Student's diary will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary
- Adequacy & quality of information recorded
- Drawings, design, sketches and data recorded
- Thought process and recording techniques used
- Organization of the information.

The format of student's diary

Name of the Organization/Section :

Name and Address of the Section Head :

Name and Address of the Supervisor :

Name and address of the student :

Internship Duration : From ..... To .....

Brief description about the nature of internship:

	Brief write up about the Activities carried out: Such as design, sketches, result

Day	observed, issues identified, data recorded, etc.
1	
2	
3	

Signature of Industry Supervisor *Signature of Section Head/HR Manager Office Seal*

Attendance Sheet

Name of the Organization/Section :

Name and Address of the Section Head :

Name and Address of the Supervisor :

Name and address of the student :

Internship Duration : From ..... To .....

Month & Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	...
Month & Year																					
Month & Year																					

Signature of Industry Supervisor *Signature of Section Head/HR Manager Office Seal*

Note:

- Student's Diary shall be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.
- Attendance Sheet should remain affixed in daily training diary. Do not remove or tear it off.
- Student shall sign in the attendance column. Do not mark 'P'.
- Holidays should be marked in red ink in the attendance column. Absent should be

marked as ‘A’ in red ink.

Evaluation done by the Industry (Marks 25)

Format for Supervisor Evaluation of Intern

Student Name :_____Date:_____

Supervisor Name :_____Designation:_____

Company/Organization _____

Internship Address: _____

Dates of Internship: From_____To _____

Please evaluate intern by indicating the frequency with which you observed the following parameters:

Parameters Marks	Needs improvement (0 – 0.25 mark)	Satisfactory (0.25 – 0.50mark)	Good (0.75 mark)	Excellent (1 mark)
Behavior				
Performs in a dependable Manner				
Cooperates with coworkers and supervisor				
Shows interest in work				
Learns quickly				
Shows initiative				
Produces high quality work				
Accepts responsibility				
Accepts criticism				
Demonstrates organizational skills				
Uses technical knowledge and expertise				
Shows good judgment				
Demonstrates creativity/originality				

Analyzes problems effectively				
Is self-reliant				
Communicates well				
Writes effectively				
Has a professional attitude				
Gives a professional appearance				
Is punctual				
Uses time effectively				

Overall performance of student

Intern (Tick one) : Needs improvement (0 - 0.50 mark)
Satisfactory (0.50 – 1.0 mark) / Good (1.5 mark) / Excellent (2.0 mark)

Additional comments, if any (2 marks) :

Signature of Industry Supervisor *Signature of Section Head/HR Manager Office Seal*

End Semester Evaluation (External Evaluation) : 50 Marks

Internship Report - 25 Marks

Viva Voce - 25 Marks

Internship Report: After completion of the internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period and should be submitted to the Faculty Mentor. The student may contact Industrial Supervisor/ Faculty Mentor for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor, Programme Coordinator and Faculty Mentor.

The Internship report (25 Marks) will be evaluated on the basis of following criteria:

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.

- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taught in the course

Viva Voce (25 Marks) will be done by a committee comprising Faculty Mentor, PG Programme Coordinator and an external expert (from Industry or research/academic Institute). This committee will be evaluating the internship report also.

(v) LABORATORY COURSES

Lab work and Viva-voce : 60 marks

Final evaluation Test and Viva voce : 40 marks

The laboratory courses will be having only Continuous Internal Evaluation and carries 100 marks. Final evaluation shall be done by two examiners; one examiner will be a senior faculty from the same department.

(vi) INDUSTRY INTEGRATED COURSE

Engineering students frequently aspire to work in areas and domains that are key topics in the industry. There are concerns by recruiters that skill sets of engineering students did not match with the Industry requirements, especially in the field of latest topics. In response to their desires, the College has incorporated Industry integrated course in the curriculum.

The evaluation pattern for Industry based course is as follows:

Continuous Internal Evaluation	**:**	**40 marks**
Seminar	:	10 marks
Course based task/Seminar/Data collection and interpretation/Case study	:	10marks
Test paper 1 (Module 1 and Module 2)	:	10 marks
Test paper 2 (Module 3 and Module 4)	:	10 marks
End Semester Examination	**:**	**60 marks**

The examination will be conducted by the College with the question paper provided by the Industry. The examination will be for 3 Hrs and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12

marks. The valuation of the answer scripts shall be done by the expert in the Industry handling the course.

(vii) MOOC COURSES

The MOOC course shall be considered only if it is conducted by the agencies namely AICTE/NPTEL/SWAYAM or NITTTR. The MOOC course should have a minimum duration of 8 weeks and the content of the syllabus shall be enough for at least 40 hours of teaching. The course should have a proctored/offline end semester examination. The students can do the MOOC courses according to their convenience, but shall complete it before the end of fourth semester. The list of MOOC courses will be provided by the concerned BoS if at least 70% of the course content match with the area/stream of study. The course shall not be considered if its content has more than 50% of overlap with a core/elective course in the concerned discipline or with an open elective.

MOOC Course to be successfully completed before the end of fourth semester (starting from semester 1) A credit of 2 will be awarded to all students whoever successfully completes the MOOC course as per the evaluation pattern of the respective agency conducting the MOOC.

(viii) MINI PROJECT

Total marks: 100, only CIA

Mini project can help to strengthen the understanding of student's fundamentals through application of theoretical concepts and to boost their skills and widen the horizon of their thinking. The ultimate aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects increases problem- solving skills. The introduction of mini projects ensures preparedness of students to undertake dissertation. Students should identify a topic of interest in consultation with Faculty Mentor. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.

Interim evaluation: 40 (20 marks for each review), final evaluation by a Committee (will be evaluating the level of completion and demonstration of functionality/specifications, clarity of presentation, oral examination, work knowledge and involvement): 35, Report (the committee will be evaluating for the technical content, adequacy of references, templates followed and permitted plagiarism level is not more than 25%): 15, Supervisor/Guide: 10.

(ix) DISSERTATION

Dissertation: All Students should carry out the dissertation in the college or can work either in any CSIR/Industrial R&D organization/any other reputed Institute which have facilities for dissertation work in the area proposed.

Dissertation outside the Institute: For doing dissertation outside the Institution, the following conditions are to be met:

- They have completed successfully the course work prescribed in the approved curriculum up to the second semester.
- They should choose Track 1 in semester 3 and 4
- The student has to get prior approval from the DLAC and CLAC.
- Facilities required for doing the dissertation shall be available in the Organization/Industry (A certificate stating the facilities available in the proposed organization and the time period for which the facilities shall be made available to the student, issued by a competent authority from the Organization/Industry shall be submitted by the student along with the application).
- They should have an external as well as an internal supervisor. The internal supervisor should belong to the parent institution and the external supervisor should be Scientists or Engineers from the Institution/Industry/ R&D organization with which the student is associated for doing the dissertation work. The external supervisor shall be with a minimum post graduate degree in the related area.
- The student has to furnish his /her monthly progress as well as attendance report signed by the external guide and submit the same to the concerned Internal guide.
- The external guide is to be preferably present during all the stages of evaluation of the dissertation.

Note1- Students availing this facility should continue as regular students of the College itself.
Note 2-The course work in the 3rd semester is to be completed as per the curriculum requirements (i) MOOC can be completed as per the norms mentioned earlier

Internship leading to Dissertation: The M. Tech students who after completion of 16 weeks (Track 2) internship at some reputed organization are allowed to continue their work as dissertation for the third and fourth semester after getting approval from the DLAC. Such students shall make a brief presentation regarding the work they propose to carry out before the DLAC for a detailed scrutiny and to resolve its suitability for accepting it as an M.Tech

dissertation. These students will be continuing as regular students of the Institute in third semester for carrying out all academic requirements as per the curriculum/regulation. However, they will be permitted to complete their dissertation in the Industry/Organization (where they have successfully completed their internship) during fourth semester.

Dissertation as part of Employment: Students may be permitted to discontinue the programme and take up a job provided they have completed all the courses till second semester (FE status students are not permitted) prescribed in the approved curriculum. The dissertation work can be done during a later period either in the organization where they work if it has R & D facility, or in the Institute. Such students should submit application with details (copy of employment offer, plan of completion of their project etc.) to the Dean (PG) through HoD. The application shall be vetted by CLAC before granting the approval. When the students are planning to do the dissertation work in the organization with R & D facility where they are employed, they shall submit a separate application having following details:

- Name of R&D Organization/Industry.
- Name and designation of an external supervisor from the proposed Organization/Industry (Scientists or Engineers with a minimum post graduate degree in the related area) and his/her profile with consent.
- Name and designation of a faculty member of the Institute as internal supervisor with his/her consent.
- Letter from the competent authority from the Organization/Industry granting permission to do the dissertation.
- Details of the proposed work.
- Work plan of completion of project.

DLAC will scrutinize the proposal and forward to CLAC for approval.

When students are doing dissertation work along with the job in the organization (with R & D facility) where they are employed, the dissertation work shall be completed in four semesters normally (two semesters of dissertation work along with the job may be considered as equivalent to one semester of dissertation work at the Institute). Extensions may be granted based on requests from the student and recommendation of the supervisors such that he/she will complete the M. Tech programme within four years from the date of admission as per the regulation. Method of evaluation and grading of the dissertation will be the same as in the case of

regular students. The course work in the 3rd semester for such students are to be completed as per the curriculum requirements (i) MOOC course can be completed as per the norms mentioned earlier. However, for self learning students, all evaluations shall be carried out in their parent Institution as in the case of regular students.

Mark Distribution:

Phase 1: Total marks: 100, only CIE

Phase 2: Total marks: 200, CIE = 100 and ESE = 100 marks

- Maximum grade (S grade) for the dissertation phase II will be awarded preferably if the student publishes the dissertation work in a peer reviewed journal.
- Final Evaluation (ESE) should be done by a three-member committee comprising of the Department Project coordinator, Guide and an External expert. The external expert shall be an academician or from industry.

(x) TEACHING ASSISTANCESHIP (TA)

All M.Tech students irrespective of their category of admission, shall undertake TA duties for a minimum duration as per the curriculum. Being a TA, the student will get an excellent opportunity to improve their expertise in the technical content of the course, enhance communication skills, obtain a hands-on experience in handling the experiments in the laboratory and improve peer interactions.

The possible TA responsibilities include the following: facilitate a discussion section or tutorial for a theory/ course, facilitate to assist the students for a laboratory course, serve as a mentor for students, and act as the course web-master. TAs may be required to attend the instructor's lecture regularly. A TA shall not be employed as a substitute instructor, where the effect is to relieve the instructor of his or her teaching responsibilities.

For the tutorial session:

(i) Meet the teacher and understand your responsibilities well in advance, attend the lectures of the course for which you are a tutor, work out the solutions for all the tutorial problems yourself, approach the teacher if you find any discrepancy or if you need help in solving the tutorial problems, use reference text books, be innovative and express everything in English only.

(ii) Try to lead the students to the correct solutions by providing appropriate hints rather than solving the entire problem yourself, encourage questions from the students, lead the group to a discussion based on their questions, plan to ask them some questions be

friendly and open with the students, simultaneously being firm with them.

(iii) Keep track of the progress of each student in your group, give a periodic feedback to the student about his/her progress, issue warnings if the student is consistently under-performing, report to the faculty if you find that a particular student is consistently underperforming, pay special attention to slow-learners and be open to the feedback and comments from the students and faculty.

(iv) After the tutorial session you may be required to grade the tutorials/assignments/tests. Make sure that you work out the solutions to the questions yourself, and compare it with the answer key, think and work out possible alternate solutions to the same question, understand the marking scheme from the teacher. Consult the teacher and make sure that you are not partial to some student/students while grading. Follow basic ethics.

Handling a laboratory Session:

(i) Meet the faculty – in- charge a few days in advance of the actual lab class and get the details of the experiment, get clarifications from him/her regarding all aspects of the experiment and the expectations, prepare by reading about the theoretical background of the experiment, know the physical concepts involved in the experiment, go to the laboratory and check out the condition of the equipment/instrumentation, perform the laboratory experiment at least once one or two days before the actual laboratory class, familiarize with safety/ security aspects of the experiment / equipment/laboratory, prepare an instruction sheet for the experiment in consultation with the faculty, and keep sufficient copies ready for distribution to students for their reference.

(ii) Verify condition of the equipment/set up about 30 minutes before the students arrive in the class and be ready with the hand outs, make brief introductory remarks about the experiment, its importance, its relevance to the theory they have studied in the class, ask the students suitable questions to know there level of preparation for the experiment, discuss how to interpret results, ask them comment on the results.

(iii) Correct/evaluate/grade the submitted reports after receiving suitable instructions from the faculty in charge, continue to interact with students if they have any clarifications regarding any aspect of the laboratory session, including of course grading, Carefully observe instrument and human safety in laboratory class, Preparing simple questions for short oral quizzing during explanation of experiments enables active participation of students, facilitate attention, provides feedback and formative evaluation.

POINTS TO REMEMBER

1. Arrange an awareness programme to all M.Tech students on day 1 regarding the curriculum and the regulation.
2. The departments should prepare the list of MOOC courses suitable to their programmes and encourage the students to complete at the earliest.
3. Make a tie up with industries by the middle of semester for Industry Integrated Course. While choosing the course, it should be ensured that the programme is relevant and updated in that discipline. The Industry expert handling the course shall be a postgraduate degree holder. The evaluation procedure shall also be clearly explained to them.
4. Each department offering M.Tech programme should be careful in selecting the mini project in semester 2.
5. The departments should invite the Industries/research organizations during first semester and inform them about the mandatory 6-8 weeks internship that the students should undergo after their second semester. The possibility of doing their dissertation at the Industry shall also be explored. They should also be made aware about the evaluation procedure of the Internships. They may also be informed that it is possible to continue internship provided if it leads to their dissertation. Proposals may be collected from them for allotting to students according to their fields of interest.
6. Make sure that all internal evaluations and the end semester examinations to be conducted by the college are carried out as per the evaluation procedure listed in the curriculum. Any dilution from the prescribed procedure shall be viewed seriously.
7. Teaching assistance shall be assigned to all students as per the curriculum. However, a TA shall not be employed as a substitute instructor, where the effect is to relieve the instructor of his or her teaching responsibilities.
8. The possible TA responsibilities include the following: facilitate a discussion section or tutorial for a theory/ course, facilitate to assist the students for a laboratory course, serve as a mentor for students, and act as the course web-master

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SEMESTER I

BRANCH : Civil Engineering

SPECIALIZATION : Structural Engineering and Construction Management

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1T101	NUMERICAL METHODS IN STRUCTURAL ENGINEERING	CORE	4	0	0	4	4

Preamble:

The course provides a comprehensive understanding of diverse numerical techniques applicable in civil engineering across different domains. Special focus is given to optimization problems, explaining its significance, versatility and fundamental concepts relevant to civil engineering scenarios.

Prerequisite: Calculus and Linear Algebra

Course Outcomes: After the completion of the course the student will be able to

CO 1	Solve both linear and non-linear systems of equations simultaneously. **(Cognitive knowledge level: Apply)**
CO 2	Apply solution technique in structural engineering problems. **(Cognitive knowledge level: Analyse)**
CO 3	Evaluate numerical solutions for ordinary differential equations and their application in structural engineering. **(Cognitive knowledge level: Analyse)**
CO 4	Comprehend various optimization algorithms and tools to tackle problem-solving tasks. **(Cognitive knowledge level: Evaluate)**
CO 5	Develop problem formulations and apply appropriate techniques to solve them. **(Cognitive knowledge level: Evaluate)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	1	1	2	2	2
CO 2	1	1	1	2	2	2
CO 3	1	1	1	2	2	2
CO 4	1	1	2	2	2	2
CO 5	1	1	2	2	2	2

Assessment Pattern

Course Name	NUMERICAL METHODS IN STRUCTURAL ENGINEERING		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (% Marks)
	Test 1 (% Marks)	Test 2 (% Marks)	
Remember			
Understand	10	10	10
Apply	50	50	50
Analyse	30	30	30
Evaluate	10	10	10
Create			

Mark distribution

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern

Micro project/Course based project : 10 marks

Course based task/Seminar/Quiz : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (11 hours)

Solution of Linear and Non-linear equations:- Linear system of equations, Gaussian Elimination, Numerical examples. Nonlinear system of equations: Newton-Raphson's method for single and multiples variables, Limitations. Modified Newton-Raphson's methods, Numerical examples.

Solution Techniques for Eigenvalue Problems:- Eigenvalue problems in structural engineering, Solution by characteristics polynomial, Numerical examples.

MODULE 2 (11 hours)

Numerical Integration:- Newmark's Method: Equivalent Loads, Newmark's Procedure, Application of Newmark's method for the slope and deflection of beams (Simply supported, Cantilever and Overhanging) having uniform and varying flexural rigidity with different loading cases (Concentrated, Uniformly distributed and uniformly varying). Slope and deflection of propped cantilevers and fixed beams having uniform flexural rigidity with uniformly distributed loads.

MODULE 3 (11 hours)

Finite Difference Technique for Ordinary Differential Equations and its Applications in Structural Engineering:- Forward, Backward and central difference. Initial and boundary value problems.

Application of finite difference method for statically determinate beam problems: Calculation of bending moment and deflection of beams (simply supported and cantilever) having uniform and varying flexural rigidity subjected to loads (concentrated and uniformly distributed).

Application of finite difference method for statically indeterminate beam problems: Calculation of bending moment and deflection of beams (propped cantilevers and fixed) having uniform and varying flexural rigidity subjected to loads (concentrated and uniformly distributed).

MODULE 4 (6 hours)

Introduction to optimization-Definitions, classification. Single variable optimization algorithms – optimality criteria, bracketing methods, region elimination methods, gradient based methods. Root finding using optimization techniques.Unconstrained optimization algorithm - Multivariable optimization algorithms – optimality criteria, direct search methods, gradient search methods.

MODULE 5 (6 hours)

Constrained optimization algorithms - Multivariable Optimization-Lagrange Multipliers - Kuhn-Tucker

Conditions- Introduction to Genetic algorithms. Application of GAs in structural optimization- Particle Swarm Optimization -Problems

References

1. Gupta,S.K. “Numerical Methods for Engineers”. Wiley Eastern, New Delhi, 1995.
2. Singiresu S. Rao, “Engineering Optimization: Theory and Practice”, Willey
3. K. K. Jain, S. R. K Iyengar and R. K. Jain, “Numerical Methods - Problem and Solutions”, Wiley India Pvt. Ltd, 2001.
4. Rajasekaran S., “Numerical Methods in Science and Engineering, A practical approach”, A H Wheeler & Co.
5. Krishna Raju N. and Muthu K.U, “Numerical Methods for Engineering Problems”, Macmillan India Limited.
6. J. H. Mathews and K.D. Fink, “Numerical Methods using MATLAB”, Pearson Education,2004.
7. Kalyanmay Deb, “Optimization of Engineering Design: Algorithms and Examples”, PHI.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module 1	**11**
1.1	Solution of Linear and Non-linear equations:- Linear system of equations	1
1.2	Gaussian Elimination, Numerical examples.	2
1.3	Nonlinear system of equations: Newton-Raphson’s method for single and multiples variables, Limitations.	2
1.4	Modified Newton-Raphson's methods, Numerical examples.	3
1.5	Solution Techniques for Eigenvalue Problems:- Eigenvalue problems in structural engineering, Solution by characteristics polynomial, Numerical examples.	3
	Module 2	**11**
2.1	Newmark’s Method: Equivalent Loads, Newmark’s Procedure	1
2.2	Slope and deflection of simply supported beams having uniform and varying flexural rigidity with different loading cases ..	2
2.3	Slope and deflection of cantilever beams having uniform and varying flexural rigidity with different loading cases ..	2
2.4	Slope and deflection of Overhanging beams having uniform and	2

	varying flexural rigidity with different loading cases .	
2.5	Slope and deflection of propped cantilevers having uniform flexural rigidity with uniformly distributed loads.	2
2.6	Slope and deflection of fixed beams having uniform flexural rigidity with uniformly distributed loads.	2
	Module 3	**11**
3.1	Finite Difference Technique Forward, Backward and central difference	2
3.2	Initial and boundary value problems	1
3.3	Application of finite difference method for statically determinate beam problems: Calculation of bending moment and deflection of beams (simply supported and cantilever) having uniform and varying flexural rigidity subjected to loads (concentrated, uniformly distributed).	4
3.4	Application of finite difference method for statically indeterminate beam problems: Calculation of bending moment and deflection of beams (propped cantilevers and fixed) having uniform and varying flexural rigidity subjected to loads (concentrated and uniformly distributed).	4
	Module 4	**6**
4.1	Introduction to optimization-Definitions, classification.	1
4.2	Single variable optimization algorithms- optimality criteria	1
4.3	Bracketing methods, region elimination methods, gradient-based methods	1
4.4	Root finding using optimization techniques	1
4.5	Multivariable optimization algorithms – optimality criteria	1
4.6	Direct search methods, gradient search methods	1
	Module 5	**6**
5.1	Constrained optimization algorithms Multivariable Optimization	1
5.2	Lagrange Multipliers - Kuhn-Tucker Conditions	2
5.3	Introduction to Genetic Algorithms- Application of GAs in Structural Optimization	1
5.4	Particle Swarm Optimization	2

Model Question Paper

QP CODE: Pages: 2

Reg. No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: M24CE1T101

Course Name: NUMERICAL METHODS IN STRUCTURAL ENGINEERING

Max. Marks:60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Determine the roots of the following pairs of simultaneous non-linear equations by modified N-R method

$$x^2 - 2y^2 + 4.82 = 0$$

$$2x + 4y^2 - 16.74 = 0$$

Starting value may be assumed as $x_0 = 1.30$ and $y_0 = 1.70$

2. A cantilever of length L and uniform flexural rigidity EI supports a uniformly distributed load of intensity w kN/m over its entire span length. Evaluate the maximum slope and deflection at the free end using Newmark's method.
3. The boundary value problem governing the deflection of a beam of length 3m is given by

$$\frac{d^4y}{dx^4} + 2y = \frac{1}{9}x^2 + \frac{2}{3}x + 4,\ y(0) = y'(0) = y(3) = y''(3) = 0$$

Determine the deflection at pivotal points x=1 and x=2.

4. Find the points on the circle $x^2+y^2 = 100$ which are closest to and farthest from the point (1,2). Use the Lagrange Multiplier method
5. What is the relevance of Particle Swarm Optimization in structural engineering?

PART B

Answer any five questions. Each question carries 8 marks.

6. Solve the system of equations Gaussian Elimination

$$5\,x_1 + x_2 + x_3 = 10$$

$$x_1 + 5\,x_2 + 2\,x_3 = -20$$

$$x_1 + 2\,x_2 + 3\,x_3 = -40$$

7. A simply supported beam of length L, supports a uniformly distributed load of intensity wkN/m. Calculate the maximum moment and deflection in the beam. Assume EI as constant. Use a third order differential equation. Divide the beam into four equal parts with nodal points 0, 1, 2, 3, 4.
8. A propped cantilever AB fixed at A and propped at B is of length L and has constant flexural rigidity EI. The cantilever supports a udl of wkN/m over the whole length as shown in Fig. 1. Using 4 subintervals, estimate the deflection at pivotal points using 4^{th} order differential equations.

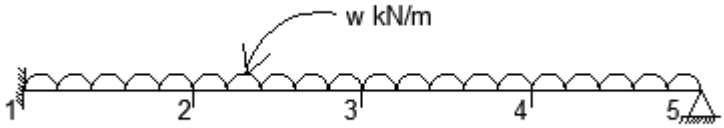


Fig. 1

9. A simply supported beam of length "L" span supports a uniformly distributed w kN/m over the mid $1/3^{rd}$ span. Estimate the maximum deflection in the beam. Apply the finite difference method.
10. A propped cantilever AB fixed at A and propped at B is of length L and has a constant flexural rigidify. The cantilever supports a concentrated load of W kN at the centre of the left quarter span. Assuming four intervals, estimate the deflection under load.
11. A fully enclosed rectangular box is to be constructed from a sheet metal with a total area of 10 m^2. The goal is to maximize the volume of the box. The dimensions of the box are represented by length *l*, breadth *b*, and height *h* (all in meters).

    a) Convert this into a two variable unconstrained optimization problem in *l* and *b.*

    b) Choose a suitable optimization technique to determine the optimal dimensions of the box. Take initial assumption as *l*=*b*=0.5m
12. Enumerate the principle and operation of genetic algorithms? How it can be used for solving structural engineering problems.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT

M24CE1T102	**THEORY OF ELASTICITY AND PLASTICITY**	**CORE**	**4**	**0**	**0**	**4**	**4**

Preamble: The course offers a strong foundation for analyzing and optimizing the behaviour of materials under various mechanical and environmental situations by combining theoretical precision with real-world application.

Prerequisite: Mechanics of Solids

Course Outcomes: After the completion of the course the student will be able to

CO1	Interpret the relationships between forces, stress, strain, and deformations and their applications in structural elements. **(Cognitive knowledge level: Understand)**
CO2	Apply concepts of elasticity in plane stress and plane strain conditions to solve problems in engineering contexts **(Cognitive knowledge level: Apply)**
CO3	Acquire a comprehensive understanding of axisymmetric problems, enabling them to analyze and evaluate complex engineering problems. **(Cognitive knowledge level: Evaluate)**
CO4	Apply concepts of torsion in different structural configurations. **(Cognitive knowledge level: Apply)**
CO5	Apply theoretical concepts to solve practical engineering problems related to material behaviour and failure prediction **(Cognitive knowledge level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	1	1	1	1	2	2
CO 2	1	1	2	2	1	2
CO 3	1	1	2	1	1	2
CO 4	1	1	2	2	2	2
CO 5	1	1	2	2	2	2

Assessment Pattern

Course Name	Theory of Elasticity & Plasticity		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (% Marks)
	Test 1 (% Marks)	Test 2 (% Marks)	
Remember			
Understand	10	10	10
Apply	50	50	50
Analyse	30	30	30
Evaluate	10	10	10
Create			

Mark distribution

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern

Microproject/Course based project	:	10 marks
Course based task/Seminar/Quiz	:	10 marks
Test paper 1 (Module 1 and Module 2)	:	10 marks
Test paper 2 (Module 3 and Module 4)	:	10 marks

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (8 hours)

Elasticity: Forces acting on a body – stress, strain and deformations- relationships between stress and strain in Three Dimensions- Equilibrium equations- Strain displacement relationships – Compatibility equations- Decomposition of deformation into symmetric and anti-symmetric parts- State of stress on an oblique plane – stress transformation – principal stresses and principal planes-Generalized Hooke's Law

MODULE 2 (10 hours)

Problems of Elasticity: Plane stress and plane strain Problems. Analysis–transformation equations–stress–strain relations– equilibrium equations in Cartesian and polar co-ordinates Airy's stress function– Biharmonic Equilibrium–St Venant's principle–2D problems in Cartesian coordinate–cantilever with concentrated load at free end– Simply supported with UDL–Cantilever with moment at free end.

MODULE 3 (9 hours)

Axisymmetric problems: Introduction - Definition and significance of axisymmetric problems. Overview of polar coordinates: r(radial), θ (angular), and z (axial) components. Basic concepts of stress and strain in polar coordinates. General equations in polar co-ordinates–Stress distribution symmetric about an axis– Stress analysis of thick-walled and thin-walled cylinders.-Lame's equations and their applications-Cylinders subjected to internal pressure: applications in pressure vessels.

MODULE 4 (9 hours)

Torsion: Introduction – St.Venant's approach- boundary conditions – Expression for torque- torsion of circular cross section- torsion of elliptical cross section- torsion of rectangular cross section. Membrane analogy – sand heap analogy - torsion of narrow rectangular strip- torsion of multi connected thin-walled sections.

MODULE 5 (9 hours)

Plasticity: Introduction – idealized stress-strain behaviour – Elastic- perfectly plastic material-perfectly plastic material – linearly strain hardening material –strain hardening- nominal and true stress strain-Yeilding criteria independent of hydrostatic pressure – Tresca's Failure Criteria – von Mises Hencky Failure Criteria.

References

1. Timoshenko S P and Goodier J. N, “Theory of Elasticity”, Tata Mcgraw Hill International Student Edition, third edition, 1970.
2. Johnson W and Mellor P. B, “Plasticity for mechanical engineers”, Van Company Ltd., first edition, 1973.
3. H. Jane Helena, “Theory of Elasticity and Plasticity”, Prentice Hal, first edition, 1980.
4. Sadhu Singh, “Theory of elasticity”, Khanna Publishers, Delhi, first edition 1970.
5. Srinath L. S, “Advanced mechanics of solids”, Tata McGraw– Hill Publishing Company Ltd., New Delhi, first edition 1973.
6. Sokolnikoff, “Mathematical Theory of Elasticity”,Mcgraw-hill Book Company New York and London, second edition 1956.
7. W.B. Lee,” Plasticity”Division of Applied Mathematics, Brown University, first edition, 1966.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture /Tutorial hours
	Module 1	**8**
1.1	Forces acting on a body – stress, strain and deformations- relationships between stress and strain	1
1.2	Equilibrium equations- Strain displacement relationships	1
1.3	Compatibility equations-Decomposition of deformation into symmetric and anti-symmetric parts	1
1.4	State of stress on an oblique plane	2
1.5	Stress transformation	1
1.6	Principal stresses and principal planes	1
1.7	Generalized Hooke’s Law	1
	Module 2	**10**
2.1	Plane stress and plain strain problems	1
2.2	Analysis–transformation equations–stress–strain relations	1
2.3	Equilibrium equations in Cartesian and polar co-ordinates Airy’s stress function	2

2.4	Biharmonic Equilibrium	1
2.5	St Venant's principle	1
2.6	2D problems in Cartesian coordinate–cantilever with concentrated load at free end	2
2.7	Simply supported with UDL	1
2.8	Cantilever with moment at free end	1
	Module 3	**9**
3.1	Introduction-Definition and significance of axisymetric problems	1
3.2	Overview of polar coordinates: radial,angular,axial components	1
3.3	Basic concepts of stress and strain in polar coordinates	1
3.4	Stress distribution symmetric about an axis	2
3.5	Stress analysis of thick walled and thin walled cylinders	1
3.6	Lame's equations and their applications	1
3.3	Cylinder subjected to internal pressures	2
	Module 4	**9**
4.1	Introduction – St.Venant's approach- boundary conditions	1
4.2	Expression for torque- torsion of circular cross section	1
4.3	Torsion of elliptical cross section	1
4.4	Torsion of rectangular cross section	2
4.5	Membrane analogy – sand heap analogy	2
4.6	Torsion of narrow rectangular strip	1
4.7	Torsion of muti connected thin-walled sections	1
	Module 5	**9**
5.1	Introduction – idealized stress-strain behaviour	1
5.2	Elastic- perfectly plastic material-perfectly plastic material	1
5.3	Linearly strain hardening material –strain hardening	1
5.4	Nominal and true stress strain	1
5.5	Yeilding criteria independent of hydrostatic pressure	1
5.6	Tresca's Failure Criteria	2
5.7	Von Mises Hencky Failure Criteria	2

Model Question Paper

QP CODE: Pages:2

Reg. No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M. TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: M24CE1T102

Course Name: Theory of Elasticity and Plasticity

Max.Marks:60 Duration: 3 hours

PARTA

Answer all questions. Each question carries 4 marks.

1. Identify how compatibility equations are essential for analyzing deformations in structures.
2. Examine the difference between plane stress and plane strain problems in elasticity? Provide examples of situations where each type of problem would be applicable.
3. Develop axisymmetric problems in the context of elasticity analysis.
4. Illustrate the primary factors that influence torsional behavior in materials in the context of mechanics.
5. Examine the concept of Airy's stress function which can be used in solving two-dimensional elasticity problems.

PART B

Answer any five questions. Each question carries 8 marks.

6. a. Examine the concept of principal stresses and principal planes (2marks)
   b. Discuss the state of stress on an oblique plane. How can it be analyzed and resolved into principal stresses? (6 marks)
7. Investigate a cantilever beam with a moment applied at the free end. Apply two-dimensional elasticity analysis techniques to determine the stress distribution and deflection of the beam.
8. Consider a cylindrical pressure vessel subjected to external and internal pressures. Using axisymmetric analysis techniques, determine the stress distribution within the cylinder and discuss the implications for structural integrity.

9. Analyze the torsion of a narrow rectangular strip. What assumptions are made in the analysis, and how do they simplify the problem?
10. a. Inspect how the behavior of elastic-perfectly plastic material differ from other idealizations. Conclude it with the help of its characteristics (3 marks)

    b. Compare and contrast Tresca's and von Mises-Hencky's failure criteria. What are the strengths and weaknesses of each criterion? (5 marks)
11. A tubular section having three cells as shown in the figure 1 is subjected to a torque of 113 kN-m. Determine the shear stresses developed in the walls of the section.

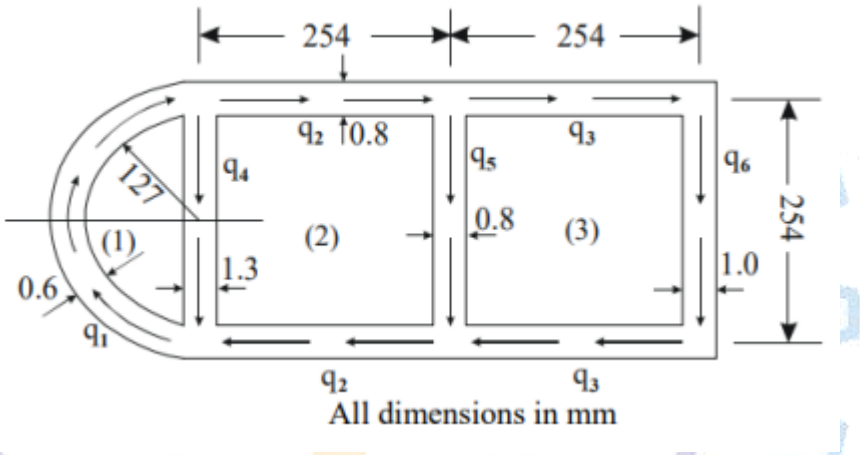


Fig:1

12. Provide examples or scenarios where the concepts of stress, strain, deformation, and their relationships are applied in real-world engineering or structural analysis problems.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
M24CE1T103	CONSTRUCTION PLANNING, SCHEDULING AND CONTROL	CORE	4	0	0	4

Preamble: The course equips students with comprehensive understanding of project planning and safety management. This enables them to optimize various project outcomes. The program integrates theoretical knowledge with practical applications, preparing graduates to effectively manage complex construction projects and deliver successful results**.**

Prerequisite **:** Construction technology and Management

Course Outcomes **:** After the completion of the course the student will be able to

CO 1	Apply fundamental construction planning principles to organize and track various construction projects **(Cognitive knowledge level:Apply)**
CO 2	Accurately estimate and analyze project timelines, effectively manage uncertainties, and optimize various construction projects using advanced scheduling techniques **(Cognitive knowledge level:Analyse)**
CO 3	Optimize project performance by conducting comprehensive time-cost-risk trade-off analysis to manage complex scheduling scenarios. **(Cognitive knowledge level:Analyse)**
CO 4	Develop expertise in establishing and managing project budgets, integrating financial systems, and controlling expenditures. **(Cognitive knowledge level:Apply)**
CO 5	Implement quality control systems ensuring safety standards and practices. **(Cognitive knowledge level:Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	1	2	1		
CO 2	1	1	3	2		
CO 3	1	1	2			1
CO 4		1	3			
CO 5		1			2	

Assessment Pattern

Course Name	CONSTRUCTION PLANNING, SCHEDULING AND CONTROL		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	40	10	20
Apply	20	50	40
Analyse	40	40	40
Evaluate			
Create			

Mark distribution

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern

Course based Project/Micro Project	:	10 marks
Course based Task/Seminar /Quiz	:	10 marks
Test paper 1	:	10 marks
Test paper 2	:	10 marks

The project shall be done individually. Group projects are not permitted. The project may include the implementation of theoretical computation using software packages.

The test papers hall includes a minimum 80% of the syllabus.

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

Module 1 (10 hours)

Construction Planning Fundamentals : Fundamental principles in construction planning choice of technology and construction methods, Defining work tasks and establishing precedence relationships among activities, Estimating activity duration and resource requirements, Introduction to coding systems for project organization and tracking

Module 2 (10 hours)

Construction Scheduling Techniques : Importance of construction schedules and project timelines, Critical Path Method (CPM) for scheduling project activities, Activity-on-Node diagrams for visualizing project schedules, Understanding leads, lags, and activity floats, Handling uncertain duration in project scheduling, Advanced scheduling techniques including Program Evaluation and Review Technique (PERT)

Module 3 (9 hours)

Advanced Scheduling Methods: Monte Carlo Schedule Simulation for risk analysis in construction planning, Strategies for crashing and time/cost tradeoffs in project scheduling and levelling, Resource-oriented scheduling and managing resource constraints, Handling scheduling in poorly structured scenarios, Optimization approaches in the scheduling process

Module 4 (8 hours)

Cost Control and Budget Management: Establishing the project budget and forecasting for activity cost control, Integration of financial accounting systems and cost accounts, Managing project cash flows and controlling expenditures, Techniques for schedule control and updating project schedules and budgets, Project delay management, Analysis of the relationship between project cost and schedule information

Module 5 (8 hours)

Quality and Safety Management: Organizational aspects of ensuring quality and safety in construction projects, Development of work and material specifications for quality assurance, Implementation of Total Quality Control principles, Application of statistical methods for quality control, Quality control through sampling techniques (both attributes and variables), Importance of safety standards and practices in construction projects

References

1. Chitkara. K.K(1998) “Construction Project Management: Planning Scheduling and ontrol”, Tata McGraw Hill Publishing Company, New Delhi,
2. Calin M. Popescu, Chotchal Charoenngam (1995), “Project Planning, Scheduling and Control in Construction: An Encyclopaedia of terms and Applications”, Wiley, New York, 34
3. Chris Hendrickson and Tung Au(2000), “Project Management for Construction – fundamental concepts for Owners, Engineers, Architects and Builders”, Prentice Hall Pittsburgh,
4. Moder, J., C. Phillips and E. Davis (1983) “Project Management with CPM, PERT precedence Diagramming”, Van Nostrand Reinhold Company, Third Edition, Willis, E. M, Scheduling Construction Projects
5. John Wiley & Sons, Halpin, D. W (1985). “Financial and Cost Concepts for Construction Management”, John Wiley & Sons. New York.
6. Project Management for Business and Technology - Principles and Practice, by John M. Nicholas, Prentice-Hall of India Ltd.
7. Projects Planning, Analysis, Selection, Implementation & Review, by Prasanna Chandra, Tata-McGraw Hill Publishing Co.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module 1	**10**
1.1	Fundamental principles in construction planning choice of technology and construction methods	2
1.2	Defining work tasks and establishing precedence relationships among activities	2
1.3	Estimating activity duration and resource requirements	3
1.4	Estimating resource requirements for work activities -coding systems	3
	Module 2	**10**
2.1	Relevance of Construction Schedules and timeline. The Critical Path Method	2
2.2	Presenting project schedules with Activity - on - Node diagrams, Leads and Lags	2

2.3	Calculations for critical path scheduling	2
2.4	Activity Float and Schedules	2
2.5	Scheduling with uncertain duration - Programme Evaluation and Review Technique	2
	Module 3	**9**
3.1	Simulation for risk analysis in construction planning	2
3.2	Strategies for crashing and time/cost tradeoffs in project scheduling	2
3.3	Resource-oriented, scheduling and managing resource constraint	2
3.4	Handling scheduling in poorly structured scenarios, Optimization approaches in the scheduling process	3
	Module 4	**8**
4.1	Establishing the project budget and forecasting for activity cost control	2
4.2	Integration of financial accounting systems and, Managing project cash flows	3
4.3	Analysis of the relationship between project cost and schedule information	3
	Module 5	**8**
5.1	Quality and safety in construction projects,	2
5.2	Use of advanced scheduling techniques with awareness on scheduling software	2
5.3	Implementation of Total Quality Control and Application of statistical methods for quality control	2
5.4	Techniques for schedule control and updating budgets. Analysis of the relationship between project cost and schedule	2

Model Question Paper

QP CODE: Pages: 2

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24CE1T103**

Course Name: **CONSTRUCTION PLANNING, SCHEDULING AND CONTROL**

Max. Marks:60 Duration: 2.5 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Elucidate the factors affecting choice of technology and construction method?
2. Illustrate different types of activity floats.
3. Explain the concept of time cost trade off.
4. Elaborate the importance of 'Resource Levelling'.
5. Explain the indices which denote the time efficiency of construction projects.

PART B

Answer any five questions. Each question carries 8 marks.

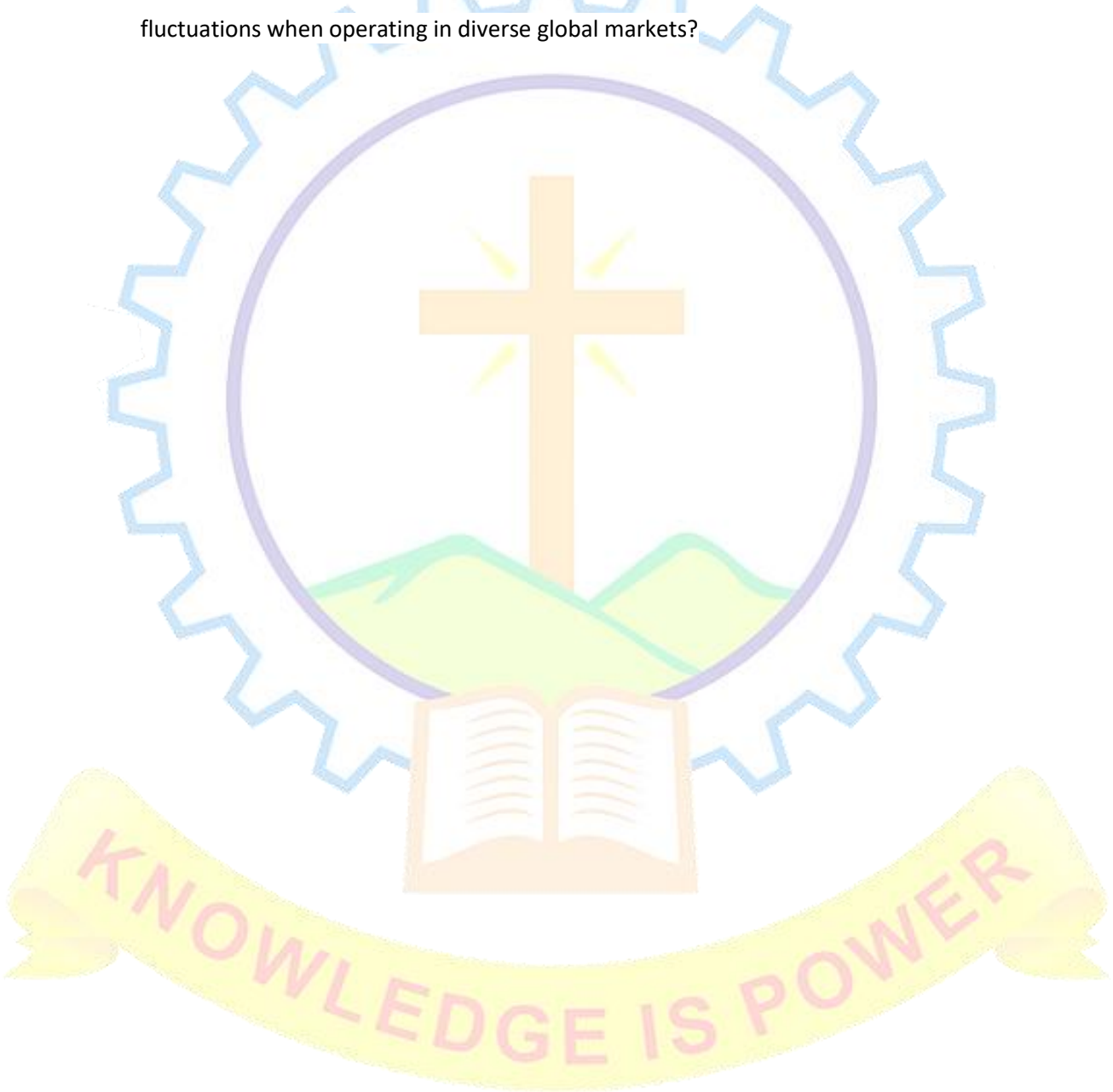
6. Enlist the need for universal coding system for identifying activities with a detailed example.
7. The following details regarding the activities of a project are given.
   i. Prepare an Activity on Node Diagram.
   ii. Prepare a schedule of activities.
   iii. Find the expected duration of the project
   iv. Determine the critical activities.
   v. Find the total and free floats of all activities.
8. Illustrate in detail about the techniques that can be used to handle uncertainties in construction project scheduling.
9. Elaborate the significance of accounting, considering the time value of money and risk ,when making financial decisions in construction projects?
10. Describe the types of insurance commonly used in the construction industry and how bonding requirements help protect project stakeholders from financial risks?

11. a. What ethical considerations are important for construction management professionals?

    b. Scrutinize the principles of professional ethics in construction, address issues related to conflicts of interest

12. a. Explore the global perspectives of construction economics, including international construction markets, cross-border transactions, and currency risk management.

    b. List out the methods adopted by project managers to navigate challenges like currency fluctuations when operating in diverse global markets?



CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1R106	RESEARCH METHODOLOGY & IPR	THEORY	2	0	0	2	2

Preamble: The course covers strategies and methods essential to scientific research. Students will learn to write technical thesis, reports, and research papers. Key topics include publication, patenting, and the importance of ethics in research.

Prerequisite : NIL

Course Outcomes : After the completion of the course the student will be able to

CO 1	Conduct extensive literature study to identify a research problem **(Cognitive Knowledge Level: Apply)**
CO 2	Design suitable methodological approach that suits the research and formulate methods for data collection **(Cognitive Knowledge Level: Apply)**
CO 3	Analyse data and interpret results implementing statistical methods **(Cognitive Knowledge Level: Analyse)**
CO 4	Prepare well-structured technical presentations and technical reports **(Cognitive Knowledge Level: Apply)**
CO 5	Adopt methodologies for ethical and effective publication of research outcomes and to acquire intellectual property rights **(Cognitive Knowledge Level: Analyse)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	1	1	2	1	1
CO 2	1	1	2	1	1	1
CO 3	2	1	2	1	1	1
CO 4	2	2	2	1	1	1
CO 5	2	2	2	2	2	1

Assessment Pattern

Course Name	Research Methodology & IPR		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (% Marks)
	Test 1 (% Marks)	Test 2 (% Marks)	
Remember			
Understand			
Apply	70	70	70
Analyse	30	30	30
Evaluate			
Create			

Mark distribution

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern

Preparing a review article based on peer reviewed
Original publications in the relevant discipline
(minimum 10 publications shall be referred) : 10 marks
Course based task/Seminar/Quiz : 10 marks
Test paper 1 (Module 1 and Module 2) : 10 marks
Test paper 2 (Module 3 and Module 4) : 10 marks

End Semester Examination Pattern: The end semester examination should be conducted by the college. The time duration will be for 3 Hrs and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

SYLLABUS

MODULE 1 (4 hours)

Introduction to Research & Literature Study:

Philosophy of research, Purpose of research, Research methodology, Research process-Problem identification and formulation, Frameworks in research, Literature review - Systematic Literature Review, Sources of Literature – Introduction to tools for Reference Management

MODULE 2 (5 hours)

Research Design and Data Collection:

Research Design - Types of research, Methods of data collection - Types of data- Primary & Secondary data- Scales of measurement- Instrument Design - Validity and Reliability.

MODULE 3 (5 hours)

Sampling and Statistical Analysis

Sampling: Types of sampling distributions, Sampling error - Statistics in research: Descriptive statistics and inferential statistics, Hypothesis testing - multivariate analysis - Parametric and Nonparametric tests, Correlation and regression- Simple regression.

MODULE 4 (5 hours)

Research Communication and Report Writing

Research Communication: Philosophy, Research Outlets - Reporting and presenting research - Written and oral communications, Scientific Writing: Paper title, abstract, graphical abstract and keywords, Introduction, Literature Review, Methods, Results, Findings, Discussion, Implication, Conclusion, Limitation, Future Studies, References, Bibliography, Annexure, Appendix, Tables and Figures, Citation, Reference styles, Introduction to tools for document preparation.

MODULE 5 (5 hours)

Publication & IPR

Various forms of publication – Research paper, Conference publication, Technical note

Reviewing process – Submission, Revision, Acceptance

Research metrics - Journal level, Article level, Author level

Research Ethics: Scientific misconduct, Plagiarism, Falsification, Tools for Plagiarism check.

Intellectual property rights: Copyright - Patents - Industrial Design - Trademarks – Geographical Design.

References

1. Kothari, Chakravanti Rajagopalachari. Research methodology: Methods and techniques. New Age International, 2013.
2. Krishnaswamy, K. N., Appa Iyer Sivakumar, and M. Athirajan. Management research methodology: Integration of principles, methods and techniques. Pearson Education India, 2006.
3. Gupta, S.P., Statistical Methods, Sultan Chand, New Delhi, 46th Ed., 2021
4. Levin, R. I., and D. S. Rubin. Statistics for Management Prentice-Hall. Inc., New Jersey, 1987.
5. Box, George EP, et al., Time series analysis: Forecasting and Control. John Wiley & Sons, 2015.
6. Jackson, Sherri L., Research methods and statistics: A critical thinking approach, 2009.
7. Lebrun, Jean-Luc, and Justin Lebrun. Scientific writing 3.0: a reader and writer's guide. World Scientific, 2021.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module 1	**4**
1.1	Philosophy of research, Purpose of research, Research methodology	1
1.2	Research process, Problem identification and formulation, Frameworks in research	1
1.3	Literature review - Systematic Literature Review	1
1.4	Sources of Literature - Reference Management Tools	1
	Module 2	**5**
2.1	Research Design	1
2.2	Types of research	1
2.3	Methods of data collection - Types of data- Primary & Secondary data	1
2.4	Scales of measurement	1
2.5	Instrument Design - Validity and Reliability	1
	Module 3	**5**
3.1	Sampling: Types of sampling distributions, Sampling error	1
3.2	Statistics in research: Descriptive statistics and inferential statistics	1
3.3	Hypothesis testing - multivariate analysis	1
3.4	Parametric and Nonparametric tests, Correlation and regression- Simple regression	2

	Module 4	**5**
4.1	Research Communication: Philosophy, Research Outlets	1
4.2	Reporting and presenting research - Written and oral communications	1
4.3	Scientific Writing: Paper title, abstract and keywords, Introduction, Literature Review, Methods, Results, Findings, Discussion, Implication, Conclusion, Limitation, Future Studies, References, Bibliography, Annexure, Appendix, Tables and Figures, Citation, Reference styles	2
4.4	Introduction to tools for document preparation	1
	Module 5	**5**
5.1	Relative importance of various forms of publication: Journal, Conference, Technical note	1
5.2	Reviewing process: Stages in the realization of a paper – Submission, Revision, Acceptance	1
5.3	Research metrics: Journal level, Article level and Author level	1
5.4	Research Ethics: Scientific misconduct, Plagiarism, Falsification, Tools for Plagiarism check.	1
5.5	Intellectual property rights : Copyright - Patents - Industrial Design - Trademarks - Geographical Design	1

Model Question Paper

QP CODE: Pages: 1

Reg. No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24CE1R106**

Course Name: **Research Methodology & IPR**

Max. Marks:60 Duration: 3 hours

Answer any five questions. Each question carries 12 marks.

1. Analyse the different research types and identify the most appropriate type of research to address a contemporary challenge faced by either an organization or society. Provide justification for your selection.
2. How does conducting a comprehensive literature review and suitably identifying research gaps contribute to the success and relevance of the research process?
3. What guidelines apply to effectively formulate a research problem with social relevance? Discuss with an example.
4. "Students who eat breakfast will perform better on a mathematics examination than students who do not eat breakfast." Examine the type of hypothesis. Explain various types of hypotheses. What is the significance of formulating the hypothesis in research work?
5. Explain essential features of scientific report writing highlighting the importance and implication of research outcomes.
6. How can researchers assess and compare journals and authors in their respective fields by analyzing research matrices? Detail with significant examples.
7. Describe the procedure for filing for a patent. What are the benefits associated with the reception of a patent?

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1L107	Advanced Structural Engineering Lab	Laboratory	0	0	3	3	2

Preamble: This course provides practical experience in advanced concrete technology and structural testing. Students will conduct experiments including mix designs for high-strength, self-compacting, and fiber-reinforced concrete, as well as flexural and slab testing. Additionally, non-destructive evaluations, corrosion measurements, sorptivity tests, and modulus of elasticity determination will be performed. This hands-on course reinforces theoretical concepts and equips students with essential skills for modern structural engineering practices.

Prerequisite : Material Testing Laboratory II

Course Outcomes : After the completion of the course the student will be able to

CO 1	Develop different grades of high-strength concrete mixes. **(Cognitive knowledge level: Apply)**
CO 2	Identify the failure mechanisms of RC structural members in flexure. **(Cognitive knowledge level: Apply)**
CO 3	Evaluate the material characteristics of existing structures using NDT methods. **(Cognitive knowledge level: Evaluate)**
CO4	To identify the corrosion in a reinforced concrete system. **(Cognitive knowledge level: Apply)**
CO 5	Evaluate the durability characteristics of the concrete. **(Cognitive knowledge level: Evaluate)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2		2	3	2	2
CO 2	2		2	3	2	2
CO 3	2		2	3	2	2
CO 4	2		2	3	2	2
CO 5	2		2	3	2	2

Mark distribution

Total Marks	CIE Marks	ESE Marks
100	60	40

Continuous Internal Evaluation Pattern :

Lab work and Viva-voce : 60 marks

Final assessment Test and Viva voice : 40 marks

The laboratory courses will be having only Continuous Internal Evaluation and carries 100 marks. Final assessment shall be done by two examiners; one examiner will be a senior faculty from the same department.

SYLLABUS

LIST OF EXPERIMENTS

1	Marsh cone and mini slump
2	Mix design for high strength concrete
3	Mix design of self-compacting concrete
4	Determine mechanical properties like Flexure,compressive strength,split tensile strength, Modulus of elasticity of high strength concrete
5	Non-destructive evaluation by ultrasonic pulse velocity, rebound hammer, and rebar locator
6	Corrosion measurements using half-cell potentiometer
7	Study of Autogenous and Drying shrinkage
8	Mix design for fiber-reinforced concrete and determination of fracture toughness.
9	Sorptivity test and water permeability test on concrete

References

1. H.G. Harris and G.M. Sabnis, “Structural Modeling and Experimental Techniques”, 2nd Ed, CRC Press, 1999.
2. E. Bray and R. K. Stanley, “Non Destructive Evaluation”, CRC Press, 2002.
3. J.W. Dally and W.F. Riley, “Experimental Stress Analysis”, McGraw Hill, 3rd Ed, 1991.
4. J.F. Doyle, “Modern Experimental Stress Analysis”, John Wiley and Sons, 2004.
5. P.C. Aitcin, “High-Performance Concrete”, E & FN SPON, 1998.

PROGRAMME ELECTIVE I

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT

M24CE1E104A	PRESTRESSED CONCRETE	ELECTIVE	3	0	0	3	3

Preamble: The course equips students with the knowledge and skills needed to design various types of prestressed concrete elements, including flexural, compression, and tension members. Additionally, the inclusion of composite member design broadens students' perspectives, highlighting the versatility of prestressed concrete in combination with other materials.

Prerequisite : Basics of structural analysis and Reinforced concrete design

Course Outcomes : After the completion of the course the student will be able to

CO 1	Understand the basic aspects of prestressed concrete structures and to compute the losses in prestressing. **(Cognitive knowledge level: Apply)**
CO 2	Analyze and design prestressed concrete structural members and sections subjected to flexure and shear **(Cognitive knowledge level: Analyze)**
CO 3	Analyze and design statically indeterminate prestressed concrete beams adopting suitable cable profiles. **(Cognitive knowledge level: Analyze)**
CO 4	Analyze composite prestressed concrete structural members and sections subjected to flexure and shear. **(Cognitive knowledge level: Analyze)**
CO 5	Apply the concept of prestressing in members like tanks, poles, pipes, slabs etc. **(Cognitive knowledge level: Apply)**

Mapping of course outcomes with program outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	2	2	2	2	2
CO 2	2	2	2	2	2	2
CO 3	2	2	2	2	2	2
CO 4	2	2	2	2	2	2
CO 5	1	2	2	2	2	2

Assessment Pattern

Course Name	Prestressed concrete		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (% Marks)
	Test 1 (% Marks)	Test 2 (% Marks)	
Remember			
Understand	10	10	10
Apply	30	30	30
Analyze	40	40	40
Evaluate	20	20	20
Create			

Mark distribution

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern :

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (8 hours)

Basic Concept of prestressing -Historical overview of prestressing–Advantages and disadvantages – Materials required – Systems and methods of prestressing

Analysis of sections: Stress concept – Strength concept – Load balancing concept

Effect of tendon profile on deflections – Factors influencing deflections – Calculation of deflections – Short term and long-term deflections (Concepts only) - Losses of prestress- Immediate losses and long term losses (Concept only).

MODULE 2 (8 hours)

Basic assumptions of flexural design – Permissible stresses in steel and concrete as per I.S.1343 Code – Different types of sections - Design of sections- post-tensioned and pre tensioned beams – Check for flexural capacity based on I.S. 1343 Code – Influence of Layout of cables in post-tensioned beams – Location of wires in pre-tensioned beams – Design for shear based on I.S. 1343 Code.

Anchorage zone reinforcement- Design based on IS Code.

MODULE 3 (7 hours)

Prestressed continuous beams: Classifications - Methods of achieving continuity- Analysis and design of continuous beams, Concept of linear transformations, concordant cable profile.

MODULE 4 (7 hours)

Composite Sections: Types – Advantages – applications- Analysis of stresses for composite sections - Composite beams Analysis and design of Flexural and shear strength - Differential Shrinkage

Partial prestressing : its advantages and applications.

MODULE 5 (6 hours)

Role of prestressing in members subjected to Tensile forces and compressive forces - Design of tension and compression members (Basic principles only) – Tanks, pipes and poles – Design of prestressed concrete slab (concepts only).

References

1. Dayaratnam.P., “Prestressed Concrete Structures”, Oxford and IBH, 2013
2. Lin T.Y. and Ned.H.Burns, “Design of prestressed Concrete Structures”, Third Edition, Wiley India Pvt. Ltd., New Delhi, 2013

3. Krishna Raju N., "Prestressed concrete", 5th Edition, Tata McGraw Hill Company New Delhi, 2012
4. Pandit.G.S. and Gupta.S.P., "Prestressed Concrete", CBS Publishers and Distributers Pvt. Ltd, 2012
5. Rajagopalan.N, "Prestressed Concrete", Narosa Publishing House, 2002.
6. Nagarajan, P., Prestressed Concrete Design, Pearson 2013
7. IS 1343:2012, Code of Practice for Prestressed Concrete, Bureau of Indian Standards, New Delhi, 2012
8. IS 3370- Part 3 (1967) (Reaffirmed – 2008) Indian standard Code of practice for concrete structures for the storage of liquids, Bureau of Indian Standards, New Delhi, 2008
9. IS 3370- Part 4 (2008) Indian standard Code of practice for concrete structures for the storage of liquid- Design tables, Bureau of Indian standards, New Delhi

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module 1	**8**
1.1	Basic Concept of prestressing-Historical overview of prestressing– Advantages and disadvantages – Materials required – Systems and methods of prestressing	2
1.2	Analysis of sections – Stress concept – Strength concept – Load balancing concept	2
1.3	Effect of tendon profile on deflections – Factors influencing deflections – Calculation of deflections – Short term and long-term deflections(Concepts only)	2
1.4	Losses of prestress- Immediate losses and long term losses (Concept only).	2
	Module 2	**8**
2.1	Basic assumptions of flexural design – Permissible stresses in steel and concrete as per I.S.1343 Code – Different types of sections	2
2.2	Design of sections- post-tensioned and pre tensioned beams – Check for flexural capacity based on I.S. 1343 Code	3
2.3	Influence of Layout of cables in post-tensioned beams – Location of wires in pre-tensioned beams – Design for shear based on I.S. 1343	2

	Code.	
2.4	Anchorage zone reinforcement- Design based on IS Code.	1
	Module 3	**7**
3.1	Prestressed continuous beams- Classifications - Methods of achieving continuity	2
3.2	Analysis and design of continuous beams	3
3.3	Concept of linear transformations, Concordant cable profile.	2
	Module 4	**7**
4.1	Composite Sections – Types – Advantages-applications,	1
4.2	Analysis of stresses for composite sections	2
4.3	Composite beams- Analysis and design of Flexural and shear strength, Differential Shrinkage	3
4.4	Partial prestressing - its advantages and applications	1
	Module 5	**6**
5.1	Role of prestressing in members subjected to Tensile forces and compressive forces	2
5.2	Design of tension and compression members (Basic principles only)	2
5.3	Tanks, pipes and poles – Design of prestressed concrete slab. (concepts only).	2

Model Question Paper

QP CODE: Pages: 3

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: M24CE1E104A

Course Name: Prestressed Concrete

Max. Marks: 60 Duration: 3 hours

PART A
Answer all Questions. Each question carries 4 Marks

1. Answer the questions in a few sentences. Give a brief justification in maximum of five sentences for full credit

   i) Two beams having the same properties are prestressed with straight tendons having the same force and steel area. The first one is concentric and the second one is eccentric with a positive eccentricity. Which beam carries more external load and why? (2 marks)

   ii) Two identical beams loaded with live load and dead load are prestressed with straight tendons. Both beams are having the same eccentricity but the first one is having a positive eccentricity and the second one is with a negative eccentricity. Which beam will deflect more? Provide a valid argument for full credit. (2 marks)
2. Consideration of transmission length and development length in post tensioned members is meaningless. Justify. Also explain the nature of stresses developed in anchorage of post tensioned members.
3. Indicate whether the following statements are 'TRUE' 'FALSE' or 'MAYBE'. Give a brief justification in maximum of five sentences for full credit

   i) Secondary moments can be eliminated by selecting a proper tendon profile (2 marks)

   ii) In a prestressed continuous beam, The resultant moment diagram has a similar shape of the primary moment diagram, which is again similar to the profile of the tendon. (2 marks)
4. Justify the statement with proper reasoning "Composite prestressed concrete member is superior when compared with a reinforced or prestressed concrete member".

5. Explain the design criteria of prestressed concrete pipes.

PART B

Answer any 5 questions. Each question carries 8 marks

6. A prestressed concrete beam 250mm wide and 400mm deep is prestressed by an eccentric tendon. The span of the beam is 7m and the beam has to support an imposed load of 4.5kN/m. Find the prestressing force necessary so that the tension is just avoided at the soffit of the mid section if the eccentricity is 60mm. Concrete weight is 25kN/m^3.

7. A beam 10m span having 200mm wide and 300mm deep is post tensioned with parabolic cable having an area of 320mm^2 located at an eccentricity of 50mm at mid-span and zero at supports. Initial stress in the cable is 1000MPa. Calculate the maximum percentage loss of prestress due to friction, if it is stressed from one end. Take E_s=2.1×10^5 MPa, E_c=3.5×10^4MPa and age of concrete is 28 days and missing data if any can be assumed based on relevant code.

8. The support section of a prestressed concrete beam 100mm wide and 250mm deep is required to support an ultimate shear force of 60kN. The compressive prestress at the centroidal axis is f_{cp}=5N/mm^2. f_{ck}=40N/mm^2 and cover to the tension reinforcement is 50mm. if the characteristic tensile strength of steel in stirrups is 250N/mm^2. Design suitable shear reinforcement at the section using IS code recommendations.

9. Obtain desirable locations of concordant cable profile for the continuous beam loaded as shown in Figure 1. Take prestressing force as 250kN.

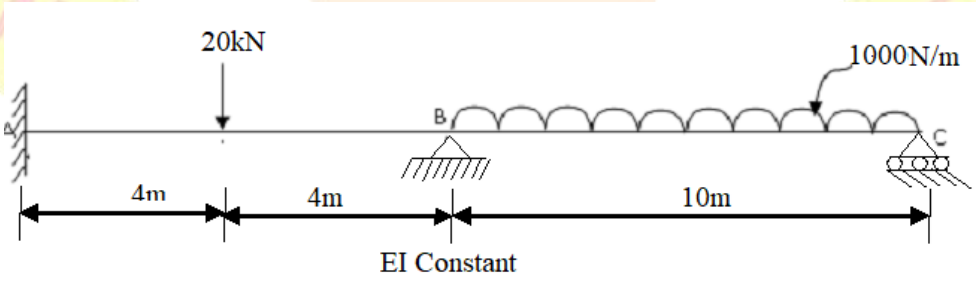


Figure 1

10. A composite beam of rectangular section is made up of a pretensioned inverted T-beam as shown in figure 2 having a slab thickness and width of 150mm and 1000mm respectively. The rib size is

150mm and 850mm. the cast in situ concrete has a thickness and width of 1000mm with a modulus of elasticity of 30kN/mm^2. If the differential shrinkage is 100x10^{-6} units, estimate the shrinkage stresses developed in the precast and cast in situ units.

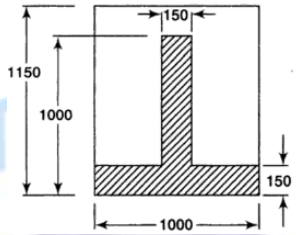


Figure 2

11 (i) Explain the design criteria of prestressed circular water tanks. (5 marks)

(ii) Sketch the commonly used cross-sections of Prestressed concrete Poles. (3 marks)

12. Design the bearing plate and the end zone reinforcement for the following bonded post-tensioned beam shown in figure 3. The strength of concrete at transfer (f_{ci}) is 50N/mm^2. A prestressing force of 1055kN is applied by a single tendon symmetrically placed over a mild steel anchor of size 150mm x 200mm. Permissible bending stress for the bearing plate is 165 N/mm^2. There is no eccentricity of the tendon at the ends. Use Fe250 grade steel for reinforcement.

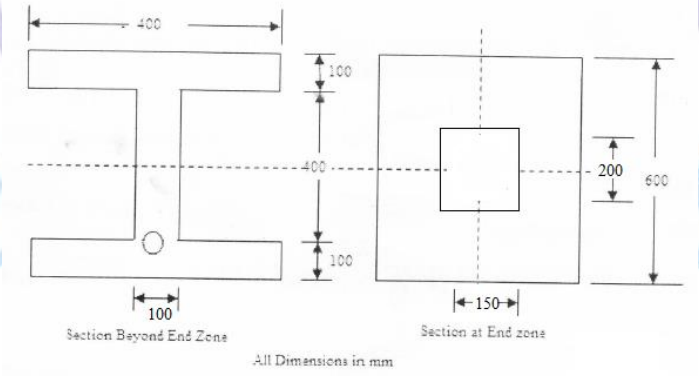


Figure 3

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E104B	MODERN CONSTRUCTION MATERIALS	ELECTIVE	3	0	0	3	3

Preamble: The course provides an understanding of the properties, behaviours, and applications of

various engineering materials. The course includes the fundamental and advanced concepts of material science and engineering, emphasizing the critical aspects of mechanical behavior, surface properties, fracture mechanics, and the diverse applications of traditional and modern materials, to develop a strong understanding of the material science of various construction materials and its influence on the performance of the materials in the structure.

Prerequisite : NIL

Course Outcomes : After the completion of the course the student will be able to

CO 1	Relate the fundamentals of materials science with properties and behaviour of materials. **(Cognitive knowledge level: Understand)**
CO 2	Apply the fundamental material properties to predict the failure of elements. **(Cognitive knowledge level: Apply)**
CO 3	Explain the failure behaviour of materials under different loading conditions. **(Cognitive knowledge level: Evaluate)**
CO 4	Decide the appropriateness of a material for a specific application. **(Cognitive knowledge level: Evaluate)**
CO 5	Explains the properties of bituminous materials and its application. **(Cognitive knowledge level: Understand)**

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	1	1	2	2	1	1
CO 2	1	1	2	2	1	1
CO 3	1	1	2	2	2	1
CO 4	1	1	2	2	2	1
CO 5	1	1	2	2	2	1

Assessment Pattern

Course Name	**MODERN CONSTRUCTION MATERIALS**	
Bloom's	**Continuous**	**End Semester Examination**

Category	Internal Evaluation Tests		(% mark)
	Test 1 (% Mark)	Test 2 (% Mark)	
Remember			
Understand	40	40	40
Apply	40	40	40
Analyse	20	20	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (7 hours)

Bonds - Review of chemical bonds, states of matter, structure of materials, Movement of atoms, Development of microstructure; Surface Properties: Introduction to Surface Energy, Surface Tension, wetting, Adhesion, Adsorption, Surfactants, Capillary Rise, Colloids

MODULE 2 (7 hours)

Review of mechanical behaviour - Deformation, Stress, Strain, Hooke's Law, Stress- Strain Diagram; Response to stress – Elastic Properties, Plasticity, Yielding, Slip along atomic planes, Strain Hardening, Annealing; Response to stress - Ductile Failure, Brittle Fracture, Fatigue Failure, Creep; Probabilistic Fracture -Tensile and Compressive Strengths, Statistics of Strength; Failure theories – Uni axial (Tensile) Behaviour of a Metal, Complex Inelastic Response, Multi axial Loading, Introduction to Rankine Theory, Tresca Criterion, von Mises Theory, Mohr coulomb Failure Theory

MODULE 3 (8 hours)

Introduction to Fracture Mechanics - Stress concentration, Pure modes of fracture - Mode I or opening crack, Linear Elastic Fracture Mechanics, Brittle Ductile Transition, Brittle Fracture, Elasto-Plastic Fracture; Fracture in Polymers, Fracture in Composites, Fracture in Concrete. Rheology - Time-Dependent Material Response, Rheological Models, Rheological Behaviour of Liquids, Thixotropy; Thermal properties - Heat Capacity, Thermal Expansion, Thermal Stresses, Thermal Conductivity.

MODULE 4 (7 hours)

Metals - Structure, Properties and Applications of Iron and Steel, Aluminium; Timber - Structure of Wood, Properties of Wood, Seasoning of Timber, Engineering Properties, Thermal Properties, Applications of Timber, Wood-Based Composites; Concrete - Structure, Properties and Applications

MODULE 5 (7 hours)

Bituminous materials - Structure of Bitumen, Specification of Bitumen, Asphalt Concrete Mixtures; Polymers and Plastics - Structure, Properties and Applications; FRP - Structure, Properties and Application; Glass – Types, properties and applications, Smart and intelligent materials (shape memory alloys, piezo electric materials).

References

1. J.F. Young, S. Mindess, R.J. Gray and A. Bentur, "The Science and Technology of Civil Engineering Materials", Prentice Hall, 1998
2. W.D. Callister, "Materials Science and Engineering: An introduction", John Wiley, 1994
3. J.M. Illston and P.L.J. Domone, "Construction Materials: Their nature and behaviour", Spon Press, 2001
4. P. Kumar Mehta and Paulo J. M. Monteiro, "Concrete, Microstructure, Properties and Materials", Indian Concrete Institute, Chennai.
5. V. Raghavan, "Materials Science and Engineering: A first course", Prentice Hall, 2004
6. R.A. Higgins, "Properties of Engineering Materials", Industrial Press, 1994
7. J.M. Gere, "Mechanics of Materials", Nelson Thornes, 2001

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module 1	**7**
1.1	Introduction to the subject – Need to understand the material structure – Relationship between micro structure to macro structure behaviour	1
1.2	Bonds - Review of chemical bonds, states of matter, structure of materials	1
1.3	Movement of atoms, development of microstructure	1
1.4	Surface Properties: Introduction to Surface Energy, Surface Tension, Wetting, Adhesion	2
1.5	Surface Properties: Adsorption, Surfactants, Capillary Rise, Colloids	2
	Module 2	**7**
2.1	Review of mechanical behaviour - Deformation, Stress, Strain, Hooke's Law, Stress-Strain Diagram	1
2.2	Elastic Properties, Plasticity, Yielding, Slip Along Atomic Planes, Strain Hardening, Annealing	2
2.3	Ductile Failure, Brittle Fracture, Fatigue Failure, Creep.	1
2.4	Probabilistic Fracture -Tensile and Compressive Strengths, Statistics of Strength	1

2.5	Failure theories – Uni axial (Tensile) Behaviour of a Metal, Complex Inelastic Response, Multi axial Loading	2
	Module 3	**8**
3.1	Introduction to fracture Mechanics - Stress Concentration, Pure Modes of Fracture-Mode I or opening crack, Linear Elastic Fracture Mechanics, Brittle-Ductile Transition, Brittle Fracture, Elasto-Plastic Fracture	2
3.2	Fracture in Composites, Fracture in Concrete	2
3.3	Rheology - Time-Dependent Material Response, Rheological Models, Rheological Behaviour of Liquids, Thixotropy;	2
3.4	Thermal properties - Heat Capacity, Thermal Expansion, Thermal Stresses, Thermal Conductivity	2
	Module 4	**7**
4.1	Metals - Structure, Properties and Applications of iron, steel and aluminium	2
4.2	Timber - Structure of Wood, Properties of Wood, Seasoning of Timber,	1
4.3	Engineering Properties, Thermal Properties, Applications of Timber	1
4.4	Wood-Based Composites	1
4.5	Concrete - Structure, Properties and Applications	2
	Module 5	**7**
5.1	Bituminous materials - Structure of Bitumen, Specification of Bitumen, Asphalt Concrete Paving Mixtures	1
5.2	Polymers and Plastics - Structure, Properties and Applications	2
5.3	FRP - Structure, Properties and Applications	1
5.4	Glass – Types, Properties and Applications	1
5.5	Smart and intelligent materials (shape memory alloys, piezo electric materials)	2

Model Question Paper

QP CODE: Pages: 1

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24CE1E104B**

Course Name: MODERN CONSTRUCTION MATERIALS

Max. Marks:60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. List out any two types of chemical bonds and their influence on material properties.
2. Slip along the atomic planes affects the material behaviour. Justify the statement.
3. Explain any one rheological model. Also describe the suitability of that model for practical conditions.
4. Explain how the microstructure of concrete influences its macro behaviour.
5. Explain the application of any two smart and intelligent materials used in the construction industry. Correlate the material structure with the application

PART B

Answer any five questions. Each question carries 8 marks.

6. Elaborate on the wetting behaviour of liquids on solids. Also describe how this fundamental understanding can lead to development of new materials.
7. What is rheology? Explain the rheological parameters and their influence in the flow of liquids.
8. Explain the significance of target compressive strength and target mean strength in concrete mix design.
9. Illustrate the characteristics of bitumen and asphalt concrete. Explain why bitumen is a competitive choice as a pavement construction material.
10. Relate the properties of TMT steel with its production process. Explain why TMT steel is a better choice for buildings in earthquake prone areas.
11. Elaborate on various failure theories. Give a comparison between them in terms of confining pressure.
12. Explain the structure, properties and applications of Fibre Reinforced Plastics.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E104C	RESILIENT STRUCTURES AND SUSTAINABLE CONSTRUCTION	ELECTIVE	3	0	0	0	3

Preamble: Resilient structures and sustainable construction are complementary approaches that aim to create buildings and infrastructure that are not only environmentally responsible but also capable of withstanding and adapting to future challenges and disruptions. Integrating both concepts into the built environment is essential for creating a more resilient and sustainable future.

Prerequisite : **NIL**

Course Outcomes : After the completion of the course the student will be able to

CO 1	Understand the basic vocabulary for Sustainable Construction. **(Cognitive knowledge level: Understand)**
CO 2	Recognize fundamental concepts of energy and science of climate that defines Sustainable Construction techniques. **(Cognitive knowledge level: Understand)**
CO 3	Recognize the fundamental elements that can impact the energy efficiency of buildings. **(Cognitive knowledge level: Apply)**
CO 4	Comprehend the fundamental concepts behind green building certifications and strategies for constructing low-energy buildings. **(Cognitive knowledge level: Evaluate)**
CO 5	Formulate Infrastructure Resiliency Management Strategies. **(Cognitive knowledge level: Evaluate)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	1	1	1	1	1
CO 2	3	1	2	2	2	1
CO 3	2	-	2	3	2	1
CO 4	1	-	2	2	2	2
CO 5	3	-	3	3	3	-

Assessment Pattern

Course Name	**Resilient structures and sustainable construction**	
Bloom's	**Continuous**	**End Semester Examination**

Category	Internal Evaluation Tests		(%Marks)
	Test 1 (% Marks)	Test 2 (% Marks)	
Remember			
Understand			
Apply	40	20	30
Analyse	40	30	30
Evaluate	20	50	40
Create			

Mark distribution

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (6 hours)

Sustainability and Certification -Introduction-Motivation: Importance of sustainable construction - Sustainability, discussion on major concerns both national and international-Environmental Resources and Concerns

MODULE 2 (7 hours)

Energy, Solar, Light and Climate-Built Environment and Codes, Regulations and Certifications-Energy Basics- Renewable and Energy Efficiency Auditing

MODULE 3 (8 hours)

Energy, Solar, Light and Climate-Energy Fundamentals, Internal Loads and External Loads -Shading, Lighting, Daylight, and Electric Lighting-Climate, Microclimate, Thermal Comfort, Urban Heat Island and-Evaporative Cooling + Energy Efficiency Measures (Passive Vs. Active Strategies)

MODULE 4 (8 hours)

Sustainable Building Rating Systems-Life Cycle Assessment -Special Certifications: LBC, Net Zero and Energy Star-Water Strategies, Site, Construction Materials (Recycle/Reuse)-Indoor Environmental Quality.

MODULE 5 (7 hours)

Synergies to Sustainable Construction -Lean and Bio mimicry, Commissioning and Effective Construction Difference between Sustainability and Resilience-Horizontal Construction - Green Roads

References

1. Annie Pearce, 2012, Sustainable Buildings and Infrastructure: Paths to the Future (ISB: 0415690927)
2. Traci Rose Rider, Stacy Glass, Jessica Mc Naughton, Understanding Green building
3. Charles Kibert, 2016 Sustainable Construction: Green Building Design and Delivery (4th edition),
4. Sustainable Building –Design Manual Pt 1&2, the energy and Resource, 3rd Edition by, john Wiley
5. Sustainable Building –Design Manual Pt 1 &2, The Energy and Resources Institute, TERI 2004
6. Gopalakrishnan, Kasthurirangan and Srinivas Peeta (2010) Sustainable and ResilientCritical Infrastructure Systems: Simulation, Modeling, and Intelligent Engineering, Springer
7. Environmental Sustainability in Building Design and Construction By Xiaoming Wang, Sayanthan Ramakrishnan (2022)

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/

		Tutorial hours
	Module 1	**6**
1.1	Sustainability and Certification –Introduction- basic terms and terminologies	2
1.2	Motivation: Importance of sustainable construction –Sustainability? Defining Sustainability, discussion on major concerns both national and international;	2
1.3	Environmental Resources and Concerns	2
	Module 2	**7**
2.1	Built Environment and Codes,	2
2.2	Regulations and Certifications	2
2.3	Energy Basics, Renewable and Energy Efficiency Auditing	3
	Module 3	**8**
3.1	Energy Fundamentals, Internal Loads and External Loads	2
3.2	Shading, Lighting, Daylight, and Electric Lighting	2
3.3	Climate, Microclimate, Thermal Comfort	1
3.4	Urban Heat Island and-Evaporative Cooling + Energy Efficiency Measures (Passive Vs. Active Strategies) ,Overview of LEED Certification	3
	Module 4	**8**
4.1	Sustainable Building Rating Systems-Life Cycle Assessment	2
4.2	-Special Certifications: LBC, Net Zero and Energy Star-Water Strategies, Site, Construction Materials (Recycle/Reuse)-Indoor Environmental Quality.	2
4.3	Water Strategies, Site, Construction Materials (Recycle/Reuse)-	2
4.4	Indoor Environmental Quality, case studies	2
	Module 5	**7**
5.1	Synergies to Sustainable Construction -Lean and Bio mimicry,	2
5.2	Commissioning and Effective Construction-Difference between Sustainability and Resilience-	2
5.3	Horizontal Construction - Green Roads-case studies	3

Model Question Paper

QP CODE: Pages: 1

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24CE1E104C**

Course Name: Resilient structures and sustainable construction

Max. Marks: 60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Elaborate the concept of a 'carbon footprint' and its relevance to the construction industry.
2. List out the various challenges and barriers for implementing energy efficiency improvements identified through auditing?
3. Elucidate the concept of microclimate and its relevance to building design.
4. Write on the life cycle assessment (LCA) and its importance in sustainable construction.
5. Discuss how the concept of biomimicry promotes sustainable construction.

PART B

Answer any five questions. Each question carries 8 marks.

6. a. Examine the significance of sustainable construction in reducing the effects of climate change.
   b. Elaborate on primary environmental resources that are affecting construction activities?
7. a. Traditional construction methods differ from sustainable construction practices. Justify
   b. What are the key indicators used to measure sustainability in construction projects?
8. Discuss the strategies for optimizing shading, daylighting, and electric lighting in building design. How can these strategies contribute to energy efficiency and occupant comfort?
9. Compare and contrast sustainability and resilience in the context of construction. Discuss their respective goals, strategies, and importance in addressing environmental challenges and societal needs.
10. a. Discuss the different levels of LEED certification and the criterias.
    b. Evaluate the effectiveness of active energy efficiency technologies in reducing building energy consumption.
11. a. Compare the requirements and goals of LBC, Net Zero, and Energy Star certifications.
    b. What are some effective water management strategies for sustainable buildings?
12. Elaborate how lean construction principles contribute to sustainability in the built environment.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E104D	CONSTRUCTION CONTRACTS, METHODS AND EQUIPMENTS	ELECTIVE	3	0	0	3	3

Preamble: The course provides a detailed overview of the characteristics of contracts in accordance with the Indian Contract Act. Students will also explore laws pertaining to dispute resolution, insurance, and bonds within a construction project. Additionally, the course provides an insight on the construction methods and the latest equipment utilized for the efficient execution of contemporary construction projects

Prerequisite : NIL

Course Outcomes : After the completion of the course the student will be able to

CO1	Comprehend the various elements and requirements of contracts, empowering individuals to draft contracts in compliance with the Indian Contract Act. **(Cognitive Knowledge Level : Apply)**
CO2	Prepare tender documents for different projects and apply the acquired knowledge to resolve various disputes arising at different stages in construction project **(Cognitive Knowledge Level : Apply)**
CO3	Formulate diverse risk management strategies addressing the distinct conditions observed in various construction project **(Cognitive Knowledge Level : Analyse)**
CO4	Assess the current construction methods and their application in the construction industry, and to implement them effectively in various construction projects. **(Cognitive Knowledge Level : Evaluate)**
CO5	Apply the various equipments suitably in construction projects, assessing their capabilities in the construction sector. **(Cognitive Knowledge Level : Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	2	2	1	1	1
CO 2	2	2	2	1	1	2
CO 3	2	2	2	1	1	2
CO 4	1	2	2	1	2	1
CO 5	1	2	2	2	2	1

Assessment Pattern

Course Name	**Construction Contracts Methods and Equipment**	
Bloom's Category	**Continuous Internal Evaluation Tests**	**End Semester**

	Test 1 (%)	Test 2(%)	Examination (%)
Remember			
Understand	15	15	15
Apply	40	40	40
Analyse	35	35	35
Evaluate	10	10	10
Create			

Mark distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	40	60	3Hours

Continuous Internal Evaluation Pattern

Seminar* : 10marks

Course based task/Micro Project//Data Collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (7 hours)

Contracts: Requirement of Contract- Elements of Contracts based on Indian Contract Act (1872)- Types of Contracts based on Stakeholder responsibilities, Project Delivery Models (Turnkey, EPC and

PPP Models), Standard forms of contract (FIDIC, NHAI and CPWD) - General conditions of the contract for construction- Understanding of Major Parts of Contract – Agreement, Conditions, Specifications, BOQ and Drawings- Case studies

MODULE 2 (8 hours)

Contract Administration: Project Documentation- Submission and approval of documents- Permits and approvals Tendering and Bidding: Types of tenders- Tendering procedure – Notice Inviting Tender (NIT), stages of tendering, E-tendering, Bid/No bid analysis, Preparation and submission of bids, Two package system, Multi-criteria bid evaluation system, tenders for LCB, NCB and ICB, Rights and obligations in tendering, Pre-bid conference and site surveys- Acceptance of Tender Offer; Negotiation; Award of Contract; contract signing. Case Studies of Tendering process.

Construction claims and disputes- Potential major claim areas- Bid Proposal Process and Potential for Disputes- Modes of resolving disputes- Understanding of The Limitation Act, Arbitration and Conciliation Act 1996 with latest amendments

MODULE 3 (7 hours)

Contract Management: Discharge of contract- Breach of contract- Tendering issues- Risks in construction contract- Regulatory aspects and ethics- Intellectual property act- Law of Torts- General Construction specifications - Commercial Construction Specifications.

Bonds: Types of Bonds – Insurance: Workers compensation Insurance- Commercial general liability insurance- Builders Risk insurance.

MODULE 4 (7 hours)

Construction Methods: Horizontal Systems – Hand - set slab forms, Table forms, Vertical Systems – Wall forms, Column forms, Combined Horizontal and Vertical Systems – Tunnel Form Systems, Trench Safety. Cost effective construction methods - Prestressed concrete construction - 3D printing. Precast Flat Panel System-3D Volumetric Construction-Flat Slabs-Hybrid Concrete Construction-Precast Foundations-Insulating Concrete Formwork-Soil stabilisation methods.

MODULE 5 (**7 hours**)

Construction Equipment: Dozers and graders, Scrapers, hydraulic excavators, Draglines and Clamshells. Tower cranes, Passenger hoists.

Concreting equipment - Crushers – feeders – screening equipment – batching and mixing equipment

– Batching plants- hauling, pouring and pumping equipment- concrete pumps – transporters. Equipment for compaction- Pneumatic Tired Rollers, Impact Compactors, Compaction Wheels, Intelligent compaction. Trucks and Hauling Equipments - Capacities of Trucks and Hauling Equipment– Calculation of truck productivity.

References

1. Indian Contract Act (1872)
2. Sidney M. Levy –"Project Management in Construction, 7th Edition", 2018 McGraw-HillEducation.
3. Richard Lambeck and John Eschemuller- "Urban Construction Project Management",2009 The McGraw-Hill Companies, Inc.
4. Donald L. Marston, J.D., P.Eng "Law for Professional Engineers: Canadian and GlobalInsights", 5th Edition.
5. David A. Madsen "Commercial Building Construction: Materials and Methods", 1st Edition.
6. Clifford J. Schexnayder, Christine M. Fiori, "Handbook for Building Construction: Administration, Materials, Systems, and Safety", 1st Edition, 2021 McGraw Hill.
7. Construction Planning, Equipment, and Methods, 9th Edition, 2018 McGraw-Hill Education.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/Tutorial hours
	Module 1	**7**
1.1	Requirements of Contract	1
1.2	Elements of Contract based on ICA	1
1.3	Types of contracts based on stakeholder responsibilities	1
1.4	Project delivery models - Turnkey model, EPC model, PPP model	1
1.5	Standard forms of contract – FIDIC, NHAI, CPWD	1
1.6	General conditions of the contract for construction-Understanding of Major Parts of Contract – Agreement, Conditions, Specifications, BOQ and Drawings- Case studies	2
	Module 2	**8**
2.1	Project Documentation- Submission and approval of documents- Permits and approvals	1

2.2	Tendering and Bidding: Types of tenders- Tendering procedure – Notice Inviting Tender (NIT), stages of tendering, E-tendering,	1
2.3	Bid/No bid analysis, Preparation and submission of bids, Two package system, Multi-criteria bid evaluation system, tenders for LCB, NCB and ICB, Rights and obligations in tendering,	1
2.4	Pre-bid conference and site surveys- Acceptance of Tender Offer; Negotiation; Award of Contract; contract signing. Case Studies of Tendering process.	2
2.5	Construction claims and disputes- Potential major claim areas	1
2.6	The Bid Proposal Process and the Potential for Disputes, Modes of resolving disputes	1
2.7	Understanding of The Limitation Act, Arbitration and Conciliation Act 1996 with latest amendments	1
	Module 3	**7**
3.1	Discharge of contract, Breach of contract, Tendering issues	1
3.2	Risks in construction contract, Regulatory aspects and ethics, Intellectual property act, Law of Torts	1
3.3	General Construction Specifications, Commercial Construction Specifications	2
3.4	Bonds, Types of Bonds	1
3.5	Insurance, Workers compensation Insurance, Commercial general liability insurance, Builders risk insurance	2
	Module 4	**7**
4.1	Horizontal systems-Hand-Set slab form, Table forms, Vertical Systems-Column form-Wall forms	1
4.2	Combined Horizontal and vertical Systems-Tunnel form systems, Trench safety	1
4.3	Cost effective Construction Methods-Prestressed Concrete Construction-3 D Printing	1
4.4	Precast Flat Panel System-3D Volumetric, Flat Slab, Hybrid Concrete Construction	1
4.5	Precast Foundations, Insulating Concrete Formwork	1
4.6	Soil Stabilization Methods	2

	Module 5	**7**
5.1	Dozers and graders, Scrapers, hydraulic excavators, Draglines and Clamshells. Tower cranes, Passenger hoists.	2
5.2	Concreting equipment - Crushers – feeders – screening equipment – batching and mixing equipment – Batching plants- hauling, pouring and pumping equipment- concrete pumps – transporters.	2
5.3	Equipment for compaction- Pneumatic Tired Rollers, Impact Compactors, Compaction Wheels, Intelligent compaction	1
5.4	Trucks and Hauling Equipment - Capacities of Trucks and Hauling Equipment – Calculation of truck productivity	2

Model Question Paper

QP CODE: Pages:1

RegNo.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION,DECEMBER 2024

CourseCode:M24CE1E104D

Course Name: Construction Contracts Methods and Equipment

Max.Marks:60 Duration:3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. As per Indian Contract Act, explain the term 'Competency of Parties'.
2. List out the roles and responsibilities assigned to an arbitrator.
3. Describe the different ways by which a contract can be discharged?
4. Differentiate between 3D volumetric and tunnel form of construction.
5. Illustrate the operating principle of a clam shell with a neat sketch.

PART B

Answer any five questions. Each question carries 8 marks.

6. "All agreements are not contracts." Justify the statement as per Indian Contract Act.
7. In the context of the arbitration act ,write on appointment and removal of arbitrators State and explain the laws related to workmen's compensation act.
8. Elaborate in detail the types of specifications and standards used in construction projects.
9. Elucidate the various methods used for soil stabilisation.
10. Assess several types of cost-effective construction methods.
11. List the different compaction equipment with neat sketches and assess the suitability of each equipment.
12. For a project involving site grading, earthmoving, and concrete placement, select suitable dozers, graders, hydraulic excavators, and compaction equipment. Justify your choices and calculate the productivity of trucks and hauling equipment based on their capacity and haul distance.

PROGRAMME ELECTIVE II

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E105A	STRUCTURAL DYNAMICS	ELECTIVE	3	0	0	3	3

Preamble: The course provides the concepts of structural dynamics and focus on analysis of single and multi-degree freedom systems. This includes introduction to mass distributed systems and earthquake analysis of structures.

Prerequisite **:** Mechanics of Solids and Structural Analysis

Course Outcomes **:** After the completion of the course the student will be able to

CO 1	Model single degree freedom systems for dynamic analysis and develop equations of motion. **(Cognitive knowledge level: Apply)**
CO 2	Perform dynamic analysis of single degree freedom systems. **(Cognitive knowledge level: Analyze)**
CO 3	Model multi degree freedom systems for dynamic analysis and develop equations of motion. **(Cognitive knowledge level: Apply)**
CO 4	Perform dynamic analysis of multi - degree freedom systems. **(Cognitive knowledge level: Analyze)**
CO 5	Perform dynamic analysis of mass distributed parameter systems.**(Cognitive knowledge level: Analyze)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	2	2	1	2	1
CO 2	2	2	2	1	2	1
CO 3	2	2	2	1	2	1
CO 4	1	2	1	1	2	1
CO 5	1	2	1	1	2	1

Assessment Pattern

Course Name	STRUCTURAL DYNAMICS		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	20	20	20
Apply	40	30	40
Analyse	40	50	40
Evaluate			
Create			

Mark distribution:

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (7 hours)

Vibration studies and its importance to structural engineering applications – Types of dynamic loading – Systems with single degree of freedom – Elements of a vibratory system – Mathematical model for single degree of freedom systems - Equation of motion. Undamped and damped free vibration of a single degree of freedom system. Measurement of damping from free vibration response - Logarithmic decrement.

MODULE 2 (9 hours)

Response of single degree of freedom systems to harmonic loading, Measurement of damping from forced response – Half power band-width method. Impulse response function, Response of single degree of freedom systems subjected to impulse, periodic and general loading- Duhamel integral. Single degree freedom subjected to support motion. Vibration isolation –Transmissibility.

MODULE 3 (7 hours)

Multi-degree of freedom systems – Equation of motion. Shear building concept and models for dynamic analysis –Evaluation of natural frequencies and mode shapes by solution of characteristic equation. Co-ordinate coupling - Orthogonality of normal modes.

MODULE 4 **(6 hours)**

Forced vibration analysis of multi-degree of freedom systems - Mode superposition method of analysis. Response of multi degree of freedom systems to support motion.

MODULE 5 (7 hours)

Distributed mass (continuous) systems – differential equation of motion – Axial vibration of rods. Flexural vibration of beams, natural frequencies and mode shapes of simply supported beams. Evaluation of frequencies and mode shapes of cantilever beam and fixed beam (formulation only) – Variational formulation of the equation of motion – Hamilton's principle - Lagrange's equation.

References

1. Anil K Chopra, "Dynamics of Structures- Theory and Application to Earthquake Engineering", Pearson Education, New Delhi, 5th edition, 2017.
2. Mukhopadhyay M, "Structural Dynamics - Vibrations and Systems", Ane Books India, Delhi, first edition, 2008.

3. Clough R W and Penzien J, “Dynamics of Structures”, McGraw Hill, New Delhi, 2nd edition, 1993.
4. Mario Paz, “Structural Dynamics – Theory and Computation”, CBS Publishers and Distributors, Delhi, 4th edition, 2004.
5. Weaver W, Timoshenko S P, and Young D H, “Vibration Problems in Engineering”, John Wiley and Sons, USA, 4th edition, 1990.
6. "Fundamentals of Structural Dynamics" by Roy R. Craig and Andrew J. Kurdila, 3rd edition, 2021.
7. "Structural Dynamics: Concepts and Applications" by Paul A. Kurowski, first edition, 2000.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module 1	**7**
1.1	Vibration studies and its importance to structural engineering applications – Types of dynamic loading – Systems with single degree of freedom – Elements of a vibratory system – Mathematical model for single degree of freedom systems - Equation of motion.	3
1.2	Undamped and damped free vibration of single degree of freedom system.	2
1.3	Measurement of damping from free vibration response - Logarithmic decrement.	2
	Module 2	**9**
2.1	Response of single degree of freedom systems to harmonic loading, Measurement of damping from forced response – Half power band width method.	3
2.2	Impulse response function, Response of single degree of freedom systems subjected to impulse (rectangular, triangular and half sine wave), periodic and general loading- Duhamel integral.	3
2.3	Single degree freedom subjected to support motion.	2
2.4	Vibration isolation –Transmissibility	1
	Module 3	**7**
3.1	Multi-degree of freedom systems – Equation of motion.	2

3.2	Shear building concept and models for dynamic analysis – Evaluation of natural frequencies and mode shapes by solution of characteristic equation.	4
3.3	Co-ordinate coupling - Orthogonality of normal modes.	1
	Module 4	**6**
4.1	Forced vibration analysis of multi-degree of freedom systems - Mode superposition method of analysis.	3
4.2	Response of multi degree of freedom systems to support motion.	3
	Module 5	**7**
5.1	Distributed mass (continuous) systems – differential equation of motion – Axial vibration of rods.	2
5.2	Flexural vibration of beams, natural frequencies and mode shapes of simply supported beam. Evaluation of frequencies and mode shapes of cantilever beam and fixed beam (formulation only).	3
5.3	Variational formulation of the equation of motion – Hamilton's principle - Lagrange's equation.	2

Model Question Paper

QP CODE: Pages: 3

Reg. No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: M24CE1E105A

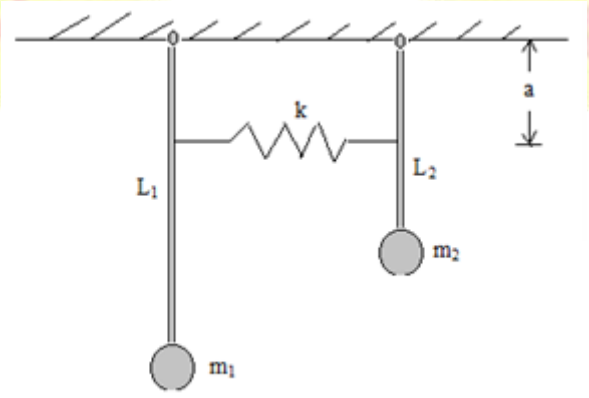
Course Name: STRUCTURAL DYNAMICS

Max. Marks: 60 Duration: 3 hours

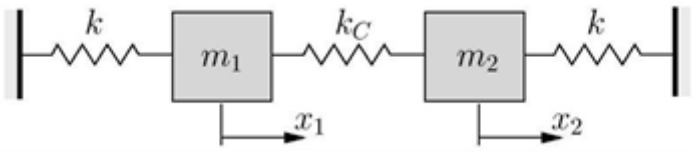
PART A

Answer all questions. Each question carries 4 marks.

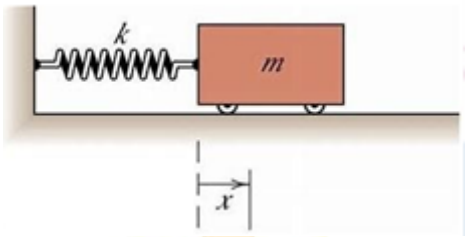
1. Calculate the natural frequency of transverse vibrations of a cantilever beam 40mm diameter circular cross section, carrying a load of 500N at the free end. Span of the cantilever is 800mm. E = 200GPa. If a spring of stiffness 52.75kN/m is introduced between the mass and the beam, calculate the change in natural frequency.
2. A sieving machine weighs 2500 kg and when operating at full capacity, it exerts a harmonic force of 3kN amplitude at 20 Hz on its supports. After mounting the machine on spring type vibration isolators, it was found that the harmonic force exerted on the supports had been reduced to a 250N amplitude. Determine the stiffness of the isolator springs. Take ζ = 10%.
3. Two pendulum bobs are suspended from the ceiling using massless rigid bars and the bars are connected using a spring as shown in figure. Derive the equation of motion for small oscillations. Write down the mass and stiffness matrices of the system. Take m_1 = 2.0kg, m_2 = 1.5kg, L_1 = 1.5m, L_2 = 1.0m, a = 0.5m, k = 150N/m.



4. Establish the equation of motion for the frame shown in figure, if it is subjected to a suddenly applied constant acceleration 0.28g at its base. Take m_1 = 10kg, m_2 = 20kg, k = 1500N/m, k_c = 2000N/m.



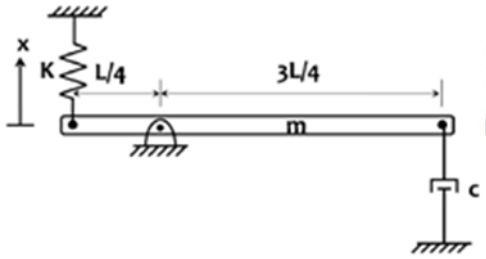
5. Obtain the equation of motion of a SDOF system shown in figure using Lagrange's equation. Take m = 10 kg and k = 5000N/m.



PART B

Answer any five questions. Each question carries 8 marks.

6. Determine the parameters in an equivalent model of the system as shown in the figure when θ, the clockwise angular displacement of the bar from the system's equilibrium position, is used as a generalized coordinate. Assume small θ.



7. One of the construction companies hires you to determine the dynamic properties of a frame system for which it has lost the original blueprints. Being a civil engineer, you were assigned to do a free vibration test of the frame system. Supplied with a hydraulic jack, you were able to apply a jacking force to displace the frame. With a jacking force of 134kN, you noted down that the frame has displaced 0.76cm. On the first return swing after release, the frame did not come back to the release point but rather it stopped at 0.64cm towards it. You recorded time between the release and the first return as 2s. Determine the following;

    a. Weight of the frame

b. Natural frequency

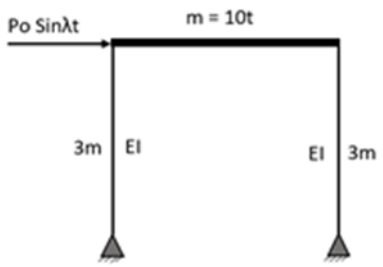
c. Logarithmic decrement

d. Damping ratio

e. Damping frequency

f. Amplitude of the frame after 6 cycles

8. A frame is subjected to harmonic loading as shown in figure. If Po = 20kN, calculate the dynamic amplification factor and amplitude of steady state response for the following cases. (i) λ = 10rad/s, (ii) λ = 15rad/s, (iii) λ = 20rad/s. Comment on the results. Take ζ = 5% and EI = 1010kNmm^2.



9. Derive the expression for the response of a SDOF system subjected to a rectangular impulse of duration t_1 and magnitude P_0.
10. State and prove the orthogonality condition of normal modes in a MDOF system.
11. Explain mode superposition method of analysis.
12. Derive the differential equation governing the flexural vibration of beams. How will you find the undamped free vibration solution? Demonstrate for a simply supported beam of span L having uniform flexural rigidity EI and m mass per unit length.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E105B	ADVANCED STRUCTURAL ANALYSIS	ELECTIVE	3	0	0	3	3

Preamble: The course explores the sophisticated methods and principles for analyzing complex structural systems. Students acquire knowledge in advanced techniques for evaluating structural components, stability, stiffness, and load-bearing capacities, equipping them with essential skills for tackling real-world engineering challenges.

Prerequisite : Mechanics of Solids, Structural Analysis

Course Outcomes : After the completion of the course the student will be able to

CO1	Master the fundamentals of structural analysis and apply these concepts to classify and analyze structures. **(Cognitive Knowledge Level-Understand)**
CO2	Develop comprehensive skills in structural analysis using stiffness and direct stiffness methods. (**Cognitive Knowledge Level-Apply)**
CO3	Analyse the rigid and pin-jointed beams, frames and trusses using the flexibility method. (**Cognitive Knowledge Level-Analyse)**
CO4	Analyze the effects of axial force on the flexural stiffness of braced and unbraced beam-columns under axial compression. (**Cognitive Knowledge Level-Analyze)**
CO5	Evaluate the prismatic beam-columns using slope deflection method and stability functions. (**Cognitive Knowledge Level-Evaluate)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	1	2	2	1	1
CO 2	2	1	2	2	2	2
CO 3	2	1	2	2	2	2
CO 4	2	1	2	1	2	2
CO 5	2	1	2	1	2	2

Assessment Pattern

Course Name	Advanced Structural Analysis		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (% marks)
	Test 1 (% marks)	Test 2 (% marks)	
Remember			
Understand	20		10
Apply	30	40	30
Analyze	40	40	40
Evaluate	10	20	20
Create			

Mark distribution:

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (5 Hours)

Overview of fundamental principles in structural analysis: Basic structural components, connections, and supports; Internal Hinge characteristics; Stability, stiffness, and static and kinematic indeterminacy; Types of loads; Equilibrium equations; Compatibility conditions; Force-displacement relationships; Classification of structures; Nodes and degrees of freedom; Coordinate systems; Boundary conditions; Direction cosines; Member Stiffness Matrix concept; Member Flexibility Matrix concept.

MODULE 2 ((8 Hours)

Stiffness method: Element stiffness matrix analysis of pin jointed frames (temperature effect, lack of fit), continuous beams (settlement of supports), rigid jointed frames and grids.

MODULE 3 (7 Hours)

Direct stiffness approach: Structure stiffness matrix, assembly, equivalent joint load, incorporation of boundary conditions, solutions, Gauss elimination, analysis of pin jointed frames, continuous beams, and frames.

MODULE 4 (8 Hours)

Flexibility method: Element Flexibility matrix, truss element, beam element, force transformation matrix, analysis of pin jointed and rigid jointed structures (including support movements) analysis of plane grid.

MODULE 5 (8 Hours)

Analysis of Elastic Instability and Second–Order Effects: Effects of axial force on flexural stiffness: Review of buckling of ideal columns flexural behavior and stiffness measures for beam-columns - braced and unbraced, under axial compression. The stiffness matrix for prismatic beam-column element; estimation of critical elastic buckling loads; second-order analysis

References

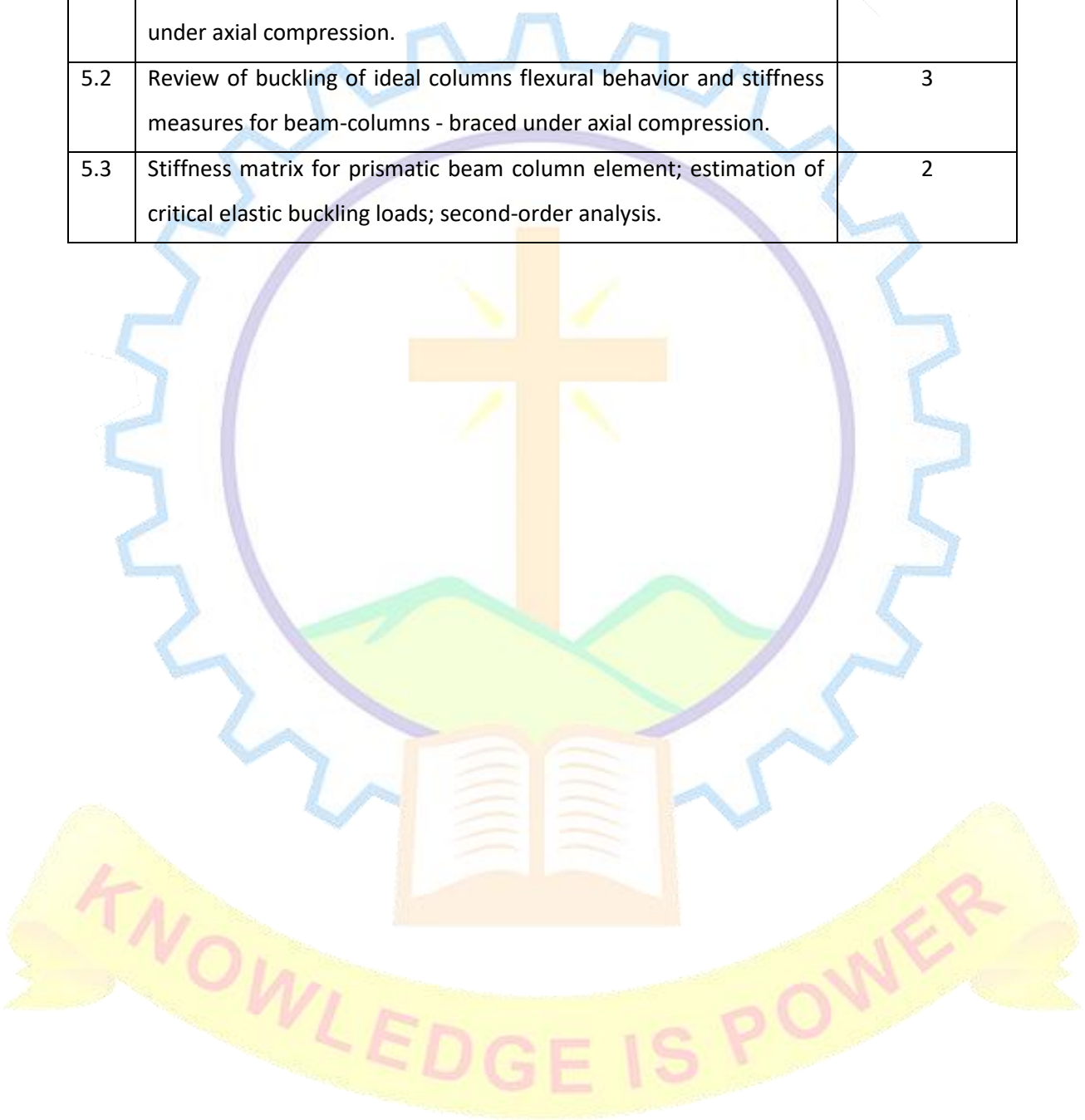
1. Devdas Menon,"Advanced StructuralAnalysis", Narosa Publishing House, 2009.
2. Devdas Menon,"StructuralAnalysis", Narosa Publishing House, 2008.
3. Basic Structural Analysis: Wilbur and Norris, first edition, 1971.
4. Basic Structural Analysis by C S Reddy, first edition, 2004.
5. Matrix Methods for structural engineering.by Gere, Weaver.

6. Structural Analysis by R.C. Hibbeler, 10th edition, 2016.
7. Advanced Structural Analysis by Praveen Nagarajan, first edition, 2010.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module I	**5**
1.1	Basic structural components, connections, and supports; Internal Hinge characteristics; Stability, stiffness, and static and kinematic indeterminacy	1
1.2	Types of loads; Equilibrium equations; Compatibility conditions; Force-displacement relationships; Classification of structures; Nodes and degrees of freedom; Coordinate systems; Boundary conditions; Direction cosines;	2
1.3	Member Stiffness Matrix concept; Member Flexibility Matrix concept.	2
	Module 2	**8**
2.1	Element stiffness matrix analysis of pin jointed frames (temperature effect, lack of fit). Element stiffness matrix analysis of continuous beams (settlement of supports)	2
2.2	Element stiffness matrix analysis of continuous beams (settlement of supports)	2
2.3	Element stiffness matrix analysis of rigid jointed frames and grids.	4
	Module 3	**7**
3.1	Direct stiffness approach: Structure stiffness matrix, assembly, equivalent joint load, incorporation of boundary conditions, solutions, Gauss elimination.	3
3.2	Direct stiffness approach: Analysis of pin jointed frames.	2
3.3	Direct stiffness approach: Analysis of continuous beams, and frames.	2
	Module 4	**8**
4.1	Element Flexibility matrix, truss element, beam element, force transformation matrix.	3
4.2	Analysis of pin jointed and rigid jointed structures (including support movements).	3

4.3	Analysis of plane grid.	2
	Module 5	**8**
5.1	Analysis of Elastic Instability and Second –Order Effects: Effects of axial force on flexural stiffness: Review of buckling of ideal columns flexural behavior and stiffness measures for beam-columns unbraced under axial compression.	3
5.2	Review of buckling of ideal columns flexural behavior and stiffness measures for beam-columns - braced under axial compression.	3
5.3	Stiffness matrix for prismatic beam column element; estimation of critical elastic buckling loads; second-order analysis.	2



Model Question Paper

QP CODE: Pages: 2

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: M24CE1E105B

Course Name: Advanced Structural Analysis

Max. Marks:60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Compare and contrast pin-jointed frames and rigid frames, demonstrating understanding through examples.
2. Analyze the impact of lack of fit in pin-jointed truss analysis, applying knowledge of structural analysis principles to evaluate its effects on truss stability and member forces.
3. Apply the flexibility method to determine the deflection at the free end of a cantilever beam with a length of '2L' and a center point load.
4. Describe the concept of slope deflection equations for prismatic beam columns, highlighting the role of stability functions in their formulation and application.
5. Given a prismatic beam-column with length L, flexural rigidity EI, and axial load P, use the slope deflection equations to determine the moments at the ends of the beam-column for pinned and guided-fixed-end conditions.

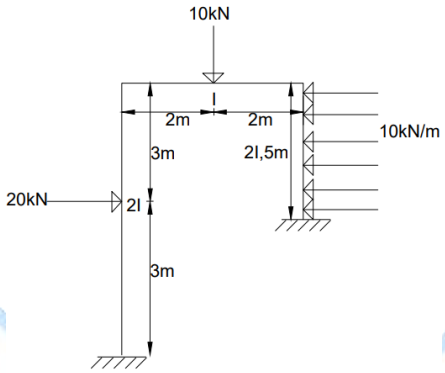
PART B

Answer any five questions. Each question carries 8 marks.

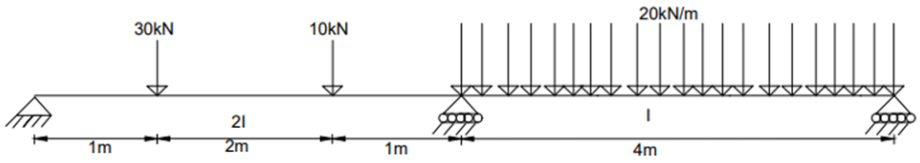
6. a. Elaborate how the member stiffness matrix concept is utilized in the analysis of complex structural systems. (4 Marks)

   b. Calculate the member stiffness matrix for a simple beam element, given its material properties and geometric characteristics. (4 Marks)

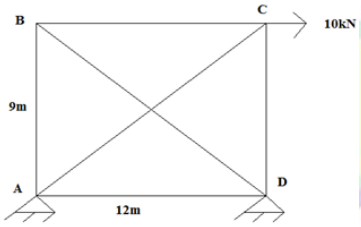
7. Analyze the structure using the element stiffness approach.



8. Illustrate the application of the flexibility matrix method in analyzing a real-world plane grid structure. What considerations need to be considered when using this method for practical structural analysis?
9. Analyze the continuous beam shown below using the direct stiffness method.



10. Analyze the truss using flexibility method.



11. a. Using the principles of second-order analysis, determine the critical buckling load for a column

based on its length, material properties, and specified boundary conditions. (4 Marks)

b. Analyze the impact of P-delta effects in second-order analysis on structural stability and design, demonstrating understanding through examples to illustrate how these effects influence the behavior of structures under various loading conditions. (4 Marks)

12. Derive the slope deflection equations for prismatic beam columns using stability functions, including modifications for pinned and guided-fixed-end conditions.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E105C	ADVANCED DESIGN OF STEEL STRUCTURES	ELECTIVE	3	0	0	3	3

Preamble: The course provides an in-depth study of limit state design, encompassing tension and compression members, welded and bolted connections, industrial buildings, light gauge structures, and structures resistant to blast, impact, snow, and fire loads, emphasizing practical design principles and analysis methods for various structural components and systems.

Prerequisite : Mechanics of Solids, Design of Steel Structures

Course Outcomes : After the completion of the course the student will be able to

CO 1	Comprehend the principles of limit state design to various members and analyze and design welded connections (**Cognitive Knowledge Level: Analyze)**
CO 2	Analyze and design bolted connections(**Cognitive Knowledge Level: Apply)**
CO 3	Design members subjected to lateral loads and axial loads and design light guage structures (**Cognitive Knowledge Level: Apply)**
CO 4	Design structures to resist blast, impact, and fire loads, (**Cognitive Knowledge Level: Apply)**
CO 5	Design industrial buildings and gantry girders(**Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	2	2	2	2	1
CO 2	1	2	2	2	2	1
CO 3	1	2	2	2	2	1
CO 4	2	2	2	2	2	2
CO 5	2	2	2	2	2	1

Assessment Pattern

Course Name	Advanced Design of Steel Structures		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (% Marks)
	Test 1 (% Marks)	Test 2 (% Marks)	
Remember			
Understand	10	10	10
Apply	50	50	50
Analyze	40	40	40
Evaluate			
Create			

Mark distribution:

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern :

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (7 hours)

Limit state design: Review: Tension members, compression members and laterally supported and unsupported beams; bolted and welded connections subjected to in-plane and out of plane loading; splice connections.

Welded Connections: Structure and properties of weld metal. Beam-to-column connections and angle seat, Stiffened beam seat connection and web angle and end plate connections and Beam and column welded splices, Tubular connections and Parameters of an in-plane joint. Welds in tubular joints and curved weld length at intersection of tubes and SHS and RHS tubes and design parameters and Weld defects.

MODULE 2 (7 hours)

Bolted Connections: Classification (Simple, Rigid, Semi rigid), Moment rotation characteristics Failure modes of a joint, Types of bolts, Bearing and High strength bolts Prying force, Beam to Column connections, Design of seat angle Unstiffened, Design of seat angle Stiffened Web angle & end plate connections, Beam and column bolted splices Design of framed beam connection continuous beam to beam connection.

MODULE 3 (8 hours)

Design of members subjected to lateral loads and axial loads – Principles of analysis and design of industrial buildings and bents – Crane gantry girders and crane columns – Bracing of industrial buildings and bents - Introduction – Shape factors – Moment redistribution Static, Kinematic and uniqueness theorems – Combined mechanisms – Analysis Portal frames. Method of plastic moment distribution – Connections, moment resisting connections.

Design of Light Gauge Structures: Design of light gauge steel structures: Introduction, Types of cross sections, Local and post buckling of thin elements, Stiffened and multiple stiffened compression elements, Tension members, Beams and deflection of beams Combined stresses and connections.

MODULE 4 (6 hours)

Design of Blast, Impact, Snow and Fire-resistant structures: Blast loads, impact loads, Ice-infested loads on structures, Fire loads, Fire-resistant design, Simple problems in Fire loads calculations. Design of Low-rise multi-storey building steel structure for housing, with and without interior walls and partitions. Planning and structural framing.

MODULE 5 (8 hours)

Design of Industrial buildings and Gantry girders: Design of members subjected to lateral loads and axial loads sway and non-sway frames, bracings, and bents Rigid frame joints Knees for rectangular frames and pitched roofs - Knees with curved flanges, Valley joints - Rigid joints in multistory buildings, Vierendeel girders. Design of gantry girders, Introduction, Loading consideration, Selection of gantry girder, Position of moving load for maximum effects, profile of gantry girder, limitation on vertical deflection, Design of gantry girders.

References:

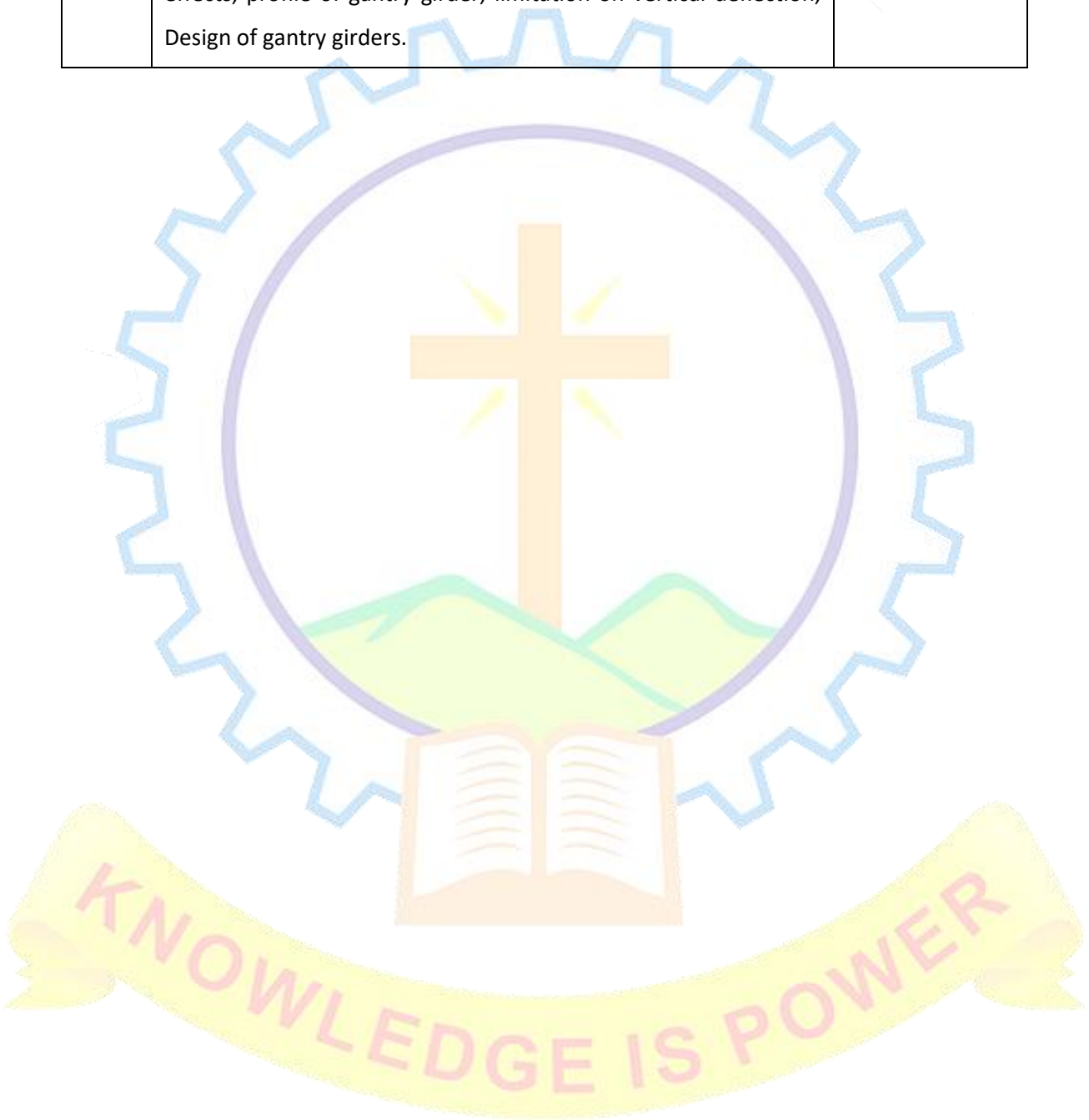
1. Punmia B. C., Jain A. K. and Jain A. K., "Design of Steel Structures", Laxmi Publications (P)
2. S. K. Duggal, Design of Steel Structures.
3. Bhavikatti S. S., "Design of Steel Structures: By Limit State Method as Per IS: 800-2007".
4. Srinivasan Chandrasekaran, "Advanced Design of Steel Structures".
5. Ramchandra S and Virendra Gehlot, "Design of Steel Structures Vol. II", Standard Book
6. N.Subramanian, "Steel Structures", Oxford Publication
7. P. Dayaratnam., "Design of Steel Structures", Wheeler Publishing, 2003
8. IS 800 – 2007, "Code of practice for Structural steel design", BIS
9. IS:875-Part 3-2015 "Design loads for buildings Part 3: Wind loads", BIS

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module 1	**7**
1.1	Review: Tension members, compression members and laterally supported and unsupported beams.	2
1.2	Bolted and welded connections subjected to in-plane and out of plane loading; splice connections.	1
1.3	Structure and properties of weld metal. Beam-to-column connections and Angle seat.	1
1.4	Stiffened beam seat connection and Web angle and end plate connections and Beam and column welded splices	1
1.5	Tubular connections and Parameters of an in-plane joint	1
1.6	Welds in tubular joints and curved weld length at intersection of tubes and SHS and RHS tubes and design parameters and Weld defects.	1
	Module 2	**7**

2.1	Classification (Simple, Rigid, Semi rigid)	1
2.2	Moment rotation characteristics, Failure modes of a joint, Types of bolts, Bearing and High strength bolts Prying force, Beam to Column connections,	2
2.3	Design of seat angle- Unstiffened	1
2.4	Design of seat angle Stiffened Web angle & end plate connections, Beam and column bolted splices	2
2.5	Design of framed beam connection continuous beam to beam connection.	1
	Module 3	**8**
3.1	Principles of analysis and design of Industrial buildings and bents	1
3.2	Principles of analysis and design – Crane gantry girders and crane columns – Bracing of industrial buildings and bents.	2
3.3	Introduction – Shape factors – Moment redistribution Static, Kinematic and uniqueness theorems – Combined mechanisms – Analysis Portal frames. Method of plastic moment distribution – Connections, moment resisting connections.	2
3.4	Design of light gauge steel structures: Introduction, Types of cross sections, Local and post buckling of thin elements.	1
3.5	Stiffened and multiple stiffened compression elements, Tension members, Beams and deflection of beams Combined stresses and connections.	2
	Module 4	**6**
4.1	Blast loads, impact loads, Ice-infested loads on structures, Fire loads	2
4.2	Fire-resistant design, Simple problems in Fire loads calculations.	2
4.3	Design of Low rise multi-storey building steel structure for housing, with and without interior walls and partitions. Planning and structural framing	2
	Module 5	**8**
5.1	**Design of Industrial buildings and Gantry girders:** Design of members subjected to lateral loads and axial loads Sway and non-sway frames, bracings, and bents.	3
5.2	Rigid frame joints Knees for rectangular frames and pitched roofs	2

	- Knees with curved flanges, Valley joints - Rigid joints in multistory buildings, Vierendeel girders.	
5.3	Design of gantry girders, Introduction, Loading consideration, Selection of gantry girder, Position of moving load for maximum effects, profile of gantry girder, limitation on vertical deflection, Design of gantry girders.	3



Model Question Paper

QP CODE: Pages: 2

Reg. No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: M24CE1E105C

Course Name: ADVANCED DESIGN OF STEEL STRUCTURES

Max. Marks:60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Apply the principles of limit state design to distinguish between tension and compression members, and utilize knowledge of weld metal properties in designing welded connections.
2. Identify the factors that influence the moment-rotation characteristics and failure modes of bolted joints.
3. Outline the considerations for designing light gauge steel structures to prevent local and post-buckling.
4. Analyze how blast, impact, snow, and fire loads influence the design of structures, and propose strategies to mitigate these effects.
5. Elucidate the process of designing gantry girders and industrial buildings to manage lateral and axial loads.

PART B

Answer any five questions. Each question carries 8 marks.

6. Design a tension member made of a steel flat section subjected to an axial tensile force of 200 kN. The member length is 3 meters. Assume the steel grade is Fe410 and use the limit state design method to determine the required cross-sectional area and size of the flat section. Provide necessary calculations and justify your choices with appropriate figures.
7. Design a welded beam-to-column connection for a steel frame structure. The beam carries an end moment of 40 kNm and a shear force of 60 kN. Use E70 electrodes and assume the column is an ISHB 300 section. Provide a detailed design of the weld size and length,

including necessary calculations and a sketch of the connection.

8. Design a bolted beam-to-column end-plate connection for a steel frame. The beam is an ISMB 400 and the column is an ISHB 450. The connection must resist a moment of 50 kNm and a shear force of 80 kN. Use M20 bolts of grade 8.8. Provide a detailed design, including bolt arrangement, end-plate thickness, and a sketch of the connection with dimensions.
9. Analyse the moment-rotation characteristics and failure modes of a semi-rigid bolted joint in a steel structure. The joint consists of an end-plate connection with 4 bolts (M16, grade 8.8). Discuss how the bolt pretension, connection geometry, and material properties influence the joint's behavior.
10. Design a light gauge steel C-section beam for a span of 4 meters subjected to a uniformly distributed load of 2 kN/m. Ensure that local and post-buckling behavior is considered in your design. Provide detailed calculations, selection of the C-section, and a diagram of the beam with loading conditions and dimensions.
11. Design a fire-resistant steel column for a multi-story building. The column is subjected to an axial load of 500 kN and must have a fire resistance rating of 2 hours. Select appropriate fireproofing materials and methods, and calculate the required column dimensions. Provide a detailed design and a diagram showing the column, fireproofing layers, and loading conditions.
12. Evaluate the structural design of an industrial building subjected to blast loads. Assume the building has a steel frame with a height of 8 meters and a span of 20 meters. Discuss the impact of blast loads on the design and propose strategies for blast mitigation. Include relevant calculations and a schematic diagram of the building's frame.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT

M24CE1E105D	**CONSTRUCTION MANAGEMENT AND ENGINEERING ECONOMICS**	**ELECTIVE**	**3**	**0**	**0**	**3**	**3**

Preamble: The course provides a comprehensive understanding of the construction industry's economic condition, equipping students with the skills to navigate its difficulties. Students will develop expertise in financial management, project feasibility analysis, contract law, and ethical considerations. Additionally, they will explore advanced topics such as value engineering, sustainable construction economics, and global industry trends.

Prerequisite : Nil

Course Outcomes : After the completion of the course the student will be able to

CO 1	Enhancing labour productivity and project performance through work study and earned value analysis.(**Cognitive Knowledge Level: Apply)**
CO 2	Acquire knowledge and skills necessary to navigate legal complexities, mitigate risks, and resolve disputes within the construction industry. (**Cognitive Knowledge Level: Analyse)**
CO 3	Analyze and interpret economic data relevant to construction projects. (**Cognitive Knowledge Level: Analyse)**
CO 4	Develop the skills necessary to effectively manage finances within construction projects. (**Cognitive Knowledge Level: Apply)**
CO 5	Assess the economic viability of construction projects through various techniques. **(Cognitive Knowledge Level: Evaluate**)

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	2	2	2	2	2	1
CO 2	2	2	2	2	2	1
CO 3	2	2	2	2	1	1
CO 4	1	2	2	2	2	1
CO 5	1	2	2	2	2	1

Assessment Pattern

Course Name	Construction Management and Engineering Economics		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	40		20
Apply	40	60	50
Analyse	20	30	20
Evaluate		10	10
Create			

Mark distribution

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (7 hours)

Introduction to Construction Project Management

Essential project management methodologies: Critical Path Method (CPM), Program Evaluation Review Technique (PERT), Precedence Diagramming Method (PDM), and Line of Balance (LOB) - Labor productivity variations and improvement through work study - Measuring project progress and performance using Earned Value Analysis (EVA).

MODULE 2 (8 hours)

Contracts and Legal Aspects

Construction Contracts: Types of contracts (e.g., lump sum, cost-plus, design-build), Contract negotiation and administration, Dispute resolution mechanisms - Legal Framework: Construction law and regulations, Liability and insurance, Intellectual property rights - Ethical Considerations: Professional ethics in construction management, Conflict of interest, Corporate social responsibility.

MODULE 3 (7 hours)

Introduction to Construction Economics

Overview of Construction Industry: Historical perspective, Current trends and challenges -
Basic Economic Concepts: Supply and demand, Market structures, Elasticity - Cost Analysis in Construction: Types of costs, Cost estimation methods, Cost control techniques –Inflation and Price Indices: Wholesale Price Index (WPI), Consumer Price Index (CPI) - Basics of Accounting: Revenue and accrual systems, ledger accounting. Working Capital Management: Unbilled revenue, managing debtors.

MODULE 4 (7 hours)

Financial Management in Construction Projects

Financial Planning: Capital budgeting, Time value of money, Risk analysis - Financing Methods: Debt financing vs. equity financing, Public-private partnerships (PPPs), Project financing - Financial Control and Reporting: Budgeting and cash flow management, financial statements analysis, Performance metrics.

MODULE 5 (7 hours)

Project Economics and Feasibility Analysis

Project Appraisal Techniques: Net present value (NPV), Internal rate of return (IRR), Payback period - Feasibility Studies: Market analysis, technical feasibility, Economic viability - Risk Management in Construction Projects: Identification and assessment of risks, Risk mitigation Strategies, Insurance and bonding.

References

1. Value Management in Construction: A Client's Guide, David Lowe.
2. Sustainable Construction: Green Building Design and Delivery, Charles J. Kibert.
3. Arvind N. Sharma, "Construction Law in India".
4. International Construction Contract Law, Lukas Klee
5. Construction Economics: A New Approach, Danny Myers and Peter Brandon.
6. Construction Financial Management, Steven Peterson and W. Crispin Luckett.
7. Construction Project Management: Planning, Scheduling, and Controlling, Frederick Gould and Nancy Joyce.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module 1	7
1.1	Essential project management methodologies: Critical Path Method (CPM), Program Evaluation Review Technique (PERT)	3
1.2	Precedence Diagramming Method (PDM), and Line of Balance (LOB).	2
1.3	Labor productivity variations and improvement through work study.	1
1.4	Measuring project progress and performance using Earned Value Analysis (EVA).	1
	Module 2	**8**
2.1	Construction Contracts: Types of contracts (e.g., lump sum, cost-plus, design-build), Contract negotiation and administration, Dispute resolution mechanisms	3
2.2	Legal Framework: Construction law and regulations, Liability and insurance, Intellectual property rights	3
2.3	Ethical Considerations: Professional ethics in construction management, Conflict of interest, Corporate social responsibility	2

	Module 3	**7**
3.1	Overview of Construction Industry: Historical perspective, Current trends and challenges	1
3.2	Basic Economic Concepts: Supply and demand, Market structures, Elasticity	1
3.3	Cost Analysis in Construction: Types of costs, Cost estimation methods, Cost control techniques.	2
3.4	Inflation and Price Indices: Wholesale Price Index (WPI), Consumer Price Index (CPI)	1
3.5	Basics of Accounting: Revenue and accrual systems, ledger accounting. Working Capital Management: Unbilled revenue, managing debtors.	2
	Module 4	**7**
4.1	Financial Planning: Capital budgeting, Time value of money, Risk analysis	2
4.2	Financing Methods: Debt financing vs. equity financing, Public-private partnerships (PPPs), Project financing	3
4.3	Financial Control and Reporting: Budgeting and cash flow management, Financial statements analysis, Performance metrics	2
	Module 5	**7**
5.1	Project Appraisal Techniques: Net present value (NPV), Internal rate of return (IRR), Payback period	2
5.2	Feasibility Studies: Market analysis, Technical feasibility, Economic viability	2
5.3	Risk Management in Construction Projects: Identification and assessment of risks, Risk mitigation Strategies, Insurance and bonding	3

Model Question Paper

QP CODE: Pages: 2

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: M24CE1E105D

Course Name: Construction Management and Engineering Economics

Max. Marks:60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Compare and contrast the Critical Path Method (CPM) and the Program Evaluation Review Technique (PERT) in project management.
2. How do contract negotiation and administration processes contribute to successful project outcomes in construction?
3. Comment on the fundamental economic concepts relevant to the construction industry, such as supply and demand, market structures How do contract negotiation and administration processes contribute to successful project outcomes in construction?
4. Discuss the concept of Public-Private Partnerships (PPPs) and their role in financing construction projects.
5. Enlist the importance of market analysis, technical feasibility, and economic viability assessments in determining the feasibility and potential success of a construction project?

PART B

Answer any five questions. Each question carries 8 marks.

6. Discuss how labour productivity variations can impact a construction project and describe one work study technique that can be used to improve labor productivity. (8 Marks)

7. a. What ethical considerations are important for construction management professionals? (3 marks)

   b. Scrutinize the principles of professional ethics in construction, address issues related to conflicts of interest (5 marks)

8. a. “Understanding the historical perspective of the construction industry help in analysing

its current trends and challenges". Justify the statement. (4 marks)

b. Provide examples of how past economic factors have influenced the industry's evolution over time? (4 marks)

9. How do economic factors, such as inflation rates or fluctuations in material prices, impact cost analysis and decision-making in construction projects? (8 marks)
10. a. Compare and contrast debt financing and equity financing as methods of financing construction projects. (4 marks)

    b. How do project managers determine the most suitable financing method based on project requirements and risk profiles? (4 marks)
11. Elucidate the importance of considering the time value of money and conducting risk analysis when making financial decisions for construction ventures? (8 marks)
12. Elaborate on the types of insurance commonly used in the construction industry and how bonding requirements help protect project stakeholders from financial risks? (8 marks)

KNOWLEDGE IS POWER

SEMESTER II

BRANCH : Civil Engineering

SPECIALIZATION : Structural Engineering and Construction Management

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1T201	ADVANCED DESIGN OF CONCRETE STRUCTURES	CORE	4	0	0	4	4

Preamble: The course covers the fundamental design principles of advanced concrete elements, including continuous beams, slender columns, flat slabs, grid floors, reinforced concrete footings, and pile caps. It emphasizes critical considerations such as deflection and cracking control and detailing for ductility, in structural members. Through this course, students will acquire an in-depth understanding of advanced concrete design principles and their practical applications in real-world scenarios.

Prerequisite : Understanding of structural analysis and the design of concrete structures.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Analyze and design continuous beams and portal frames considering moment redistribution. **(Cognitive Knowledge Level: Analyse)**
CO 2	Apply the design of slender columns and shear walls under various loading conditions. **(Cognitive Knowledge Level: Apply)**
CO 3	Apply the yield line method for the analysis and design of slabs, and to design floor systems like grid floors. **(Cognitive Knowledge Level: Apply)**
CO 4	Examine the deflection and cracking in concrete structures and ensure detailing for ductility and fire resistance and deign of flat slab. **(Cognitive Knowledge Level: Analyse)**
CO 5	Apply the design reinforced concrete footings and pile caps subjected to bending in real world scenarios. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	1	2	2	2	2
CO 2	2	1	2	2	2	2
CO 3	2	1	2	2	2	2
CO 4	2	1	2	2	2	2
CO 5	2	1	2	2	2	2

Assessment Pattern

Course Name	Advanced Design of Concrete Structures		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (% marks)
	Test 1 (% marks)	Test 2 (% marks)	
Remember			
Understand	20	20	20
Apply	50	50	50
Analyse	30	30	30
Evaluate			
Create			

Mark distribution

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern :

Micro project/Course based project : 10 marks

Course based task/Seminar/Quiz : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

End Semester Examination: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (10 hours)

Introduction to continuous beams, definition and significance in structural engineering, analysis of loading conditions for maximum moment, overview of IS code provisions and design coefficients, design problems and practical applications, redistribution of moments and its implications in design.

Introduction to portal frames, basic concepts and structural behavior, analysis and design of portal frames, design problems and real-world examples.

MODULE 2 (9 hours)

Introduction to Slender columns, characteristics and significance in structural design, analysis of additional moments due to slenderness, behavior of columns under axial compression, uniaxial, and biaxial bending, generation and application of P-M interaction diagrams, design examples.

Introduction to shear walls, classification, importance in lateral load resistance, Basic concepts and design considerations, design examples.

MODULE 3 (11 hours)

Yield line method of analysis of slabs, characteristic features of yield lines, analysis by virtual work method. Introduction to grid floors, design concepts and problems.

MODULE 4 (**12 hours)**

Introduction to flat slabs, components, IS code provisions for design, design examples of exterior and interior panel. Control of defection, immediate and long-term defection, control of cracking, detailing for ductility .

MODULE 5 (6 hours)

Introduction to footings, classifications, design of isolated square and rectangular footing,

Introduction to pile, and pile cap, classifications, design of end-bearing piles, Design of piles cap for two, three and four piles.

References

1. Pillai S. U. and Menon D., “Reinforced Concrete Design”, Tata McGraw-Hill (2016).
2. Arthur H. Nilson, David Darwin& Charles W. Dolan, "Design of Concrete Structures", Tata Mcgraw Hill, 2004
3. Park R. & Paulay T., "Design of Concrete Structures",John Wiley & Sons, NewYork,1975
4. Varghese P.C, “Advanced Reinforced Concrete Design”, Prentice Hall of India, 2005.

5. Punmia B.C. , Ashok k. Jain, Arun k. Jain.Reinforced Concrete Structures Vol. II. Laxmi Publications.
6. Advanced R.C.C. Design (R.C.C. Volume-II). By S. S. Bhavikatti, New Age International pvt.ltd, 3rd edition, 2018.
7. IS456-2000 (2000) Indian Standard Plain and Reinforced Concrete Code of Practice. Bureau of Indian Standards, New Delhi

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module 1	**10**
1.1	Introduction to continuous beams, loading conditions for maximum moment, IS code provisions and design coefficients,	2
1.2	Design problems	3
1.3	Redistribution of moments, design after redistribution	2
1.4	Portal frames design problems	3
	Module 2	**9**
2.1	Slender columns, design concepts and failure mode.	2
2.2	Column under axial compression, and uniaxial and biaxial bending, design examples.	3
2.3	Generation of P-M interaction diagram	1
2.4	Classification of shear wall and loading conditions.	1
2.5	Design of shear wall.	2
	Module 3	**8**
3.1	Yield line method of analysis of slabs, characteristic features of yield lines	2
3.2	Analysis by virtual work method	2
3.3	Introduction to Grid floors, design concepts and example	4
	Module 4	**8**
4.1	Introduction to flat slabs, components, IS code provisions for design	1
4.2	Design examples of exterior and interior panel	4
4.3	Control of deflection	1
4.4	Immediate and long-term defection, control of cracking	1
4.5	Detailing for ductility	1

	Module 5	10
5.1	Introduction to footings, and classifications.	1
5.2	Design of isolated square and rectangular footing	3
5.3	Introduction to pile, and pile cap, classifications	1
5.4	Design of end-bearing piles	2
5.5	Design of piles cap for two, three and four piles.	3

Model Question Paper

QP CODE: Pages: 3

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2025

Course Code: M24CE1T201

Course Name: **Advanced Design of Concrete Structures**

Max. Marks: 60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. How can codal provisions applied for the concept of redistribution of moments.
2. Compare ordinary RCC wall and shear wall with sketches.
3. Enumerate the limitations of yield line theory.
4. Outline the design considerations of pile caps.
5. Compare the short term deflection and long term deflection in reinforced concrete flexural members.

PART B

Answer any five questions. Each question carries 8 marks.

6. a. A continuous beam of a multi-storyed frame has three equal spans of 8m each. The characteristic DL is 10 kN/m and the characteristic LL is 15 kN/m. Design the critical section of the beams using the limit state method. Use M20 Concrete and Fe 500 grade steel. (4 marks)

b. Design a portal frame hinged at the base to suit the following data

Spacing of portal frame = 4m

Height of column = 4m

Distance between the column centers = 10m

LL on roof = 1.5kN/m^2

RCC Slab continues over the portal frame

SBC = 200 kN/m^2

Adopt M20 concrete and Fe 415 steel (4 marks)

7. a. A shear wall 200mm x 600mm is subjected to an axial load of 12000 kN and a moment of

11000kNm. Design considering the following.

a. using interaction charts

b. using elastic stress distribution, design end portion 600mm length

c. Assuming end zones to resist moments. Consider two 500x 500 mm column are centrally available in the end zone (4 marks)

b. Design a braced column of size 400x 300 mm bent in double curvature with the following values f_{ck} = 30 N/mm^2 and f_y = 415 N/mm^2. L_0 = 7m L_{ex}(on major axis)= 6m,L_{ey}= on minor axis)= 5m. the ultimate moments t top M_x = 40kNm and M_y = 30 kNm , at bottom M_x = 22.5 kNm, M_y= 20kNm, P_u= 1500 kN. (4 marks)

8. a. A rectangular slab with a size of 3mx5m is simply supported along its circumference and subjected to a concentrated load at its center. Using the virtual work method, derive an expression for the collapse load. (4 marks)

b. RC grid floor is designed to cover a floor area of 12mx18m. The spacing of ribs in a mutually perpendicular direction is 1.5m c/c LL on the floor is 2kN/m^2. Analyze the grid floor by the IS456 method. Design the suitable reinforcement (Only for flexure). (4 marks)

9. a. How does one (a) check for deflection for the two-way slab and (b) control crack width in the two-way slab? (4 marks)

b. Calculate the short-term deflection in a cantilever beam of cross section 250 mm x 400 mm and span 3m. The maximum bending moment in the beam under service loads is 150 kNm. The beam is reinforced with 3, 16 mm diameter bars on the tension side. Assume M20 concrete and Fe 415 steel. (4 marks)

10. Design the interior panel of a flat slab with a panel size 5m×5m with drop and column head. It has to carry a live load of 4kN/m^2 and a floor finish load of 1kN/m^2. The column supporting the system is 450mm×450mm. Use M25 concrete and Fe415 steel and sketch the reinforcement details.

11.a. Design a pile cap a system of three piles of diameter 400mm supporting a column 500mm which is carrying an axial load 600 kN, piles are placed at the vertex of an equilateral triangle of size 1200mm adopt M 20 concrete and Fe 415 steel. (4 marks)

b. Design a pile under a column transmitting an axial load of 800 kN. The pile is to be driven to hard strata available at a depth of 8m using M20 concrete and Fe 415 steel. (4 marks)

12. The foundation for a structure consists of 12 piles to carry a load of 6000kN. The piles are

spaced 2m centre to centre. They are driven through a hard stratum available at a depth of 5m. Design one of the piles and sketch the details of reinforcement. Adopt M20 concrete and Fe415 steel.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1T202	PROJECT PLANNING AND IMPLEMENTATION	CORE	4	0	0	4	4

Preamble: The course provides planning stages and concepts as well as a productivity analysis tool for a project. Quality management models integrated with safety approaches in construction are introduced.

Prerequisite : Construction Technology and Management

Course Outcomes : After the completion of the course the student will be able to

CO 1	Comprehend the different stages of planning, tendering and execution of works in the construction industry. **(Cognitive Knowledge Level-Understand**)
CO 2	Perform work study and evaluate productivity. **(Cognitive Knowledge Level-Evaluate)**
CO 3	Execute concepts of quality management, field implementation and documentation. **(Cognitive Knowledge Level-Apply)**
CO 4	Assess the total quality in construction to avoid failures while implementing its principles in the industry. **(Cognitive Knowledge Level-Analyse)**
CO 5	Understand the fundamentals of safety management systems in the construction industry and demonstrate it in construction projects. **(Cognitive Knowledge Level-Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	1	1	1	1	1
CO 2	2	1	2	2	2	1
CO 3	2	1	2	2	2	1
CO 4	2	1	2	2	2	1
CO 5	1	1	1	1	1	1

Assessment Pattern

Course Name	PROJECT PLANNING AND IMPLEMENTATION		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	40		30
Apply	40	50	40
Analyse	20	40	20
Evaluate		10	10
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern :

Micro project/Course based project : 10 marks

Course based task/Seminar/Quiz : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (9 hours)

Project Planning: Objectives of planning, role of project manager and stakeholders; Stages of planning by different agencies; Sanctions; Tendering; Contracts; Execution of works; Project risk management plan; Work measurements, disputes, settlement of disputes and modes of settlement

MODULE 2 (9 hours)

Work and Productivity Analysis: Work study and difficulties involved, procedure and techniques; Factors influencing productivity, productivity indices, measurement of productivity and productivity improvement techniques; Human relations in productivity, motivation, leadership and communication

MODULE 3 (9 hours)

Quality in Construction: Evolution of quality, elements of quality and factors affecting; Quality control, field of application and methods; Quality management programme, quality assurance system, manual and audit; Quality control in construction industry

MODULE 4 (9 hours)

Quality Management: ISO standards; Total Quality Management (TQM), principles, elements and approaches, TQM in Construction industry, major focuses to avoid failure and constraints to the use of TQM; TQM models

MODULE 5 (9 hours)

Safety in Construction: Importance of safety, causes of accidents and human factors in construction safety management; Safety codes, safety committee and inspection, measuring of safety and approaches to improve safety in construction; Safety in various construction operations.

References

1. Sengupta and H. Guha (1995), “Construction Management and Planning”, Tata McGrew Hill Publishing Company Pvt. Ltd., New Delhi.
2. Clarkson Oglesby, Henry Parker (1989), Grogory Howell, “Productivity Improvement in Construction”, McGrew Hill Book Company, Inc.
3. R.P. Mohanty and R.R. Lakhe, “Total Quality Mangement”, Jaico Publishing House.
4. S. Seetharaman, “Construction Engineering and Management”, Umesh Publications.

5. K. N. Vaid, "Construction Safety Management", National Institute of Construction Management and Research
6. Kerzner, H. (2017), "Project Management: A Systems Approach to Planning, Scheduling, and Controlling", John Wiley & Sons, Hoboken, NJ.
7. Lewis, J.P. (2001), "Project Planning, Scheduling & Control: A Hands-on Guide to Bringing Projects in on Time and on Budget", McGraw-Hill, New York.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture
	MODULE 1	
1.1	Project Planning: Objectives of planning, role of project manager and stakeholders	3
1.2	Stages of planning by different agencies; Sanctions; Tendering; Contracts; Execution of works; Project risk management plan	3
1.3	Work measurements, disputes, settlement of disputes and modes of settlement	3
	MODULE 2	
2.1	Work and Productivity Analysis: Work study and difficulties involved, procedure and techniques	3
2.2	Factors influencing productivity, productivity indices, measurement of productivity and productivity improvement techniques	4
2.3	Human relations in productivity, motivation, leadership and communication	2
	MODULE 3	
3.1	Quality in Construction: Evolution of quality, elements of quality and factors affecting	3
3.2	Quality control, field of application and methods	2
3.3	Quality management programme, quality assurance system, manual and audit; Quality control in construction industry	4
	MODULE 4	
4.1	Quality Management: ISO standards; Total Quality Management (TQM), principles, elements and approaches	3
4.2	TQM in Construction industry, major focuses to avoid failure	3
4.3	Constraints to the use of TQM in construction industry; TQM models	3
	MODULE 5	
5.1	Safety in Construction: Importance of safety, causes of accidents and	3

	human factors in construction safety management	
5.2	Safety codes, safety committee and inspection, measuring of safety	2
5.3	Approaches to improve safety; Safety in various construction operations	4

Model Question Paper

QP CODE: Pages: 1

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2025

Course Code: **M24CE1T202**
Course Name: **PROJECT PLANNING AND IMPLEMENTATION**

Max. Marks:60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Enumerate the stages of planning by different agencies.
2. Analyse the effects of productivity in a construction industry.
3. Illustrate the importance of Quality.
4. Discuss on Quality audit as a management programme for quality assurance.
5. Signify the Indian scenario of safety in the construction industry.

PART B

Answer any five questions. Each question carries 8 marks.

6. Indicate some of the root causes of disputes in a construction industry and ways of settling them.
7. Identify the difficulties faced by the work study team and the ways to tackle them.
8. Discuss on Quality circle and the effect of leadership, Motivation and communication on productivity.
9. Interpret how Quality control can be exercised in the field by various methods.
10. Define the various elements of Total Quality Management and throw light on its implementation in the construction industry.
11. List and detail the causes of accidents according to their nature in an industry.
12. Describe the various safety approaches in the construction industry.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1S205	BUILDING INFORMATION MODELLING	INDUSTRY COURSE	3	0	0	3	3

Preamble: The course provides a structured framework for understanding and implementing BIM principles, incorporating real-world examples and practical exercises to enhance student learning. This course ensures a solid foundation and practical proficiency in BIM methodologies, preparing students to integrate BIM into their professional practice for enhanced efficiency and collaboration in the

architecture, engineering, and construction industry.

Prerequisite: Nil

Course Outcome: After the completion of the course the student will be able to

CO 1	Understand the fundamental principles of Building Information Modeling (BIM) and assess the advantages associated with its implementation. **(Cognitive Knowledge Level: Understand)**
CO 2	Analyse different data exchange models and standardize product data models for Interoperability and to understand the roles and responsibilities of stake holders **(Cognitive Knowledge Level: Analyse)**
CO 3	Develop a comprehensive BIM execution plan. **(Cognitive Knowledge Level: Create)**
CO 4	Comprehend the principles of Integrated Project Delivery and to empower students to establish an Integrated Project Team for the seamless execution of projects. **(Cognitive Knowledge Level: Apply)**
CO 5	Solve real life examples using advanced softwares.**(Cognitive Knowledge Level: Analyse)**

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	1	1	2	1	1	2
CO 2	2	1	2	2	2	2
CO 3	2	1	2	2	2	2
CO 4	1	1	2	2	2	2
CO 5	2	1	2	2	2	2

Assessment Pattern

Course Name	**BUILDING INFORMATION MODELLING**		
Bloom's Category	**Continuous Internal Evaluation Tests**		**End Semester Examination (% marks)**
	Test 1 (% marks)	**Test 2 (% marks)**	
Remember			
Understand	20	20	20
Apply	35	35	35

Analyse	25	25	25
Evaluate	20	20	20
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	**40**	**60**	**3 hours**

Continuous Internal Evaluation Pattern :

Seminar : 10 marks

Course based task/Seminar/Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

End Semester Examination : The examination will be conducted by the College with the question paper provided by the Industry. The examination will be for 3 Hrs and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks. The valuation of the answer scripts shall be done by the expert in the Industry handling the course.

SYLLABUS

Module 1: (7 hours)

Introduction to BIM - Understanding the Evolution of Building Information Modeling (BIM) - Exploring the Transition from Traditional AEC Business Models to BIM- Differentiating BIM from 3D and 2D Approaches- LOD

Conceptualizing BIM as both a Product and a Process- Emphasizing BIM as a Lifecycle Platform- Assessing the Incentives and Benefits of BIM: Technical, Financial, and Sustainable Examining Object-Based Parametric Modeling and its Role in BIM- Ensuring BIM Model Quality through Model Checking Processes

Module 2: (7 hours)

Collaboration, Interoperability, and Roles: Exploring Stakeholder Engagement in BIM: Owners, Facility Managers, Government Institutions, Architects, Engineers, Contractors, Subcontractors, and Fabricators.

Understanding BIM Adoption and Maturity Levels- Reviewing BIM Guides from Leading Countries (e.g., Finland, Denmark, Belgium)

Analyzing Data Exchange Methods: File-based, Cloud-based, and Local - Standardizing Product Data Models for Interoperability. Implementing File-Based Exchange and BIM Servers: Industry Foundation Classes (IFC), COBie

Module 3: (7 hours)

BIM Execution Planning : Developing a Comprehensive BIM Execution Plan (BEP) - Establishing Project Modeling Goals and Objectives - Selecting Model Uses for Different Project Phases - Designing the BIM Process Workflow - Defining Information Exchanges among Project Stakeholders - Planning Infrastructure for Effective BIM Implementation - Implementing the BEP for Successful Project Execution - Adapting BIM Project Execution Planning Procedures for Organizational Contexts

Module 4: (7 hours)

Integrated Project Delivery (IPD): Understanding the Principles of Integrated Project Delivery (IPD) - Cultivating Collaboration and Mutual Respect among Project Stakeholders - Establishing an Integrated Project Team and Defining Roles - Implementing Early Involvement of Key Participants and Goal Definition - Utilizing Technology for Open Communication and Collaborative Decision Making - Building an Integrated Project Team for Seamless Project Execution - Redefining Project Phases for Enhanced Integration and Efficiency

Module 5: (8 hours)

BIM Software Training: Hands-on Training with BIM Software (e.g., Revit, ArchiCAD, Tekla, Navisworks)

Creating Modeling Views and Architectural, Structural, MEP, and Construction Modeling - Project Management Tools and Techniques within BIM Software - Utilizing Revit Families for Efficient Model Development - Conducting Design Analysis (Energy, Solar, Area, etc.) and Generating Schedules - Enhancing Design Visualization with Rendering and Walkthroughs - Documenting and Presenting Designs Effectively

Note: Topics in Module 5 have to be discussed and demonstrated with the help of software at the Laboratory. Each topic will be an assignment in each week. Theory classes may progress with the other modules.

References

1. "Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations" by Willem Kymmell (McGraw-Hill Construction Series) 2007.
2. "BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors" by Chuck Eastman, Paul Teicholz, Rafael Sacks, and Kathleen Liston first edition 2008.
3. "BIM and Integrated Design: Strategies for Architectural Practice" by Randy Deutsch 2011.
4. "Building Information Modeling: Framework for Structural Design" by Rafael Sacks, Chuck Eastman, and Ghang Lee 2012.
5. "Implementing BIM: A Guide to BIM Management in Construction Projects" by Richard Garbe 2014.
6. "BIM for Facility Managers" by Kathleen Liston and Paul Teicholz 2013.
7. "Integrated Project Delivery: An Action Guide for Leaders" by Ed Friedrichs and Iris Tommelein 2023.

COURSE CONTENTS AND LECTURE SCHEDULE

(Topics in Module 5 have to be discussed and demonstrated with the help of software at the Laboratory. Each topic will be an assignment in each week. Theory classes may progress with the other modules.)

No	Topic	No. of Lectures
MODULE 1		
1.1	Introduction to BIM Ensuring BIM Model Quality through Model Checking Processes	1
1.2	Understanding the Evolution of Building Information Modeling (BIM)	1
1.3	Exploring the Transition from Traditional AEC Business Models to BIM	1
1.4	Differentiating BIM from 3D and 2D Approaches-LOD- Conceptualizing BIM as both a Product and a Process	1
1.5	Emphasizing BIM as a Lifecycle Platform Assessing the Incentives and Benefits of BIM: Technical, Financial, and Sustainable	1
1.6	Examining Object-Based Parametric Modeling and its Role in BIM	1
1.7	Examining Object-Based Parametric Modeling and its Role in BIM	1
MODULE 2		

2.1	Collaboration, Interoperability, and Roles Exploring Stakeholder Engagement in BIM: Owners, Facility Managers, Government Institutions, Architects, Engineers, Contractors, Subcontractors, and Fabricators	1
2.2	Understanding BIM Adoption and Maturity Levels	1
2.3	Reviewing BIM Guides from Leading Countries (e.g., Finland, Denmark, Belgium)	1
2.4	Analyzing Data Exchange Methods: File-based, Cloud-based, and Local	1
2.5	Standardizing Product Data Models for Interoperability	1
2.6	Implementing File-Based Exchange and BIM Servers: Industry Foundation Classes (IFC), COBie	2
MODULE 3		
3.1	BIM Execution Planning Developing a Comprehensive BIM Execution Plan (BEP) Establishing Project Modeling Goals and Objectives	1
3.2	Selecting Model Uses for Different Project Phases	1
3.3	Designing the BIM Process Workflow	1
3.4	Defining Information Exchanges among Project Stakeholders	1
3.5	Planning Infrastructure for Effective BIM Implementation	1
3.6	Implementing the BEP for Successful Project Execution	1
3.7	Adapting BIM Project Execution Planning Procedures for Organizational Contexts	1
MODULE 4		
4.1	Integrated Project Delivery (IPD) Understanding the Principles of Integrated Project Delivery (IPD)	1
4.2	Cultivating Collaboration and Mutual Respect among Project Stakeholders	1
4.3	Establishing an Integrated Project Team and Defining Roles	1
4.4	Implementing Early Involvement of Key Participants and Goal Definition	1
4.5	Utilizing Technology for Open Communication and Collaborative Decision Making	1
4.6	Building an Integrated Project Team for Seamless Project Execution	1
4.7	Redefining Project Phases for Enhanced Integration and Efficiency	1

MODULE 5		
5.1	BIM Software Training Hands-on Training with BIM Software (e.g., Revit, ArchiCAD, Tekla) Creating Modeling Views and Architectural Modeling	1
5.2	Structural Modeling ,	1
5.3	MEP Modeling	1
5.4	Construction Modeling	1
5.5	Project Management Tools and Techniques within BIM Software - Utilizing Revit Families for Efficient Model Development	1
5.6	Conducting Design Analysis (Energy, Solar, Area, etc.) and Generating Schedules	1
5.7	Enhancing Design Visualization with Rendering and Walkthroughs	1
5.8	Documenting and Presenting Designs Effectively	1

Model Question Paper

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MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2025

Course Code: M24CE1S205

Course Name: BUILDING INFORMATION MODELLING

Max. Marks:60 Duration: 3 hours

Answer any five questions. Each question carries 12 marks.

1. (a) Elucidate in detail the technical and financial incentives of using BIM? (9 Marks)
   (b) How is BIM different from 2D and 3D CAD? (3 Marks)
2. With respect to its 5 phases, elaborate on BIM Modelling. (12 Marks)
3. Differentiate between File based, Cloud based and Local Data exchange methods in BIM. (12 Marks)
4. Illustrate the role of each stakeholders - Owners, Facility Managers and Government Institutions, Architects and Engineers, Contractors, Subcontractors and Fabricators in BIM. (12 Marks)
5. (a) List out the importance of developing a BIM Project Execution Plan (3 Marks)
   (b) Outline and discuss the 5 step procedure to develop a detailed BEP. (9 Marks)
6. Explain in detail how the Information Exchange worksheet is designed? (12 Marks)
7. Elucidate the principles of integrated project delivery (12 Marks)

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1P206	MINI PROJECT	PROJECT	0	0	3	3	2

Preamble: Mini project can help to strengthen the understanding of student's fundamentals through application of theoretical concepts and to boost their skills and widen the horizon of their thinking. The aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects increases problem solving skills.

The introduction of mini projects ensures preparedness of students to undertake dissertation. Students should identify a topic of interest in consultation with the PG programme coordinator that should lead to their dissertation/research project. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.

Evaluation Committee - Programme Coordinator, One Senior Professor and Guide.

Sl. No	Type of evaluations	Marks	Evaluation criteria
1	Interim evaluation 1	20	
2	Interim evaluation 2	20	
3	Final evaluation by a Committee	35	Will be evaluating the level of completion and demonstration of functionality/ specifications, clarity of presentation, oral examination, work knowledge and involvement
4	Report	15	The committee will be evaluating for the technical content, adequacy of references, templates followed and permitted plagiarism level (not more than 25%)
5	Supervisor/Guide	10	
Total Marks		100	

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1L207	STRUCTURAL DESIGN STUDIO LAB	LAB	0	0	3	3	2

Preamble: The course provides an ability to interpret the response of structural elements/whole structure using software packages such as ETABS, STAAD, ANSYS, ABAQUS. The course develops a firm foundation for research and practice in Structural Engineering. All design and detailing shall be done as per the latest IRC , IS and other relevant Codes of Practice.

Prerequisite: Civil Engineering Software Lab

Course Outcomes: After the completion of the course the student will be able to

CO 1	Analyze and design Reinforced Concrete Structures using ETABS/STAAD. **(Cognitive Knowledge Level: Analyze)**
CO 2	Analyze and design steel Structures using ETABS/STAAD. **(Cognitive Knowledge Level: Analyze)**
CO 3	Develop structural detailing and design documents. **(Cognitive Knowledge Level: Apply)**
CO4	Model and conduct static analysis of structural elements/ whole structures using ANSYS/ABAQUS. **(Cognitive Knowledge Level: Analyze)**
CO 5	Model and conduct dynamic analysis of structural elements/ whole structures using ANSYS/ABAQUS. **(Cognitive Knowledge Level: Analyze)**

Mapping of course outcomes with program outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	1	2	2	2	2
CO 2	1	1	2	2	2	2
CO 3	2	1	1	2	1	1
CO 4	1	1	2	2	2	2
CO 5	1	1	2	3	2	2

Mark distribution:

Total Marks	CIE Marks	ESE Marks
100	60	40

Continuous Internal Evaluation Pattern :

Lab work and Viva-voce : 60 marks

Final assessment Test and Viva Voce : 40 marks

The laboratory courses will be having only Continuous Internal Evaluation and carries 100 marks. Final assessment shall be done by two examiners; one examiner will be a senior faculty from the same department.

SYLLABUS

LIST OF EXPERIMENTS

I. Using **ETABS/STAAD** perform Static and Dynamic analysis ,design and detailing of :

Note: Consider the loads DL,LL,WL and EL.

1	G + 5 residential building with shear wall.
2	Overhead rectangular water tank with staging.
3	Ribbed slab floor system.
4	Raft Foundation.
5	Simply supported slab bridge of spans less than or equal to 6 m.
6	Single storey steel building with truss.
7	Multi-storey steel building.

II. Using **ABAQUS / ANSYS** perform Modelling and Analysis of:

8	Beams, Frames and Trusses (Static).
9	Plane Stress and Plane Strain problems in Plate (Static).
10	Free Vibration of Cantilever beam and simply supported beam subjected to harmonic load. (Dynamic)
11	Crack Pattern Detection in RCC Beam.
12	Three storied building frame subjected to harmonic base Motion. (Dynamic)

References:

1. **IS 456:2000**: *"Code of Practice for Plain and Reinforced Concrete"*
2. **IS 800:2007**: *"General Construction in Steel – Code of Practice"*
3. **IS 875 Part 1:*1987*:** *"Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures – Part 1: Dead Loads – Unit Weights of Building Materials and Stored Materials"*
4. **IS 875 Part 2:1987**: *"Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures – Part 2: Live Loads"*
5. **IS 875 Part 3:2015**: *"Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures – Part 3: Wind Loads"*
6. **IS 3370 Part 1:2009**: *"Code of Practice for Concrete Structures for Retaining Aqueous Liquids – Part 1: General Requirements"*
7. **IS 3370 Part 2:2009**: *"Code of Practice for Concrete Structures for Retaining Aqueous Liquids – Part 2: Plain and Reinforced Concrete"*
8. **IS 3370 Part 3:2021**: *"Code of Practice for Concrete Structures for Retaining Aqueous Liquids – Part 3: Prestressed Concrete"*
9. **IS 3370 Part 4:2021**: *"Code of Practice for Concrete Structures for Retaining Aqueous Liquids – Part 4: Design Considerations for Retaining Structures"*
10. ***IS 1893 (Part 1):2016****: "Criteria for Earthquake Resistant Design of Structures – Part 1: General Provisions and Buildings"*
11. ***IS 1893 (Part 2):2014****: "Criteria for Earthquake Resistant Design of Structures – Part 2: Industrial Structures including Stack, Silo, and Chimney"*
12. ***IS 1893 (Part 3):2014****: "Criteria for Earthquake Resistant Design of Structures – Part 3: Design Requirements for Structures including Bridges and Other Structures"*
13. ***IS 1893 (Part 4):2005****: "Criteria for Earthquake Resistant Design of Structures – Part 4: Design and Construction of Foundations"*
14. ***IS 1893 (Part 6):2022****: "Criteria for Earthquake Resistant Design of Structures – Part 6: Requirements for Special Structures, including Seismic Isolation and Damping"*
15. ***IRC 6:2017:*** *"Standard Specifications and Code of Practice for Road Bridges – Section II: Loads and Load Combinations"*
16. ***IRC 21:2000****: "Standard Specifications and Code of Practice for Road Bridges – Section I: General Design and Documentation"*
17. ***IS 13920:2016****: "Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces"*
18. Manuals of ETABS, STAAD, ANSYS, ABAQUS

PROGRAMME ELECTIVE III

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E203A	DESIGN OF BRIDGES	ELECTIVE	3	0	0	3	3

Preamble: The course covers the concept and design of concrete and steel bridges as per the Indian Road Congress (IRC) and Indian Railway Standard (IRS) specifications. The student will be exposed to real-life bridge design and construction practices enabling them to independently plan, analyse, design, and detail various types and components of bridges.

Prerequisite : Analysis of Structures

Course Outcomes : After the completion of the course the student will be able to

CO 1	Decide the structural form for a bridge depending on the functional requirements and site conditions. Identify various structural components of the chosen bridge form. **(Cognitive Knowledge Level: Understand)**
CO 2	Design various components of bridges based on relevant IRC and Indian railway loading standards. **(Cognitive Knowledge Level: Apply)**
CO 3	Design various components of the T beam bridge. **(Cognitive Knowledge Level: Analyse)**
CO 4	Comprehend the design principles of long span bridges. **(Cognitive Knowledge Level: Evaluate)**
CO 5	Design bearings, piers and abutments for bridges. **(Cognitive Knowledge Level: Analyse)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	1	2	2	2	1
CO 2	1	1	2	2	2	1
CO 3	1	1	2	2	2	1
CO 4	1	1	2	2	2	1
CO 5	1	1	2	2	2	1

Assessment Pattern

Course Name	Design of Bridges

Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (% marks)
	Test 1 (% marks)	Test 2 (% marks)	
Remember			
Understand	10		10
Apply	40	40	40
Analyse	30	40	30
Evaluate	20	20	20
Create			

Mark distribution

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern :

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

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MODULE 1 (6 hours)

Planning of bridge

Classification and components of bridges - Investigation for bridges– need for investigation– selection of site– economical span– subsoil exploration– investigation report– importance for proper investigation– Structural forms of bridge decks.

MODULE 2 (8 hours)

Design standard for bridges

Standard specifications for bridges: IRC loadings for road bridges: IRC class AA, class A and class B, loading standard- standards for railway bridges: loading standards - design of RC slab bridge, box culverts.

MODULE 3 (9 hours)

Design of girder bridges

T-beam bridges– Analysis and design of interior slab, exterior slab and cantilever slab, longitudinal girders and cross girders–Pigeaud's method– Courbon's method– prestressed concrete bridges (simply supported case only): Introduction, Concepts, advantages, and applications, Design of Prestressed Concrete Bridges.

MODULE 4 (7 hours)

Design of plate girder bridges - steel truss bridges - Introduction to long span bridges: cable stayed bridges and suspension bridges: Structural system and components – instability: Buckling of bridge components, Measures to prevent instability.

MODULE 5 (6 hours)

Design of elastomeric bearings−Abutments – General features, Loads on abutments, Stability analysis of abutments−Piers – Types, Loads on Piers, Stability analysis of Piers.

References

1. E.C. Hambly, Bridge deck behaviour, Taylor & Francis, London, 1991.
2. P. Nagarajan, Design of Concrete Bridges, Wiley Publications, 2020.
3. E J O'Brien and Leo h, Bri eeck analysis, E& FN pon, New York , 1999
4. D.Johnson Victor, Essentials of bridge engineering, Oxford & IBH publishing Co. Ltd., New Delhi, 2017.
5. N.Krishna Raju, Design of bridges, Oxford & IBH publishing Co. Ltd., New Delhi, 2009.
6. Jaikrishna and O.P Jain, Plain and reinforced concrete-Vol.II, Nemchand & Bros,Roorkee, 2007.
7. Relevant IRC and IRS codes.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial hours
	Module 1	**6**
1.1	Classification and components of bridges	2
1.2	Investigation for bridges– need for investigation – selection of site	2
1.3	economical span– subsoil exploration– investigation report	1
1.4	Structural forms of bridge decks	1
	Module 2	**8**
2.1	IRC loadings for road bridges - IRC class AA, class A and class B	1
2.2	loading standard	1
2.2	Standards for railway bridges- loading standards	2
2.3	Design of box culverts	2
2.4	Design of RC slab bridge	2
	Module 3	**9**
3.1	Design of T beam bridges– Analysis and design of interior slab, exterior slab and cantilever slab	3
3.2	Longitudinal girders and cross girders – Pigeaud's method – Courbon's method	4
3.3	Prestressed concrete bridges(simply supported case only)- Introduction, Concepts, advantages, and applications, Design of Prestressed Concrete Bridges.	2
	Module 4	**7**
4.1	Design of plate girder bridges	2
4.2	Design of Steel truss bridges	2

4.3	Introduction to long span bridges: cable stayed bridges and suspension bridges - Structural system and components	2
4.4	instability :Buckling of bridge components, Measures to prevent instability	1
	Module 5	**6**
5.1	Design of elastomeric bearings	2
5.2	Abutments – General features, Loads on abutments, Stability analysis of abutments	2
5.3	Piers – Types, Loads on Piers, Stability analysis of Piers.	2

Model Question Paper

QP CODE: Pages: 2

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2025

Course Code: M24CE1E203A

Course Name: DESIGN OF BRIDGES

Max. Marks:60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Comment on impact factors? How do these factors vary with respect to the type of loading, span, and type of bridge?
2. How to apply the effective width procedure for finding moments due to concentrated loads acting on one-way slabs.
3. With an example, justify Courbon's method to tabulate the reaction factors in a T beam girder bridge.
4. Examine the causes of the instability in long span bridges.
5. Importance of bearing in bridges and its classification.

PART B

Answer any five questions. Each question carries 8 marks.

6. a. How the bridges can be classified in accordance with IS code. (4 marks)

   b. Discuss the importance of site investigation in bridge engineering. (4 marks)
7. Design an RCC slab culvert for a state highway the following data.(Design of kerb is not expected)

   Clear span = 7m

   Width of carriageway = 7.5m

   Thickness of wearing coat = 80mm

   Kerbs 600 mm wide are provided on either side.

   Loading: IRC Class A

   Materials: M25 concrete and Fe 415 steel

   Sketch the reinforcement details.

8. Design an interior cross girder for a T beam bridge for the following data:
   Effective span = 16 m, Live load – IRC Class 70R tracked; Materials – M25 concrete and Fe 415 steel; spacing of cross girders 5 m c/c; width of carriage way 7.5m; thickness of wearing coat = 80 mm; kerbs on either side = 600 mm wide × 300 mm deep; width of main girder = 300 mm; width of cross girder = 300 mm; spacing of main girders = 2.5 m c/c. Sketch reinforcement details.
9. Design the longitudinal girders and interior panel of a T-beam and slab bridge for the following data:(shear calculations are not expected)
   Effective span = 12m
   Carriage way width = 7.8m
   Cross beams are spaced at 4m c/c
   Kerbs 600 mm wide are provided on either side.
   Loading: IRC Class AA tracked vehicle
   Materials: M25 concrete and Fe 415 steel
   Sketch the reinforcement details.
10. Sketch and explain various parts and their functions of suspension bridge and cable stayed bridge.
11. Design a welded deck type plate girder bridge for a BG track to suit the following data: Effective span = 40 m; Dead load of track = 10 kN/m; Equivalent uniformly distributed load for bending moment calculations/track = 3498 kN; Equivalent uniformly distributed load for shear force calculations/track = 3815 kN. Take CDA = 0.324. Use plates of Fe410 grade.
12. Design an elastomeric bearing as per IRC 83 Part 2:2018 with the following data.
    Maximum vertical design force = 1009 kN
    Minimum vertical design force = 666 kN
    Horizontal force along span direction = 10.39 kN
    Horizontal force along width direction = 41.56 kN
    Resultant of all horizontal forces = 42.84 kN
    Relative displacement in the direction of dimension ‘a’ = 3.77 mm
    Relative displacement in the direction of dimension ‘b’ = 1.88 mm
    Angle of rotation across the width ‘a’ of bearing = 0.00381
    Angle of rotation across the length ‘b’ of bearing = 0.001
    Adopt an elastomeric bearing (based on International Standards) of dimension 250 mm(a) × 400 mm(b) Yield strength of steel laminate = 500 MP.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E203B	ADVANCED CONCRETE TECHNOLOGY	ELECTIVE	3	0	0	3	3

Preamble: The course covers the properties of the ingredients of concrete and its influence on the performance of concrete. The course also focuses on developing a strong understanding about the latest developments in the area of concrete technology with a clear knowledge about the fundamental mechanisms.

Prerequisite : Basics of Civil Engineering and Concrete Technology

Course Outcomes : After the completion of the course the student will be able to

CO 1	Conceive the fundamentals of cement, aggregates, admixtures, and concrete rheology. **(Coginitive knowledge level:understand)**
CO 2	Design concrete mixes emphasizing particle packing, durability, and strength as per the requirements in the field **(Coginitive knowledge level:Apply)**
CO 3	Analyze the effects of water-cement ratio, time, and environmental conditions on concrete behavior, including creep, shrinkage, and fresh and hardened concrete properties. **(Coginitive knowledge level:Analyse)**
CO 4	Assess the durability performance of existing concrete structures through the application of non-destructive testing techniques. **(Coginitive knowledge level:Evaluate)**
CO 5	Gain expertise in specialized concrete types and construction techniques and apply them to solve real-life construction problems **(Coginitive knowledge level:Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5		PO 6
CO 1	1	1	1	1	1	1	1
CO 2	3	1	2	3	2		3
CO 3	2	1	3	2	1		2
CO 4	1	1	2	1	2	2	1
CO 5		1	2	3	3		

Assessment Pattern

Course Name	ADVANCED CONCRETE TECHNOLOGY		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (% Marks)
	Test 1 (% Marks)	Test 2 (% Marks)	
Remember			
Understand	20	20	20
Apply	40	40	40
Analyse	30	30	30
Evaluate	10	10	10
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern :

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer

any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (8 hours)

Cement -Review of manufacturing process- chemical composition, Bogue's compounds, mechanism of hydration-heat of hydration-Aggregate-Review of types, sampling and testing, artificial aggregates – Chemical Admixtures- types, uses, mechanism of action - effects on properties of concrete - Mineral admixtures- types, chemical composition - physical characteristics - effects on properties of concrete - Rheology – basic concepts – Bingham model

MODULE 2 (7 hours)

Mix design - nominal mix- design mix – concept of mix design - variables of proportioning - general considerations - factors considered in the design of concrete mix- various methods of mix design - design of concrete mix as per IS 10262-2019, Importance of particle packing, Statistical quality control of concrete – mean strength – standard deviation – coefficient of variation – sampling - testing - acceptance criteria

MODULE 3 (7 hours)

Properties of fresh concrete- workability-factors affecting workability - slump test- compaction factor test- Vee Bee consistometer test- Properties of hardened concrete - modulus of elasticity, compressive strength, split tensile strength, flexural strength- effect of water cement ratio – maturity concept- Creep - factors affecting creep - effect of creep- Shrinkage- factors affecting shrinkage - plastic shrinkage, drying shrinkage, autogenous shrinkage, carbonation shrinkage.

MODULE 4 (7 hours)

Durability of concrete- Factors affecting durability - permeability- cracking-reinforcement corrosion; carbonation, chloride penetration, sulphate attack, acid attack, fire resistance; frost damage, alkali silica reaction, concrete in sea water - Non-destructive testing of concrete- surface hardness test- ultrasonic pulse velocity method - penetration resistance- pull-out test- core cutting - measuring reinforcement cover.

MODULE 5 (7 hours)

Special concretes - lightweight concrete-heavy weight concrete - high strength concrete – high performance concrete - self compacting concrete -roller compacted concrete– fibre reinforced concrete - polymer concrete-pumped concrete - ready mix concrete - green concrete. Special

processes and technology - sprayed concrete; underwater concrete, mass concrete; slip form construction, prefabrication technology- 3D concrete printing

Reference Books

1. Neville A.M., "Properties of Concrete", Trans-Atlantic Publications, Inc.; 5e, 2016
2. R. Santhakumar ,"Concrete Technology", Oxford Universities Press, 2018
3. Shetty M. S., "Concrete Technology", S. Chand & Co., 2018
4. Mehta and Monteiro, "Concrete-Micro structure, Properties and Materials", McGraw Hill Professional 2017
5. Neville A. M. and Brooks J. J., "Concrete Technology", Pearson Education, 2019
6. Lea, "Chemistry of Cement and Concrete", Butterworth-Heinemann Ltd, 5e, 2017
7. Gambhir, M. L. (2013). *Concrete Technology: Theory and Practice* (5th ed.). McGraw-Hill Education.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture
	MODULE 1	
1.1	Cement -Review of manufacturing process- chemical composition,	2
1.2	Bogue's compounds, mechanism of hydration-heat of hydration	1
1.3	Aggregate-Review of types, sampling and testing, artificial aggregates	1
1.4	Chemical Admixtures- types, uses, mechanism of action - effects on properties of concrete	1
1.5	- Mineral admixtures- types, chemical composition - physical characteristics - effects on properties of concrete	1
1.6	Rheology – basic concepts	1
1.7	Bingham model	1
	MODULE 2	
2.1	Mix design - nominal mix- design mix – concept of mix design	1
2.2	Variables of proportioning - general considerations	1
2.3	Factors considered in the design of concrete mix- various methods of mix design	1
2.4	Design of concrete mix as per IS 10262-2019	1
2.5	Statistical quality control of concrete – mean strength – standard deviation	1

2.6	Coefficient of variation – sampling - testing - acceptance criteria	1
2.7	Mix design - nominal mix- design mix – concept of mix design	1
	MODULE 3	
3.1	Properties of fresh concrete- workability-factors affecting workability	
3.2	Slump test-compaction factor test- Vee Bee consistometer test	1
3.3	Properties of hardened concrete - modulus of elasticity, compressive strength	1
3.4	split tensile strength, flexural strength- effect of water cement ratio – maturity concept	1
3.5	Creep - factors affecting creep - effect of creep	1
3.6	Shrinkage- factors affecting shrinkage - plastic shrinkage, drying shrinkage	1
3.7	Autogenous shrinkage, carbonation shrinkage.	1
	MODULE 4	
4.1	Durability of concrete- Factors affecting durability	1
4.2	Permeability- cracking-reinforcement corrosion; carbonation,	1
4.3	Chloride penetration, sulphate attack, acid attack, fire resistance	1
4.4	Frost damage, alkali silica reaction, concrete in sea water	1
4.5	Non-destructive testing of concrete- surface hardness test	1
4.6	Ultrasonic pulse velocity method - penetration resistance	1
4.7	Pull-out test- core cutting - measuring reinforcement cover.	1
	MODULE 5	
5.1	Special concretes - lightweight concrete-heavy weight concrete	1
5.2	High strength concrete – high performance concrete	1
5.3	self compacting concrete	1
5.4	Roller compacted concrete– fibre reinforced concrete - polymer concrete	1
5.5	Special processes and technology - sprayed concrete; underwater concrete	1
5.6	mass concrete; slip form construction	1
5.7	Prefabrication technology- 3D concrete printing	1

Model Question Paper

QP CODE: Pages: 1

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2025

Course Code: M24CE1E203B

Course Name: ADVANCED CONCRETE TECHNOLOGY

Max. Marks:60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Describe the characteristics of hydration products of cement and its influence in the properties of concrete.
2. Explain the influence of various factors affecting the workability of concrete on the rheological parameters.
3. Explain the methods to prevent corrosion of rebars in RCC.
4. Briefly describe the polymer concrete and its advantages and disadvantages.
5. How will the temperature affect the properties of concrete?

PART B

Answer any five questions. Each question carries 8 marks.

6. What are admixtures in concrete and its classification? Briefly explain superplasticizers and its mechanism of action.
7. Mention the various steps involved in the high strength concrete mix design.
8. What are the transport mechanisms in concrete and describe any one test for each of the mechanisms.
9. In a congested reinforced concrete work which type of concrete will you prefer and why? Explain its mix proportioning, properties, advantages and disadvantages.
10. The condition assessment needs to be done in a concrete water tank. Which are the tests you recommend for assessing the quality and strength of concrete. Briefly explain the tests also.
11. Why special concretes are needed and explain any three special concretes based on their application.
12. What is the durability of concrete? Describe the factors affecting the durability of concrete

structures.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E203C	STRUCTURAL HEALTH MONITORING	ELECTIVE	3	0	0	3	3

Preamble: The course focuses on the assessment, evaluation, and technical diagnosis of strategically important structural systems. It equips students with the skills to assess the risk and reliability of critical structures. Covering both basic and advanced applications of Structural Health Monitoring (SHM), the course includes detailed case studies to provide practical insights and real world applications.

Prerequisite : Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Exhibit understanding of the concepts and methods of Structural Health Monitoring. **(Cognitive Knowledge Level: Understand)**
CO 2	Apply non-destructive techniques and sensor technologies for effective health monitoring of structure. **(Cognitive Knowledge Level: Apply)**
CO 3	Demonstrate techniques for damage identification, detection, and assessment in various structural systems**(Cognitive Knowledge Level: Apply)**
CO 4	Analyze case studies of SHM applications in bridges, buildings, and offshore structures to understand real-world implementation. **(Cognitive Knowledge Level: Analyse)**
CO 5	Evaluate the integration of SHM with emerging technologies such as Building Information Modeling (BIM), digital twins, and IoT. **(Cognitive Knowledge Level: (Evalute)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	1	-	1	1	-
CO 2	1	1	1	2	2	2
CO 3	2	1	2	3	2	2
CO 4	1	1	2	3	2	2
CO 5	2	1	3	3	2	2

Assessment Pattern

Course Name	Structural Health Monitoring		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	20	20	20
Apply	50	50	50
Analyse	30	30	30
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern :

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (6 hours)

Introduction to Structural Health Monitoring (SHM), Overview of SHM: Definition, importance, and objectives

Historical development of SHM, Basic concepts and components of SHM systems, Overview of methods and techniques used in SHM.

MODULE 2 (8 hours)

Non-destructive techniques in SHM: Overview and applications, Static and vibration-based health monitoring methods

Sensor technologies used in SHM: Types, selection criteria, and deployment strategies Introduction to SHM using Artificial Intelligence (AI): Machine learning and data-driven approaches.

MODULE 3 (8 hours)

Damage Identification and Assessment, Fundamentals of damage identification in SHM, Techniques for damage detection and localization, Damage assessment methods: Quantitative and qualitative approaches, Case studies: Examples of damage identification in real-world structures.

MODULE 4 (7 hours)

Applications of SHM in Infrastructure, SHM applications in bridges: Monitoring strategies, sensors, and case studies, SHM applications in buildings: Structural assessment, performance evaluation, and case studies, SHM in offshore structures: Challenges, sensor technologies, and case studies.

MODULE 5 (7 hours)

Applications of structural control strategies in SHM, Integration of SHM with building information modeling (BIM) and digital twins, Future trends in SHM: Smart materials, autonomous systems, and IoT integration, Challenges and opportunities in the advancement of SHM technology.

References

1. Maierhofer C, Reinhardt H and Dobmann G, Non-destructive Evaluation of Reinforced Concrete Structures: Volume 1: Deterioration Processes and Standard Test Methods, 1st Edition, Woodhead Publishing (2010).
2. Mehta P K and Monteiro P J M, Concrete: Microstructure, Properties and Materials, 4th

Edition, McGraw-Hill Education (2014).

3. Hellier C, Handbook of Non-destructive Evaluation, 3rd Edition, Mc-Graw Hill Education (2020).
4. Emmons P H, Concrete Repair and Maintenance Illustrated, 1st Edition, R.S. Means Company Inc. (2002).
5. Wieslaw Ostachowicz, Alfredo Güemes, New Trends in Structural Health Monitoring (2013).
6. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring (2010)
7. Vistasp M. Karbhari, Farhad Ansari Structural Health Monitoring of Civil Infrastructure Systems (2009).

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture
	MODULE 1	
1.1	Introduction to Structural Health Monitoring (SHM)	1
1.2	Overview of SHM: Definition, importance, and objectives	1
1.3	Historical development of SHM	1
1.4	Basic concepts and components of SHM systems	1
1.5	Overview of methods and techniques used in SHM.	2
	MODULE 2	
2.1	Non-destructive techniques in SHM: Overview and applications	1
2.2	Static and vibration-based health monitoring methods	2
2.3	Sensor technologies used in SHM: Types, selection criteria and deployment strategies	2
2.4	Introduction to SHM using Artificial Intelligence (AI): Machine learning and data-driven approaches.	3
	MODULE 3	
3.1	Damage Identification and Assessment	1
3.2	Fundamentals of damage identification in SHM	1
3.3	Techniques for damage detection and localization	2
3.4	Damage assessment methods: Quantitative and qualitative approaches	2
3.5	Case studies: Examples of damage identification in real-world structures.	2
	MODULE 4	
4.1	Applications of SHM in Infrastructure	1

4.2	SHM applications in bridges: Monitoring strategies, sensors, and case studies	2
4.3	SHM applications in buildings: Structural assessment, performance evaluation, and case studies	2
4.4	SHM in offshore structures: Challenges, sensor technologies, and case studies.	2
	MODULE 5	
5.1	Applications of structural control strategies in SHM	1
5.2	Integration of SHM with building information modeling (BIM) and digital twins	2
5.3	Future trends in SHM: Smart materials, autonomous systems, and IoT integration	2
5.4	Challenges and opportunities in the advancement of SHM technology	2

Model Question Paper

QP CODE: Pages:1

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MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2025

Course Code: **M24CE1E203C**

Course Name: **Structural Health Monitoring**

Max. Marks:60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Classify Structural Health Monitoring (SHM) systems in detail.
2. Explain the process and importance of anchor cable tests in structural health monitoring.
3. Elucidate the design principles and working mechanisms used in non-destructive testing (NDT) evaluations.
4. Compare active and passive monitoring systems with suitable examples.
5. Discuss the significance of concrete cracking, the major causes of cracking in concrete, and prevention methods.

PART B

Answer any five questions. Each question carries 8 marks.

6. Identify the techniques used for long-term health monitoring of structures.
7. Outline the procedure for assessing structural conditions in reinforced concrete (RCC) structures.
8. Interpret the failure mechanisms in structural systems and how they can be controlled.
9. Detail the procedure for assessing corrosion in the reinforcement of RCC elements.
10. Examine in detail a case study of structural failure and the lessons learned from it.
11. Discuss the use of stress history tests as a monitoring technique.
12. Assess the role of sensors and sensing technology in structural monitoring.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E203D	CONSTRUCTION PROJECT MANAGEMENT	ELECTIVE	3	0	0	3	3

Preamble: The course equips students with proficiency in project lifecycle management, advanced scheduling techniques, cost engineering, risk assessment, and quality control. This course emphasizes the practical application of industry-standard tools and methodologies, including BIM and lean construction principles.

Prerequisite : Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Develop proficiency in applying project management methodologies to effectively initiate, plan, execute, monitor, and control construction projects. (**Cognitive Knowledge Level: Apply)**
CO 2	Develop comprehensive project plans using advanced scheduling techniques. **(Cognitive Knowledge Level: Evaluate)**
CO 3	Excel in cost estimation, budgeting, and control processes, procurement strategies and contract management practices. **(Cognitive Knowledge Level: Apply)**
CO 4	Develop skills in identifying, assessing, and managing risks inherent in construction projects. (**Cognitive Knowledge Level: Analyse)**
CO 5	Apply modern construction practices, including Lean principles, Building Information Modeling to achieve sustainability in construction projects. (**Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	2	1	2	2	1
CO 2	2	2	2	2	2	2
CO 3	2	2	2	2	2	2
CO 4	2	2	1	2	2	2
CO 5	2	2	1	2	2	2

Assessment Pattern

Course Name	Construction Project Management		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	20	20	20
Apply	40	40	40
Analyse	30	30	30
Evaluate	10	10	10
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern :

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (7 hours)

Introduction: Overview of construction industry - historical development - current trends and challenges - Project Life Cycle: initiation, planning, execution, monitoring & control, and closure phases - key activities and deliverables in each phase - Roles and Responsibilities in construction projects - project stakeholders and their interests - project team structure and dynamics.

MODULE 2 (7 hours)

Project planning process - Work Breakdown Structure (WBS) - activity sequencing and network diagrams (PERT/CPM) - scheduling techniques: gantt charts, resource-constrained scheduling, resource allocation and leveling - Earned Value Management (EVM) - performance indicators and dashboards - change management processes.

MODULE 3 (8 hours)

Cost Estimation Methods: Bottom-up estimation, parametric estimation, analogous estimation - Project Budgeting: cost baseline development, budget allocation and management, variance analysis and cost control - Procurement and contract management - procurement strategies: tendering, negotiation etc. - contract types and administration - claims management and dispute resolution.

MODULE 4 (**7 hours)**

Risk Identification and Assessment: types of risks in construction projects, risk registers and matrices, qualitative and quantitative risk analysis techniques - risk response planning, - mitigation strategies - contingency planning and reserves - risk transfer and insurance - Project Quality Management: quality planning and assurance, quality control techniques, continuous improvement processes.

MODULE 5 (7 hours)

Lean Construction Principles: waste reduction techniques, lean scheduling and production control, Last Planner System (LPS) - Building Information Modeling (BIM): fundamentals, BIM implementation in project management, collaborative BIM workflows - Sustainable construction practices - environmental considerations in project management - green building certifications and standards - life cycle assessment and sustainable procurement.

References

1. Gould, Frederick, Joyce, Nancy (2014), "Construction Project Management", Pearson Education, London.
2. Hendrickson, Chris, Au, Tung (2000), "Project Management for Construction", Prentice Hall, Upper Saddle River, NJ.
3. Murdoch, John, Hughes, Will (2008), "Construction Contract Management", Taylor & Francis, London.
4. Seetharaman, S. (2014), "Construction Engineering and Management", Umesh Publications, Delhi.
5. Jha, Kumar Neeraj (2011), "Construction Project Management: Theory and Practice", Pearson Education, Delhi.
6. Schaufelberger, John, Bock, Kent D. (2017), "Risk Management in Construction Projects", ASCE Press, Reston, VA.
7. Gao, Shang, Low, Sui Pheng (2014), "Lean Construction Management: The Toyota Way", Springer, Singapore.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	**No. of Lecture**
	MODULE 1	
1.1	Overview of construction industry - historical development - current trends and challenges.	**2**
1.2	Project Life Cycle - initiation, planning, execution, monitoring & control, and closure phases - key activities and deliverables in each phase.	**3**
1.3	Roles and Responsibilities in construction projects - project stakeholders and their interests - project team structure and dynamics.	**2**
	MODULE 2	
2.1	Project planning process - Work Breakdown Structure (WBS) - activity sequencing and network diagrams (PERT/CPM) -	**2**
2.2	Scheduling techniques - gantt charts - resource-constrained scheduling, resource allocation and leveling.	**2**
2.3	Project Control and Monitoring - Earned Value Management (EVM) -	**3**

	performance indicators and dashboards - change management processes	
	MODULE 3	
3.1	Cost Estimation Methods - bottom-up estimation - parametric estimation - analogous estimation.	**2**
3.2	Project Budgeting - cost baseline development, budget allocation and management, variance analysis and cost control.	**3**
3.3	Procurement and contract management - procurement strategies - tendering, negotiation etc. - contract types and administration - claims management and dispute resolution.	**3**
	MODULE 4	
4.1	Risk Identification and Assessment - types of risks in construction projects - risk registers and matrices - qualitative and quantitative risk analysis techniques.	**3**
4.2	Risk response planning - mitigation strategies - contingency planning and reserves - risk transfer and insurance.	**2**
4.3	Project Quality Management - quality planning and assurance - quality control techniques - continuous improvement processes.	**2**
	MODULE 5	
5.1	Lean Construction Principles - waste reduction techniques - lean scheduling and production control - Last Planner System (LPS).	**3**
5.2	Building Information Modeling (BIM) – fundamentals - BIM implementation in project management - collaborative BIM workflows.	**2**
5.3	Sustainable construction practices - environmental considerations in project management - green building certifications and standards - life cycle assessment and sustainable procurement.	**2**

Model Question Paper

QP CODE: Pages: 2

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2025

Course Code: M24CE1E203D

Course Name: Construction Project Management

Max. Marks:60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Elucidate the historical development of the construction industry influenced its current trends and challenges? Provide examples of significant milestones or shifts that have shaped the industry over time.
2. Outline the Work Breakdown Structure (WBS) which contribute to effective project planning in the construction industry with suitable examples .
3. Demonstrate the methods adopted by project managers to handle claims and dispute in construction projects?
4. Discuss the importance of risk response planning in construction project management with due considerations to mitigation strategies.
5. Summarize the importance of sustainable construction practices in project management?

PART B

Answer any five questions. Each question carries 8 marks.

6. a. In what ways does project team structure and dynamics impact the success of construction projects? (4marks)

   b. How can project managers effectively manage team dynamics to optimize performance and ensure project objectives are met? (4marks)

7. a. Discuss the advantages and limitations of scheduling techniques commonly used in construction projects, including Gantt charts and resource-constrained scheduling.

(4marks)

b. How do project managers prioritize tasks and allocate resources efficiently while considering project constraints? (4marks)

8. a. Elucidate Earned Value Management (EVM), and how is it utilized in the construction industry to monitor project performance? (4marks)

b. Elaborate on key performance indicators and dashboards used in EVM, and their role in assessing project progress and identifying potential issues? (4marks)

9. a. List out various procurement strategies employed in the construction industry, including tendering and negotiation. (4marks)

b. How do project managers determine the most suitable procurement strategy for a specific project, and what are the key considerations in selecting vendors or subcontractors? (4marks)

10. a. How do bottom-up estimation, parametric estimation, and analogous estimation methods differ in their approach to cost estimation in construction projects? (4marks)

b. Can you provide examples of when each method would be most appropriate to use? (4marks)

11. a. How do project managers ensure adherence to quality standards throughout the project lifecycle? (4marks)

b. What continuous improvement processes are implemented to enhance project outcomes and stakeholder satisfaction? (4marks)

12. a. How do lean construction principles contribute to waste reduction in construction projects? (4marks)

b. Differentiate between various techniques employed in the construction industry to minimize waste. (4marks)

PROGRAMME ELECTIVE IV

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E204A	FINITE ELEMENT METHOD	ELECTIVE	3	0	0	3	3

Preamble: The course offers a systematic approach to discretize continuous systems into finite elements, and obtain approximate solutions to differential equations governing various engineering problems.

Prerequisite : Theory of Elasticity and Plasticity

Course Outcomes : After the completion of the course the student will be able to

CO1	Idealize the physical problem into a mathematical model to obtain approximate solutions. **(Cognitive Knowledge Level: Apply)**
CO2	Formulate shape functions to solve using finite element method **(Cognitive Knowledge Level: Apply)**
CO3	Derive stiffness matrices to solve various structural mechanics and continuum mechanics problems **(Cognitive Knowledge Level: Analyse)**
CO4	Achieve proficiency in isoparametric formulation, numerical integration, and their applications. **(Cognitive Knowledge Level: Evaluate)**
CO5	Develop stiffness matrix for plate bending elements and acquire a knowledge of solution techniques.**(Cognitive Knowledge Level:Apply)**

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	1	1	1	1	2	2
CO 2	1	1	2	2	1	2
CO 3	1	1	2	1	1	2
CO 4	1	1	2	2	2	2
CO 5	1	1	2	2	1	2

Assessment Pattern

Course Name	**Finite Element Method**

Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (% marks)
	Test 1 (% marks)	Test 2 (% marks)	
Remember			
Understand	10	10	10
Apply	50	50	50
Analyse	30	30	30
Evaluate	10	10	10
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern :

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (8 hours)

Historical Background – General steps of finite element method – Applications and advantages of finite element method – Computer Programs for finite element method.

Idealization of physical problem- Mathematical modelling of Engineering problems -Concept of Boundary, initial and eigen value problems – Variational methods of approximation-Rayleigh Ritz Method-Weighted residual method – Galerkin's Residual methods - method of least square.

MODULE 2 (7 hours)

Formulation of finite element problem - Generalized and natural coordinates of FEA-Shape functions-polynomials- Lagrangian and Hermitian interpolation- Strong formulation and weak formulation - Compatibility- C0 and C1 elements-convergence criteria- Conforming and non-conforming elements-Patch test.

MODULE 3 (8 hours)

Axial deformation of bars under uniformly varying loads- Definition of stiffness matrix- derivation of stiffness matrix for a spring element- derivation of stiffness matrix for a bar element - derivation of stiffness matrix for a beam element (two noded and three noded) - derivation of stiffness matrix for a CST element - derivation of stiffness matrix for a LST element- derivation of bilinear four noded rectangular element stiffness matrix.

MODULE 4 (7 hours)

Isoparametric formulation – Introduction- Isoprametric formulation of a bar element stiffness matrix – Isoparametric formulation of a plane quadrilateral element (beam) stiffness matrix- Isoparametric formulation of quadratic rectangular (Q8) element- Isoparametric formulation of serendipity element - Newton cotes and Gauss quadrature.

MODULE 5 (6 hours)

Basic concepts of plate bending- derivation of plate bending element stiffness matrix -Shear locking, reduced and selective reduced integrations; Spurious energy modes – Global assembly of element equations; Storage schemes in FEA – Banded and Skyline storage; Calculation of semi band width – node numbering for optimal bandwidth – Solution schemes in FEA – Frontal solver

References

1. Cook R D et al., Concepts and Applications of Finite Element Analysis, John Wiley & Sons, Singapore.
2. Logan D L, A First Course in Element Method, Thomson, 2007.
3. J.N. Reddy, An Introduction to Finite Element Method, Tata McGraw Hill Publishing Company Ltd., New Delhi.
4. Hutton D V, Fundamentals of Finite Element Analysis, Tata McGraw Hill Education Private Ltd. New Delhi.
5. Bathe K J, Finite Element Procedures in Engineering Analysis, Prentice Hall, New Delhi
6. Zienkiewicz O C and Taylor R W., Finite Element Method, Elsevier ButterworthHeinemann, UK
7. Y. M. Desai, T. I. Eldho, A. H. Shah, Finite Element Method with Applications in Engineering,Pearson Education India.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture
	MODULE 1	
1.1	Historical Background- General steps of finite element method – Applications and advantages of finite element method	1
1.2	Computer Programs for finite element method.	2
1.3	Idealization of physical problem- Mathematical modelling of Engineering problems	1
1.4	Concept of Boundary, initial and eigen value problems	1
1.5	Variational methods of approximation-Rayleigh Ritz Method	1
1.6	Weighted residual method	1
1.7	Method of least square methods	1
	MODULE 2	
2.1	Concept of nodes – elements	1
2.2	Generalized and natural coordinates of FEA	1
2.3	Shape functions- polynomials	1
2.4	Lagrangian and Hermitian interpolation	2
2.5	Compatibility- C0 and C1 elements	1
2.6	Conforming and non-conforming elements	1
	MODULE 3	
3.1	Definition- derivation of stiffness matrix for a spring element	1

3.2	Derivation of stiffness matrix for a bar element and equations	2
3.3	Derivation of stiffness matrix for a beam element and equations	1
3.4	Derivation of stiffness matrix for a CST element and equations	2
3.5	derivation of stiffness matrix for a LST element and equations	2
	MODULE 4	
4.1	Introduction – Isoparametric formulation of a bar element stiffness matrix	2
4.2	Isoparametric formulation of a plane quadrilateral element (beam) stiffness matrix	2
4.3	Newton- cots and Gauss quadrature	3
	MODULE 5	
5.1	Basic concepts of plate bending	1
5.2	Derivation of plate bending element stiffness matrix and equations	1
5.3	Shear locking, reduced and selective reduced integrations; Spurious energy modes	1
5.4	Global assembly of element equations; Storage schemes in FEA Banded and Skyline storage	1
5.5	Calculation of semi-band width-node numbering for optimal bandwidth	1
5.6	Solution schemes in FEA – Frontal solver	1

Model Question Paper

QP CODE: Pages: 2

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2025

Course Code: M24CE1E204A

Course Name: Finite Element Method

Max. Marks:60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Outline the general steps involved in the finite element method for solving engineering problems.

2. Distinguish between conforming and non-conforming elements in finite element analysis.

3. In what manner does the stiffness matrix reflect the behavior of a spring in finite element analysis?

4. Illustrate the concept of isoparametric formulation for a one-dimensional bar element.

5. Some elements exhibit more stiffness than they actually are. What are these problems called? Suggest and discuss remedial measures.

PART B

Answer any five questions. Each question carries 8 marks.

6. a. Elucidate the significance of idealizing a physical problem in the context of finite element analysis. (4 marks)

   b. Discuss the importance of assumptions and simplifications in mathematical modeling for finite element analysis. (4 marks)

7. Illustrate the concepts of boundary and eigenvalue problems in the domain of finite element analysis with examples. (8 marks)
8. Develop the shape functions for four noded bar element using Normalized coordinates. (8 marks)
9. Derive the stiffness matrix for a linear quadrilateral (LST) element. (8 marks)
10. Illustrate the finite element form of Galerkein's method in one dimension with an example. (8 marks)
11. Extend the process of deriving the stiffness matrix for a plane quadrilateral element (beam) using isoparametric formulation. (8 marks)
12. Derive stiffness matrix for a plate bending element. (8 marks)

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E204B	ADVANCED CONSTRUCTION TECHNIQUES	ELECTIVE	3	0	0	3	3

Preamble: The course provides an overview of current construction techniques, encompassing both traditional and advanced methodologies. It also incorporates emerging technologies to equip students with the knowledge and skills necessary to excel in the modern construction industry.

Prerequisite : Construction technology and management

Course Outcomes : After the completion of the course the student will be able to

CO 1	Gain essential knowledge and abilities to comprehend, strategize, and proficiently carry out substructure construction projects(**Cognitive Knowledge Level: Analyze)**
CO 2	Comprehend advanced concrete construction techniques for structures(**Cognitive Knowledge Level: Understand)**
CO 3	Apply steel construction principles for various structural elements and connections (**Cognitive Knowledge Level: Apply)**
CO 4	Familiarize various construction sequences for industrial buildings. (**Cognitive Knowledge Level: Apply)**
CO 5	Develop proficiency in advanced construction techniques for special structures and smart construction strategies. (**Cognitive Knowledge Level: Analyze)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	1	2	2	2	2
CO 2	2	1	2	2	2	2
CO 3	2	1	2	2	2	2
CO 4	2	1	2	2	2	2
CO 5	2	1	2	2	2	2

Assessment Pattern

Course Name	Advanced Construction Techniques		
Bloom's Category	**Continuous Internal Evaluation Tests**		**End Semester Examination (%Marks)**
	Test 1 (%Marks)	**Test 2 (%Marks)**	
Remember			
Understand	20	20	30
Apply	50	50	50
Analyse	30	30	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern :

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (8 hours)

Construction Techniques for Substructure and Earth retaining Systems - Box jacking - Pipe jacking - Under water construction of diaphragm walls and basement, tunneling techniques - Piling techniques - Driving well and caisson - sinking cofferdam - Sheet piles - Deep Excavation support system - Dewatering for underground open excavation Earth retaining systems - soil nailing, grouting, rock bolting and retaining walls.

MODULE 2 (6 hours)

Super Structure Construction- Flooring-Vacuum dewatering of concrete flooring – Concrete paving technology – Techniques of construction for continuous concreting operation in tall buildings of various shapes and varying sections – Erection techniques of tall structures -in-situ prestressing in high rise structures-Post tensioning of slab- Handling and erecting - Metal deck concrete flooring/roofing

MODULE 3 (7 hours)

Steel Construction -Shop and in-situ construction techniques, different connections -Moment resisting connection of brackets- Bolted and welded-semi-rigid connections - Types of welds – Types of rivets. High strength bolts, Clearances and Tolerances, Erection of steel structures like Bridges, Lattice towers and silos, Steel and composite construction- construction techniques for composite structures – composite beam – column construction - shear connector

MODULE 4 (7 hours)

Industrial buildings- construction techniques of braced and unbraced - Gable frames with gantry-Rigid industrial frames – Fixing and assembly of steel structures.

Prefabrication - construction, Modular coordination, Assembly and erection techniques for precast and modular structures - Handling and erection stresses.

MODULE 5 (8 hours)

Special Structures Construction sequences in sky scrapers, bow string bridges, cable stayed bridges – Launching techniques for heavy decks and box decks – support structure for heavy equipment and machinery in industries.

Introduction to Smart Construction Strategies - Building Information Modeling (BIM) - Smart Buildings and IoT Integration - 3D Printing in Construction - Robotics and Automation - Virtual and Augmented Reality (VR/AR) - Lean Construction - Integrated Project Delivery (IPD)

References

1. Lean Construction: A Guide to Applying Lean to Your Building Project, Gerhard Bosché
2. Integrated Design and Delivery Solutions, Matthijs Prins and Robert Owen
3. Das. B. M., (2010), Principles of Foundation Engineering, CL Engineering
4. Construction 4.0: An Innovation Platform for the Built Environment - Marco Casini
5. Modern Construction and Ground Engineering Equipment and Methods, Harris, F., Prentice Hall, 2013.
6. Heavy Construction – Planning, Equipment and Methods, Singh. J, Third Edition, CRC Press, 2009.
7. Construction Technology for Tall Buildings, Michael Chew Yit Lin, Singapore University Press, Singapore, 2001.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture
	MODULE 1	
1.1	Box jacking - Pipe jacking - Under water construction of diaphragm walls and basement	2
1.2	Tunneling techniques - Piling techniques	2
1.3	Driving well and caisson - sinking cofferdam - Sheet piles - Deep Excavation support system	2
1.4	Dewatering for underground open excavation.	1
1.5	Earth retaining systems - soil nailing, grouting, rock bolting and retaining walls	1
	MODULE 2	
2.1	Flooring-Vacuum dewatering of concrete flooring – Concrete paving technology	1
2.2	Techniques of construction for continuous concreting operation in tall buildings of various shapes and varying sections – Erection techniques of tall structures -	3
2.3	in-situ prestressing in high rise structures-Post tensioning of slab-Handling and erecting - Metal deck concrete flooring/roofing	2
	MODULE 3	

3.1	Shop and in-situ construction techniques, different connections -Moment resisting connection of brackets-Bolted and welded-semi-rigid connections -	2
3.2	Types of welds – Types of rivets. High strength bolts, Clearances and Tolerances	1
3.3	Erection of steel structures like Bridges, Lattice towers and silos,	2
3.4	Steel and composite construction- construction techniques for composite structures – composite beam – column construction - shear connector	2
	MODULE 4	
4.1	Construction techniques of braced and unbraced	2
4.2	Gable frames with gantry- Rigid industrial frames – Fixing and assembly of steel structures.	3
4.3	Construction, Modular coordination, Assembly and erection techniques for precast and modular structures - Handling and erection stresses	2
	MODULE 5	
5.1	Construction sequences in sky scrapers, bow string bridges, cable stayed bridges	2
5.2	Launching techniques for heavy decks and box decks – support structure for heavy equipment and machinery in industries.	2
5.3	Building Information Modeling (BIM) - Smart Buildings and IoT Integration	2
5.4	3D Printing in Construction - Robotics and Automation - Virtual and Augmented Reality (VR/AR)	1
5.5	Lean Construction - Integrated Project Delivery (IPD)	1

Model Question Paper

QP CODE: Pages: 2

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2025

Course Code: M24CE1E204B

Course Name: **Advanced Construction Techniques**

Max. Marks:60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Enlist the key considerations for ensuring alignment and minimizing ground disturbance during pipe jacking?
2. Describe the modern technologies used in concrete paving.
3. Describe the different types of welds used in steel construction.
4. Enumerate how modular coordination promote the standardization and compatibility of building components?
5. Compare and contrast different launching techniques for heavy decks and box decks.

PART B

Answer any five questions. Each question carries 8 marks.

6. Discuss the step-by-step process of constructing diaphragm walls underwater. What challenges are associated with underwater construction, and how are they mitigated?
7. Compare steel construction techniques with composite construction methods. What are the benefits and challenges of using composite structures in modern construction?
8. Describe the post-tensioning process of concrete slabs. How does post-tensioning improve the performance and service life of slabs in high-rise buildings?
9. Compare and contrast the construction techniques of braced and unbraced industrial buildings. How do these techniques influence the structural stability and load distribution?
10. How does the integration of gantry cranes affect the structural requirements and construction sequence?

11. Enumerate the construction sequences specific to bow string bridges. What are the critical steps that distinguish this construction from other bridge types?
12. Elucidate the principles of Lean Construction. How do these principles help in minimizing waste and maximizing value in construction projects?

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E204C	FORENSIC ENGINEERING IN CIVIL ENGINEERING STRUCTURES	ELECTIVE	3	0	0	3	3

Preamble: The course covers the different aspects of assessing the integrity of structures. Through a blend of theoretical knowledge and practical insights, students will learn to assess structural integrity, diagnose performance problems, and implement effective solutions.

Prerequisite : Nil

Course Outcomes : After the completion of the course the student will be able to

CO 1	Develop a thorough understanding and identification of the various causes of structural failures. **(Cognitive Knowledge Level: Analyse)**
CO 2	Diagnose distress within structural elements, utilizing a range of techniques.**(Cognitive Knowledge Level: Evaluate)**
CO 3	Evaluate various environmental challenges and natural hazards affecting structural integrity. **(Cognitive Knowledge Level: Analyse)**
CO 4	Use modern techniques of retrofitting to enhance the resilience and longevity of structures. **(Cognitive Knowledge Level: Analyse)**
CO 5	Gain practical insights into real-world instances of structural failure analysis and remediation. **(Cognitive Knowledge Level: Evaluate)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	1	1	2	1	1
CO 2	2	1	2	2	1	1
CO 3	2	1	2	2	1	1
CO 4	1	1	2	2	1	1
CO 5	1	1	2	2	1	1

Assessment Pattern

Course Name	FORENSIC ENGINEERING IN CIVIL ENGINEERING STRUCTURES		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	20	20	20
Apply	30	30	30
Analyse	40	40	40
Evaluate	10	10	10
Create			

Mark distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern :

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (7 hours)

Review of construction theory and principles, understanding performance problems and their implications, Responsibility and accountability in structural failures, Case studies illustrating lessons learned from failures, Causes of distress in structural members: design and material deficiencies, overloading.

MODULE 2 (7 hours)

Introduction to non-destructive testing (NDT) methods, Ultrasonic pulse velocity method, rebound hammer method, ASTM classifications for distress assessment, Case studies analyzing distress in single and multistorey buildings, Prediction of structural weakness using fiber optic methods.

MODULE 3 (7 hours)

Impact of corrosive, chemical, and marine environments on structures, Pollution and carbonation issues affecting durability, Damage assessment due to earthquakes and floods, Strengthening strategies for buildings as per BIS 1893 and 4326 provisions, Durability considerations for RCC structures.

MODULE 4 (8 hours)

Introduction to modern retrofitting techniques, Structural first aid and post-disaster rehabilitation approaches, Guniting, jacketing, and use of chemicals in repair, Application of polymers, Ferro cement, and fiber concretes, Rust eliminators and polymer coating for rebar protection, Foamed concrete and mortar repair for cracks, Shoring, underpinning, and pre-stressing for strengthening.

MODULE 5 (7 hours)

Analysis of building failures, including heritage and high-rise buildings, Case studies focusing on water tanks, bridges, and other structures, Examination of investigative techniques and forensic engineering principles, Lessons learned and best practices in structural failure analysis.

References

1. Robert Ratay, "Forensic Structural Engineering Handbook"
2. V. Ramachandran, "Failure Analysis of Engineering Structures: Methodology and Case Histories"
3. Robert Ratay, "Investigation of Structural Failures: A Guide for Engineers"

4. Christiane Maierhofer, "Non-Destructive Evaluation of Reinforced Concrete Structures: Non-Destructive Testing Methods"
5. Malcolm Holland, "Practical Guide to Diagnosing Structural Movement in Buildings"
6. Roberto Barros, "NDT Techniques for the Diagnosis of Concrete Structures"
7. Luca Bertolini, "Corrosion of Steel in Concrete: Prevention, Diagnosis, Repair"

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture
	MODULE 1	
1.1	Review of construction theory and principles	1
1.2	Understanding performance problems and their implications	2
1.3	Responsibility and accountability in structural failures	1
1.4	Case studies illustrating lessons learned from failures	1
1.5	Causes of distress in structural members: design and material deficiencies, overloading	2
	MODULE 2	
2.1	Visual inspection techniques for identifying distress	1
2.2	Introduction to non-destructive testing (NDT) methods	1
2.3	Ultrasonic pulse velocity method, rebound hammer method	2
2.4	ASTM classifications for distress assessment	1
2.5	Case studies analyzing distress in single and multistorey buildings	1
2.6	Prediction of structural weakness using fiber optic methods	1
	MODULE 3	
3.1	Impact of corrosive, chemical, and marine environments on structures	2
3.2	Pollution and carbonation issues affecting durability	1
3.3	Damage assessment due to earthquakes and floods	1
3.4	Strengthening strategies for buildings as per BIS 1893 and 4326 provisions	2
3.5	Durability considerations for RCC structures	1
	MODULE 4	
4.1	Introduction to modern retrofitting techniques	1
4.2	Structural first aid and post-disaster rehabilitation approaches	1
4.3	Guniting, jacketing, and use of chemicals in repair	1
4.4	Application of polymers, Ferro cement, and fiber concretes	1
4.5	Rust eliminators and polymer coating for rebar protection	1
4.6	Foamed concrete and mortar repair for cracks	1
4.7	Shoring, underpinning, and pre-stressing for strengthening	2
	MODULE 5	
5.1	Analysis of building failures, including heritage and high-rise buildings	2
5.2	Case studies focusing on water tanks, bridges, and other structures	2
5.3	Examination of investigative techniques and forensic engineering principles	2
5.4	Lessons learned and best practices in structural failure analysis	1

Model Question Paper

QP CODE: Pages: 2

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2025

Course Code: M24CE1E204C

Course Name: **Forensic Engineering in Civil Engineering Structures**

PART A

Answer all questions. Each question carries 4 marks.

1. Examine the responsibilities and accountabilities of engineers and construction managers in preventing structural failures.
2. Identify a method to the quality of concrete in a structure.
3. Outline the key considerations in damage assessment for structures affected by earthquakes and floods.
4. Discuss the use of polymer coatings in the protection of rebar.
5. Examine the forensic engineering principles applied in the examination of failed structures.

PART B

Answer any five questions. Each question carries 8 marks.

6. (a) Explain the basic principles of construction theory. How do these principles guide the design and building processes? (4 marks)

   (b) Identify and explain the common design and material deficiencies that cause distress in structural members. (4 marks)

7. (a) Discuss the ASTM classifications for distress assessment in concrete structures. How are these classifications used in practice? (4 marks)

   (b) Describe the principle and applications of the ultrasonic pulse velocity method in non-destructive testing. (4 marks)

8. (a) Discuss the impact of corrosive, chemical, and marine environments on the durability of structures. (4 marks)

   (b) Explain the importance of durability considerations in the design and maintenance of RCC structures. (4 marks)

9. (a) Provide an overview of modern retrofitting techniques used in the construction industry. (4 marks)

   (b) What is structural first aid, and how is it applied in post-disaster rehabilitation? (4 marks)

10. Analyze a case study of a building failure, focusing on either a heritage or a high-rise building What were the key factors leading to the failure?

11. Illustrate how ASTM standards guide the evaluation of distressed concrete structures through a case study.

12. (a) Compare and contrast the effects of design deficiencies and material deficiencies on structural integrity. (4 marks)

    (b) Provide an example of a structure that failed due to overloading. Discuss the key factors that led to the failure. (4 marks)

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24CE1E204D	EARTHQUAKE RESISTANT DESIGN OF STRUCTURES	ELECTIVE	3	0	0	3	3

Preamble: The course offers a comprehensive understanding of the fundamental principles behind the earthquake-resistant design of structures. It introduces engineering aspects of earthquakes, including their characterization and impacts. The syllabus encompasses the design and detailing in accordance with the Indian Standards. Additionally, the course covers earthquake-resistant construction techniques for masonry structures and methods for retrofitting existing buildings.

Prerequisite: An understanding of structural dynamics and design of concrete structures is preferable

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the fundamentals of earthquake occurrence, its effects and the engineering aspects of earthquake resistance. **(Cognitive Knowledge Level: Understand)**
CO 2	Analysis and design of earthquake-resistant structures. **(Cognitive Knowledge Level: Apply)**
CO 3	Analyze real-life structures using static and dynamic seismic analysis techniques to evaluate the seismic forces acting on them. **(Cognitive Knowledge Level: Analyze)**
CO 4	Apply construction techniques for earthquake resistance in masonry and reinforced concrete structure. **(Cognitive Knowledge Level: Apply)**
CO 5	Execute seismic response reduction, repair and rehabilitation techniques for existing buildings. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	1	2	1	1	1
CO 2	2	1	2	2	2	
CO 3	1	1	2	3	2	2
CO 4	1	1	2	3	3	1
CO 5	1		3	3	3	1

Assessment Pattern

Course Name	Earthquake Resistant Design of Structures		
Bloom's Category	Continuous Internal Evaluation Tests		End Semester Examination (% marks)
	Test 1 (% marks)	Test 2 (% marks)	
Remember			
Understand	20	20	20
Apply	50	50	50
Analyse	30	30	30
Evaluate			
Create			

Mark distribution

Total Marks	CIE Marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern :

Micro project/Course based project : 10 marks

Course based task/Seminar/Quiz : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (7 hours)

Introduction to earthquakes and earthquake engineering, Mechanism of earthquake, seismic waves, effects of earthquakes. Measurement of earthquakes, intensity and magnitude and seismographs. Strong motion characteristics, response spectrum, , Design spectrum, construction of tripartite response spectrum.

MODULE 2 (7 hours)

Effect of architectural features and structural irregularities. Damages of structures during past earthquakes, principles of earthquake resistant construction.

Philosophy of earthquake resistant design. Code provisions as per IS: 1893-2016 and IS: 4326.

MODULE 3 (8 hours)

Codal provisions for calculation of seismic force. Design coefficients. Design seismic force calculation in multi storied frames by equivalent static method. Dynamic method of analysis. Mode shapes. Response spectrum method for calculator of seismic force. .

MODULE 4 (8 hours)

Torsion – code provisions, Design and detailing for earthquake resistance – Discussion of code provisions in IS 13920

Ductility – Significance, Ductility factors. Ductile detailing considerations as per IS:13920. Reinforcement detailing in joints.

Repair and rehabilitation, Response reduction techniques, Base isolation.

MODULE 5 (6 hours)

Masonry Buildings:- Performance during earthquakes, Methods of improving performance of masonry walls, box action, influence of openings, role of horizontal and vertical bands, rocking of masonry piers.

References

1. Bruce A. Bolt, “Earth quakes”, W.H. Freeman and Company, New York
2. Steven L. Kramer, “Geotechnical Earthquake Engineering”, Pearson Education, India.
3. S. K. Duggal, “Earthquake Resistant Design of Structures”, Oxford University Press, New Delhi.

4. Pankaj Agarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall of India Private Limited, New Delhi, India.
5. Anil K. Chopra, "Dynamics of Structures". Theory and Applications to Earthquake Engineering, Pearson Education, India.
6. Datta T.K., "Seismic Analysis of Structures", John Wiley & Sons (Asia) Pte. Ltd.
7. Murthy C. V. R, "Earthquake tips, Building Materials and Technology Promotion Council", NewDelhi, India.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture
	Module 1	
1.1	Earthquakes, Mechanism, Elastic rebound theory. Seismic waves, Effects of earthquakes	3
1.2	Size of earthquake – intensity & magnitude, concept of Richter scale, saturation, moment magnitude. Measurement of earthquakes – seismographs and accelerograph	2
1.3	Strong motion characteristics, response spectrum, Characteristics of response spectrum, design spectrum, construction of tripartite response spectrum	2
	Module 2	
2.1	Structural irregularities, Effect of architectural features, Damages during past earthquakes.	3
2.2	Concept of capacity design, Strong Column and weak beam	2
2.3	Philosophy of earthquake resistant construction. Principle of earthquake resistant construction	2
	Module 3	
3.1	Seismic force computation using IS code provisions	2
3.2	Static method of analysis	2
3.3	Response spectrum analysis – theoretical aspects,	2
3.4	Seismic force computation using Response spectrum method	2
	Module 4	
4.1	Torsion – code provisions	1
4.2	Ductility – significance in earthquake resistant design, Ductility factors.	1
4.3	Ductile detailing considerations as per IS:13920	2
4.4	Detailing of structural members & joints	1
4.5	Repair and retrofitting of RCC structures	1
4.6	Response reduction techniques, Base isolation	2
	Module 5	
5.1	Performance of masonry structures during earthquakes	2
5.2	Methods of improving, box action, influence of openings, role of horizontal and vertical bands, rocking of masonry piers.	2
5.3	Repair and retrofitting of masonry structures	2

Model Question Paper

QP CODE: Pages: 2

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2025

Course Code: M24CE1E204D

***Course Name:* EARTHQUAKE RESISTANT DESIGN OF STRUCTURES**

Max. Marks:60 Duration: 3 hours

PART A

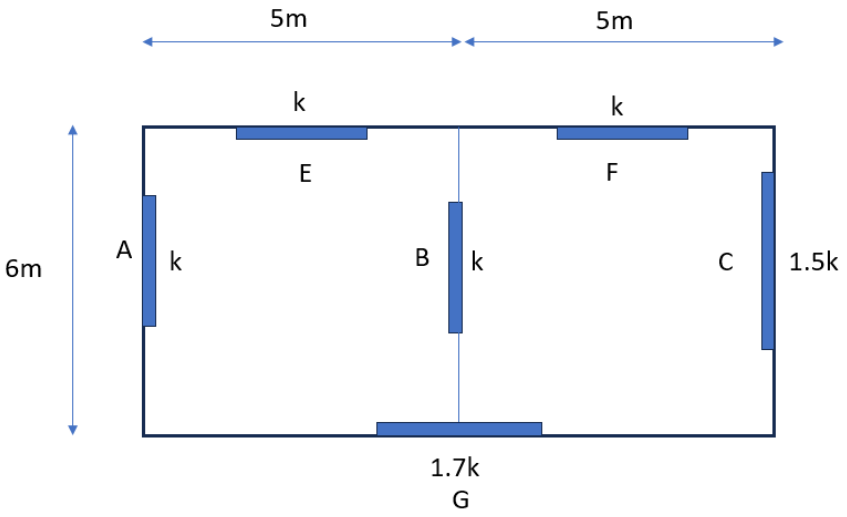
Answer all questions. Each question carries 4 marks.

1. What seismic hazards can be anticipated from an earthquake in a hilly area?
2. How is the design spectrum developed, and how does it assist in earthquake analysis?
3. Explain the influence of earthquakes in buildings with vertical and horizontal irregularities.
4. How does the ductility of a structure impact its response to an earthquake?
5. Describe the techniques for retrofitting the RCC beam of a 60-year-old building to withstand earthquakes.

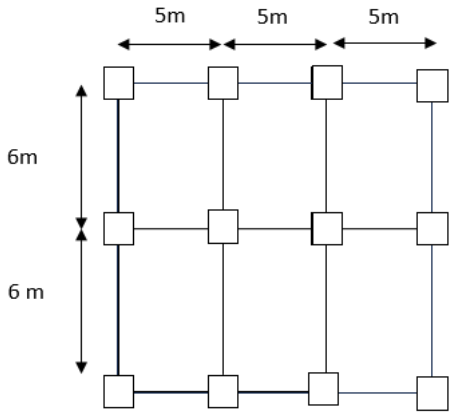
PART B

Answer any 5 questions, each question carries 8 marks.

6. How do we represent the energy released and impact of an earthquake? Which scales are employed to illustrate these factors?
7. How does a soft storey influence the response of structure during earthquake?
8. Find out the force resisted by the walls in shear in a single storeyed building with shear walls as shown in figure below, given below. All walls having the same thickness and centre of mass are at the geometric center of the building. The earthquake load is 180kN in the X-direction and 110kN in the Y-direction. Assume that mass is uniformly distributed.



9. The plan and elevation of a typical frame of a four storied residential framed building shown in figure below. The size of the columns are same. The lumped weight due to Dead loads is 13kN/m2 on floors and 10kN/m2 on roof and an imposed load of 4kN/m2 and 1.5kN/m2 on floor and roof respectively. Determine the lateral design load on the structure.



10. Describe the various aspects of ductile detailing for beams, columns, and joints in an RC framed structure, complemented by a clear diagram.
11. What are your suggested measures for seismic response reduction in a multi-story RCC hospital structure located in Bhuj, Gujarat, India (Zone 5)?
12. How does having an open ground floor in a multi-story building affect its behaviour during seismic events?

KNOWLEDGE IS POWER