Course code	Course Name	L-T-P - Credits	Year of Introduction
**341	DESIGN PROJECT	0-1-2-2	2016

Prerequisite : Nil

Course Objectives

- To understand the engineering aspects of design with reference to simple products
- To foster innovation in design of products, processes or systems
- To develop design that add value to products and solve technical problems

Course Plan

Study : Take minimum three simple products, processes or techniques in the area of specialisation, study, analyse and present them. The analysis shall be focused on functionality, strength, material, manufacture/construction, quality, reliability, aesthetics, ergonomics, safety, maintenance, handling, sustainability, cost etc. whichever are applicable. Each student in the group has to present individually; choosing different products, processes or techniques.

Design: The project team shall identify an innovative product, process or technology and proceed with detailed design. At the end, the team has to document it properly and present and defend it. The design is expected to concentrate on functionality, design for strength is not expected.

Note : The one hour/week allotted for tutorial shall be used for discussions and presentations. The project team (not exceeding four) can be students from different branches, if the design problem is multidisciplinary.

Expected outcome.

The students will be able to

i. Think innovatively on the development of components, products, processes or technologies in the engineering field
ii. Analyse the problem requirements and arrive workable design solutions

Reference:

Michael Luchs, Scott Swan, Abbie Griffin, 2015. Design Thinking. 405 pages, John Wiley & Sons, Inc

Evaluation

First evaluation (Immediately after first internal examination) 20 marks
Second evaluation (Immediately after second internal examination) 20 marks
Final evaluation (Last week of the semester) 60 marks

Note: All the three evaluations are mandatory for course completion and for awarding the final grade.

Course code	Course Name	L-T-P - Credits	Year of Introduction
**352	Comprehensive Examination	0-1-1-2	2016
Prerequisite : Nil			

Course Objectives

- To assess the comprehensive knowledge gained in basic courses relevant to the branch of study
- To comprehend the questions asked and answer them with confidence.

Assessment

Oral examination – To be conducted by the college (@ three students/hour) covering all the courses up to and including V semester– 50 marks

Written examination - To be conducted by the Dept. on the date announced by the University– common to all students of the same branch – objective type (1 hour duration)– 50 multiple choice questions (4 choices) of 1 mark each covering the six common courses of S1&S2 and six branch specific courses listed – questions are set by the University - no negative marks – 50 marks.

Note: Both oral and written examinations are mandatory. But separate minimum marks is not insisted for pass. If a students does not complete any of the two assessments, grade I shall be awarded and the final grade shall be given only after the completion of both the assessments.

The two hours allotted for the course may be used by the students for discussion, practice and for oral assessment.

Expected outcome.

- The students will be confident in discussing the fundamental aspects of any engineering problem/situation and give answers in dealing with them

Course code	Course Name	L-T-P - Credits	Year of Introduction
**451	Seminar and Project Preliminary	0-1-4-2	2016
Prerequisite : Nil			

Course Objectives

- To develop skills in doing literature survey, technical presentation and report preparation.
- To enable project identification and execution of preliminary works on final semester project

Course Plan

Seminar: Each student shall identify a topic of current relevance in his/her branch of engineering, get approval of faculty concerned, collect sufficient literature on the topic, study it thoroughly, prepare own report and present in the class.

Project preliminary:

Identify suitable project relevant to the branch of study. Form project team (not exceeding four students). The students can do the project individually also. Identify a project supervisor. Present the project proposal before the assessment board (excluding the external expert) and get it approved by the board.

The preliminary work to be completed: (1) Literature survey (2) Formulation of objectives (3) Formulation of hypothesis/design/methodology (4) Formulation of work plan (5) Seeking funds (6) Preparation of preliminary report

Note: The same project should be continued in the eighth semester by the same project team.

Expected outcome.

The students will be able to

i. Analyse a current topic of professional interest and present it before an audience
ii. Identify an engineering problem, analyse it and propose a work plan to solve it.

Evaluation

Seminar : **50 marks**

(Distribution of marks for the seminar is as follows: i. Presentation : 40% ii. Ability to answer questions : 30% & iii. Report : 30%)

Project preliminary : **50 marks**(Progress evaluation by the supervisor : 40% and progress evaluation by the assessment board excluding external expert : 60%. Two progress evaluations, mid semester and end semester, are mandatory.)

Note: All evaluations are mandatory for course completion and for awarding the final grade.

Course code	Course Name	Credits	Year of Introduction
**492	PROJECT	6	2016

Prerequisite : Nil

Course Objectives

- To apply engineering knowledge in practical problem solving
- To foster innovation in design of products, processes or systems
- To develop creative thinking in finding viable solutions to engineering problems

Course Plan

In depth study of the topic assigned in the light of the preliminary report prepared in the seventh semester
Review and finalization of the approach to the problem relating to the assigned topic
Preparing a detailed action plan for conducting the investigation, including team work
Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed
Final development of product/process, testing, results, conclusions and future directions
Preparing a paper for Conference presentation/Publication in Journals, if possible
Preparing a report in the standard format for being evaluated by the dept. assessment board
Final project presentation and viva voce by the assessment board including external expert

Expected outcome

The students will be able to

iii. Think innovatively on the development of components, products, processes or technologies in the engineering field
iv. Apply knowledge gained in solving real life engineering problems

Evaluation

Maximum Marks : 100

(i) Two progress assessments	20% by the faculty supervisor(s)
(ii) Final project report	30% by the assessment board
(iii) Project presentation and viva voce	50% by the assessment board

Note: All the three evaluations are mandatory for course completion and for awarding the final grade.

University Examination Pattern
PART A: Analytical/problem solving SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.
PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.
Maximum Total Marks: 100

CE 14 806 (P): Seminar

Conducting schedule **Credits: 2**
3 hours presentations per week

Objective
To measure as well as flourish the ability of the student to study a topic, in Civil Engineering, of current relevance, from technical literature and present a seminar on that topic. Individual students should be asked to choose a topic in any field of civil engineering, preferably from outside the B. Tech syllabus and give a seminar on that topic for about thirty minutes. It enables the students to gain knowledge in any of the technically relevant current topics and acquire the confidence in presenting the topic. The student will undertake a detailed study on the chosen topic under the supervision of a faculty member, by referring papers published in reputed journals and conferences. Each student has to submit a seminar report (in two copies), based on these papers; the report must not be reproduction of any original paper. A committee consisting of three/four faculty members (preferably specialized in various sub-fields of Civil Engineering) will evaluate the seminar. One of the two copies submitted by the student should be returned to him/her after duly certifying it by the staff in charge of the seminar and Head of the department and the other copy shall be kept in the departmental library.

Internal Continuous Assessment
20% - Relevance of the topic and literature survey
50% - Presentation and discussion
20% - Report
10% - Regularity in the class and Participation in the seminar

CE 14 807 (P): Project

Teaching scheme **Credits:4**
7 hour per week

The project work started in the seventh semester will continue in this semester. The students should complete the project work in this semester and present it to the assessing committee (as constituted in the seventh semester). The performance of the students in the project work shall be assessed on a continuous basis by the project evaluation committee through „progress seminars. And demonstrations conducted during the semester. Each project group should maintain a log book of activities of the project. It should have entries related to the work done, problems faced, solution evolved etc.There shall be at least an Interim Evaluation and a final evaluation of the project in the 8th semester. Each project group has to submit an interim report in the prescribed format for the interim evaluation. Each student is expected to prepare a report in the prescribed format, for final evaluations based on the project work. Members of the project group will present the relevance, design, implementation, and results of the project to the project evaluation committee. Each group will submit the copies of the completed project report signed by the guide to the department. The head of the department will certify the copies and return them to the students. One copy will be kept in the departmental library and one by the respective guide. The assessment committee and project guides will award the marks for the individual students in a project as follows: 50% of the marks is to be awarded by the guide and 50% by the evaluation committee.

CS14 708(P) : Project

Teaching scheme **Credits**: 4

3 hours Practicals per week

Objectives

- *To judge the capacity of the students in converting the theoretical knowledge into practical systems/investigative analysis.*

Project work is for duration of two semesters and is expected to be completed in the eighth semester. Each student group consisting of not more than five members is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The project may be implemented using software, hardware, or a combination of both. The project work may be undertaken in computer science engineering or allied areas like -

OS platforms: relevant to the current state of the art with support for networked environment, distributed computing and development of multi-platform applications, Internet technologies: Architectural concepts, XML, Scripting languages, Middle-ware (Component) technologies, Front end / GUI: Code development or development based on tools, RDBMS/Back End: Relevant to current state with database connectivity to different platforms, Languages: Qt, Glade or any similar 4GLs, Scripting languages and C & C-Linux (under GNU gcc) etc, Universal network applications development platforms such as JAVA, OS internals: Device drivers, RPC, Threads, Socket programming etc., Networking: Mechanisms, protocols, security etc., Embedded systems: RTOS, Embedded hardware with software for an application,Code optimization, security etc.

Project evaluation committee consisting of the guide and three/four faculty members specialised in computer science & engg. will perform the screening and evaluation of the projects.

Each project group should submit project synopsis within three weeks from start of seventh semester. Project evaluation committee shall study the feasibility of each project work before giving consent. Design is to be completed in the seventh semester.

Students should execute the project work using the facilities of the institute. However, external projects can be taken up in reputed industries, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the head of department before taking up external project work and there must be an internal guide for such projects.

Each student has to submit an interim report of the project at the end of the 7th semester. Members of the group will present the project details and progress of the project before the committee at the end of the 7th semester.

CS14 807 (P) : Project

Teaching scheme
Credits: 4

7 hours practical per week

Objectives

- *To estimate the ability of the student in transforming the theoretical knowledge studied so far into a working model of a computer / information system.*

This project work is the continuation of the project initiated in seventh semester. The performance of the students in the project work shall be assessed on a continuous basis by the project evaluation committee through progress seminars and demonstrations conducted during the semester. Each project group should maintain a log book of activities of the project. It should have entries related to the work done, problems faced, solution evolved etc.

There shall be at least an Interim Evaluation and a final evaluation of the project in the 8th semester. Each project group has to submit an interim report in the prescribed format for the interim evaluation.

Each project group should complete the project work in the 8th semester. Each student is expected to prepare a report in the prescribed format, based on the project work. Members of the group will present the relevance, design, implementation, and results of the project before the project evaluation committee comprising of the guide, and three/four faculty members specialized in computer science and engineering.

50% of the marks is to be awarded by the guide and 50% by the evaluation committee.

Internal Continuous Assessment:

40%- Development/ Simulation and Analysis

30%- Presentation & Demonstration of results

20%- Report

10%- Regularity in the class

EC14 708 (P) PROJECT

Teaching scheme **Credit:** 4

4 hours practical per week

Objectives

- *To judge the capacity of the students in converting the theoretical knowledge into practical systems/investigative analysis.*

Project work is for duration of two semesters and is expected to be completed in the eighth semester. Each student group consisting of not more than five members is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The project may be implemented using software, hardware, or a combination of both. The project work may be undertaken in electronics/ communication / computer / instrumentation / biomedical engineering or any allied area and must have relevance in electronics and communication engineering. Project evaluation committee consisting of the guide and three/four faculty members specialised in the above field shall perform the screening and evaluation of the projects.

Each project group should submit project synopsis within three weeks from start of seventh semester. Project evaluation committee shall study the feasibility of each project work before giving consent. Literature survey and 40% of the work has to be completed in the seventh semester.

Students should execute the project work using the facilities of the institute. However, external projects can be taken up in reputed industries, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the head of department before taking up external project work and there must be an internal guide for such projects.

Each student has to submit an interim report of the project at the end of the 7^{th} semester. Members of the group will present the project details and progress of the project before the committee at the end of the 7^{th} semester.

50% of the mark is to be awarded by the guide and 50% by the evaluation committee.

Internal Continuous Assessment
20% - Technical relevance of the project
40% - Literature survey and data collection
20% - Progress of the project and presentation
10% - Report
10% - Regularity in the class

EC14 807 (P) PROJECT

Teaching scheme **Total Credits:** 4

7 hours practical per week Credits for interim evaluation: 2

Credits for final evaluation: 2

Objectives

- *To estimate the ability of the student in transforming the theoretical knowledge studied so far into a working model or a system.*

This project work is the continuation of the project initiated in seventh semester. The performance of the students in the project work shall be assessed on a continuous basis by the project evaluation committee through progress seminars and demonstrations conducted during the semester. Each project group should maintain a log book of activities of the project. It should have entries related to the work done, problems faced, solution evolved etc.

There shall be at least an Interim Evaluation and a final evaluation of the project in the 8^{th} semester. Each project group has to submit an interim report in the prescribed format for the interim evaluation.

Each project group should complete the project work in the 8^{th} semester. Each student is expected to prepare a report in the prescribed format, based on the project work. Members of the group will present the relevance, design, implementation, and results of the project before the project evaluation committee comprising of the guide, and three/four faculty members specialised in electrical power system / machines/ electronics/ computer/ instrumentation/ biomedical Engg. etc.

50% of the mark is to be awarded by the guide and 50% by the evaluation committee.

Internal Continuous Assessment *(Maximum Marks - 100)*
40% - Design and development/Simulation and analysis
30% - Presentation & demonstration of results
20% - Report
10% - Regularity in the class

EE14 708 (P) PROJECT

Teaching scheme **Credit:** 4
4 hour practical per week

Objectives

- *To judge the capacity of the students in converting the theoretical knowledge into practical systems/investigative analysis.*

Project work is for duration of two semesters and is expected to be completed in the eighth semester. Each student group consisting of not more than five members is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The project may be implemented using software, hardware, or a combination of both. The project work may be undertaken in electrical power systems / machines/ electronics / computer / instrumentation / biomedical engineering or any allied area and must have relevance in electrical or electronics engineering. Project evaluation committee consisting of the guide and three/four faculty members specialised in the above field shall perform the screening and evaluation of the projects.

Each project group should submit project synopsis within three weeks from start of seventh semester. Project evaluation committee shall study the feasibility of each project work before giving consent. Literature survey and 40% of the work has to be completed in the seventh semester.

Students should execute the project work using the facilities of the institute. However, external projects can be taken up in reputed industries, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the head of department before taking up external project work and there must be an internal guide for such projects.

Each student has to submit an interim report of the project at the end of the 7th semester. Members of the group will present the project details and progress of the project before the committee at the end of the 7th semester.

50% of the mark is to be awarded by the guide and 50% by the evaluation committee.

Internal Continuous Assessment
20% - Technical relevance of the project
40% - Literature survey and data collection
20% - Progress of the project and presentation
10% - Report
10% - Regularity in the class

EE14 807 (P) PROJECT

Teaching scheme
4 hours practical per week

Total Credits: 4
Credits for interim evaluation: 4
Credits for final evaluation: 4

Objectives

- *To estimate the ability of the student in transforming the theoretical knowledge studied so far into a working model or a system.*

This project work is the continuation of the project initiated in seventh semester. The performance of the students in the project work shall be assessed on a continuous basis by the project evaluation committee through progress seminars and demonstrations conducted during the semester. Each project group should maintain a log book of activities of the project. It should have entries related to the work done, problems faced, solution evolved etc.

There shall be at least an Interim Evaluation and a final evaluation of the project in the 8th semester. Each project group has to submit an interim report in the prescribed format for the interim evaluation.

Each project group should complete the project work in the 8th semester. Each student is expected to prepare a report in the prescribed format, based on the project work. Members of the group will present the relevance, design, implementation, and results of the project before the project evaluation committee comprising of the guide and three/four faculty members specialised in electrical power system / machines/electronics / power electronics/ computer/ instrumentation/ biomedical Engg. etc.

50% of the mark is to be awarded by the guide and 50% by the evaluation committee.

Internal Continuous Assessment *(Maximum Marks - 50)*
40% - Design and development/Simulation and analysis
30% - Presentation & demonstration of results
20% - Report
10% - Regularity in the class

End semester Examination *(Maximum Marks - 100)*
Report Evaluation by external examiner: 50 marks
Presentation evaluated by external / internal examiner: 50 marks

CE09 709(P): PROJECT

Teaching scheme **Credits: 1**
1 hour per week

Objective

- *To develop the capacity of the students in converting the theoretical knowledge into practical systems either to perform creative works or to perform analysis and hence to suggest solutions to problems, pertaining to Civil Engineering domain.*

Project work is of duration of two semesters and is expected to be completed in the eighth semester. Each student group consisting of not more than five members is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The project work can be a planning and / or design project, experimental project, field surveying or computer application based project on any of the topics of civil engineering interest. HOD will frame the rules for forming batches. If required, HOD can combine project hours of many weeks together and allot a maximum of 4 weeks exclusively for project. The project batches are expected to fix their topics, complete preliminary studies like literature survey, field measurements etc. in the seventh semester.

Each project group should submit project synopsis within three weeks from start of seventh semester. Project evaluation committee consisting of three or four faculty members specialised in the various fields of civil engineering, shall study the feasibility of each project work before giving consent.

As far as possible, students should execute the project work using the facilities of the institute. However, external projects can be taken up in government departments/institutions, reputed construction industries, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the head of department before taking up external project work and there must be an internal guide for such projects.

The assessment of all the projects should be done at the end of the seventh semester by the project evaluation committee formed as mentioned earlier. The students will present their project details and progress of their project to the committee. The complete project report is not expected at the end of the seventh semester. However, a three-four page typed report based on the work done should be submitted by each student to the assessing committee. The assessment committee and project guides will award the marks for the individual students in a project as follows:
50% of the marks is to be awarded by the guide and 50% by the evaluation committee.

CS09 608(P) : MINI PROJECT

Teaching scheme **Credits:** 2
3 hours practical per week

Objectives

- *To estimate the ability of the student in transforming the theoretical knowledge studied so far into a working model of a computer / information system.*
- *For enabling the students to gain experience in organisation and implementation of a small project and thus acquire the necessary confidence to carry out main project in the final year.*

In this practical course, each group consisting of three/four members is expected to design and develop a moderately complex computer / information system with practical applications; this should be a working model. The basic concepts of product design may be taken into consideration while designing the project. A committee consisting of minimum three faculty members specialised in computer science and engineering will perform assessment of the mini project. Students have to submit a report on the mini project and demonstrate the mini project before the evaluation committee.

The division of the total marks is into two namely, 60% of the total marks to be awarded by the guide / Co-ordinator and the remaining 40% by the evaluation committee.

Internal Continuous Assessment *(50 marks)*
40% - Design and development
30% - Final result and Demonstration
20% - Report
10% - Regularity in the class

Semester End Examination *(Maximum Marks-50)*

20% - Demonstration of mini project
50% - Practical test connected with mini project
20% - Viva voce
10% - Fair record

CS09 709 (P) : PROJECT

Teaching scheme **Credits:** 2
3 hours practical per week

Objectives

- *To judge the capacity of the students in converting the theoretical knowledge into practical systems/investigative analysis.*

Project work is for duration of two semesters and is expected to be completed in the eighth semester. Each student group consisting of not more than five members is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The project may be implemented using software, hardware, or a combination of both. The project work may be undertaken in computer science engineering or allied areas like -

OS platforms: Relevant to the current state of the art with support for networked environment, distributed computing and development of multi-platform applications, Internet technologies: Architectural concepts, XML, Scripting languages, Middleware (Component) technologies, Front end / GUI: Code development or development based on tools, RDBMS/Back End: Relevant to current state with database connectivity to different platforms, Languages: Qt, Glade or any similar 4GLs, Scripting languages and C & C-Linux (under GNU gcc) etc, Universal network applications development platforms such as JAVA, OS internals: Device drivers, RPC, Threads, Socket programming etc.,Networking: Mechanisms, protocols, security etc., Embedded systems: RTOS, Embedded hardware with software for an application,Code optimization, security etc.

Project evaluation committee consisting of the guide and three/four faculty members specialised in biomedical/electronics/ computer science/instrumentation engg. (Please write areas of specialisations relevant to the concerned branch concerned) will perform the screening and evaluation of the projects.

Each project group should submit project synopsis within three weeks from start of seventh semester. Project evaluation committee shall study the feasibility of each project work before giving consent. Literature survey is to be completed in the seventh semester.

Students should execute the project work using the facilities of the institute. However, external projects can be taken up in reputed industries, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the head of department before taking up external project work and there must be an internal guide for such projects.

Each student has to submit an interim report of the project at the end of the 7th semester. Members of the group will present the project details and progress of the project before the committee at the end of the 7th semester.

50% of the marks is to be awarded by the guide and 50% by the evaluation committee.

Internal Continuous Assessment

20% - Technical relevance of the project	:
40% - Literature survey and data collection	
20% - Progress of the project and presentation	:
10% - Report	
10% - Regularity in the class	

EC09 608(P) : MINI PROJECT

Teaching scheme **Credits:** 2
3 hours practical per week

Objectives

- *To estimate the ability of the student in transforming the theoretical knowledge studied so far into a working model of an electronic system.*
- *For enabling the students to gain experience in organisation and implementation of a small project and thus acquire the necessary confidence to carry out main project in the final year.*

In this practical course, each group consisting of three/four members is expected to design and develop a moderately complex electronic system with practical applications; this should be a working model. The basic concepts of product design may be taken into consideration while designing the project. A committee consisting of minimum three faculty members specialised in Electronics Engineering will perform assessment of the mini project. Students have to submit a report on the mini project and demonstrate the mini project before the evaluation committee.

60% of the total marks to be awarded by the guide/Co-ordinator and the remaining 40% by the evaluation committee.

Internal Continuous Assessment *(*50 marks)
40% - Design and development
30% - Final result and Demonstration
20% - Report
10% - Regularity in the class

University Examination Pattern *(*Maximum Marks-50)
20% - Demonstration of mini project
50% - Practical test connected with mini project
20% - Viva voce
10% - Fair record

PART B

7. P and NMOS transistors - I_D-V_{DS} Characteristics – extraction of V_T and body effect factor
8. DC transfer characteristics of an inverter
9. Buffer & Ring Oscillator
10. XOR using different logic styles - comparison
11. Single stage CS amplifiers - their responses for different types of load
12. Single stage source follower - their responses for different types of load
13. Current mirror circuits

Notes

(i) A minimum of **10** experiments must be conducted, at least four from each part

(ii) Experiments in part – B should include lay out of at least two circuits and their verification.

Internal Continuous Assessment (Maximum Marks-50)

60% - Laboratory practical and record
30% - Test/s
10% - Regularity in the class

University Examination *(*Maximum Marks-50*)*

70% - Procedure and tabulation form, Conducting experiment, results and inference
20% - Viva voce
10% - Fair record

EC09 709(P): PROJECT

Teaching scheme **Credit:** 1

1 hour practical per week

Objectives

To judge the capacity of the students in converting the theoretical knowledge into practical systems/investigative analysis.

Project work is for duration of two semesters and is expected to be completed in the eighth semester. Each student group consisting of not more than five members is expected to design and

develop a complete system or make an investigative analysis of a technical problem in the relevant area. The project may be implemented using software, hardware, or a combination of both. The project work may be undertaken in Electronics/Communication/ Computer science or any allied area. Project evaluation committee consisting of the guide and three/four faculty members specialised in Electronics/ Communication/ Computer science Engg. will perform the screening and evaluation of the projects.

Each project group should submit project synopsis within three weeks from start of seventh semester. Project evaluation committee shall study the feasibility of each project work before giving consent. Literature survey is to be completed in the seventh semester.

Students should execute the project work using the facilities of the institute. However, external projects can be taken up in reputed industries, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the head of department before taking up external project work and there must be an internal guide for such projects.

Each student has to submit an interim report of the project at the end of the 7^{th} semester. Members of the group will present the project details and progress of the project before the committee at the end of the 7^{th} semester.

50% of the marks is to be awarded by the guide and 50% by the evaluation committee.

Internal Continuous Assessment

20% - Technical relevance of the project	:
40% - Literature survey and data collection	
20% - Progress of the project and presentation	:
10% - Report	
10% - Regularity in the class	

EE09 608 (P) MINI PROJECT

Teaching scheme **Credits:** 2
3 hours practical per week

Objectives

- *To estimate the ability of the student in transforming the theoretical knowledge studied so far into a working model of an electrical/electronic system.*
- *For enabling the students to gain experience in organisation and implementation of a small project and thus acquire the necessary confidence to carry out main project in the final year.*

In this practical course, each group consisting of three/four members is expected to design and develop a moderately complex electrical/electronic system with practical applications; this should be a working model. The basic concepts of product design may be taken into consideration while designing the project. A committee consisting of minimum three faculty members will perform assessment of the mini project. Students have to submit a report on the mini project and demonstrate the mini project before the evaluation committee.
50% of the total marks to be awarded by the guide/Co-ordinator and the remaining 50% by the evaluation committee.

Internal Continuous Assessment *(Maximum marks - 50)*
40% - Design and development
30% - Final result and Demonstration
20% - Report
10% - Regularity in the class

Semester End Examination *(Maximum Marks-50)*

20% - Demonstration of mini project
50% - Practical test connected with mini project
20% - Viva voce
10% - Final Report

EE09 709 (P) PROJECT

Teaching scheme **Credit:** 1

1 hour practical per week

Objectives

- *To judge the capacity of the students in converting the theoretical knowledge into practical systems/investigative analysis.*

Project work is for duration of two semesters and is expected to be completed in the eighth semester. Each student group consisting of not more than five members is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The project may be implemented using software, hardware, or a combination of both. The project work may be undertaken in electrical power systems / machines/ electronics / computer / instrumentation / biomedical engg. or any allied area and must have relevance in electrical or electronics engineering. Project evaluation committee consisting of the guide and three/four faculty members specialised in the above field. will perform the screening and evaluation of the projects.

Each project group should submit project synopsis within three weeks from start of seventh semester. Project evaluation committee shall study the feasibility of each project work before giving consent.
Students should execute the project work using the facilities of the institute. However, external projects can be taken up in reputed industries, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the head of department before taking up external project work and there must be an internal guide for such projects.
Each student has to submit an interim report of the project at the end of the 7th semester. Members of the group will present the project details and progress of the project before the committee at the end of the 7th semester.

50% of the mark is to be awarded by the guide and 50% by the evaluation committee.

Internal Continuous Assessment

20% - Technical relevance of the project :
40% - Literature survey and data collection
20% - Progress of the project and presentation :
10% - Report
10% - Regularity in the class

ME09 607(P): Mini Project

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To practise the steps involved for the selection, execution, and reporting of the project.*
- *To train the students for group activities to accomplish an engineering task.*

A team of students having a maximum of five members shall constitute a batch for the mini-project. The head of the department will decide the framing of the project batches. The subject content of the mini project shall be from emerging /thrust areas, topics of current relevance having research aspects or shall be based on industrial visits undergone in 4th, 5th semesters. At the end of the semester, each group of students should submit a report duly authenticated by the respective guide, to the head of the department.

Mini Project will have internal marks 50 and Semester-end examination marks 50. Internal marks will be awarded by respective guides as per the stipulations given below.

- Attendence, regularity and individual contribution of each student (20 marks)
- Individual evaluation through viva voce / test (30 marks)

Total (50 marks)

Semester End examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, before the committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.

- Report = 25 marks
- Concept/knowledge in the topic = 15 marks
- Presentation = 10 marks

Total marks = 50 marks

ME09 709(P): Project

Teaching scheme **Credits:** 1
1 hour practical per week

Objectives

- *To practise the steps involved for the selection, execution, and reporting of the project.*
- *To train the students for group activities to accomplish an engineering task.*

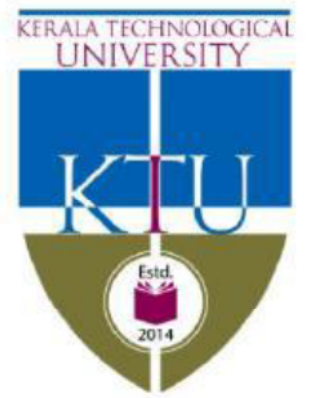
The project work shall be a theoretical/ experimental/ design/ software project on any of the topics of mechanical engineering interest. The head of the department will decide the framing of the project batches. Each of the batches shall consist a minimum of five students. The topic of the project should be different from his/her mini project. A faculty member will always be supervising each group as a internal guide. In case an industrial project is selected by a batch, in addition to the internal guide, there should be an external guide from the industry.

During this semester, each group is required to select a topic for the project and study the feasilbility. A project evaluation committee will be constituted by head of the department at the beginning of the semester. A brief report of the chosen project should be submitted before the committee within two weeks from the beginning of the VIIth semester. The committee will give permission for the project after examining the feasibility. In the event of rejection of the topic by the committee, the students should resubmit a new project topic within one week, and get it approved by the committee. After getting the permission, they have to conduct a detailed literature survey, and collect sufficient information and necessary data. Further, they have to a prepare an action plan to carry out the project in the next semester. At the end of the semester, each group should prepare a preliminary report of the project, and appear before the committee for evaluation.

The assessment of the projects should be done at the end of the seventh semester by the committee. The committee will award the group average marks based on the group-wise performance. Based on the group average awarded by the committee, the respective guide will award the individual internal marks (max. 100 marks). For awarding individual marks following points shall be noted.

- Attendence, regularity and individual contribution of each student
- Individual evaluation through viva voce / test

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY



(PALAKKAD CLUSTER - 08)

SCHEME AND SYLLABI

M. TECH. PROGRAMME

in

STRUCTURAL ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

2015

CLUSTER LEVEL GRADUATE PROGRAM COMMITTEE

Chairman : Dr K V Jayakumar, Professor, N I T Warangal, Telangana. 506 004

S.No	MEMBER
1	Principal, Government Engineering College, Mannampatta, Sreekrishnapuram, Palakkad. 679513
2	Principal, N S S College of Engineering, Akathethara, Palakkad. 678 008
3	Principal, Jyothi Engg College, Cheruthuruthi, Thrissur. 678531
4	Principal, Sreepathy Institute of Management and Technology, Vavanoor, Koottanad, Palakkad 679 553
5	Principal, Nehru college of Engineering & Research Centre,Pampady, Thrissur, 680 588
6	Principal, Jawaharlal College of Engineering & Technology, Lakkidi, Palakkad. 679 301
7	Principal, Al Ameen College of Engineering, Kulappulli, Palakkad. 679 523
8	Principal, Prime College of Engineering, Pallathery, Palakkad. 678 551
9	Principal, Malabar College of Engineering & Technology, Pallur, Thrissur, 679 532

This program is offered in the following Institutes :

1. N S S College of Engineering, Akathethara, Palakkad 678 008
2. Sreepathy Institute of Management & Technology, Koottanad, Palakkad 679 553

CERTIFICATE

This is to certify that

1. The scheme and syllabi are prepared in accordance with the regulations and guidelines issued by the KTU from time to time and also as per the decisions made in the CGPC meetings.
2. The suggestions/modifications suggested while presenting the scheme and syllabi before CGPC have been incorporated.
3. There is no discrepancy among the soft copy in MS word format, PDF and hard copy of the syllabi submitted to the CGPC.
4. The Scheme and syllabus has been vetted by Er. Asraf A K, Group Director, Structural Dynamics & Analysis Group, Liquid Propulsion Systems Centre,Valiamala, Trivandrum 7.
5. E- document has been verified by all the constituent colleges

Coordinator in charge of syllabus revision of the programme

Dr.Jayalekshmi.R

Professor

Department of Civil Engineering

N S S College of Engineering Palakkad

Kerala 678 008

PROGRAMME OUTCOMES

1. An ability to Practice the profession of Structural engineering proficiently by applying fundamental technical knowledge and skills and demonstrate high degree of analytical handiness to solve real world engineering problems.

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

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

4. An ability to inculcate professional and ethical attitude, effective communication skills, exercise leadership qualities and professional integrity with a commitment to the social needs and sustainable development.

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

Scheme of M. Tech Programme in Structural Engineering

SEMESTER 1 (Credits 22)

Exam Slot	Course Code	Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	08 CE 6011	Structural Dynamics	4-0-0	40	60	3	4
B	08 CE 6021	Theory of Elasticity	3-0-0	40	60	3	3
C	08 CE 6031	Advanced Theory and Design of Concrete Structures	3-0-0	40	60	3	3
D	08 CE 6041	Numerical Methods in Structural Engineering	3-0-0	40	60	3	3
E	08 CE 6051	Elective -1	3-0-0	40	60	3	3
	08 GN 6001	Research Methodology	0-2-0	100	0	0	2
	08 CE 6061(P)	Seminar I	0-0-2	100	0	0	2
U	08 CE 6071(P)	Concrete Technology & Structural Engineering Lab	0-0-2	100	0		2
			16-2-4				22

L-Lecture T-Tutorial P-Practical

ELECTIVE 1

08 CE 6051 (A) Advanced Foundation Engineering
08 CE 6051 (B) Experimental stress analysis and instrumentation
08 CE 6051 (C) Construction and Maintenance Management

Note: Remaining hours for departmental assistance by students.

SEMESTER 2 (Credits 19)

Exam Slot	Course Code	Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration Hrs	
A	08 CE 6012	Finite Element Analysis	3-0-0	40	60	3	3
B	08 CE 6022	Analysis and Design of Earthquake Resistant Structures	3-0-0	40	60	3	3
C	08 CE 6032	Advanced Design of Metal Structures	3-0-0	40	60	3	3
D	08 CE 6042	Elective- 2	3-0-0	40	60	3	3
E	08 CE 6052	Elective- 3	3-0-0	40	60	3	3
T	08 CE 6062	Mini Project based on Industrial Training	0-0-4	100	0	0	2
U	08 CE 6072 (P)	Structural Engineering Design Studio	0-0-3	100	0	0	2
			15-0-7				19

L-Lecture T-Tutorial P-Practical

ELECTIVE 2
08 CE 6042 (A) Design of Offshore Structures
08 CE 6042 (B) Pavement Analysis and Design
08 CE 6042 (C) Analysis and Design of Plates and Shells

ELECTIVE 3
08 CE 6052 (A) Soil Structure Interaction
08 CE 6052 (B) Advanced Concrete Technology
08 CE 6052 (C) Design of Bridges

Note: Remaining hours for departmental assistance by students.

SEMESTER 3 (Credits 8)

Exam Slot	Course Code	Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration Hrs	
A	08 CE 7011	Elective- 4	3-0-0	40	60	3	3
B	08 CE 7021	Elective- 5	3-0-0	40	60	3	3
	08 CE 7031	Seminar II	0-0-2	100	0		2
	08 CE 7041	Project (Phase I)	0-0-12	50	0		0
			6-0-14				8

ELECTIVE 4
08 CE 7011 (A) Design of Pre-stressed Concrete Structures
08 CE 7011 (B) Mechanics of Composite Materials
08 CE 7011 (C) High Rise buildings

ELECTIVE 5
08 CE 7021 (A) Design of Industrial Structures
08 CE 7021 (B) Probability Methods in Civil Engineering
08 CE 7021 (C) Structural Optimization and Reliability Analysis
08 CE 7021 (D) Forensic Engineering and Rehabilitation of Structures

Note: Remaining hours for departmental assistance by students.

SEMESTER 4 (Credits 18)

Exam Slot	Course Code	Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration Hrs	
A	08 CE 7012	Project (Phase II)	0-0-21	70	30	1 hr	18

Note: Remaining hours for departmental assistance by students.

Total Credits for the Course: 67

Internal Evaluation for all the Subjects

Internal Assessment (40 Marks)

Two Tests – 15 Marks each

Tutorials, Assignments – 10 Marks

End Semester Examination – 60 Marks

SYLLABI OF M TECH PROGRAME IN STRUCTURAL ENGINEERING

SEMESTER 1

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6011	STRUCTURAL DYNAMICS	4-0-0-4	2015

Course objectives

To impart in depth knowledge of structural behaviour under dynamic loads and thus to establish foundation for acquiring principles of seismic design

Syllabus

Fundamental objective of structural dynamic analysis - generalized displacements – Single degree of freedom system – Free and forced vibration of single degree of freedom system:-.Undamped system- damped system- Response to impulsive loads -Response to general dynamic loading- Two degree of freedom system – Multi-degree of freedom system – Distributed Parameter System – Free and forced vibrations of beams - Approximate solutions - Vibrations of building frames - Modal Analysis (principle only)-Numerical evaluation of dynamic response

Course Outcomes

1. An ability to perform analysis of SDOF and MDOF systems.
2. An ability to explain different physical forms of dynamic loading in a force response analysis
3. An ability to compute natural frequency in relation to a continuum and discrete system.
4. An ability to explain the terms modeshape/eigen vector, modal mass, modal damping, and modal stiffness factors.
5. An ability to evaluate the results from dynamic analysis.

References:

1. Anil.K.Chopra, “Dynamics of Structures (Theory and Applications to Earthquake Engineering), Prentice Hall of India Private Limited. New Delhi.
2. Clough, R.W. & Penzein, J. "Dynamics of Structures", McGrawHill
3. Mukhopadhyay, M., "Structural Dynamics", Ane Books, India.
4. Mario Paz, "Structural Dynamics - Theory and Computations", CBS Publications, New Delhi.
5. Timoshenko, “Vibration problems in Engineering”, Van Nostrand Co., Inc.
6. Short course on *Seismic Design of Reinforced Concrete Buildings*,(1995) CEP, IIT, Kanpur.
7. IS 1893 – Criteria for Earthquake Resistant Design of Structures
8. SP 22: Explanatory Handbook on Codes for Earthquake Engineering.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	Introduction: Fundamental objective of structural dynamic analysis – types of prescribed loadings – essential characteristics of a dynamic problem – method of discretization, lumped mass procedure – generalized displacements Single degree of freedom system – Components of the basic dynamic system – formulation of the equation of motion-D'Alembert's principle Influence of gravitational forces - generalized SDOF system- Rigid body assemblage - expression for generalized system properties.	3 3 2	15
II	Free vibration of single degree of freedom system:- Solution of equation of motion, undamped free vibration Damped free vibration, critically damped, under damped and over damped systems, Negative damping. SDOF- Response to harmonic loading, Undamped system- damped system, Response to periodic loading	2 3 3 2	15
FIRST INTERNAL EXAMINATION			
III	Fourier series expansion of the loading- response to Fourier series loading Exponential form of Fourier series loading and response- Complex frequency transfer functions Response to impulsive loads :- Suddenly applied load, sine wave impulse, rectangular impulse, triangular impulse, spike loading, approximate analysis	3 3 4	15
IV	Response to general dynamic loading:- Duhamel integral for undamped system Unit impulse response function – numerical evaluation, response of damped system- classical and non classical damping- numerical evaluation, Numerical analysis in the frequency domain, fast Fourier transform analysis.	2 3 3	15
SECOND INTERNAL EXAMINATION			
V	Multi degree of freedom system:- Two degree of freedom system – equation of motion, characteristic equation, frequencies and mode shapes Vanello Stodola method, coordinate coupling and choice of degree of freedom, Orthogonality of modes, natural coordinates,	3 3 2	20

	superposition of natural modes , response of two degree of freedom system to initial excitation, response to harmonic excitation Multi- degree of freedom system – analysis of multi- degree of freedom system- mode superposition analysis.	2	
VI	Distributed Parameter System: Partial differential 1equation of motion - Axial and torsional vibration of prismatic bars -Elementary case of flexural vibration of beams - Beam flexure including axial force effects. Free and forced vibrations of beams - Approximate solutions - Rayleigh and Rayleigh - Ritz Methods - Vibrations of building frames - Modal Analysis (principle only). Numerical evaluation of dynamic response – Time stepping method – methods based of interpolation of excitation – central difference method – Newmark's method.	3 2 3 2	20
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6021	THEORY OF ELASTICITY	3-0-0-3	2015

Course objectives

- *To understand the behavior of elastic solids under given applied loads and also the limitations of the results given by the Elementary Mechanics of Materials.*
- *To provide essential fundamental knowledge of the subject matter with compilation of solutions that required in engineering practice and design.*

Syllabus

Introduction to the general theory of elasticity-Analysis of stress at a point- analysis of strain at a point - Strain-displacement relations, compatibility conditions (in rectangular and cylindrical polar coordinate systems), governing equations of elasticity, Stress-strain relations- generalized Hooke's law-solution of two-dimensional problems - plane stress and plane strain problems - Equations of equilibrium in terms of displacements-conditions of compatibility in terms of stresses. -Plane stress-plane strain problems- Airy's stress function in rectangular and polar coordinates-solution by polynomials- St.Venant's principle- Axisymmetric stress distribution-Thick cylinders- Stress concentration due to circular holes in plates-Torsion of prismatic bars- St.Venant's semi-inverse approach- Prandtl's stress function approach- elliptic cross-section- Membrane Analogy -thin walled open and closed tubes. Introduction to Energy Methods-Principle of linear superposition- Uniqueness theorem - Advanced topics- Theories of failure-yield criteria.

Course Outcomes

- An ability to apply principles of elastic theory to estimate stresses and strains of structural engineering problems.
- An ability to apply concepts, principles and governing equations to solve the problems in elasticity such as thick cylinders, shafts, stress concentration and complex loading on structural members and visualize the elasticity concepts for formulating real problems.
- An ability to model and analyse homogeneous and elastic plane problems.
- An ability to apply energy principles to solve engineering problems
- An ability to obtain a firm foundation for more advanced courses, for research and practice in civil engineering fields.

References:

1. Timoshenko.S.P and Goodier. JN.,"Theory of Elasticity",3rd edition Tata McGraw Hill.
2. Wang, C.T., "Applied Elasticity", McGraw–Hill Co., New York.
3. Srinath.L.S., ''Advanced Mechanics of Solids", Tata McGraw Hill.
4. Sadhu Singh, "Theory of Elasticity"), Khanna Publishers, New Delhi
5. Ameen.M., "Computational Elasticity", Narosa Publishing House.
6. Chou P.C. and Pagano, N.J. "Elasticity Tensor, Dyadic and Engineering Approaches",Dover publishers
7. Xu, Z., "Applied Elasticity", Wiley Eastern Ltd, India,
8. Irving H.Shames and James, M.Pitarresi, "Introduction to Solid Mechanics", Prentice Hall of India Pvt. Ltd., Newl Delhi

Course Plan			
Module	**Contents**	**Hours**	**Sem Exam Marks %**
I	Introduction to the general theory of elasticity, Assumptions and Applications of linear elasticity	**2**	**15**
	Analysis of stress and strain in 3D-State of stress at a point-Stress Tensor-Equilibrium equations- Stress on Arbitrarily oriented plane-Transformation of stresses-Principal stresses-Stress invariants-Octahedral stresses- Traction boundary conditions-Hydrostatic and deviatoric stresses.	**5**	
II	Strain at a point- Strain tensor-Strain-displacement relations-Compatibility conditions - strain transformations-Principal strains- Strain invariants-spherical and deviatoric components of strain.	**4**	**15**
	Stress-strain relations- Generalised Hooke's law-systematic reduction of the constitutive coefficients from9 x 9 = 81 to 3 - 1 = 2; general anisotropy, orthotropy and isotropy. Equations of equilibrium in terms of displacements-Conditions of compatibility in terms of stresses.	**4**	
FIRST INTERNAL EXAMINATION			
III	Plane Cartesian Elasticity-Plane stress- Plane strain problems	**2**	**15**
	Airy's stress function-stress function for plane stress and plain strain cases	**2**	
	Solution by polynomials-Bending of cantilever loaded at free end- Bending of simply supported beam with udl	**3**	
IV	Plane problems in polar coordinates- Equilibrium equations-strain-displacement relations and stress-strain relations- Airy's stress function- Biharmonic equations- bending of curved bar by force at the end.	**3**	**15**
	Axisymmetric stress distribution- St.Venant's principle-Thick cylinders- Stress concentration due to circular holes in plates.	**4**	
SECOND INTERNAL EXAMINATION			
V	Torsion of prismatic bars- St.Venant's semi-inverse approach- Prandtl's stress function approach-elliptic cross-section- Membrane Analogy -thin walled open and closed tubes	**6**	**20**
VI	Introduction to Energy Methods- strain energy and complementary energy; Virtual work and potential energy principles; principles of minimum total potential energy and minimum complementary	**5**	**20**

	energy; Betti's reciprocal theorem; Principle of linear superposition- Uniqueness theorem		
	Advanced topics- Theories of failure-yield criteria.	**2**	
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6031	ADVANCED THEORY AND DESIGN OF CONCRETE STRUCTURES	3-0-0-3	2015

Course objectives

- *To impart in depth knowledge of material and structural behaviour of concrete, background of provisions made in codes of design and to familiarize with the design of some important structures*
- *To equip the students with advanced knowledge in RCC structures so that they will be able to perform research activities later*

Syllabus

Stress-strain characteristics, cyclic loading on concrete and reinforcing steel, ductility, immediate and long term deflection in flexure, deflection control, Strut and Tie Models, Torsion, Deep Beam, Corbel, Biaxial bending of columns, cracking in beams and slabs,
Crack width, Inelastic behaviour of concrete beams, plastic hinge formation, moment redistribution in continuous beams, plastic design, principles of capacity design, ductile detailing of frames

Course Outcomes

An ability to design special structures by limit state method. To have advanced knowledge on material behaviour to persuade research work in the field. Theories behind specifications of design codes will be understood and well utilized.

References:

1. Varghese.P.C., "Advanced Reinforced Concrete Design", Prentice Hall of India,
2. Park,R and Paulay T," Reinforced Concrete Structures",John Wiley & Sons, New York
3. Purushothaman.P. "Reinforced Concrete Structural Elements", Behaviour, Analysis and Design. (Tata Mc Graw Hill)
4. Pillai.S.V and Menon.D, "Reinforced Concrete Design", Tata McGraw Hill Book Co.
5. Arthur. H. Nilson, David Darwin and Charles W Dolan, "Design of Concrete Structures", Tata McGraw Hill.
6. Thomas T. C. Hsu,"Unified Theory of Reinforced Concrete", CRC Press, London.
7. IS 456 –2000, Indian Standard for Plain and Reinforced Concrete- Code of Practice, New Delhi
8. ACI – 318: 2002, Building Code Requirements for Structural Concrete and Commentary, ACI Michigan.

Course Plan			
Module	**Contents**	**Hours**	**Sem Exam Marks %**
I	Stress-strain characteristics of concrete under single and multi- axial stresses- confined concrete	**2**	**15**
	Effect of cyclic loading on concrete and reinforcing steel - Ultimate Deformation and ductility of members with flexure	**2**	
	Control of deflections- immediate and long term deflections.	**3**	
II	Strut and Tie Models- Development- Design methodology- selecting dimensions for struts- IS and ACI recommendations.	**3**	**15**
	Application: Deep Beams	**2**	
	Application: corbel, beam column joints.	**2**	
FIRST INTERNAL EXAMINATION			
III	Biaxial bending of columns- interaction diagrams – IS method of design- comparison with ACI	**4**	**15**
	Analysis and Design of slender RCC columns	**3**	
IV	Control of cracking in beams and slabs: classical theory of cracking	**3**	**15**
	Codal procedures on crack width computation in flexure as per IS	**2**	
	Comparison with BS and ACI codes.	**2**	
SECOND INTERNAL EXAMINATION			
V	Inelastic behaviour of concrete beams- moment curvature diagrams	**2**	**20**
	plastic hinge formation – length of hinge	**2**	
	moment redistribution in continuous beams- ductility	**3**	
VI	Baker's method of plastic design	**3**	**20**
	Design of cast in-situ frames- principles of capacity design[Numerical examples not expected for capacity design]	**3**	
	Ductile detailing of frames	**1**	
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6041	NUMNERICAL METHODS IN STRUCTURAL ENGINEERING	3-0-0-3	2015

Course objectives

To impart in-depth knowledge of various mathematical tools applied to diversified problems in structural engineering and provide the theoretical background to advanced modelling techniques in numerical computation and provide the necessary software application skills.

Syllabus

Solution of systems of linear algebraic equations- Direct and iterative methods, Solving Systems of non-linear equations, Interpolation, Numerical differentiation and numerical integration, Numerical solution of partial differential equations, Eigen Value Problems

Course Outcomes

1. Ability to formulate and solve linear and non linear systems of equations numerically.
2. Ability to perform numerical integration and differentiation and to understand the principles of curve fitting and interpolations.
3. Ability to formulate and solve partial differential equations in civil engineering
4. Ability to formulate and solve structural stability and structural dynamic problems.
5. To understand the logic of the development of finite element software packages.

References:

1. B.S Grewal,"Numerical Methods in Engineering and Science", Khanna Publications.
2. Rajasekaran S,"Numerical Methods in Science and Engineering – A practical approach", AH Wheeler & Co.
3. P Kandasamy,"Numerical Methods", S Chand and Company.
4. Stevan C. Chapra and Raymond P. Canale,"Numerical Methods for Engineers", McGraw Hill
5. Erwin Kreyszig "Advanced Engineering Mathematics",10th Edition, Weiley Eastern Ltd.
6. Michael D Greenberg,"Advanced Engineering Mathematics", Pearson education.
7. Balagurusamy E , "Numerical Methods", Tata McGraw Hill
8. Curtis F Gerald and Patrick O Wheatley,"Applied Numerical Analysis", Pearson Education Pte ltd.

Course Plan			
Module	**Contents**	**Hours**	**Sem Exam Marks %**
I	Numerical Computing and computers and software applications **Systems of Linear Equations**: Elimination and factorization methods: Gauss, Cholesky and Crout's methods	**1** **3**	**15**
	Norms, Ill-conditioned systems – Symmetric and Banded systems	**2**	
	Gauss Siedel iteration - Relaxation method-condition of convergence of iterative methods.	**3**	
II	**Systems of non-linear equations** – Newton-Raphson Method.	**2**	**15**
	Interpolations: Newtons divided differences, Lagrange, Hermitian and cubic spline methods – Isoparametric style of interpolation	**4**	
FIRST INTERNAL EXAMINATION			
III	Numerical Integration using Gaussian quadrature - One and Two Dimensions	**2**	**15**
	Gauss Hermite Quadrature Method - Newton–Cotes open quadrature methods	**3**	
	Solution of ordinary differential equations by modified Euler and Runge Kutta method and simultaneous ordinary differential equations by Runge Kutta Method	**3**	
IV	**Partial differential equations**:Applications, and formulation of one dimension and two dimensional problems	**2**	**15**
	Boundary value problems -Laplace equation,Poisson equation, derivative boundary conditions, irregular and non rectangular grids	**4**	
SECOND INTERNAL EXAMINATION			
V	**P**arabolic and Hyperbolic partial differential equations, Heat equation and wave equation in one and two dimensions	**4**	**20**
	Eigen Value Problems:Introduction – Methods of solutions: method of characteristic polynomial, Faddeev-Leverrier Method	**2**	
VI	Approximate Methods Eigen Value problems-Forward iteration, inverse iteration – (Vianello-Stoodala method)	**3**	**20**
	Power Method with deflation – Rayleigh – Ritz Method.	**3**	
	Applications and strategy for large systems	**1**	
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6051(A)	ADVANCED FOUNDATION ENGINEERING	3-0-0-3	2015

Course Objectives

To impart the knowledge in the analysis and design of various foundation systems required for various infrastructure projects .

Syllabus

Shallow foundations, design principles and methodology of footings and raft, pile foundation , well foundation, soil dynamics and design of machine foundations - types of machine foundations - IS code practice for design of machine foundation for reciprocating and impact type machines, foundations for steel towers and chimneys.

Course Outcomes

Students after the completion of the course, are able to design different types of foundations.

References:

1. P.C.Varghese,"Foundation Engineering", Prentice-Hall of India Pvt-Ltd, New Delhi.
2. B.C.Punmia,"Soil Mechanics and Foundations",Laxmi Publications Pvt Ltd,New Delhi
3. Braja M Das, "Principles of Foundation Engineering" ,Global Engineering
4. Koerner R M, "Construction and Geotechnical methods in Foundation Engineering",McGraw Hill.
5. Joseph E. & Bowles, "Foundation Analysis & Design", McGraw Hill
6. Leonards G.A., "Foundation Engineering", McGraw Hill
7. Arora K.R., "Soil Mechanics & Foundation Engineering"., Standard Publications

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	Shallow foundations- Introduction- Models used in design of foundation-Review of various theories for bearing capacity-settlement-allowable bearing pressure-SPT-Ultimate bearing capacity and settlement in sand from N values-Bearing capacity of footings and raft on clay	7	15
II	Design principles and methodology of footings and raft.Pile foundation-Introduction-Review of static and dynamic methods-load carrying capacity from SPT-Group action of piles. Piled raft foundation-Introduction-Types-Design considerations	7	15
FIRST INTERNAL EXAMINATION			
III	Well foundation- Introduction-Bearing capacity-method of analysis-Terzaghi's method-IRC and IS design recommendations--depth of scour-Minimum thickness of RC wells.	7	15
IV	Soil dynamics and Design of Machine foundations-Introduction-Mass spring system-Free vibrations-vibrating spring mass system with damping-forced vibrations-natural frequency of foundation soil system--bulb of pressure concept	7	15
SECOND INTERNAL EXAMINATION			
V	Basic principles of design of machine foundation-method of analysis-static analysis –dynamic analysis-soil properties for dynamic analysis-Types of machine foundations-IS Code practice for design of machine foundation for reciprocating and impact type machines.	7	20
VI	Foundations for Steel Towers and Chimneys:-Introduction-Loads on foundation-Common types of foundation for steel towers-Behaviour of pad and Chimney foundation-Design of Chimney and Pad foundations-Anchor foundations-Rock Anchors	7	20
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6051(B)	EXPERIMENTAL STRESS ANALYSIS AND INSTRUMENTATION	3-0-0-3	2015

Course objectives

- *To make students aware of various measurement techniques*
- *To introduce methods of selecting and installing necessary instrumentation in experiments for measuring load, strain, stress, pressure etc.*
- *To make students understand various non destructive testing methods*

Syllabus

Measurement systems - characteristics, accuracy, precision; Error analysis in experimental measurements, Strain gauges – gauge length, sensitivity and range, characteristics, types; Electrical resistance strain gauges- construction, Strain gauge circuits, Strain rosettes, Force transducers; principle of Linear variable displacement transducer (LVDT). Photo elasticity - stress optic law, circular polariscope, isoclinics and isochromatics; Model materials - calibration methods; Non Destructive Testing Methods – Ultrasonic methods – Hardness methods; Detection of embedded reinforcement and cover. Computer based data acquisition systems. Model analysis - direct and indirect models - laws of structural similitude - choice of scales - limitation
of model studies - buckingham pi-theorem - dimensional analysis

Course Outcomes

Students will be able to identify and choose measuring instruments, install and use them for their experiments in the laboratory. They shall be able to use nondestructive types of strength assessments in field investigations.

References:

1. Dally, J. W. and Raliey W.F., Experimental Stress Analysis, McGraw Hill.
2. Srinath L.S., Experimental Stress Analysis, Tata McGraw Hill
3. Roy, T.K., Experimental Analysis of stress and strain
4. Dove and Adams, Experimental Stress Analysis and Motion measurement, Prentice Hall
5. Hetenyi M., Hand book of Experimental Stress Analysis, John Wiley
6. Bently JP – Principles of Measurement Systems, Longman.
7. Nakra & Chowdhary – Instrumentation Measurement & Analysis – Tata McGraw Hill.
8. Doblins E A – Measurement Systems Application & Design Mc Graw Hill.

Course Plan			
Module	**Contents**	**Hours**	**Sem Exam Marks %**
I	The measurement system – Purpose, structure and Elements – Characteristics of measurement system. Accuracy, precision, repeatability, calibration – Standards and evaluation. Dynamic Characteristics.	**5**	**15**
	Errors in measurement – Statistical Analysis - best estimate of true value	**2**	
II	Strain gauges - definition of gauge length - sensitivity and range - characteristics of an ideal strain gauge	**2**	**15**
	Different types of mechanical strain gauges, optical strain gauge - acoustic strain gauge -pneumatic strain gauge; electrical strain gauges – resistance, inductance, capacitance and piezo electric gauges - merits and demerits	**2**	
	Electrical resistance gauges - bonded and unbonded resistance gauges and their application in stress analysis - fixing techniques and measurement of strains – procedures.	**3**	
FIRST INTERNAL EXAMINATION			
III	Strain gauge circuits-characteristics- strain gauge bridges, temperature compensation; Strain rosettes - determination of principal strains and stresses.	**4**	**15**
	Force transducers, Load cells of different types, force balance pressure gauges. Computer based data acquisition systems - principle.	**3**	
IV	Photo elasticity - basics of optics, stress optic law - plane and circularly polarized light and their use in photo elasticity - polariscopes - diffusion type - lens type polariscopes - isoclinics and isochromatics	**4**	**15**
	Model materials - calibration methods for finding material fringe values - model fringe values - examples of beam flexure and diametrically loaded circular plates.	**3**	
SECOND INTERNAL EXAMINATION			
V	Non Destructive Testing Methods – Ultrasonic methods – Hardness methods – Rebound Hammer	**3**	**20**
	Detection of embedded reinforcement, cover meter.	**2**	
	Semi-destructive testing – core cutting method-specifications	**2**	

VI	Model analysis - direct and indirect models - laws of structural similitude - choice of scales – Limitation of model studies- buckingham pi-theorem	**5**	**20**
	dimensional analysis - model materials - simple design of direct and indirect models	**2**	
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6051 (C)	CONSTRUCTION AND MAINTENANCE MANAGEMENT	3-0-0-3	2015

Course objectives:

To impart advanced knowledge of principles and methodology of planning and implementing construction projects as well as maintenance of the same.

To equip the students to face challenging situations of repair of structures, and also to identify research needs in this area.

Syllabus

Organising for Project management - Project Management – modern trends - Strategic Planning - Effects of Project Risks on Organization - Organization of Project Participants -Traditional Designer-Constructor Sequence - Professional Construction Management - Owner-Builder Operation - Turnkey Operation - Leadership and Motivation for the Project Team

Labour, Material and equipment utilisation - Historical Perspective - Labour Productivity - Factors Affecting Job-Site Productivity - Labour Relations in Construction - Problems in Collective Bargaining - Materials Management - Material Procurement and Delivery - Inventory Control

Constructions Operations Management – Trends and methods in construction project scheduling – principles-use of bar charts and networks-CPM and PERT methods

Quality management-Features of Quality management systems – general principles-Total Quality Management-ISO systems- ISO 9000 certification process in construction-quality manuals-preparation-principles

Principles of Safety management

Maintenance and repair strategies - Definitions: Maintenance, repair and rehabilitation- Life expectancy of different types of buildings- Facets of Maintenance- importance of Maintenance-Inspection-Assessment procedure for evaluating a damaged structure

Repair project management- principles- choice of materials and methods and equipment

Influence on serviceability and durability–effect of environmental elements such as heat, dampness, frost and precipitation on buildings-effect of chemical agents on building materials-effect of pollution on buildings-effect of fire on building-damage by biological agents like plants, trees, algae, fungus, moss, insects, etc.

Failure and repair of buildings: Definition of building failure-types of failures-methodology for investigation of failures-diagnostic testing methods and equipments-repair of cracks in concrete and masonry-methods of repair-repair and strengthening of concrete buildings-foundation repair and strengthening-underpinning-leakage of roofs and repair methods

Special materials for repair - Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferrocement, Fibre reinforced concrete. Rust eliminators and polymers coating for Rebars,

Course Outcomes

Students will be able to take decisions on the organizational needs of construction projects related to planning and control. They will have knowledge in assessing the repair needs of structures,

based on diagnostic testing, and also in planning and implementing repairs.

References :

1. R.T.Allen and S.C.Edwards,"Repair of Concrete Structures", Blakie and Sons, UK
2. M.S.Shetty, "Concrete Technology - Theory and Practice", S.Chand and Company, New Delhi.
3. Santhakumar, A.R., " Concrete Technology",, Oxford University Press, NewDelhi,
4. Chitkara, K.K. "Construction Project Management: Planning, Scheduling and Control, Tata McGraw-Hill Publishing Company, New Delhi.
5. Choudhury, S, "Project Management",Tata McGraw-Hill Publishing Company, New Delhi.
6. Kumar Neeraj Jha,"Project management – Theory and practice", Pearson Education India, New Delhi.
7. Raikar, R.N., "Learning from failures - Deficiencies in Design", Construction and Service - R & D Centre , Raikar Bhavan, Bombay.
8. Maintenance and Repair, Longman Scientific and Technical UK.
9. Peter H. Emmons, "Concrete Repair and Maintenance", Galgotia Publishers
10. SP:25 BIS Causes and Prevention of Cracks in buildings
11. SP:62 (S&T)-1997, BIS, Hand Book on Building Construction Practice, pp. 457-765
12. Seetharaman S., "Construction Engineering and Management" (fourth Revised and Enlarged Edition) ", Umesh Publications, Delhi
13. Chitale A. K. and Gupta R. C., "Materials Management- Text and cases", Prentice-Hall of India Private Limited, New Delhi
14. Gopalakrishnan P and Sundaresan M, "Materials Management an integrated approach", PHI Learning Private Limited, New Delhi
15. Chris Hendrickson and Tung Au," Project Management for Construction – Fundamental Concepts for Owners, Engineers, Architects and Builders, Prentice Hall, Pittsburgh.

Course Plan			
Module	**Contents**	**Hours**	**Sem Exam Marks %**
I	Organising for Project management - Project Management – modern trends - Strategic Planning	**3**	**15**
	Professional Construction Management - Owner-Builder –issues-roles- project success	**3**	
	Effects of Project Risks on Organization - Organization of Project Participants -Traditional Designer-Constructor Sequence -	**3**	
	Leadership and Motivation for the Project Team	**2**	
II	**Constructions Operations Management** – Trends and methods in construction project scheduling – principles-use of bar charts and networks-CPM and PERT methods	**4**	**15**
III	Features of Quality management systems – general principles-Total Quality Management-ISO systems- ISO 9000 certification process in construction-quality manuals-preparation-principles Safety management –principles/methods	**7**	**15**
FIRST INTERNAL EXAMINATION			
IV	**Maintenance and repair strategies -** Definitions: Maintenance, repair and rehabilitation- Life expectancy of different types of buildings- Facets of Maintenance- importance of Maintenance-Inspection-Assessment procedure for evaluating a damaged structure	**4**	**15**
	Repair project management- principles- choice of materials and methods and equipment	**3**	
	effect of environmental elements such as heat, dampness, frost and precipitation on buildings-effect of chemical agents on building materials-effect of pollution on buildings-effect of fire on building-damage by biological agents like plants, trees, algae, fungus, moss, insects, etc.	**4**	
SECOND INTERNAL EXAMINATION			
V	**Failure and repair of buildings:** Definition of building failure-types of failures-methodology for investigation of failures-diagnostic testing methods and equipments-repair of cracks in concrete and masonry-	**2**	**20**
	Methods of repair-repair and strengthening of concrete buildings-foundation repair and	**3**	

	strengthening-underpinning-leakage of roofs and repair methods		
VI	**Special materials for repair -** Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, cement admixtures. Expansive cement, polymer concrete, sulphur infiltrated concrete, ferrocement, Fibre reinforced concrete. Rust eliminators and polymers coating for Rebars,	**4**	**20**
END SEMESTER EXAMINATION			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
GN 6001	RESEARCH METHODOLOGY	0-2-0-2	2015

Course Objectives

The main objective of the course is to provide a familiarization with research methodology and to induct the student into the overall research process and methodologies. This course addresses:

The scientific research process and the various steps involved formulation of research problem and research design, Design of experiments, Thesis preparation and presentation.

Research proposals, publications and ethics, Important research methods in engineering

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role.

Syllabus

Overview of research methodology - Research process, scientific method, research design process. Research Problem and Design - Formulation of research task, literature review and web as a source, problem solving approaches, experimental research, and ex post facto research. Thesis writing, reporting and presentation -Interpretation and report writing, principles of thesis writing- format of reporting, oral presentation, seminars and conferences

Research proposals, publications and ethics - Research proposals, research paper writing, considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – Modelling and Simulation, mathematical modeling, graphs, heuristic optimization, simulation modeling, measurement design, validity, reliability, scaling, sample design, data collection methods and data analysis

Course Outcomes

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

Discuss research methodology concepts, research problems, research designs, thesis preparations, publications and research methods.

Analyse and evaluate research works and to formulate a research problem to pursue research

Prepare a thesis or a technical paper, and present or publish them

Apply the various research methods followed in engineering research for formulation and design of own research problems and to utilize them in their research project.

References:

1. C. R. Kothari, "*Research Methodology, Methods and Techniques"*, New Age International Publishers
2. K. N. Krishnaswamy, Appa Iyer Sivakumar, M. Mathirajan, "*Management Research Methodology, Integration of principles", Methods and Techniques*, Pearson Education
3. R. Panneerselvam, *"Research Methodology"*, PHI Learning
4. Deepak Chawla,Meena Sondhi,"*Research Methodology–concepts & cases"*,Vikas Publg House
5. J.W Bames, *"Statistical Analysis for Engineers and Scientists"*, McGraw Hill, N.York
6. Schank Fr.,*Theories of Engineering Experiments"*,Tata Mc Graw Hill Publication.
7. John W Best, James V Kahan, "*Research in Education"*, PHI Learnin
8. Sinha, S.C.and Dhiman,A.K., "*Research Methodology"*,Ess Publications. 2 volumes

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	**Overview of Research Methodology** Research concepts – meaning – objectives – motivation - types of research –research process – criteria for good research – problems encountered by Indian researchers - scientific method - research design process – decisional	5	15
II	**Research Problem and Design** Formulation of research task – literature review – methods – primary and secondary sources – web as a source – browsing tools -formulation of research problems – exploration - hypothesis generation - problem solving approaches- introduction to TRIZ(TIPS)- experimental research – principles -Laboratory experiment - experimental designs - ex post facto research - qualitative research	5	15
FIRST INTERNAL EXAMINATION			
III	**Thesis writing, reporting and presentation** Interpretation and report writing – techniques of interpretation – precautions in interpretation – significance of report writing – principles of thesis writing- format of reporting - different steps in report writing – layout and mechanics of research report - references – tables – figures – conclusions. oral presentation – preparation - making presentation – use of visual aids - effective communication-preparation for and presentation in seminars and conferences	4	15
IV	**Research proposals, publications, ethics and IPR** Research proposals - development and evaluation – research paper writing – layout of a research paper - journals in engineering – considerations in publishing – scientometry-impact factor- other indexing like h-index – citations - open access publication -ethical issues - plagiarism –software for plagiarism checking- intellectual property right- patenting case studies .	5	15
SECOND INTERNAL EXAMINATION			

V	**Research methods – Modelling and Simulation** Modelling and Simulation – concepts of modelling – mathematical modelling - composite modelling – modelling with – ordinary differential equations – partial differential equations – graphs heuristics and heuristic optimization - simulation modeling	5	20
VI	**Research Methods – Measurement, sampling and Data acquisition** Measurement design – errors -validity and reliability in measurement - scaling and scale construction - sample design - sample size determination - sampling errors - data collection procedures - sources of data - data collection methods - data preparation and data analysis	4	20
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6061(P)	SEMINAR I	0-0-2-2	2015

Course Objectives

To assess the debating capability of the student to present a technical topic. Also to impart training to a student to face audience and present his ideas and thus creating in him self-esteem and courage that is essential for an engineer.

Syllabus

Individual students are required to choose a topic of their interest from Structural Engineering related topics preferably from outside the M.Tech syllabus. And give a seminar on that topic about 45 minutes. A committee consisting of at least three faculty members (preferably specialized in Structural Engineering) shall assess the presentation of the seminar and award marks to the students based on merits of topic of presentation. Each student shall submit two copies of a write up of his seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library.

Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation and Simulations.

Course Outcomes

Identify and chose appropriate topic of relevance.

Assimilate literature on technical articles of specified topic and develop comprehension

Write technical report.

Design and develop presentation on a given technical topic.

Deliver technical presentation on a specified topic

Course Code.	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6071(P)	CONCRETE TECHNOLOGY & STRUCTURAL ENGINEERING LAB	0-0-2-2	2015

Course Objectives

To familiarize the students with the different sophisticated instrumentations used in the laboratory and field for measuring/monitoring stress, strain, deflection etc. in structures. New construction materials, their testing and construction practices are introduced.

Details of experiments

1. Review of testing methods of cement, coarse aggregate and fine aggregate as per Indian Standards.
2. Design of concrete mixes as per Indian Standard
3. Tests on Fresh and Hardened Concrete\
4. Study of CTM, UTM, Extensometers and Compressometers
5. Measurement of Strain: Mechanical Strain Gauges- Electrical Strain gauges
6. Measurement of Deflection:- Dial gauges - Linear Variable Differential Transducers
7.Calibration of various instruments and equipment used in the lab
8. Study of behaviour of RCC beams in flexure
9. Study of behaviour of RCC beams in shear.
10. Study of behaviour of Presressed beams in flexure.
11. Study of behaviour of steel beams.
12. Non- destructive testing of concrete

a) Rebound hammer
b) Core cutting
c) Ultrasonic pulse velocity
d) Pullout test

13.Introduction to New Reinforced Cement Composites:- Steel fiber reinforced concrete – Ferrocement – Polymer concrete - Self Compacting Concrete – High Performance Concrete.

Assessment : i) Practical Records /outputs 40%, Regular Class Viva-Voce 20%, Final Test (Objective) 40%

Minimum 10 experiments are to be conducted.

Course Outcomes

Understand Basic test for materials, Mix Design, Non-destructive and other relevant tests of concrete quality

To determine various parameters for steel and concrete and other related parameters, durability related tests for concrete. Use of fibre reinforced concrete.

References:

1. *"Concrete Technology"*- Neville – Pearson Publishers
2. *"Concrete Technology"* – M.S. Shetty – S. Chand and Co.
3. "*Experimental Stress Analysis*"Srinath L.S., , Tata McGrawHill

SEMESTER 2

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6012	FINITE ELEMENT ANALYSIS	3-1-0-3	2015

Course Objectives

To build up the back ground, basic concepts and basic formulation of finite element method to enable the students to understand various element formulations and use them for analysis, including programming.

Syllabus

Introduction to finite element method – general description of the method - basic equations of elasticity - theories of stress and strain – plane stress – plane strain conditions, direct stiffness method – Gauss elimination solution of equations , calculus of variations – variational principles of solid mechanics – principles of virtual work – Rayleigh-Ritz, Weighted residual (Galerkin). Concept of elements – displacement model – shape functions – C^0 and C^1 elements – numerical integration – Gauss quadrature method - analysis of framed structure – 2D and 3D truss and frame elements, CST and LST elements – rectangular elements – Isoparametric elements axisymmetric solid elements, analysis of plate bending - analysis of shells – analysis using recent softwares.

Course Outcomes

1. An ability to illustrate the various steps in the displacement finite element method from assumed displacement polynomial to determination of stress.
2. To employ an analysis system for the determination of stresses and strains in small displacement linear elastic problem.
3. An ability to select appropriate idealization for components /structures which are consistant with the objectives of analysis.

References:

1. Krishnamoorthy C.S., *"Finite Element Analysis-Theory and Programming"*,Tata McGraw Hill
2. Bathe K.J., "*Finite Element Procedures in Engineering Analysis"*, Prentice Hall of India
3. Desai C.S., "*Elementary Finite Element Method"*, Prentice Hall of India
4. Cook R.D., Malkus D.S. & Plesha M.F., "*Concepts & Applications of Finite Element Analysis"*, John Wiley
5. Chandrupatla T.R. & Belegundu A.D., "*Introduction to Finite Elements in Engineering"*, Prentice Hall of India
6. Cook, R.D., "*Finite Element Modelling for Structural Analysis'*, John Wiley and sons. 3.
7. Gallaghar R.H., "*Finite Element Analysis: Fundamentals"*, Prentice Hall Inc.
8. Rajasekaran S., "*Finite Element Analysis in Engineering Design"*, Wheeler Pub.
9. Zienkiewics O.C. & Taylor R.L., "*The Finite Element Method"*, Vol I & II, McGraw Hill
10. Reddy, J.N., "*An Introduction to the Finite Element Method"*, McGraw Hill.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	Introduction to Finite Element Method – History of development – Advantages – Disadvantages - General description of the method -Basic equations of elasticity- Strain – Displacement relations – Theories of stress and strain – Stress-Strain relations – Plane stress – Plane strain conditions	6	15
II	Direct stiffness method – Review of basic concepts of matrix displacement analysis – Complete stiffness matrices – Co-ordinate transformation – Global stiffness matrices – Formulation of load vector – Direct stiffness method – Assembly of elements- Displacement boundary conditions – Gauss elimination solution of equations	6	15
FIRST INTERNAL EXAMINATION			
III	Calculus of variations – Variational principles of solid mechanics – Principles of virtual work – Approximate methods – Rayleigh-Ritz, Weighted residual (Galerkin) Concept of elements – Displacement model – Shape functions – General coordinates – Natural coordinates – Convergence and Compatibility conditions	8	15
IV	C^0 and C^1 elements – Conforming and non conforming elements – Numerical integration – Gauss quadrature method- Summary of finite element procedure. Analysis of framed structure – 2D and 3D truss and frame elements – applications – Plane stress and plane strain analysis	8	15
SECOND INTERNAL EXAMINATION			
V	Triangular elements – CST and LST elements – Rectangular elements – Isoparametric elements – Incompatible models – 8 noded and 20 noded isoparametric solid elements – Axisymmetric solid elements (for solid elements principles of formulations only).	7	20
VI	Analysis of plate bending – Basic equation of thin plate theory- Reissner-Mindlin theory – plate elements and applications – Analysis of shells – generated shell elements Programming concepts – Assembling – Boundary conditions – Solution techniques – Band width minimization – Gauss elimination. Modelling and analysis using recent softwares	7	20
END SEMESTER EXAMINATION			

Course Number	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6022	ANALYSIS AND DESIGN OF EARTHQUAKE RESISTANT STRUCTURES	3-0-0-3	2015

Course objectives

To provide the students a thorough knowledge of the basis of dynamic analysis of buildings subject to earthquake and philosophy of seismic design

To make students capable of analyzing and designing various types of structures exhibiting ample safety under probable earthquakes

Syllabus

Introduction to engineering seismology, causes of earthquake, Seismic waves, Magnitude and Intensity of earthquake, seismographs, seismic zoning. Base-excited SDOF system(review), DVA Spectrum, Base-excited MDOF system, Lumped mass modeling and analysis of multi-storey shear building, response spectra. Earthquake analysis of linear systems-response history analysis-modal analysis. Earthquake response of inelastic systems, Elasto-plastic idealization, Inelastic Spectra. Effects of Earth quake on various types of structures. Philosophy and Principles of earthquake.-resistant design, ductility-based design and detailing, analysis and design as per IS 1893:2002, ductile detailing (IS 13920).

Course Outcomes

Students will be able to analyse and design earthquake-resistant buildings. They will have advanced knowledge on seismic behaviour of structures. Theories behind specifications of design codes will be understood.

References:

1. Anil.K.Chopra, Dynamics of Structures (Theory and Applications to Earthquake Engineering), Prentice Hall of India Private Limited. New Delhi.
2. Jaykrishna, Elements of earthquake engineering, Saritha Prakasan, Naunchandi, Meerut
3. Mukhopadhyay, M., "Structural Dynamics", Ane Books, India.
4. R W Clough and J Penzien, Dynamics of structures, McGraw Hill
5. Pankaj Agarwal and Manish Shrikandhe, Earthquake Resistant Design of Structures, PHI
6. Park & Paulay, Reinforced concrete, McGrawHill

Web sites:

www.peer.berkeley.edu/course, modules/eqrd www.nicee.org, www.iitk.ac.in/nicee/npeee

IS Codes:

IS:1893 - (Part I), Criteria for Earthquake Resistant structures-General Provisions and Buildings

IS:13935 – Repair and Seismic strengthening of buildings

IS:4326 - Earthquake Resistant Design and Constructions of buildings

IS:13827 – Improving Earthquake Resistance of Earthen buildings

IS:13828 - Improving Earthquake Resistance of Low strength Masonry buildings

IS:13920 – Ductile detailing of RC Structures subject to Seismic forces.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	Introduction to engineering seismology – plate tectonics- faults- causes of earthquake-energy release	**2**	**15**
	Seismic waves -primary and secondary waves – Raleigh wave, Love wave	**1**	
	Magnitude and Intensity of earthquake — measurement using seismographs, seismic zoning of India	**1**	
	SDOF system- formulation of basic equation – elastic response to harmonic, arbitrary and pulse excitations-dynamic amplification factors, Base-excited SDOF system	**3**	
II	Earthquake excitation on SDOF system - Concepts of pseudo acceleration, velocity and displacement – four way logarithmic graph – peak response values - response spectra - DVA Spectrum - construction.	**2**	**15**
	MDOF system- (review: lumped mass system-natural frequencies-mode shapes – orthogonality of modes, normalization of modes)	**2**	
	Base-excited MDOF: Lumped mass modeling of multi-storey shear building and modes of vibration – response quantities-dynamic response factor – modal contribution factors-influence of higher modes-effect of damping on responses.	**3**	
FIRST INTERNAL EXAMINATION			
III	Base-excited MDOF: Earthquake analysis of linear systems-response history analysis-modal anlysis-modal response – total response	**2**	**15**
	Multistory building with symmetric plan – effective modal mass and modal height- number of modes to be considered	**3**	
	Unsymmetrical plan- torsional response.	**2**	
IV	Response spectrum analysis of linear system-peak modal responses, Modal combination - SRSS – CQC, Multistory building with symmetric plan.	**2**	**15**
	Earthquake response of inelastic systems-hysterisis loop and energy dissipation- elasto-plastic idealizations- concept of equivalent linear system – ductility factor-ductility demand-constant	**2**	

	ductility response spectrum – yielding v/s damping		
	Elastic and inelastic design spectra- assumptions, construction method- comparison	**3**	
SECOND INTERNAL EXAMINATION			
V	Performance of building and structures under earthquakes: Main Causes of Damage - lack of strength and integrity of buildings, quasi resonance – lack of ductility, lack of detailing.	**3**	**20**
	Effects of Earth quake on - tower structures, power plants, switch yards, dams, equipments or other life line structures, soil liquefaction- Assessment of damage,	**2**	
	Concepts of seismic isolation, , passive and active control of seismic responses (Numerical exercises not expected)	**2**	
VI	Philosophy and Principles of earthquake.-resistant design- Strength and stiffness- ductility-based design and detailing– analysis and design as per IS 1893:2002 – Buildings- Seismic zones and coefficients – response reduction factors - Estimations of fundamental time period -Design spectrums – Seismic weights- equivalent static analysis – Vertical distribution of seismic forces and horizontal shears	**3**	**20**
	Dynamic analysis by response spectrum method – CQC – Irregularities - Torsional effects- –Seismic weights – Building forms and architectural design concepts- Horizontal and vertical eccentricities due to mass and stiffness distribution- soft storey - limits on drifts.	**2**	
	Load combinations and permissible stresses as per Indian Standards	**1**	
	Use of codes like IS: 4326, IS: 13828, IS: 13827, IS13920, SP:22 with reference to masonry, RCC and steel building -Detailing of reinforcement and joints.	**1**	
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6032	ADVANCED DESIGN OF METAL STRUCTURES	3-0-0-3	2015

Course Objectives

To introduce plastic analysis and design of steel structures

To familiarize with the design of light gauge steel and aluminium structures

Syllabus

Elastic analysis, inelastic analysis, bolted Connections, welded connections, forms of light gauge sections, design of compression members, design of members under flexure, braced and unbraced beams, design of members subjected to lateral loads and axial loads, Crane gantry girders and crane columns, design of tubular structures, design of aluminum structures

Course Outcomes

Students after the completion of the course, are able to understand the behaviour of steel in inelastic range. They should be able to design and detail connections and special structures listed above for various types of loadings

References:

1. Gaylord & Gaylrod, "Design of Steel Structures", Mc Graw Hill
2. Duggal, S.K., "Limit State Design of Steel Structures", Tata mcGrawHil
3. Subramanian, N., "Design of Steel Structures", Oxford University Press.
4. Salmon C.G & Johns J.E, "Steel Structures- Design and Behaviour", Harper and Row.
5. John Baker & Jacques Hayman, "Plastic Design of Frames", University – Printing House, Cambridge
6. Dr. Ramachandra, "Design of Steel Structures" – Vol II. Standard Book House, Delhi.
7. Krishnamchar B.S. & Ajith Sinha, D . "Design of steel structures", TMH Publishing Co.
8. Horne, M.R., and Morris, L.J., "Plastic Design of Low -rise frames", Granada Publishing Ltd.
9. Wie - Wen Yu., "Cold-formed Steel Structures", McGraw Hill Book Company.
10. William McGuire, Steel Structures, Prentice Hall, Inc., Englewood Cliffs, N.J.
11. Subramanian N. ,"Principles of Space Structures", Wheeler Publishing Co
12. Santhakumar A.R and Senthil.R, "Proceedings of International Conference on Space Structures", Anna University, Chennai

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	Methods of Analysis- Elastic Analysis – Inelastic Analysis – Plastic hinge concept – Methods of Plastic Analysis- Plastic design of continuous beams and frames – Effect of axial and shear force on plastic moment capacity.	7	15
II	Bolted Connections- High Strength Friction Grip Bolts . Welded Connections – advanced welding techniques Moment Resistant Connections- Beam to beam connections – Beam Column connections – Splices	7	15
FIRST INTERNAL EXAMINATION			
III	Forms of light gauge sections – Effective Area – Basic design stresses – Design of compression members – Design of members under flexure – Braced and unbraced beams	7	15
IV	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.	7	15
SECOND INTERNAL EXAMINATION			
V	Design of tubular structures - Design of tension and compression members, Connections, truss configurations, space structures- tension coefficient method.	7	20
VI	Design of Aluminum structures – Design of tension and compression members, beams and columns	7	20
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6042 (A)	DESIGN OF OFFSHORE STRUCTURES	3-0-0-3	2015

Courseobjectives

- To equip the students with the basic concepts of analysis and design of most common offshore structures.
- To understand the basics of wave mechanics, estimation of environmental loads in addition to imposed and live loads and familiarize with recommended code provisions.
- To expose the students to the design of tubular members, tubular joints and fatigue effects.

Syllabus

Offshore structures –classification-Basics of wave motion-wave theories-wave kinematics- wave breaking-random waves-wave spectrum - Loads on offshore structures- functional and environmental loads – estimation of wave, wind and current forces-Morison equation- Linear diffraction theory - materials-allowable stresses-design methods and code provisions of API - Design approaches-jacket platforms-static analysis –in place analysis-analytical modeling-Concrete gravity platforms-principles of design-Jack up platforms -Compliant platforms- Tension Leg Platforms and Spar platforms- -Design of tubular members and joints –simple design problems- Fatigue analysis-Submarine pipelines-design procedure-thickness calculations.

Course Outcomes

- Students will be able to understand the basics of wave mechanics, estimate the forces acting on offshore structures.
- Students will be able to understand the materials and properties required for offshore applications.
- Students will be able to apply theoretical principles and analytical models in the design of offshore structures conforming to APIcode provisions
- Students will be able to design tubular members and joints and evaluate their fatigue life.
- Students will be capable of taking further advanced research/ design and development projects in the emerging area of offshore structural design

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References:

1. Thomas H. Dawson. , “Offshore structural Engineering’’ Prentice -Hall
2. Subrata K Chakrabarti, “ Hydrodynamics of Offshore Structures”, Computational Mechanics Publications.
3. Subrata K Chakrabarti, “Hand book of Offshore Engineering (Vol. I & II)’’. Elsevier Science,Prentice Hall Inc. Englewood Cliffs, N.J. Graff,W.J., “Introduction to Offshore Structures” , Gulf Publ.Co.
4. Reddy, D. V &Arockiasamy, M.,’ Offshore Structures Vol.1 & 2’, Kreiger Publ. Co.
5. Gou.B, Song.S,Chacko.J and Ghalambor.A, ‘‘ Offshore Pipelines” ,GPP Publishers
6. B.C Gerwick, Jr. Construction of Marine and Offshore Structures, CRC Press, Florida
7. API RP-2A Recommended Practice for Planning Designing & Construction of Fixed offshoreplatforms – Working Stress design – American Petroleum Institute

Course Plan			
Module	**Contents**	**Hours**	**Sem Exam Marks%**
I	Introduction to Offshore structures-classification-fixed-compliant-floating platforms-examples.	**2**	**15**
	Basics of wave motion- Small amplitude wave theory-velocity potential- dispersion relationship- wave kinematics-pressure under wave-wave energy and power (Numerical exercises to be done)- Finite amplitude wave theories-wave breaking	**4**	
	Random waves-wave spectral density-Mathematical spectrum models	**2**	
II	Loads on offshore structures- Functional loads-Environmental loads -Concept of Return waves-operating and extreme conditions of offshore structures	**5**	**15**
	Estimation of wave ,wind and current forces as per API recommendations-Morison equation- force on vertical and inclined piles- numerical examples -wave forces on large structures-linear diffraction theory	**3**	
FIRST INTERNAL EXAMINATION			
III	Materials for offshore applications-properties required-applications- API specifications for steel-allowable stresses-design methods and Code Provisions of API-design wave-design approaches	**3**	**15**
	Jacket platforms –components-loads-static analysis- in place analysis- maximum global forces- analytical modeling of jacket platforms-deck, jacket and foundation.	**4**	
IV	Concrete gravity platforms- components-functions-basic principles of design- foundation stability of gravity platforms	**3**	**15**
	Jack up platforms- components-functions-modeling - Tension Leg Platforms - components- functions-design principles	**4**	
SECOND INTERNAL EXAMINATION			
V	Design of Tubular members-design procedure-Specifications as per API-design problems	**3**	**20**
	Tubular Joints-Classification-Analysis of joints-Stress concentration factor -API Code formulae for simple joints only- simple design problems	**4**	
VI	Fatigue in offshore structures-fatigue analysis- S-N curves-cumulative damage ratio-Palmgren Miner rule- evaluation of Fatigue life of components-numerical examples	**3**	**20**
	Submarine pipelines-design procedure-thickness calculations	**2**	
END SEMESTER EXAM			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6042 (B)	PAVEMENT ANALYSIS AND DESIGN	3-0-0-3	2015

Course objectives:

To impart advanced knowledge of principles and methodology of design of flexible and rigid pavements. To equip the students to face challenging situations of pavement design and construction in the field, and also to carry out research activities.

Syllabus

Types and Component layers of Pavements – their functions – Materials –properties, Testing and specifications- Factors affecting Design and Performance of Pavements -

Bituminous mix design methods, specifications and testing.

Analysis & Design of Flexible Pavement: Stresses and Deflections in Homogeneous Masses – different theories - Empirical, Semi-empirical and theoretical approaches of design, Advantages and applications of different methods.

Analysis & Design of Rigid pavements: Types of Stresses and Factors influencing the Stresses in Rigid Pavement Analysis, Combined Stresses – Design Methods –IRC Approach; Types of Joints in Cement Concrete Pavements and their functions and detailing.

Pavement Evaluation and Rehabilitation programmes - Pavement Distresses; Evaluation by Non-Destructive and Destructive Test Methods, and Specimen Testing

Pavement Overlays & Design -different methods; Use of Geo synthetics and advances in subgrade improvement.

Course Outcomes

Students will be able to design different types of pavements under varied conditions of traffic, climate and sub grade soil. They will have advanced knowledge in pavement analysis to persuade research work. Theories behind specifications of design codes and charts will be understood and well utilized.

References:

1. Yoder and Witzack, Principles of Pavement Design, John Wiley and sons.
2. Yang, Design of functional pavements, McGraw-Hill.
3. Harold N. Atkins, Highway Materials, Soils, and Concrete, Prentice Hall.
4. Haas and Hudson, Pavement Management System, McGraw Hill Book Co., New York.
5. Woods, K.B., Highway Engineering Hand Book, McGraw Hill Book Co.
6. David Croney, Design and Performance of Road Pavements, HMSO Publications.
7. Per Ullitz, Pavement Analysis, Elsevier, Amsterdam
8. Robert D. Krebs, Highway Materials, McGraw Hill Text.
9. Asphalt Institute, The Asphalt Handbook.

IRC Codes

1. IRC: 37-2001, 2012 Guidelines for the Design of Flexible Pavements.
2. IRC: 58-2002, 2011Guidelines for the Design of Plain Jointed Rigid Pavements for Highways
3. IRC: 81 -1981, Guidelines for the Design of overlay using Benkelman Beam Deflection Technique.

Course Plan			
Module	**Contents**	**Hours**	**Sem Exam Marks %**
I	Types and Component layers of Pavements – their functions	**3**	**15**
	Materials –properties, Testing and specifications-	**2**	
	Factors affecting Design and Performance of Pavements -	**3**	
II	Bituminous mix – Principles of design, properties of Mix, various design methods, specifications and testing.	**5**	**15**
FIRST INTERNAL EXAMINATION			
III	Analysis & Design of Flexible Pavement: Stresses and Deflections in Homogeneous Masses – different theories -	**4**	**15**
	Empirical, Semi-empirical and theoretical approaches of design	**4**	
	Advantages and applications of different methods.	**2**	
IV	Analysis & Design of Rigid pavements: Types of Stresses and Factors influencing the Stresses in Rigid Pavement Analysis	**3**	**15**
	Combined Stresses – Design Methods –IRC Approach	**3**	
	Types of Joints in Cement Concrete Pavements and their functions and detailing.	**3**	
SECOND INTERNAL EXAMINATION			
V	Pavement Evaluation and Rehabilitation programmes - Pavement Distresses;	**2**	**20**
	Evaluation by Non-Destructive and Destructive Test Methods, and Specimen Testing	**3**	
VI	Pavement Overlays & Design -different methods	**3**	**20**
	Use of Geo synthetics and advances in subgrade improvement.	**2**	
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6042 (C)	ANALYSIS OF PLATES AND SHELLS	3-0-0-3	2015

Course Objectives

To familiarize students to study the analysis and design of shells and folded plates.

Syllabus

Review of the theory of bending of beams, pure bending of plates, symmetrical bending of circular plates, small deflection of laterally loaded plates, formulation and solution of some problems in rectangular plates, simply supported edges, other edge conditions, membrane theory of shells, introduction to the middle surface theory and bending theory of shells .

Course Outcomes

Able to understand the behaviour of plates under loads

Able to apply the knowledge to design plates and shells.

References:

1. S.P. Timoshenko, and Woinowsky-Krieger, S.: "*Theory of Plates and Shells"*, 2nd ed., McGraw-Hill Book Company.
2. J.P. Den Hartog: "*Advanced Strength of Material"*, McGraw-Hill Book company, Inc., New York.
3. W. Flugge: "*Stresses in Shells"*, Springer-Verlag, Berlin.
4. V.V. Novozhilov: "*Thin Shell Theory"*, 2nd Russian ed., augmented and revised, translated from Russian by P.G. Lowe and edited by J.R.M. Radok, WoltersNoordorff, Groningen,
5. E. Ventsel & Th. Krauthammer, "*Thin Plates and Shells: Theory, Analysis and Applications"*, Marcel Dekker, Inc., New York.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	Review of the theory of bending of beams Pure bending of plates Love-Kirchhoff assumption and its consequences; slopes and curvature; relations between bending moments and curvatures; some particular cases of pure bending; strain energy in pure bending of plates.	7	15
II	Symmetrical bending of circular plates Differential equation for symmetrical bending of circular plates; uniformly loaded circular plates; some special cases (with a circular hole; concentrically loaded; loaded at the centre); corrections to the elementary theory.	7	15
FIRST INTERNAL EXAMINATION			
III	Small deflection of laterally loaded plates Differential equation of the deflection surface; boundary conditions; boundary conditions by variational methods; developable and non-developable surfaces and the consequences; exact theory of plates.	7	15
IV	Formulation and solution of some problems in rectangular plates Simply supported edges; other edge conditions. A brief mention of advanced topics Higher order theories; Karman theory, anisotropic plates, thermal stresses; buckling of plates. (Not included for examinations.)	7	15
SECOND INTERNAL EXAMINATION			
V	Membrane theory of shells General theory; governing equation; simple applications (as in J.P. Den Hartog: Advanced Strength of Materials, chapter on Membrane Stresses in Shells.)	7	20
VI	Introduction to the middle surface theory and bending theory of shells Differential geometry of curved surfaces; first and second fundamental forms; metric tensor; Love-Kirchhoff assumption and its consequences; Gauss-Codazzi equations; indicate how the bending theory develops from the Love-Kirchhoff assumption.	7	20
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6052 (A)	SOIL STRUCTURE INTERACTION	3-0-0-3	2015

Course Objectives

To make students understand the basics of soil structure interaction Also to impart knowledge about various linear and non-linear, isotropic and anisotropic models for soil structure interaction problems.

Syllabus

Soil structure interaction and 'flexible' approach to the design of foundations, experimental determination of dub grade modulus, introduction to idealized soil response models for the analysis of soil, introduction to soil structure interaction models, beam on elastic foundation - soil models - infinite beam and finite beam, plate on elastic medium - infinite plate - analysis of finite plates, analysis and design of rafts and mats incorporating soil structure interaction, role of soil-structure interaction in earthquake resistant design, FEM Modeling, Elastic analysis of piles

Course Outcomes

To understand behaviour of soil under loads transmitted by structures.

An ability to apply the knowledge in designing various type of foundations.

References:

1. *Soil mechanics* by TW Lambe & Whitmen.
2. Deb, D., "*Finite Element Methods- Concepts and Application in Geomechanics*", PHI Learning Pvt. Ltd.
3. Joseph E. Bowles, "*Foundation Analysis and Design*" McGraw-Hill.
4. *"Analytical and computer methods in foundation engineering"*, JE Bowles, McGraw Hill publications.
5. *"Foundation analysis"* by RF Scott, Printice Hall
6. Hytenyi, *"Beams on Elastic Foundations"* – university of Michigan Press.
7. *"Elastic Analysis of soil – Foundation Interaction"*. APS Selvadurai – Elsevier
8. *"Vibration Analysis and Foundation Dynamics"*, NSV Kameswara Rao, Wheeler Publishing, New Delhi.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	Soil structure interaction and 'flexible' approach to the design of foundations, Contact Pressure – from theory of Elasticity and Sub grade reaction, Concept of sub grade modulus, effects/parameters influencing sub grade modulus. Experimental Determination of Sub grade Modulus	7	15
II	Introduction to Idealized Soil Response Models for the Analysis of Soil – Foundation Interaction – Time Dependent Behavior of Soil Masses. Introduction to Soil-structure interaction models - Winkler, Pasternak, Hetenyi and Filonenko-Borodich.	7	15
FIRST INTERNAL EXAMINATION			
III	Beam on Elastic foundation-soil models: Infinite beam, two parameters, Isotropic elastic half space, analysis of beams of finite length, classification of finite beams in relation to their stiffness.	7	15
IV	Plate on Elastic medium: Infinite plate, Winkler, two parameters, isotropic elastic medium, thin and thick plates, analysis of finite plates: rectangular and circular plates.	7	15
SECOND INTERNAL EXAMINATION			
V	Analysis and design of rafts and mats incorporating soil structure interaction Role of soil-structure interaction in earthquake resistant design, Finite difference solution to problems of beams on elastic foundation. Soil – structure Interaction in framed structure, FEM Modeling. Use of appropriate software packages.	7	20
VI	Modern concept of analysis of piles and pile groups. Elastic analysis of piles: Elastic analysis of single pile, theoretical solutions for settlement and load distributions, analysis of pile group, interaction analysis, load distribution in groups with rigid cap. Laterally loaded pile: Load deflection prediction for laterally loaded piles, sub-grade reaction and elastic analysis, interaction analysis, pile raft system.	7	20
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6052 (B)	ADVANCED CONCRETE TECHNOLOGY	3-0-0-3	2015

Course objectives:

To equip the students to understand the properties of concrete and to familiarise the advances in concrete and concrete making

To equip the students to select appropriate mixes according to the situation and to perform mix designs with available materials.

Syllabus

Materials for concrete making- Review of cements including blended cements, manufacture, chemical composition, chemical and physical processes of hydration, structure of hydration products- modern methods of analysis, Aggregates- Review of types; elementary mineralogy and petrology; Engineering considerations for use of various types- production of artificial aggregates; sampling and testing; effects on properties of concretes, mortars and grouts.

Properties of fresh concrete - basics regarding fresh concrete – mixing, workability, placement, consolidation, and curing - Rheological models to characterize concrete - Experimental methods to characterize rheology of concrete-Flowable and pumbable concrete

Admixtures –Mineral admixtures - Review of types, - pulverised fuel ash, ground granulated blast furnace slag and silica fume;; chemical and physical processes of hydration and interaction; effects on properties of concretes, mortars and grouts; Chemical Admixtures -Review of types and classification; chemical composition; actions and interactions; usage; effects on properties of concretes – on quality and costs.

Proportioning of concrete mixtures – concepts- mixture design as per BIS, BS and ACI methods, statistical quality control, acceptance criteria as per BIS code.

Setting and hardening concrete - Plastic settlement and plastic shrinkage; early age thermal movements; strength development; maturity, accelerated curing

Properties of hardened concrete- Strength; deformation under load; elasticity; creep; drying shrinkage and other volume changes -Thermal properties

Durability of concrete and concrete construction - Durability concept; pore structure and transport processes; reinforcement corrosion; fire resistance; frost damage; sulfate attack; alkali silica reaction; delayed ettringite formation

Special concretes - Lightweight concrete- description of various types - High strength concrete and mixture design; Self compacting concrete : Rheology and mixture design - Roller compacted concrete – Ready mixed concrete – Fibre reinforced concrete - polymer concrete

Special processes and technology for particular types of structure - Sprayed concrete; underwater concrete, mass concrete; slipform construction, Prefabrication technology

Course Outcomes

An ability to select a concrete mix suitable for a particular exposure condition.

An ability to carry out the design of the concrete mix, using the test data on materials. An ability to apply theoretical knowledge in realizing a structure with adequate quality.
References : 1. Neville, A. M., "Properties of Concrete," 5th and final Edition. 2. Mehta, P. K. and Monteiro, P. J. M., "Concrete: Microstructure, Properties, and Materials ." 3. Shetty M S, Concrete Technology, - Theory and Practice", S.Chand and Company, New Delhi. Mindess S and Young JF, "Concrete", Prentice-Hall, USA. 4. H. Okamura and K. Ozawa, "Mix Design for Self-Compacting Concrete," Concrete Library of JSCE, No. 25, 1995, pp. 107 – 120 5. G. H. Tattersall, "Workability and Quality Control of Concrete," E&FN Spon, London. 6. Hewlett P C Concrete Admixtures use and applications, ed M R Rixom, The Concrete press, London.

Course Plan			
Module	**Contents**	**Hours**	**Sem Exam Marks %**
I	Materials for concrete making- Review of cements including blended cements, manufacture, chemical composition and suitability.	**4**	**15**
	Chemical and physical processes of hydration, structure of hydration products- modern methods of analysis,.	**3**	
	Aggregates- Review of types; elementary mineralogy and petrology; Engineering considerations for use of various types- production of artificial aggregates; sampling and testing; effects on properties of concretes, mortars and grout- quality of water.	**3**	
II	**Properties of fresh concrete** - basics regarding fresh concrete – mixing, workability, placement, consolidation, and curing - Rheological models to characterize concrete - Experimental methods to characterize rheology of concrete -Flowable and pumpable concrete	**3**	**15**
	Admixtures –Mineral admixtures - Review of types, - pulverised fuel ash, ground granulated blast furnace slag and silica fume;; chemical and physical processes of hydration and interaction; effects on properties of concretes, mortars and grouts; Chemical Admixtures -Review of types and classification; chemical composition; actions and interactions; usage; effects on properties of	**3**	

	concretes – on quality and costs.		
FIRST INTERNAL EXAMINATION			
III	**Proportioning of concrete mixtures –** concepts- mixture design as per BIS, BS and ACI methods, statistical quality control, acceptance criteria as per BIS code	**4**	**15**
IV	**Setting and hardening concrete -** Plastic settlement and plastic shrinkage; early age thermal movements; strength development; maturity, accelerated curing	**4**	**15**
	Properties of hardened concrete- Strength; deformation under load; elasticity; creep; drying shrinkage and other volume changes -Thermal properties	**3**	
SECOND INTERNAL EXAMINATION			
V	**Durability of concrete and concrete construction -** Durability concept; pore structure and transport processes; reinforcement corrosion; fire resistance; frost damage; sulfate attack; alkali silica reaction; delayed ettringite formation	**4**	**20**
VI	**Special concretes -** Lightweight concrete- description of various types - High strength concrete and mixture design; -	**3**	**20**
	Self compacting concrete : Rheology and mixture design Roller compacted concrete – Ready mixed concrete – Fibre reinforced concrete - polymer concrete	**4**	
	Special processes and technology for particular types of structure - Sprayed concrete; underwater concrete, mass concrete; slipform construction, Prefabrication technology	**4**	
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6052 (C)	DESIGN OF BRIDGES	3-0-0-3	2015

Course Objectives

To impart knowledge on important types of bridge structures, their selection and planning, structural configurations, assessment of loads, choose the appropriate method of analysis according to the situation and perform design.

Syllabus

Classification of bridges, Review of road and railway bridges, steel and concrete bridges, loads on bridges - Indian Road Congress (IRC) bridge codes, design of slab culverts, R.C. Bridges, analysis and design of T - beam bridges, principles of design of balanced cantilever bridges, design of sub structure - design of piers and abutments, prestressed concrete bridges, steel bridges, temperature, shrinkage, creep, construction techniques and effects of construction sequence on design.

Course Outcomes

Understand the codal provisions for loading and design standards of bridges.
Design the substructure including pier and pier cap and well elements.
Design the superstructure of bridge using different methods.
Understand, design and select materials suitable for bearings.

References:

1. Johnson Victor D.- *Essentials of Bridge Engineering*.
2. Krishna Raju. N. "*Design of Bridges*", Oxford & IBM Publishing Co, Bombay.
3. Raina.V.K. "*Concrete Bridge Practice*", Tata McGraw Hill Publishing Co., New Delhi
4. Taylor F.W, Thomson S.E. and Smulski.E. "*Reinforced Concrete Bridges*", John Wiley & Sons, New York.
5. FR Jagadeesh, M.A. jaya Ram, "*Design of Bridge structures*", Eastern Economy edition.
6. Murthy S.S. and Santhakumar A.R., "*Transmission Line Towers'*, McGrawHill.
7. Punmia B.C., Asok K. Jain and Arun K. Jain, "*Design of Steel Structures*", Lexmi Publications.
8. Conference Proceedings, '*Advances and Innovations in Bridge Engineering*', IIT, Madras and Indian Institute of Bridge Engineers, Tamilnadu, Allied Publisher, New Delhi.

Note :

Latest IS IRC codes and charts giving EUDLL are permitted for the examination

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	Classification of bridges, Review of road and railway bridges, steel and concrete bridges, Components of bridges, Need for investigation - Bridge site - Data collection - design discharge - linear waterway – alignment - economical span - scour depth - traffic projection - choice of bridge type. Loads on bridges: Indian Road Congress (IRC) bridge codes - dimensions - dead and live loads - impact effect - wind and seismic forces - longitudinal and centrifugal forces - hydraulic forces - earth pressure - temperature effect and secondary stresses- specifications and I.R.C. provisions. RC Slab Bridges	7	15
II	Design criteria for box culverts. T-beam bridges – Analysis of slabs using Pigeaud curves – Analysis of beams using Courbon's theory - Hendry Jaegar method	7	15
FIRST INTERNAL EXAM			
III	Analysis for moving loads on T beam bridge, Design of Main girder, load distribution on Cross girder and design. Reinforcement Detailing of main girder and Cross Girder. Principles of design of Balanced Cantilever bridges. Introduction to continuous girder bridges.	7	15
IV	Design of Sub structure: Design of piers and abutments-forces-combinations-design principles of foundations- well, piles (detailed designs not expected). Bearings:- Design of elastomeric bearings, steel bearings.	7	15
SECOND INTERNAL EXAM			
V	Prestressed Concrete Bridges: Design of single span bridges. – design principles of composite prestressed concrete(RCC+PSC) super structures – methods of erection of precast girders - recent trends in construction practice	7	20
VI	Steel Bridges: Design of Plate girder and Truss bridges. Introduction to Suspension and Cable Stayed Bridges. Introduction to Secondary Effects, Temperature, Shrinkage, Creep. Construction Techniques and Effects of Construction Sequence on Design.	7	20
END SEMESTER EXAM			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6062	MINI PROJECTBASED ON INDUSTRIAL TRAINING/INTERNSHIP	0-0-4-2	2015

Course Objectives

To estimate the ability of the student in transforming the theoretical knowledge studied so far into a practical problem in structural engineering.
To prepare students for future employment
Students must be able to do a mini project – either actual design or rehabilitation, using hand computation and Softwares like ETABS / SAP and submit a report with relevant structural drawings.

Syllabus

Internship in an organization and use of softwares like ETABS, SAP and also hand computation for analysis and design. Student has to analyse, design, and detail structures. The basic concepts of design may be taken into consideration while designing the project. .Each student shall prepare the project report and submit to the Department through the guide. Evaluation is based on the project completed at the end of the semester. The student shall undergo Internship/ Industrial Training for minimum four weeks in the same organization or in another Educational/Industrial organization after the End Semester Examinations and the student shall be eligible for next semester course registration only after undergoing the Internship/Industrial Training.
Two level evaluation should be conducted.
Level one evaluation is based on literature survey, methodology and problem identification.
Level two evaluation at the end of semester.
Mark distribution (Total 100 Marks)
Level one evaluation by the internal guide : 30 Marks
Level two evaluation duly constituted by the departmental committee : 70 Marks

Course Outcomes

Experience the discipline of working in a professional engineering organization.
Develop understanding of functioning and organization of a business
Interact with other professional and non professional groups
Apply engineering methods such as design and problem solving.
Develop technical,inter personal and communication skills both oral and written

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6072	STRUCTURAL ENGINEERING DESIGN STUDIO	0-0-3-2	2015

Course Objectives

Students are expected to use important softwares used in the field of structural engineering for analysis, design and drafting.

Syllabus

Exercises on Concrete Structures: -

Analysis, design and detailing of solid slabs in a typical floor for a residential building- Analysis, design and detailing of beams in a typical intermediate floor of a multi-storey building- Analysis, design and detailing of circular ring beam supporting an overhead water tank-

Analysis, design and detailing of shear walls- considering shear wall-frame interaction in a tall RC structure subject to wind loading and seismic loading.

Exercises on Metal Structures: -

Design of Steel Industrial Building – Design of roof trusses - Design of Steel Multi-storey Building – Design of storage structures - Design of towers

1. References:

2. Arthur. H. Nilson, David Darwin and Charles W Dolan, Design of Concrete Structures, Tata
3. McGraw Hill
4. Park,R and Paulay T, Reinforced Concrete Structures, John Wiley & Sons, New York
5. Macleod, I.A, Shear Wall Frame Interaction. A design aid with commentary Portland Cement
6. Association.
7. IS 456 :2000, Indian Standard for Plain and Reinforced Concrete- Code of Practice, BIS, New Delhi
8. IS 13920 , Indian Standard for Ductile Detailing of Reinforced Concrete Structures subjected toSeismic Forces - Code of Practice, BIS, New Delhi
9. Gaylord ., Design of steel structures, McGraw Hill, New York.

10. 7. Dayaratnam, P., Design of steel structures, Wheeler Pub.

Course Outcomes

Analyse, Design and detail industrial structures.

Analyse, Design and detail R.C.C., bunkers and silos.

Analyse, Design and detail bridge structures

Analyse, Design and detail multi-storey frame buildings

SEMESTER 3

Course No.	Course Name	L-T-P-Credits	Year of Introduction
08 CE 6051(B)	DESIGN OF PRESTRESSED CONCRETE STRUCTURES	3-0-0-3	2015

Course Objectives

To make students familiar with the concepts of design of typical pre-stressed concrete structural elements

Syllabus

Basic concept and principles of pre-stressed concrete systems- loss of pre-stress, stresses at transfer and service loads, ultimate strength in flexure -Calculation of deflection (short & long term)- IScode provisions – Analysis and design of members for flexure, shear and torsion- End block design- design of axially loaded members -design of PSC slabs - analysis and design of statically indeterminate structures- continuous beams- Circular pre-stressing- analysis and design of pipes and water tanks. composite beams – analysis and design, partial pre-stressing, definitions, principles and design approaches.

Course Outcomes

Students after the completion of the course, are able to understand the behaviour of pre-stressed concrete structures.

They are able to apply the knowledge to anlayse and design of pre-stressed concrete structures.

References:

1. Krishna Raju.N, "*Prestressed Concrete*", 4th Edition, Tata McGraw Hill Publishing Co. New Delhi.
2. Dayaratnam.P. "*Prestressed Concrete*", Tata McGraw Hill Publishing Co. New Delhi
3. Sinha .N.C & S.K. Roy, "*Fundamentals of Prestressed Concrete*, S.Chand& Co.,
4. Rajagopalan.N. "*Prestressed Concrete*", Narosa Publishing House, New Delhi.
5. Lin .T.Y."*Design of Prestressed Concrete Structures*", John Wiley and Sons - Inc
6. Leonhardt.F."*Prestressed Concrete Design and Construction*", - Second Edition Wilhelm Ernst &Sohn, Berlin.
7. Guyon .V. "*Limit State Design of Prestressed Concrete*", - Vol - 1 & 2, Applied Science Publishers, London
8. Mallick and Rangaswamy."*Mechanics of Prestressed Concrete Design* ", KhannaPublishers.Pandit& Gupta., " *Prestressed Concrete* ", CBS Publishers
9. F.K. Hong & R.H. Evans.,*"Reinforced and PrestressedConcrete* " Tata McGraw Hill Co.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	Review- Basic concept of Prestressing, Systems of Prestressing:-Pretensioning and Post tensioning ,Analysis of prestress and bending stress: - Stress concept, Strength concept: Pressure line and internal resisting couple and Load balancing concept for extreme fiber stresses for various tendon profiles. Stresses at transfer and service loads	7	15
II	**Losses of Prestress:** Losses of Prestress:- Stages of losses, Types of losses in pre-tensioning and post-tensioning due to Elastic shortening, Shrinkage, Creep, Relaxation, Anchorage Slip, Friction and Sudden changes in temperature. **Deflection of beams:** Short term, Load deflection curve, Importance of control of deflections, factors influencing deflections, Pre-cracking and Post-cracking, Effect of tendon profile on deflections, Prediction of long term deflections (Concept only,) Code provisions for calculation of deflection (short & long term)	7	15
FIRST INTERNAL EXAM			
III	Analysis of members under flexure, shear and torsion. Code Provisions- Ultimate Strength in Flexure-Design of axially loaded members	7	15
IV	Design of flexural members (Type I and Type II) and design for shear and torsion. - Anchorage Zone stresses- Design of End block – End zone reinforcement- Design of one-way and two-way slabs	7	15
SECOND INTERNAL EXAM			
V	Analysis and design of statically indeterminate structures-continuous beams-con-cordancy and linear transformation- Circular pre-stressing- analysis and design of pipes and water tanks.	7	20
VI	Composite beams –Analysis and design – Ultimate strength – applications, Elementary idea of composite construction for tee beams in bridges. Partial pre-stressing- Definitions, principles and design approaches.	7	20
END SEMESTER EXAM			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 7011(B)	MECHANICS OF COMPOSITE MATERIALS	3-0-0-3	2015

Course Objectives

To make students familiar with the concepts of analysis and design of composite structural elements.

Syllabus

Composite beams - elastic behaviour of composite beams, serviceability limits - basic design considerations - design of composite beams, composite floors - analysis for internal forces and moments, composite columns - reinforced steel-composite column design, combined compression and uniaxial bending, continuous beams and slab - design strategies distribution.

Course Outcomes

The student will be able to:

Describe the behaviour of composite materials.

To design various types of structural elements

References:

1. Johnson,R.P,(2012) "*Composite Structures of Steel and Concrete"*, Vol.1Beams, Slabs, Columns and Frames in Buildings, Oxford Blackwell Scientific Publications, London.
2. INSDAG teaching resource for structural steel design, Vol 2, INSDAG, Ispat Niketan, Calcutta.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	Introduction: - Composite beams- Elastic behaviour of composite beams- No interaction case-Full interaction case-Shear connectors-Characteristics of shear connectors-Ultimate load behavior.	7	15
II	Serviceability limits-Basic design considerations-Design of composite beams.	7	15
FIRST INTERNAL EXAM			
III	Composite floors: - Structural elements-Profiled sheet decking-Bending resistance-Serviceability criteria - Analysis for internal forces and moments.	7	15
IV	Composite columns: - Materials-Structural steel - Concrete-Reinforced steel-Composite column design -Fire resistance.	7	15

SECOND INTERNAL EXAM			
V	Combined compression and uniaxial bending	7	20
VI	Continuous beams and slab - hogging moment regions of composite beams-Vertical shear and moment- Shear interaction - Global analysis of continuous beams- Design strategies	7	20
END SEMESTER EXAM			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 7011 (C)	HIGH RISE BUILDINGS	3-0-0-3	2015

Course Objectives

To impart students with basic knowledge on analysis and design philosophy, structural systems and their structural behaviour applied to high rise buildings.

Syllabus

Design philosophy- materials: RCC, steel, PSC - loading - gravity loading - wind loading- earthquake loading - blast Loading, structural planning of tall building, behaviour of various structural systems - analysis and design, shear wall frame interaction - basic design of shear walls, stability of tall buildings - overall buckling analysis of frames - P- Delta analysis

Course Outcomes

To develop a thorough understanding of structural systems of high rise buildings.
An ability to select suitable structural systems for tall buildings
Ability to analyse and design high rise structures using structural engineering software.
To dDevelop a thorough understanding of fire protection in tall buildings.

References:

1. Taranath , B.S.,"*Structural Analysis and design of Tall Building"*,Tata McGraw Hill.,
2. Wilf gang Schuller, High Rise Building Structures, John Wiley and Sons.
3. Lynn S. Beedle,"*Advances in Tall Buildings",*CBS Publishers and Distributers, Delhi,
4. Brayan Stafford Smith, Alex coull, "*Tall Building Structures, Analysis and Design"*, John Wiley and Sons.
5. M. Fintal, "*Handbook of Concrete Structures*" Springer publications.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	Design philosophy- materials: RCC, steel, PSC - loading- Gravity loading- Wind loading- Earthquake loading-blast Loading.	7	15
II	Structural planning of tall building - Building frames- rigid frames, braced frames, infilled frames, shear walls, coupled shear walls; Frame-shear wall combo; other structural forms -tubular, cores, hybrid mega system.	7	15
FIRST INTERNAL EXAM			
III	Analysis for member forces, drift and twist, computerised general three dimensional analysis.	7	15

	Structural elements: Sectional shapes, properties and resisting capacity, deflection, cracking.		
IV	Analysis for member forces, drift and twist, computerised general three dimensional analysis. Structural elements: Sectional shapes, properties and resisting capacity, deflection, cracking.	7	15
SECOND INTERNAL EXAM			
V	Stability of tall buildings - Overall buckling analysis of frames- P- Delta analysis- Translational, torsional instability, out of plumb effects, effect of foundation rotation.	7	20
VI	Stability of tall buildings - Overall buckling analysis of frames- P- Delta analysis- Translational, torsional instability, out of plumb effects, effect of foundation rotation.	7	20
END SEMESTER EXAM			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 7021 (A)	DESIGN OF INDUSTRIAL STRUCTURES	3-0-0-3	2015

Course objectives

- To reinforce the fundamental courses in structural design in the perspective of industrial applications.
- To make students capable of planning and organizing various types of industrial buildings
- To familiarize with the design of special structures widely used in industrial plants.

Syllabus

Functional design of industrial buildings:- Classification, layout planning requirements, factories act, Principles of Lighting, ventilation, noise and vibration control. Industrial floorings.

General overview of Thermal /Nuclear power plant structures, conveyor structures – Boiler supporting structures-Substation structures.

Structural Design of Industrial Buildings: Braced and Unbraced Industrial frames, Gantry girders, Machine foundations, Reinforced concrete deep and shallow bins, Tall Chimneys (RCC), Cooling Towers, Transmission line Towers

Course Outcomes

Students will be able to perform functional planning and structural design of various types of industrial buildings. They will be able to design and detail different types of machine foundations and gantry girders. They will acquire an overall knowledge on structural behaviour of tall chimneys, bins, towers etc.

References:

1. Proceedings of an advanced course on industrial structures, SERC – 1982.
2. S.N.Manohar, “Tall Chimneys-Design and Construction”, Tata Mc Graw Hill.
3. P.Dayaratnam, “Design of steel structures”, S Chand publishers..
4. Ramchandra,” Design of steel structures,” Vol. 1 and 2, Standard Book house Delhi.
5. Srivasulu and Vaidyanathan, Handbook of machine foundations-Tata McGraw Hill.
6. Murthy and Santhakumar, Transmission Line structures, McGraw Hill
7. V.Kalayanaraman,”Advances in steel structures”. Tata McGraw Hill
8. Krishnaraju N., Advanced Reinforced concrete design, CBS Publishers.
9. K.K.Mc Kelvey and Maxey Brooke, The Industrial Cooling Tower, Elsevier Publishing Co.

IS Codes:

SP: 32–1986-Hand book on functional requirements of Industrial buildings (Lighting and ventilation).

IS: 4995- Design of RC Bins-Parts 1,2

IS: 4998-criteria for design of RCC Chimneys Part 1,2

IS: 11504- Structural design of Natural Draft Cooling Towers

IS:802- Design of steel transmission line towers- Parts 1,2,3

IS:2974 – Design of Machine foundations- Parts 1,2,3,4

Course Plan			
Module	**Contents**	**Hours**	**Sem Exam Marks %**
I	Functional design of industrial buildings: Classification of industrial structures-layout planning requirements –Guidelines from factories act	**2**	**15**
	Lighting- Illumination levels – Principles of day lighting, artificial lighting design	**2**	
	Natural / Mechanical ventilation – Fire safety requirements Protection against noise	**2**	
	vibration isolation techniques	**1**	
II	Cladding systems, Industrial floors.	**1**	**15**
	General overview of Thermal power plant/Nuclear power plant structures / Process plant structures	**3**	
	Conveyor structures, Boiler supporting structures, Substation structures.	**3**	
FIRST INTERNAL EXAMINATION			
III	Structural Design of Braced Industrial Buildings.	**3**	**15**
	Design of Unbraced Industrial Buildings.	**2**	
	Structural analysis and design of Gantry girders	**2**	
IV	Machine foundations – Strength and deformation of soil under dynamic loads; dynamic coefficients for soils, shear modulus and elastic constants of soil;	**2**	**15**
	Types of foundations -Design Requirements-Analysis and design of block type machine foundations (IS 2974 method)	**2**	
	Design of foundation for reciprocating and rotary machines, foundation for impact type loading-simple design exercises; vibration isolation technique.	**3**	
SECOND INTERNAL EXAMINATION			
V	Design of Reinforced concrete bunkers and silos as per IS: 4995.	**4**	**20**
	Tall Chimneys (RCC)– Types -Chimney sizing parameters- Overview of wind and temperature effects. Design principles of Reinforced concrete chimneys as per IS: 4998. Principles of design for seismic loads.	**3**	
VI	Cooling Towers –Types and functions- Design principles of RC natural draught cooling towers as per IS: 11504 [No numerical exercise expected]	**3**	**20**
	Transmission line Towers- Types-Design loadings-Analysis and design concepts- Tower testing. Description of Tower construction- tower foundations.	**4**	
END SEMESTER EXAMINATION			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
08 CE 7021(B)	PROBABILITY METHODS IN CIVIL ENGINEERING	3-0-0-3	2015

Course Objectives

To provide the students the concept and an understanding of probability and random processes. It also helps to understand the Design of experiments. Emphasis shall be given to problems in Civil Engineering.

Syllabus

Random variables - random variables - probability function, functions of two dimensional random variables – regression curve – correlation, analytical problems based on civil engineering context, testing of hypothesis - sampling distributions - type I and type II errors, multivariate analysis - covariance matrix – correlation matrix, Ddsign of experiments- analysis of variance – one-way and two-way classifications – completely randomized design – randomized block design – Latin square design

Course Outcomes

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

An abiity to apply probabilist methods in civil engineering

To be able to apply the knowledge to interpret data and analyse results when they do experiments and analyse

References:

1. Richard Johnson. "*Miller & Freund's Probability and Statistics for Engineers*", Prentice – Hall of India, Private Ltd.,, New Delhi.
2. Benjamin J R and Cornell C A, "*Probability, statics, and Decision for Civil Engineers*", McGraw Hill Book Company. New York,
3. Douglas C., Montgomery and George C. Runger, "*Applied Statistics and Probability for Engineer"s*, Wiley India.
4. A.H.S. Ang and W. H. Tang,"*Probability Concepts in Engineering Planning and Design*", Volume I and II.
5. Richard A. Johnson and Dean W. Wichern., "*Applied Multivariate Statistical Analysis*", Pearson Education, Asia.
6. Gupta, S.C. and Kapoor, V.K. "*Fundamentals of Mathematical Statistics*", Sultan and Sons, New Delhi.
7. Jay L. Devore, "*Probability and statistics for Engineering and the Sciences*", Thomson and Duxbbury, Singapore.
8. Dallas E Johnson et al., "*Applied multivariate methods for data analysis*" Thomson and Duxbbury press, Singapore.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	Random Variables - Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a Random Variable. Joint distributions – Marginal and Conditional distributions	7	15
II	Functions of two dimensional random variables – Regression Curve – Correlation, Analytical problems based on Civil Engineering contexteg. sampling and quality control. Estimation Theory - Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation - Curve fitting by Principle of least squares – Regression Lines	7	15
FIRST INTERNAL EXAMINATION			
III	Testing of Hypothesis - Sampling distributions - Type I and Type II errors - Tests based on Normal, t, Chi-square and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit. Analytical problems based on Civil Engineering context-eg. Characteristic strength, load.	7	15
IV	Multivariate analysis - Covariance matrix – Correlation Matrix – Multivariate Normal density function – Principal components – Sample variation by principal components –	7	15
SECOND INTERNAL EXAMINATION			
V	Principal components by graphing- Analytical problems based on Civil Engineering context eg. problems on reliability.	7	20
VI	Design of experiments- Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design- Analytical problems based on Civil Engineering context.	7	20
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 7021 (C)	STRUCTURAL OPTIMIZATION AND RELIABILITY ANALYSIS	3-0-0-3	2015

Course Objectives

To impart students with various techniques of structural optimization and to familiarize students with the applications of probability analysis and reliability techniques in structural engineering.

Syllabus

Optimisation methods in civil engineering - linear and nonlinear programming problems, applications of linear programming problems in civil engineering - limit design of steel portal frames. introduction to dynamic programming, geometric programming, introduction to genetic algorithms, concepts of structural safety, probability theory, random events, random variables, resistance distributions and parameters, basic structural reliability

Course Outcomes

To understand optmisation techniques and reliability analysis.
Ability to apply the knowledge for structural optimisation.

References:

1. Sastry S.S. *"Introductory Methods of Numerical Analysis"*, Prentice Hall of India
2. Scarborough J.B., "*Numerical Mathematical Analysis"*, Oxford and IBH
3. Rao S.S., "*Engineering Optimization-Theory and Applications"*, New Age International Publishers
4. Kirsch U.,"*Optimum Structural Design"*, McGraw Hill
5. Fox R.L., *"Optimization Methods for Engineering Design"*, Addison Wesley
6. Singiresu S. Rao, "*Engineering Optimization (Theory and Practice)"* , New Age International (P) Ltd.
7. Press W.H.,et al."*Numerical Recipes in C–The art of Computation"*,Cambridge Press
8. R. Ranganathan., "*Reliability Analysis and Design of Structures"*, Tata McGraw Hill,
9. Ang, A. H. S & Tang, W. H., "*Probability Concepts in Engineering Planning and Design"*, Vol. I Basic Principles, John Wiley & Sons.
10. Ang, A. H. S & Tang, W. H., "*Probability Concepts in Engineering Planning and Design"*, Vol. II Decision, Risks and Reliability, John Wiley & Sons.
11. Jack R. Benjamin & C. Allin Cornell., "*Probability, Statistics and Decision for Engineers"*, McGrawHill.
12. H. O. Madsen, S. Krenk & N. C. Lind, "*Methods of Structural Safety"*, Prentice-Hall.
13. R. E. Melchers. "*Structural Reliability - Analysis and prediction"*, Ellis Horwood Ltd.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks%**
I	Optimisation methods in civil engineering- Problem formulation with examples- Linear programming problems: statement of an optimisation problem - linear and nonlinear programming problems - standard form of linear programming problems - simplex algorithm - degeneracy, duality, transportation problem, assignment problem.	7	15
II	Applications of linear programming problems in civil engineering - limit design of steel portal frames. Introduction to Dynamic programming, Geometric programming.	7	15
FIRST INTERNAL EXAMINATION			
III	Applications of linear programming problems in civil engineering - limit design of steel portal frames. Introduction to Dynamic programming, Geometric programming.	7	15
IV	Concepts of structural safety- Probability theory:- Introduction, random events, random variables, functions of random variables, moments and expectation, common probability distributions.	7	15
SECOND INTERNAL EXAMINATION			
V	Resistance distributions and parameters: - Introduction, Statistics of properties of concrete, steel and other building materials, statistics of dimensional variations, characterization of variables, allowable stresses based on specified reliability.	7	20
VI	Basic structural reliability:- Introduction, computation of structural reliability. Level 2 Reliability methods: Introduction, basic variables and failure surface, first order second moment methods (FOSM). System reliability-series and parallel systems modeling. Reliability based design: Introduction, determination of partial safety factors, development of reliability based design criteria.	7	20
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 7021 (D)	FORENSIC ENGINEERING AND REHABILITATION OF STRUCTURES	3-0-0-3	2015

Course Objectives

To provide the students the concept and applications of forensic engineering to failure analysis and damage mitigation of structures. Structural retrofitting and rehabilitation techniques are also presented.

Syllabus

Failure of structures - review of the construction theory – performance problems – responsibility and accountability, diagnosis and assessment of distress - visual inspection – non destructive tests – ultrasonic pulse velocity method – rebound hammer technique, environmental problems and natural hazards, durability of RCC structures – damage due to earthquakes and strengthening of buildings – provisions of BIS 1893 and 4326, modern techniques of retrofitting, use of chemicals in repair – application of polymers – ferrocement, fiber composites and fiber reinforced concretes as rehabilitation materials – strengthening by pre-stressing

Course Outcomes

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

Understand the causes of failures

Analyse the causes and suggest solutions like repair or strengthening

References:

1. Dovkaminetzky, *"Design and Construction Failures"*, Galgotia Publication, New Delhi,2001
2. Jacob Feld and Kenneth L Carper, "*Structural Failures"*, Wiley Europe.
3. Raikar R.N "*Diagnosis and treatment of Structures in Distress" ,Jioural of performance of Xonstitutional Facilities,ASCE.*
4. Raina V.K., "*Bridge Rehabilitation" Shroff publications*
5. Ransom W.H., "*Building Failures – Diagnosis and Avoidance"*,Wiley Europe.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	Failure of Structures: Review of the construction theory – performance problems – responsibility and accountability – case studies – learning from failures – causes of distress in structural members – design and material deficiencies – over loading	7	15
II	Diagnosis and Assessment of Distress: Visual inspection – non destructive tests – ultrasonic pulse velocity method – rebound hammer technique – ASTM classifications – pullout tests – Bremor test – Windsor probe test – crack patterns- crack detection techniques – case studies – single and multistorey buildings – Fibre optic method for prediction of structural weakness assessments	7	15
FIRST INTERNAL EXAMINATION			
III	Environmental Problems and Natural Hazards: Effect of corrosive environments, chemical and marine environments – pollution and carbonation problems – detection and measurement of corrosion.	7	15
IV	durability of RCC structures – damage due to earthquakes and strengthening of buildings – provisions of BIS 1893 and 4326	7	15
SECOND INTERNAL EXAMINATION			
V	Modern Techniques of Retrofitting: Structural elements - first aid after a disaster – guniting, jacketing.	7	20
VI	Use of chemicals in repair – application of polymers – ferrocement, fiber composites and fiber reinforced concretes as rehabilitation materials – strengthening by pre-stressing – case studies – bridges – water tanks – cooling towers – heritage buildings – high rise buildings.	7	20
END SEMESTER EXAMINATION			

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 7031	SEMINAR II	0-0-2-2	2015

Course Objectives

To enhance the self-learning capacity of students and enable them to make a comprehensive approach to new and upcoming areas of technology. Also to impart training to students to face audience and present their ideas and thus creating in them self esteem and courage

Syllabus

Individual students are required to choose a topic of their interest from Structural Engineering related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in Structural Engineering) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic in a prescribed format. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Course Outcomes

Identify and chose appropriate topic of relevance.
Assimilate literature on technical articles of specified topic and develop comprehension
Write technical report.
Design and develop presentation on a given technical topic.
Deliver technical presentation on a specified topic

Reading Materials

1. Journal Publication.
2. Conference / Seminar Proceedings.
3. Handbooks / Research Digests/Codebooks

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Course No.	Course Name	L-T-P-Credits	Year of Introduction
08 CE 7041	PROJECT (PHASE 1)	0-0-14-0	2015

Course Objectives

To improve the professional competency and research aptitude by touching the specific areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry/field and current research.

Syllabus

The project work can be analysis and design projects of innovative nature or experimental investigation or numerical simulations or a combination of these. Appropriate software developments with sufficient literature contributions can also be taken up. Each student will be allotted with a faculty as guide. In specific cases student may consult with an external guide with the prior consents of internal guide and head of the department. In this semester, students are expected to finalize appropriate topic of research, complete the required literature survey and about 25% of the objectives of their intended research.

Course Outcomes

Define Research Problem Statement.
Critically evaluate literature in chosen area of research & Establish Scope of work.
Develop Study Methodology.
Conduct Laboratory / Field Studies
Carryout experimental/ analytical/numerical pilot study.

Reading Materials

1. Journal Publication.
2. Conference / Seminar Proceedings.
3. Handbooks / Research Digests/Codebooks.

SEMESTER 4

Course Code	Course Name	L-T-P-Credits	Year of Introduction
08 CE 7012	MAIN PROJECT PHASE II	0-0-21-18	2015

Course Objectives

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Syllabus

Main project phase II is a continuation of project phase I started in the third semester. There would be two reviews in the fourth semester, first in the middle of the semester and the second at the end of the semester. First review is to evaluate the progress of the work, presentation and discussion. Second review would be a pre-submission presentation before the evaluation committee to assess the quality and quantum of the work done. . At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis.

Course Outcomes

Define Research Problem Statement.
Critically evaluate literature in chosen area of research & Establish Scope of work.
Develop Study Methodology, Conduct Laboratory / Field Studies
Analyse Data, develop models and offer solutions.

Each project thesis is required to result in new knowhow applicable to Industry/Society and suitable for publication in discipline related Journals

Reading Materials

1. Journal Publication.
2. Conference / Seminar Proceedings.
3. Handbooks / Research Digests/Codebooks.
4. Previous thesis books

UNIVERSITY OF CALICUT

M.Tech. DEGREE COURSE

STRUCTURAL ENGINEERING
(CIVIL ENGINEERING)

Curricula, Scheme of Examinations and Syllabi
(with effect from 2012 admissions as per 2010 scheme)

CURRICULUM OF M. TECH. PROGRAMME IN STRUCTURAL ENGINEERING

SEMESTER 1

Sl No	Course Code	Subject	Hours/week			ICA	ESE	Total	Credits
			L	T	P				
1	CES10 101	Numerical methods in structural engineering	3	1	0	100	100	200	4
2	CES10 102	Theory of Elasticity and Plasticity	3	1	0	100	100	200	4
3	CES10 103	Advanced Theory and Design of concrete structures	3	1	0	100	100	200	4
4	CES10 104	Structural Dynamics	3	1	0	100	100	200	4
5	CES10 105	Elective -1	3	1	0	100	100	200	4
6	CES10 106(P)	Concrete technology & structural Engineering lab	0	0	2	100		100	2
7	CES10 107(P)	Seminar-1	0	0	2	100		100	2
Total			15	5	4	700	500	1200	24

L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment ESE-End Semester Examination

ELECTIVE 1

CES10 105 (A) Advanced Foundation Engineering

CES10 105 (B) Experimental stress analysis and instrumentation

CES10 105 (C) Construction and maintenance management

Note: 6 hours/week is meant for departmental assistance by students. Each student has to undertake the departmental work assigned by HOD.

SEMESTER 2

Sl No	Course Code	Subject	Hours/week			ICA	ESE	Total	Credits
			L	T	P				
1	CES10 201	Finite Element Analysis	3	1	0	100	100	200	4
2	CES10 202	Analysis and Design of Earthquake Resistant Structures	3	1	0	100	100	200	4
3	CES10 203	Advanced Design of Metal Structures	3	1	0	100	100	200	4
4	CES10 204	Elective- 2	3	1	0	100	100	200	4
5	CES10 205	Elective- 3	3	1	0	100	100	200	4
6	CES10 206(P)	Structural Engineering Design studio	0	0	2	100		100	2
7	CES10 207(P)	Seminar-2	0	0	2	100		100	2
Total			15	5	4	700	500	1200	24

L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment ESE-End Semester Examination

ELECTIVE 2

CES10 204 (A) Marine Structures
CES10 204 (B) Pavement Analysis and Design
CES10 204 (C) Analysis and Design of Plates and Shells

ELECTIVE 3

CES10 205 (A) Soil Structure Interaction
CES10 205 (B) Advanced Concrete Technology
CES10 205 (C) Design of Bridges and Tower Structures

Note: 6 hours / week is meant for departmental assistance by students. Each student has to undertake the departmental work assigned by HOD.

SEMESTER 3

Sl No	Course Code	Subject	Hours /week			ICA		ESE	Total	Credits
			L	T	P					
1	CES10 301	Elective 4	3	1	0	100		100	200	4
2	CES10 302	Elective 5	3	1	0	100		100	200	4
3	CES10 303(P)	Industrial Training	0	0		0		50	50	1
4	CES10 304(P)	Master Research Project Phase I	0	0	22	Guide 150	EC 150		300	6
Total			6	2	22	500		250	750	15

**Industrial Training is for a minimum period of two weeks*

L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment ESE-End Semester Examination

ELECTIVE 4

CES10 301 (A) Design of Pre-stressed Concrete Structures
CES10 301 (B) Mechanics of Composite Materials
CES10 301 (C) High Rise buildings

ELECTIVE 5

CES10 302 (A) Design of Industrial Structures
CES10 302 (B) Probability Methods in Civil Engineering
CES10 302 (C) Structural Optimization and Reliability Analysis
CES10 302 (D) Forensic Engineering and Rehabilitation of Structures

Note: 6 hours / week is meant for departmental assistance by students. Each student has to undertake the departmental work assigned by HOD

SEMESTER 4

Sl No	Course Code	Subject	Hours /week			ICA		ESE		Total	Credits
			L	T	P	Guide	Evaluation Committee	External Examiner	Viva voce		
1	CES10 401(P)	Master Research Project Phase II	0	0	30	150	150	150	150	600	12

L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment ESE-End Semester Examination.

Note: 6 hours / week is meant for departmental assistance by students. Each *student has to undertake the departmental work assigned by HOD.*

Total credits for all semesters: 75

Total marks for all semesters: 3750

SYLLABI OF M.TECH PROGRAMME IN STRUCTURAL ENGINEERING

SEMESTER 1

CES10 101 NUMERICAL METHODS IN STRUCTURAL ENGINEERING

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To impart in depth knowledge of various mathematical tools applied to diversified problems in structural engineering*

Module I (14 Hours)

Systems of linear algebraic equations:

Elimination and factorization methods: Gauss, Cholesky and Crout's methods – Ill-conditioned systems – Symmetric and Banded systems – Gauss Siedel iteration - Relaxation method-condition of convergence of iterative methods.

Systems of non-linear equations – Newton-Raphson Method.

Module II (16 Hours)

Partial differential equations:

Ordinary differential equations in more than two variables – first order P.D.E-integral surface passing through a given curve-surfaces orthogonal to given system-compatible systems of first order P.D.E-charpits method -solution satisfying the given conditions-linear P .D.E with constant coefficients

Module III (12 Hours)

Interpolation and integration

Lagrange – Hermitian and cubic spline methods – Isoparametric style of interpolation

Numerical Integration using Gaussian quadrature - One and Two Dimensions

Gauss Hermite Quadrature Method - Newton–Cotes open quadrature - Monte Carlo Method - Application to deflection of beams and plates

Module IV (12 Hours)

Eigen Value Problems

Introduction – Methods of solutions: method of characteristic polynomial – Faddeev-Leverrier Method - Approximate Methods:- Forward iteration, inverse iteration – (Vianello-Stoodala method)Power Method with deflation - Rayleigh – Ritz Method.

Text Books:

1. B.S Grewal, "Numerical Methods in Engineering and Science", Khanna Publications.
2. Rajasekaran S, "Numerical Methods in Science and Engineering – A practical approach", AH Wheeler & Co.
3. P Kandasamy, "Numerical Methods", S Chand and company.
4. Stevan C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers", McGraw Hill
5. Erwin Kreyszig ., "Advanced Engineering Mathematics", 5th Edition, Weiley Eastern Ltd., 1989.

References:

6. Michael D Greenberg, "Advanced Engineering Mathematics", Pearson education.
7. Ian Sneddon, "Elements of Partial Differential Equations", McGraw Hill, International Editions.
8. Balagurusamy , "Numerical Methods", Tata McGraw Hill
9. Carrier, G.F. and Pearson, C.E., "Partial Differential Equations", Academic Press, New York, 1976
10. Carl de Boor Verlog, "A practical guide to splines", Springer-Verlag

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 102 THEORY OF ELASTICITY AND PLASTICITY

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To equip students with concepts of elasticity and plasticity applied to structural engineering*

Module I (14 Hours)

Introduction: State of stress at a point in three dimensional elasticity - Principal stresses - Octahedral stresses - Strain at a point - Equilibrium and compatibility conditions - Generalised Hooke's law.

Plane Cartesian Elasticity: Plane stress - Plane strain - Equations of equilibrium in two dimensions - Compatibility of strain - Boundary conditions - Governing differential equation in Cartesian co-ordinates - stress functions Airy's stress function - Two dimensional problems in rectangular co-ordinates - Method of solution by Polynomials.

Module II (12 Hours)

Plane Problem in Polar Co-ordinates: Solution of two dimensional problem in Polar co-ordinates – axi-symmetric Stress distribution – thick cylinder, rotating disc, curved beam- Effect of circular holes on stress distribution in plates - Loads on straight boundaries - Concentrated force acting on a beam-stress on a circular disc under diametric compression.

Module III (14 Hours)

Strain Energy Methods: Total strain energy- complementary energy - Principle of virtual work and total potential energy- Theorem of minimum potential energy, Betti's reciprocal theorem, principle of linear superposition, uniqueness of elasticity solution. Theorem of minimum complementary energy- Griffith's theory of rupture - Castigliano's theorem - Principle of least work.

Torsion: Torsion of straight bars – elliptic cross section - Saint Venant's theory - Membrane analogy – narrow rectangular cross section - Torsion of thin-walled open sections - Torsional stress concentration.

Module IV (14 Hours)

Introduction to plasticity: One-dimensional elastic-plastic relations, isotropic and kinematic hardening, yield function, flow rule, hardening rule, incremental stress-strain relationship, governing equations of elastoplasticity.

Yield and failure criteria-Stress strain relations for perfect elasto-plastic materials-Von Mises, Tresca and Mohr-Coulomb stress functions-simple elastic plastic problem-Expansion of a thick walled cylinder – incremental stress-strain relationship

Implementation of plasticity in metals and concrete – principles only – metals - plastic stress strain matrix for metals- nonlinear stress strain relation in concrete.

Text Books:

1. C.T.Wang, "Applied Elasticity", Wiley International
2. Timoshenko, S.P. and Goodier T.N. "Theory of Elasticity", McGraw Hill.
3. Chenn, W.P. and Henry D.J. "Plasticity for Structural Engineers", Springer Verlag Newyork
4. Sadhu Singh, "Theory of Plasticity", Khanna Publishers, New Delhi 1988.
5. Verma, P.D.S., "Theory of Elasticity", Vikas Publishing Pvt. Ltd. New Delhi -1997.

References:

1. Filenenko & Boridith, “Theory of Elasticity”, Mir publisher
2. Chwo P.C. and Pagano, N.J. "Elasticity Tensor, Dyadic and Engineering applications", D.Van Nestrand Co., 1988.
3. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi 1988.
4. Ernest E Sechler, “Elasticity in Engineering”
5. Xu, Z., Applied Elasticity, Wiley Eastern Ltd, India, 1992.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 103 ADVANCED THEORY AND DESIGN OF CONCRETE STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To impart in depth knowledge of material and structural behaviour of concrete, background of provisions made in codes of design and to familiarize with the design of some important structures*

Module 1 (12 hrs)

Stress-strain characteristics of concrete under single and multi- axial stresses- confined concrete- Effect of cyclic loading on concrete and reinforcing steel - Ultimate Deformation and ductility of members with flexure- strength and deformation of members with tension - Control of deflections- immediate and long term deflections.

Module 2 (14 hrs)

Strut and Tie Models- Development- Design methodology- selecting dimensions for struts- IS and ACI Provisions- Applications: shear and torsion in beams, Deep Beam and corbel-beam column joints.

Module 3 (14 hrs)

Biaxial bending of columns- interaction diagrams-Analysis and Design of slender RCC columns- Control of cracking in beams and slabs – classical theory of cracking- codal procedures on crack-width computation as per IS-comparison with BS and ACI codes.

Module 4 (14 hrs)

Inelastic behaviour of concrete beams- moment curvature diagrams – plastic hinge formation-moment redistribution in continuous beams - Baker's method of plastic design - Design of cast in-situ frames- principles of capacity design – ductile detailing of frames.

Text Books:

1.Varghese.P.C., "Advanced Reinforced Concrete Design", Prentice Hall of India, 2001

2.Park,R and Paulay T, Reinforced Concrete Structures, (John Wiley & Sons, New York)

3.Purushothaman.P. "Reinforced Concrete Structural Elements", Behaviour, Analysis and Design. (Tata Mc Graw Hill 1986)

References:

1. Arthur. H. Nilson, David Darwin and Charles W Dolan, “Design of Concrete Structures”, Tata McGraw Hill, 2004
2. Thomas T. C. Hsu, “Unified Theory of Reinforced Concrete”, CRC Press, London,1993.
3. IS 456 –2000, Indian Standard for Plain and Reinforced Concrete- Code of Practice, New Delhi
4. ACI – 318: 2002, Building Code Requirements for Structural Concrete and Commentary, ACI Michigan.
5. Pillai.S.V and Menon.D, "Reinforced Concrete Design", Tata McGraw Hill Book Co., first Edition, 2002

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10-104 STRUCTURAL DYNAMICS

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To impart in depth knowledge of structural behaviour under dynamic loads and thus to establish foundation for acquiring principles of seismic design*

Module 1 (14 hrs)

Introduction: Fundamental objective of structural dynamic analysis – types of prescribed loadings – essential characteristics of a dynamic problem – method of discretization, lumped mass procedure – generalized displacements – Single degree of freedom system – Components of the basic dynamic system – formulation of the equation of motion – D’Alembert’s principle - influence of gravitational forces - generalized SDOF system- Rigid body assemblage - expression for generalized system properties.

Free vibration of single degree of freedom system:- Solution of equation of motion, undamped free vibration - Damped free vibration, critically damped, under damped and over damped systems, Negative damping.

Module 1I (14 hrs)

Single Degree of Freedom Systems: Response to harmonic loading, Undamped system- damped system, Response to periodic loading -Fourier series expansion of the loading- response to Fourier series loading - Exponential form of Fourier series loading and response- Complex frequency transfer functions

Response to impulsive loads :- Suddenly applied load, sine wave impulse, rectangular impulse, triangular impulse, spike loading, approximate analysis

Response to general dynamic loading:- Duhamel integral for undamped system – unit impulse response function – numerical evaluation, response of damped system- classical and non classical damping- numerical evaluation, Numerical analysis in the frequency domain, fast Fourier transform analysis.

Module 1II (12 hrs)

Multi degree of freedom system:- Two degree of freedom system – equation of motion, characteristic equation, frequencies and mode shapes, Vanello Stodola method, coordinate coupling and choice of degree of freedom, orthogonality of modes, natural coordinates, superposition of natural modes , response of two degree of freedom system to initial excitation, response to harmonic excitation Multi-degree of freedom system – analysis of multi- degree of freedom system- mode superposition analysis.

Module 1V (14 hrs)

Distributed Parameter System: Partial differential equation of motion - Axial and torsional vibration of prismatic bars - Elementary case of flexural vibration of beams - Beam flexure including axial force effects.

Free and forced vibrations of beams - Approximate solutions - Rayleigh and Rayleigh - Ritz Methods - Vibrations of building frames - Modal Analysis (principle only).

Numerical evaluation of dynamic response – Time stepping method – methods based of interpolation of excitation – central difference method – Newmark's method.

Text Books:

1. Anil.K.Chopra, Dynamics of Structures (Theory and Applications to Earthquake Engineering), 2nd Edition, Prentice Hall of India Private Limited. New Delhi, 2003
2. Clough, R.W. & Penzein, J. "Dynamics of Structures", McGrawHill 1995
3. Mukhopadhyay, M., "Structural Dynamics", Ane Books, India, 2006

References:

1. Mario Paz, "Structural Dynamics - Theory and Computations", CBS Publications, New Delhi, 1983
2. Timoshenko, "Vibration problems in Engineering", Van Nostrand Co., Inc.
3. Biggs, "Introduction to Structural Dynamics", McGraw Hill Book Co. 1975
4. Hurty and Rubinsteian, "Dynamics of structures"
5. Short course on *Seismic Design of Reinforced Concrete Buildings*, CEP, IIT, Kanpur, Dec.1995
6. IS 1893 – Criteria for Earthquake Resistant Design of Structures.
7. SP 22: Explanatory Handbook on Codes for Earthquake Engineering.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 105 (A) ADVANCED FOUNDATION ENGINEERING

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To equip the students to understand the analysis and design of various foundation systems required for various infrastructure projects*

Module I (12 hours)

Shallow foundations- Introduction**-** Models used in design of foundation-Review of various theories for bearing capacity-settlement-allowable bearing pressure-SPT-Ultimate bearing capacity and settlement in sand from N values-Bearing capacity of footings and raft on clay-Bearing capacity of stratified soils-Design principles and methodology of footings and raft.

Module II (14 hours)

Pile foundation-Introduction-Review of static and dynamic methods-load carrying capacity from SPT-Structural design of concrete piles and pile cap-Group action of piles.

Piled raft foundation-Introduction-Types-Design considerations

Well foundation- Introduction-Bearing capacity-method of analysis-Terzaghi's method-IRC and IS design recommendations-Elastic theory-Checking ultimate failure conditions for abutments-Bending strength of well-Check for settlement-depth of scour-Minimum thickness of RC wells.

Module III (14 hours)

Soil dynamics and Design of Machine foundations-Introuction-Mass spring system-Free vibrations-vibrating spring mass system with damping-forced vibrations-natural frequency of foundation soil system-Barken's method-bulb of pressure concept-Basic principles of design of machine foundation-method of analysis-static analysis –dynamic analysis-soil properties for dynamic analysis-Types of machine foundations-IS Code practice for design of machine foundation for reciprocating and impact type machines.

Module IV (14 hours)

Foundations for Steel Towers and Chimneys:- Introduction-Loads on foundation-Common types of foundation for steel towers-Behaviour of pad and Chimney foundation-Design of Chimney and Pad foundations-Anchor foundations-Rock Anchors-Design of foundation for concrete towers and chimneys-Analsis of shallow steel tower foundation.

References:-

1. P.C.Varghese, Foundation Engineering, Prentice-Hall of India Pvt-Ltd, New Delhi.
2. B.C.Punmia, Soil Mechanics and Foundations, Laxmi Publications Pvt Ltd, New Delhi
3. Braja M Das, Principles of Foundation Engineering
4. Koerner R M, Construction and Geotechnical methods in Foundation Engineering
5. Joseph E. & Bowles, *Foundation Analysis & Design*, McGraw Hill
6. Leonards G.A., *Foundation Engineering*, McGraw Hill
7. Arora K.R., *Soil Mechanics & Foundation Engg.,* Standard Publications

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 105(B) EXPERIMENTAL STRESS ANALYSIS AND INSTRUMENTATION

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To make students aware of various measurement techniques required instrumentation, experimental planning and procedures adopted in laboratory*

Module I (14 hours)

The measurement system – Purpose, structure and Elements – Characteristics of measurement system. Accuracy, precision, repeatability, calibration – Standards and evaluation. Dynamic Characteristics. Statistical Analysis – Errors in measurement – best estimate of true value Normal Distribution – Confidence level.

Strain gauges - definition of gauge length - sensitivity and range - characteristics of an ideal strain gauge - different types of mechanical strain gauges, optical strain gauge - acoustic strain gauge - pneumatic strain gauge - merits and demerits - electrical strain gauges - inductance, capacitance and piezo electric gauges - bonded and unbonded resistance gauges and their application in stress analysis - fixing techniques and measurement of strains – procedures.

Module II (14 hours)

Strain rosettes - determination of principal strains and stresses - construction of stress, strain circles - analytical solutions- Strain gauge circuits-characteristics- strain gauge bridges, temperature compensation- Force transducers, Load cells different types force balance pressure gauges.
Measurement of displacement by Linear variable displacement transducer (LVDT)

Module III (14 hours)

Photo elasticity - basics of optics, stress optic law - plane and circularly polarized light and their use in photos elasticity - polariscopes - diffusion type - lens type polariscopes - isoclinics and isochromatics - Model materials - calibration methods for finding material fringe values - model fringe values - examples of beam flexure and diametrically loaded circular plates.

- Principles of 3D photo-elasticity

Module IV (12 hours)

Non Destructive Testing Methods – Ultrasonic Methods – Hardness methods – Rebound Hammer – Detection of embedded reinforcement.
Computer based data acquisition systems.
Model analysis - direct and indirect models - laws of structural similitude - choice of scales - limitation of model studies - buckingham pi-theorem - dimensional analysis - model materials - Begg's deformater and its use - simple design of direct and indirect models

References

1. Dally, J. W. and Raliey W.F., Experimental Stress Analysis, McGraw Hill.
2. Srinath L.S., Experimental Stress Analysis, Tata McGraw Hill
3. Roy, T.K., Experimental Analysis of stress and strain
4. Dove and Adams, Experimental Stress Analysis and Motion measurement, Prentice Hall
5. Hetenyi M., Hand book of Experimental Stress Analysis, John Wiley
6. Bently JP – Principles of Measurement Systems, Longman, 1983
7. Nakra & Chowdhary – Instrumentation Measurement & Analysis – Tata McGraw Hill, 1995
8. Doblins E A – Measurement Systems Application & Design Mc Graw Hill 1975

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 105 (C) CONSTRUCTION AND MAINTENANCE MANAGEMENT

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objectives:

- *To equip the students to understand durability aspects of buildings, causes and process of failure and the methods of monitoring maintenance requirements and rehabilitation strategies of structures*
- *To study the various management techniques for successful completion of construction project*

Module I (14Hours)

Organising for Project management - Project Management – modern trends - Strategic Planning - Effects of Project Risks on Organization - Organization of Project Participants -Traditional Designer-Constructor Sequence - Professional Construction Management - Owner-Builder Operation - Turnkey Operation - Leadership and Motivation for the Project Team

Labour, Material and equipment utilisation - Historical Perspective - Labour Productivity - Factors Affecting Job-Site Productivity - Labour Relations in Construction - Problems in Collective Bargaining - Materials Management - Material Procurement and Delivery - Inventory Control - Tradeoffs of Costs in Materials Management.

Module II (12 Hours)

Constructions Operations Management – Trends and methods in construction project scheduling – principles-use of bar charts and networks-CPM and PERT methods

Quality management-Features of Quality management systems – general principles-Total Quality Management-ISO systems- ISO 9000 certification process in construction-quality manuals-preparation-principles

Principles of Safety management

Module III (14 Hours)

Maintenance and repair strategies - Definitions: Maintenance, repair and rehabilitation- Life expectancy of different types of buildings- Facets of Maintenance- importance of Maintenance-Inspection-Assessment procedure for evaluating a damaged structure

Repair project management- principles- choice of materials and methods and equipment

Influence on serviceability and durability-–effect of environmental elements such as heat, dampness, frost and precipitation on buildings-effect of chemical agents on building materials-effect of pollution on buildings-effect of fire on building-damage by biological agents like plants, trees, algae, fungus, moss, insects, etc.

Module IV (14 Hours)

Failure and repair of buildings: Definition of building failure-types of failures-methodology for investigation of failures-diagnostic testing methods and equipments-repair of cracks in concrete and masonry-methods of repair-repair and strengthening of concrete buildings-foundation repair and strengthening-underpinning-leakage of roofs and repair methods

Special materials for repair - Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferrocement, Fibre reinforced concrete. Rust eliminators and polymers coating for Rebars, foamed concrete- special equipment

Text books

1. R.T.Allen and S.C.Edwards, “Repair of Concrete Structures”, Blakie and Sons,
2. UK, 1987.
3. M.S.Shetty, “Concrete Technology - Theory and Practice”, S.Chand and
4. Company, New Delhi, 1992.
5. Santhakumar, A.R., “ Concrete Technology”,, Oxford University Press, NewDelhi, 2007.
6. S Champion “Failure and repair of concrete structures”
7. Chitkara, K.K. Construction Project Management: Planning, Scheduling and Control, Tata McGraw-Hill Publishing Company, New Delhi, 1998.
8. Choudhury, S , Project Management, Tata McGraw-Hill Publishing Company, New Delhi, 1988.
9. Kumar Neeraj Jha,Project management – Theory and practice, Pearson Education India, New Delhi,2011.

References

1. Raikar, R.N., “Learning from failures - Deficiencies in Design”, Construction and
2. Service - R & D Centre (SDCPL), Raikar Bhavan, Bombay, 1987
3. Denison Campbell, Allen and Harold Roper, “Concrete Structures”, Materials,
4. Maintenance and Repair, Longman Scientific and Technical UK, 1991.
5. Smith P & Julian W, “Building services”, Applied science publications
6. Peter H. Emmons, Concrete Repair and Maintenance, Galgotia Publishers
7. SP:25 BIS Causes and Prevention of Cracks in buildings
8. SP:62 (S&T)-1997, BIS, Hand Book on Building Construction Practice, pp. 457-765
9. Seetharaman S., “Construction Engineering and Management (fourth Revised and Enlarged Edition) ”, Umesh Publications, Delhi (2003).
10. Chitale A. K. and Gupta R. C., “Materials Management- Text and cases”, Prentice-Hall of India Private Limited, New Delhi (2006).
11. Gopalakrishnan P and Sundaresan M, “Materials Management an integrated approach”, PHI Learning Private Limited, New Delhi (2009)
12. Chris Hendrickson and Tung Au, Project Management for Construction – Fundamental Concepts for Owners, Engineers, Architects and Builders, Prentice Hall, Pittsburgh, 2000.
13. Frederick E. Gould, Construction Project Management, Wentworth Institute of Technology, Vary E. Joyce, Massachusetts Institute of Technology, 2000.
14. George J.Ritz , Total Construction Project Management - McGraw-Hill Inc, 1994.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 106(P) CONCRETE TECHNOLOGY & STRUCTURAL ENGINEERING LAB

Credits: 2

Teaching scheme: 2 hours practical per week

Objective:

To familiarize the students with the different sophisticated instrumentations used in the laboratory and field for measuring/monitoring stress, strain, deflection etc. in structures. New construction materials, their testing and construction practices are introduced.

Pre-requisite: -Nil

Measurement of Strain: - Mechanical Strain Gauges- Electrical Strain gauges- Extensometers and Compressometers

Measurement of Deflection:- Dial gauges - Linear Variable Differential Transducers

Principles of operations of UTM, hydraulic loading systems, force measuring devices etc.

Concrete Mix design practices

Study of the behaviour of structural materials and structural members- Casting and testing of simple structural members.

- Under-reinforced and Over-reinforced RC beams in flexure.
- Effect of Shear span to depth ratio on the failure pattern of RC beams.
- Behaviour of steel beam under flexure.
- Hinge formation in two span RC continuous beam.

Introduction to Non Destructive Testing of RCC members - Rebound Hammer, Ultrasonic pulse devices, Core cut test.

New Reinforced Cement Composites:- Introduction to Steel fiber reinforced concrete – Ferrocement – Polymer concrete - Self Compacting Concrete – High Performance Concrete.

References:

1. Concrete technology- Neveli – Pearson Publishers, 2000
2. Concrete Technology – M.S. Shetty – S. Chand and Co., 2001
3. Srinath L.S., “Experimental Stress Analysis”, Tata McGrawHill

Students are required to prepare a record of the experiments conducted in the laboratory and the same shall be certified by the faculty in charge of the lab class and the head of the department. There shall be a semester end examination conducted by the faculty in charge of the lab class. The internal assessment shall be based on the performance of the students in the lab and also based on marks awarded to the records.

Internal continuous assessment: 100 marks

Continuous evaluation (Assessment of individual experiments)	: 30 %
Fair Record of experiments	: 20 %
Test(s), Viva voce	: 50 %

CES 10 107(P) SEMINAR - 1

Credits: 2

Teaching Scheme: 2 hours per week

Objective:

To enhance the self-learning capacity of students and enable them to make a comprehensive approach to new and upcoming areas of technology. Also to impart training to students to face audience and present their ideas and thus creating in them self esteem and courage.

Individual students are required to choose a topic of their interest from Structural Engineering related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in Structural Engineering) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic in a prescribed format. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Internal continuous assessment: 100 marks

Evaluation shall be based on the following pattern:

Report (Relevance, Literature content, organization)	: 50 marks
Presentation, Discussion	: 40 marks
Participation	: 10 marks
Total	: 100 marks

SEMESTER 2

CES10 201 FINITE ELEMENT ANALYSIS

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To build up the back ground, basic concepts and basic formulation of finite element method to enable the students to understand various element formulations and use them for analysis, including programming.*

Module I (12 Hours)

Introduction to Finite Element Method – History of development – Advantages – Disadvantages - General description of the method -Basic equations of elasticity- Strain – Displacement relations – Theories of stress and strain – Stress-Strain relations – Plain stress – Plain strain conditions
Direct stiffness method – Review of basic concepts of matrix displacement analysis – Complete stiffness matrices – Co-ordinate transformation – Global stiffness matrices – Formulation of load vector – Direct stiffness method – Assembly of elements- Displacement boundary conditions – Gauss elimination solution of equations

Module II (14 Hours)

Calculus of variations – Variational principles of solid mechanics – Principles of virtual work – Approximate methods – Rayleigh-Ritz, Weighted residual (Galerkin) and Finite Difference Method.
Concept of elements – Displacement model – Shape functions – General coordinates – Natural coordinates – Convergence and Compatibility conditions – C_0 and C_1 elements – Conforming and non conforming elements – Numerical integration – Gauss quadrature method- Summary of finite element procedure.

Module III (16 Hours)
Analysis of framed structure **– 2D** and **3D** truss and frame elements – applications – Plain stress and plain strain analysis – Triangular elements – CST and LST elements – Rectangular elements – Isoparametric elements – Incompatible models – 8 noded and 20 noded isoparametric solid elements – Axisymmetric solid elements (for solid elements principles of formulations only).

Module IV (12 Hours)

Analysis of plate bending – Basic equation of thin plate theory- Reissner-Mindlin theory – plate elements and applications – Analysis of shells – generated shell elements
Programming concepts – Assembling – Boundary conditions – Solution techniques – Band width minimization – Gauss elimination.
Modelling and analysis using recent softwares

Text Books:

1. Krishnamoorthy C. S., Finite Element Analysis - Theory and Programming, Tata McGraw Hill
2. Bathe K.J., Finite Element Procedures in Engineering Analysis, Prentice Hall of India
3. Desai C.S., Elementary Finite Element Method, Prentice Hall of India
4. Cook R.D., Malkus D.S. & Plesha M.F., Concepts & Applications of Finite Element Analysis, John Wiley
5. Reddy, J.N., An Introduction to the Finite Element Method, McGraw Hill, 2006.

References:

1. Chandrupatla T.R. & Belegundu A.D., Introduction to Finite Elements in Engineering, Prentice Hall of India
2. Cook, R.D., Finite Element Modelling for Structural Analysis, John Wiley and sons.
3. Gallaghar R.H., Finite Element Analysis: Fundamentals, Prentice Hall Inc.
4. Rajasekaran S., Finite Element Analysis in Engineering Design, Wheeler Pub.
5. Zienkiewics O.C. & Taylor R.L., The Finite Element Method, Vol I & II, McGraw Hill
6. Segrelind., The Finite Element Method.

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 202 ANALYSIS AND DESIGN OF EARTHQUAKE RESISTANT STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective
To make students capable of analyzing and designing various types of structures exhibiting ample safety under probable earthquakes

Module I (12 HOURS)
Introduction to engineering seismology – plate tectonics- faults- causes of earthquake-energy release Seismic waves -primary and secondary waves – Raleigh wave - Love wave – Magnitude of earthquake – Intensity-measurement – seismographs – seismic zoning of India.

Base-excited SDOF system formulation of basic equation – elastic response to pulse and harmonic excitations-– concepts of pseudo acceleration, velocity and displacement – four way logarithmic graph – response to arbitrary excitations- peak response values - response spectra-DVA Spectrum.

Module II (14 HOURS)
Base-excited MDOF system- (review: lumped mass system- natural frequencies-mode shapes- Modal combination - SRSS - CQC) – Lumped mass modeling of multi-storey shear building and modes of vibration – response quantities- response spectra –modal contribution factors-influence of higher modes-effect of damping on responses.
Earthquake analysis of linear systems-response history analysis-modal anlysis-modal response – total response- multistory building with symmetric plan- torsional response-modal mass and height-unsymmetric plan- response spectrum analysis of linear system-peak modal responses-effect of appendages.

Module III (14 HOURS)
Earthquake response of inelastic systems-hysterisis loop and energy dissipation- elasto-plastic idealizations- concept of equivalent linear system – ductility factor-ductility demand- elastic and inelastic design spectra
Performance of building and structures under earthquakes- Main Causes of Damage- Intensity of earth quake forces, lack of strength and integrity of buildings, quasi resonance – lack of ductility, lack of detailing.
Effects of Earth quake on - tower structures, power plants, switch yards, equipments or other life line structures, soil liquefaction- Assessment of damage, concepts of seismic isolation and seismic active control (Numerical exercises not expected)

Module IV (14 HOURS)
Philosophy and Principles of earthquake.-resistant design- Strength and stiffness- ductility-based design and detailing– analysis and design as per IS 1893:2002 – Buildings- Seismic zones and coefficients – response reduction factors -Estimations of fundamental time period -Design spectrums – equivalent static analysis – Vertical distribution of seismic forces and horizontal shears – Dynamic

analysis –Seismic weights – Building forms and architectural design concepts- Horizontal and vertical eccentricities due to mass and stiffness distribution-limits on drifts.
Load combinations and permissible stresses as per IS. Use of codes like IS: 4326, IS: 13828, IS: 13827, IS13920, SP:22 with reference to masonry, RCC and steel building -Detailing of reinforcement and joints.

References:

1. Anil.K.Chopra, Dynamics of Structures (Theory and Applications to Earthquake Engineering), 2nd Edition, Prentice Hall of India Private Limited. New Delhi, 2003
2. Jaykrishna, Elements of earthquake engineering, Saritha Prakasan, Naunchandi, Meerut
3. Mukhopadhyay, M., "Structural Dynamics", Ane Books, India, 2006
4. R W Clough and J Penzien, Dynamics of structures, McGraw Hill
5. Pankaj Agarwal and Manish Shrikandhe, Earthquake Resistant Design of Structures, PHI
6. Park & Paulay, Reinforced concrete, McGrawHill

IS Codes:

IS:1893 - (Part I), Criteria for Earthquake Resistant structures-General Provisions and Buildings
IS:13935 – Repair and Seismic strengthening of buildings
IS:4326 - Earthquake Resistant Design and Constructions of buildings
IS:13827 – Improving Earthquake Resistance of Earthen buildings
IS:13828 - Improving Earthquake Resistance of Low strength Masonry buildings
IS:13920 – Ductile detailing of RC Structures subject to Seismic forces.

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 203 ADVANCED DESIGN OF METAL STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective:
To introduce students with plastic analysis and design methods of some important types of metal structures.

Module I (12 Hours)

Plastic method of analysis – Comparison between elastic and plastic analysis, Plastic behaviour under static and cyclic loading. Analysis of continuous beams, Portal and gable frames, method for plastic moment distribution, Effect of axial force and shear force on plastic moments and connections.

Module II (12 Hours)

Design of Connections - Types of connections - Design framed beam connections - Seated beam connections - Unstiffened, Stiffened seat connections, Continuous beam-to-beam connections and continuous beam-to-column connection both welded riveted.

Module III (14 Hours)

Design for light gauge steel structures – Types of cross sections - Local buckling and lateral buckling, post buckling strength, concepts of Effective width - Design of compression and tension members ,Design of beams, Columns. Combined stresses and connections, wall studs.

Module IV (16 Hours)

Design of tubular structures – Design of tension and compression members, Connections, truss configurations, space structures.
Design of Aluminum structures – Design of tension and compression members, beams and columns

References :

1. Gaylord & Gaylrod, Design of Steel Structures, Mc Graw Hill
2. Duggal, S.K., "Limit State Design of Steel Structures", Tata mcGrawHill
3. Subramanian, N., "Design of Steel Structures", Oxford University Press.
4. Salmon C.G & Johns J.E, Steel Structures- Design and Behaviour, Harper and Row, 1980..
5. John Baker & Jacques Hayman, Plastic Design of Frames, University – Printing House, Cambridge
6. Dr. Ramachandra, Design of Steel Structures – Vol II. Standard Book House, Delhi.
7. Krishnamchar B.S. & Ajith Sinha, D . Design of steel structures, TMH Publishing Co.
8. Horne, M.R., and Morris, L.J., Plastic Design of Low -rise frames, Granada Publishing Ltd., 1981.
9. Wie - Wen Yu., Cold-formed Steel Structures, McGraw Hill Book Company, 1973.
10. William McGuire, Steel Structures, Prentice Hall, Inc., Englewood Cliffs, N.J.1986.
11. Subramanian N. ,"Principles of Space Structures", Wheeler Publishing Co
12. Santhakumar A.R and Senthil.R, "Proceedings of International Conference on Space Structures", Anna University, Chennai

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 204 (A) MARINE STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To equip the students with basic concepts of analysis and design of most common coastal and offshore structures*

Module I (14 hrs)
Waves : Classification of water waves - Two dimensional wave equation and wave characteristics - wave theories - Small amplitude waves - Finite amplitude waves - Stokian, Solitary and Conical wave theories - Water particle kinematics - wave energy, power (Numerical exercises to be done) - wave deformation - Reflection, Refraction, Diffraction- Breaking of waves . Mass transport velocity. Introduction to Random and directional waves. Wave spectrum**-**Currents -Classification - Behaviour - Design Criteria, Scour and other effects of currents.

Module II (12 hrs)
Wave Structure interaction- Non breaking wave forces on slender structures - Morison equation; (Numerical exercises to be done). Wave loads on large Bodies - Diffraction theory. Wave loads on vertical walls and Caissons: Non breaking loads - Sainflou method; Breaking forces - Minikin method; Goda method-(Numerical exercises to be done)-forces due to broken waves.

Module III (14 hrs)
Coastal Structures- Breakwaters- Seawalls- Bulkheads- fenders and Mooring Facilities- Jetties- Wharves- Quays- Diaphragm Walls- Piles -Partial safety Factors.-Codal Requirements. - Submarine Pipelines -thickness calculations (detailed design not expected);

Module IV (14 hrs)
Offshore structures- Types of Offshore Structures - Loads on Offshore Structures Wind Loads; Wave and Current Loads; Analysis of jacket structures-Static method of analysis-Cyclic loads for fatigue analysis-Design of tubular members and joints- (Simple design problems).

Text Books:

1. Sarpkaya, T. and Isaacson, M., Mechanics of Wave Forces on Offshore Structures, Van Nostrand Reinhold Co., NewYork, 1981
2. Ippen, A.T., Estuary and Coastline Hydrodynamics, McGraw-Hill Book Company, Inc., NewYork, 1978
3. Chakrabarti,S.K., Hydrodynamics of Offshore Structures, Computational Mechanics Publications, Southampton, Boston
4. Chakrabarti,S.K., Handbook of Offshore Engineering Vol.1&II, by S.K. Chakrabarti, Elseviers,2005.
5.Offshore pipelines by B. Gou, S. Song, J. Chacko and A. Ghalambor, GPP Publishers,2006
6.Structural Stability – Theory and Implementation by W.F.Chen and E.M.Lui by Elsevier

References

1. Thomas.H.Dawson, Offshore Structural Engineering, Prentice –Hall
2. Young Bai, Marine Structural Design, Elsevier 2003
3. Coastal Engineering Manual (CEM-Department of Army-US Army Corps of Engineers- latest revision)
4. API-Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms.API-RP2A-WSD (2000)-API-RP2A-LRFD (1993)

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 204 (B) PAVEMENT ANALYSIS AND DESIGN

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective*: To impart the knowledge of principles and methodology of design of rigid and flexible pavements.*

Pre-requisite: Nil

Module I (14 Hours)

Introduction - Comparison between Flexible & Rigid Pavements -Highway and Airport pavements – Types and Component layers of Pavements – their functions - A brief study on aggregates, bitumen and modified bitumen like cutback, emulsion, polymer modified bitumen - Factors affecting Design and Performance of Pavements -

Various Methods of Assessment of Subgrade Soil Strength for Pavement Design - Causes and Effects of variation in Moisture Content and Temperature - Depth of Frost Penetration.

Bituminous mix design methods, specifications and testing.

Module II (14Hours)

Analysis & Design of Flexible Pavement: Stresses and Deflections in Homogeneous Masses - Burmister's 2-layer, 3- layer Theories - Wheel Load Stresses - ESWL of Multiple Wheels - Repeated Loads and EWLfactors - Sustained Loads and Pavement behaviour under Traffic Loads - Empirical, Semi-empirical and Theoretical Approaches - Development, Principle, Design steps, Advantages and Applications of different Pavement Design Methods

Module III (12 Hours)

Analysis & Design of Rigid pavements: Types of Stresses and Causes, Factors influencing the Stresses; General conditions in Rigid Pavement Analysis, ESWL, Wheel Load Stresses, Warping Stresses, Friction Stresses, Combined Stresses - Types of Joints in Cement Concrete Pavements and their Functions, Joint Spacing, Design of Slab Thickness, Design of Joint Details for Longitudinal Joints, Contraction Joints and Expansion Joints, IRC Method of Design.

Module IV (14 Hours)

Pavement Structure & Its Evaluation: Factors affecting Structural Condition of Flexible and Rigid Pavements; Effects of Sub grade Soil, Moisture, Pavement Layers, Temperature, Environment and Traffic on Structural Stability, Pavement Deterioration; Evaluation by Non-Destructive Tests such as FWD, Benkelman Beam Rebound Deflection, Plate Load Test, Wave Propagation and other methods of Load Tests; Evaluation by Destructive Test Methods, and Specimen Testing

Pavement Overlays & Design: Pavement Overlays, Design of Flexible Overlay over Flexible Pavement by Benkelman Beam Deflection and other Methods, Flexible Overlays and Rigid Overlays over Rigid Pavements, Use of Geo synthetics in Pavement Overlays

References:

1. Yoder and Witzack, Principles of Pavement Design, John Wiley and sons.
2. Yang, Design of functional pavements, McGraw-Hill.
3. Woods, K.B., Highway Engineering Hand Book, McGraw Hill Book Co.
4. David Croney, The Design and Performance of Road Pavements, HMSO Publications.
5. Haas and Hudson, Pavement Management System, McGraw Hill Book Co., New York.
6. Per Ullitz, Pavement Analysis, Elsevier, Amsterdam
7. Harold N. Atkins, Highway Materials, Soils, and Concrete, Prentice Hall, 1996.
8. Robert D. Krebs, Highway Materials, McGraw Hill Text, 1971
9. Asphalt Institute, The Asphalt Handbook, 1989
10. IRC: 37-2001, Guidelines for the Design of Flexible Pavements.
11. IRC: 58-2002, Guidelines for the Design of Rigid Pavements.
12. IRC: 81 -1981, Guidelines for the Design of overlay using Benkelman Beam Deflection Technique.
13. RRL, DSIR, Concrete Roads, HMSO, IRC Publications

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 204 (C) ANALYSIS AND DESIGN OF PLATES AND SHELLS

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To provide the students with the basic concepts of structural behaviour, analysis and design of shell and folded plate structures mostly used in Civil Engineering*

Module I (14 Hours)

Theory of Plates:
Introduction to thin plates under small deflection theory - Kirchoff's assumptions - Lame's parameters - Development of strain - Displacement relationships - stress-strain relationships - Force-displacement equations and equilibrium equations in curvilinear co-ordinates - Lame's parameters u,v,w equations - variational principles and its applications to plate problems - Study of various boundary conditions.

Rectangular plates - Differential equation - Solution of simply supported plates under various loading conditions - Uniformly distributed load - Hydrostatic pressure and a concentrated load - Navier and Levy types of solutions.

Module II (14 Hours)

Symmetrical bending of circular plates - Differential equations - Uniformly loaded and concentrically loaded plates with various simply supported and clamped boundary conditions.

Theory of Shells
Introduction - Review of basic theory of shells - Definition and assumptions –strain displacement relationships - Stress-strain relationships - Force displacement equations and equilibrium equation in curvilinear co-ordinates – Kirchoff's assumptions in thin shallow shell theory - Classification of shell systems - Principal curvatures - Lame's parameters.

Module III (14 Hours)

Membrane theory of shells- Application to various shapes - Shells of double curvature - Circular cylindrical shells - Membranes deformation of symmetrically loaded cylindrical and spherical shells.

Approximate methods of analysis - Design of cylindrical shells and H.P shells – by Beam theory - Membrane theory.
Detailing of reinforcement for circular cylindrical shells

Module IV (12 Hours)

Folded plates -- types- Structural Behavior of folded plates - Equation of three shears – Application- Whitney's method of analysis.

Design and detailing of folded plates- design by ACI-ASCE task committee method
Formwork for shells and folded plates

References

1. Timoshenko & Krierger, “Theory of plates and shells”, Tata McGraw Hill,
2. Szilard, “Theory and analysis of plates - classical and numerical methods”,
3. Ramaswamy, G.S., “Design and construction of concrete shell roofs”, CBS Publishers
4. Novozhilov, “Theory of thin shells”,
5. Giben, “Theory of cylindrical shell roofs”,
6. Lundgen, “Cylindrical shells“,

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 205 (A) SOIL STRUCTURE INTERACTION

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To make students understand the basics of soil structure interaction Also to impart knowledge about various linear and non-linear, isotropic and anisotropic models for soil structure interaction problems.*

Module I (14 Hours)

Soil structure interaction and 'flexible' approach to the design of foundations, Contact Pressure – from theory of Elasticity and Sub grade reaction, Concept of sub grade modulus, effects/parameters influencing sub grade modulus. Experimental Determination of Sub grade Modulus..

Introduction to Idealized Soil Response Models for the Analysis of Soil – Foundation Interaction – Time Dependent Behavior of Soil Masses. Introduction to Soil-structure interaction models - Winkler, Pasternak, Hetenyi and Filonenko-Borodich.

Module II (14 Hours)

Beam on Elastic foundation-soil models: Infinite beam, two parameters, Isotropic elastic half space, analysis of beams of finite length, classification of finite beams in relation to their stiffness.

Plate on Elastic medium: Infinite plate, Winkler, two parameters, isotropic elastic medium, thin and thick plates, analysis of finite plates: rectangular and circular plates.

Module III (12 Hours)

Analysis and design of rafts and mats incorporating soil structure interaction
Role of soil-structure interaction in earthquake resistant design,
Finite difference solution to problems of beams on elastic foundation. Soil – structure Interaction in framed structure,
FEM Modeling. Use of appropriate software packages.

Module IV (14 Hours)

Modern concept of analysis of piles and pile groups

Elastic analysis of piles: Elastic analysis of single pile, theoretical solutions for settlement and load distributions, analysis of pile group, interaction analysis, load distribution in groups with rigid cap.

Laterally loaded pile: Load deflection prediction for laterally loaded piles, sub-grade reaction and elastic analysis, interaction analysis, pile raft system.

References:

1. Soil mechanics by TW Lambe & Whitmen.
2. Deb, D., "Finite Element Methods- Concepts and Application in Geomechanics", PHI Learning Pvt. Ltd.
3. Joseph E. Bowles, "Foundation Analysis and Design" McGraw-Hill.
4. Analytical and computer methods in foundation engineering, JE Bowles, McGraw Hill publications.
5. Foundation analysis by RF Scott, Printice Hall
6. Hytenyi, Beams on Elastic Foundations – university of Michigan Press.
7. Elastic Analysis of soil – Foundation Interaction. APS Selvadurai – Elsevier
8. Vibration Analysis and Foundation Dynamics, NSV Kameswara Rao, Wheeler Publishing, New Delhi.

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 205 (B) ADVANCED CONCRETE TECHNOLOGY

Credits: 4

Teaching scheme: 3 hours lecture and 1 hour tutorial per week

Objective: *To equip the students to understand the properties of concrete and to familiarise the advances in concrete and concrete making so that the appropriate mixes and methods can be chosen according to the situation and to perform mix designs*

Module I (12 Hours)

Materials for concrete making- Review of cements including blended cements, manufacture, chemical composition, chemical and physical processes of hydration, structure of hydration products- modern methods of analysis, Aggregates- Review of types; elementary mineralogy and petrology; Engineering considerations for use of various types- production of artificial aggregates; sampling and testing; effects on properties of concretes, mortars and grouts.

Module II (15 Hours)

Properties of fresh concrete - basics regarding fresh concrete – mixing, workability, placement, consolidation, and curing - Rheological models to characterize concrete - Experimental methods to characterize rheology of concrete-Flowable and pumbable concrete
Admixtures –Mineral admixtures - Review of types, - pulverised fuel ash, ground granulated blast furnace slag and silica fume;; chemical and physical processes of hydration and interaction; effects on

properties of concretes, mortars and grouts; Chemical Admixtures -Review of types and classification; chemical composition; actions and interactions; usage; effects on properties of concretes – on quality and costs.

Proportioning of concrete mixtures – concepts- mixture design as per BIS, BS and ACI methods, statistical quality control, acceptance criteria as per BIS code.

Module III (15 Hours)

Setting and hardening concrete - Plastic settlement and plastic shrinkage; early age thermal movements; strength development; maturity, accelerated curing

Properties of hardened concrete- Strength; deformation under load; elasticity; creep; drying shrinkage and other volume changes -Thermal properties

Durability of concrete and concrete construction - Durability concept; pore structure and transport processes; reinforcement corrosion; fire resistance; frost damage; sulfate attack; alkali silica reaction; delayed ettringite formation

Module IV (12 Hours)

Special concretes - Lightweight concrete- description of various types - High strength concrete and mixture design; Self compacting concrete : Rheology and mixture design - Roller compacted concrete – Ready mixed concrete – Fibre reinforced concrete - polymer concrete

Special processes and technology for particular types of structure - Sprayed concrete; underwater concrete, mass concrete; slipform construction, Prefabrication technology

Text books

1. Neville, A. M., “Properties of Concrete,” 4th and final Edition, 2003.
2. Mehta, P. K. and Monteiro, P. J. M., “Concrete: Microstructure, Properties, and Materials,” 3rd Edition, 2006.
3. Shetty M S, Concrete Technology, - Theory and Practice”, S.Chand and Company, New Delhi, 1992.

Reference books

1. Mindess S and Young JF, “Concrete”, Prentice-Hall, USA,1981
2. H. Okamura and K. Ozawa, “Mix Design for Self-Compacting Concrete,” Concrete Library of JSCE, No. 25, 1995, pp. 107 – 120
3. G. H. Tattersall, “Workability and Quality Control of Concrete,” E&FN Spon, London, 1991
4. Hewlett P C Concrete Admixtures use and applications, ed M R Rixom, The Concrete press, London, 1972

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 205 (C) DESIGN OF BRIDGES AND TOWER STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective:
To impart the students with some knowledge on important types of bridge structures, their selection and planning, structural configurations, assessment of loads, choose the appropriate method of analysis according to the situation and perform design. Students are equipped to analyze and design transmission towers.

Module I (12 HOURS)

Classification of bridges, Review of road and railway bridges, steel and concrete bridges, Components of bridges, Need for investigation - Bridge site - Data collection - design discharge - linear waterway – alignment - economical span - scour depth - traffic projection - choice of bridge type. Loads on bridges: Indian Road Congress (IRC) bridge codes - dimensions - dead and live loads - impact effect - wind and seismic forces - longitudinal and centrifugal forces - hydraulic forces - earth pressure - temperature effect and secondary stresses-specifications and I.R.C. provisions.

Design of skew slab culverts.

Module II (14 HOURS)

R.C. Bridges: - box culverts. T-beam bridges - Pigeaud curves - Courbon's theory - Hendry Jaegar method - analysis and design of T - beam bridges, principles of design of Balanced Cantilever bridges. Introduction to continuous girder bridges, box girder bridges, rigid frame bridges and arch bridges.

Module III (14 HOURS)

Design of Sub structure: Design of piers and abutments-forces-combinations-design principles of foundations- well, piles (*detailed designs not expected*).

Bearings:- Design of elastomeric bearings, steel bearings.

Prestressed Concrete Bridges: Design of single span bridges. – design principles of composite prestressed concrete(RCC+PSC) super structures – methods of erection of precast girders - Introduction to continuous bridges -continuous construction - recent trends.

Module IV (14 HOURS)

Steel Bridges: Design of Plate girder and Pratt truss bridges.

Analysis and design of Transmission Line Towers – classifications of towers- parts of tower -types of bracings, patterns - Sag and Tension calculations – loads and load combinations - tower testing – erection – tower foundations.

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Text Books

1. Johnson Victor D.- Essentials of Bridge Engineering.
2. Krishna Raju. N. "Design of Bridges", Oxford & IBM Publishing Co, Bombay, 1988
3. Raina.V.K. "Concrete Bridge Practice", Tata McGraw Hill Publishing Co., New Delhi - 1991
4. Taylor F.W, Thomson S.E. and Smulski.E. "Reinforced Concrete Bridges", John Wiley & Sons, New York 1955
5. FR Jagadeesh, M.A. jaya Ram, “Design of Bridge structures", Eastern Economy edition.
6. Murthy S.S. and Santhakumar A.R., “Transmission Line Towers’, McGrawHill.
7. Punmia B.C., Asok K. Jain and Arun K. Jain, “Design of Steel Structures”, Lexmi Publications.

Reference Books:

1. Rowe R.E. – Concrete Bridge Design.
2. Leon Hardit F. – Prestressed Concrete Design and Construction.
3. Conference Proceedings, 'Advances and Innovations in Bridge Engineering', IIT, Madras and Indian Institute of Bridge Engineers, Tamilnadu, Allied Publisher, New Delhi, 1999

IS:802, IRC.6-2000, IRC. 21-2000 and charts giving EUDLL are permitted for the examination

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 206(P) STRUCTURAL ENGINEERING DESIGN STUDIO

Credits: 2

Teaching scheme: 2 hours practical per week

Objective: *Students are expected to use important softwares used in the field of structural engineering for analysis, design and drafting.*

Exercises on Concrete Structures: -

Analysis, design and detailing of solid slabs in a typical floor for a residential building- Analysis, design and detailing of beams in a typical intermediate floor of a multi-storey building- Analysis, design and detailing of circular ring beam supporting an overhead water tank- Analysis, design and detailing of a ribbed slab floor system- Generation of interaction curves for RC rectangular columns- Design of slender columns subject to biaxial bending- Analysis, design and detailing of shear walls- considering shear wall-frame interaction in a tall RC structure subject to wind loading- Application of strut-and-tie method to design and detail various RC elements and junctions.

Exercises on Metal Structures: -

Design of Steel Industrial Building – Design of roof trusses - Design of Steel Multi-storey Building - Design of Material Handling system - Design of steel Bridge - Design of pre-engineered buildings. Design of storage structures - Design of towers

References

1. Arthur. H. Nilson, David Darwin and Charles W Dolan, Design of Concrete Structures, Tata McGraw Hill, 2004
2. Park,R and Paulay T, Reinforced Concrete Structures, John Wiley & Sons, New York
3. Macleod, I.A, Shear Wall Frame Interaction. A design aid with commentary Portland Cement Association.
4. IS 456 :2000, Indian Standard for Plain and Reinforced Concrete- Code of Practice, BIS, New Delhi
5. IS 13920 : 1993, Indian Standard for Ductile Detailing of Reinforced Concrete Structures subjected toSeismic Forces - Code of Practice, BIS, New Delhi
6. Gaylord ., Design of steel structures, McGraw Hill, New York.
7. Dayaratnam, P., Design of steel structures, Wheeler Pub.

Students are required to prepare a record of the experiments conducted in the laboratory and the same shall be certified by the faculty in charge of the lab class and the head of the department. There

shall be a semester end examination conducted by the faculty in charge of the lab class. The internal assessment shall be based on the performance of the students in the lab and also based on marks awarded to the records.

Internal continuous assessment: 100 marks

Continuous evaluation (Assessment of individual experiments)	: 30 %
Fair Record of experiments	: 20 %
Test(s), Viva voce	: 50 %

CES10 207 (P) SEMINAR 2

Credits: 2

Teaching scheme: 2 hours per week

Objective: *To enhance the self-learning capacity of students and enable them to make a comprehensive approach to new and upcoming areas of technology. Also to impart training to students to face audience and present their ideas and thus creating in them self esteem and courage*

Individual students are required to choose a topic of their interest from Structural Engineering related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in Structural Engineering) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic in a prescribed format. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Internal continuous assessment: 100 marks

Evaluation shall be based on the following pattern:

Report (Relevance, Literature content, organization)	: 50 marks
Presentation, Discussion	: 40 marks
Participation	: 10 marks
Total	: 100 marks

SEMESTER 3

CES10 301 (A) DESIGN OF PRESTRESSED CONCRETE STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To make students familiar with the concepts of design of typical pre-stressed concrete structural elements.*

Module I (12 hours)
Review- Basic concept and principles of pre-stressed concrete systems- loss of pre-stress- computation of losses. Design and analysis of pre-stressed section for flexure -Stresses at transfer and service loads - study of code provisions - ultimate strength in flexure - code provisions for calculation of deflection (short & long term) in (IS, BS, ACI codes).

Module II (14 hours)
Complete design of post and pre-tensioned simply supported PSC beams -including end block design- cable profile- shear, bond, deflection. Serviceability requirements- deflection and cracking limit states. Design and analysis of post and pre-tensioned PSC slabs
Design of tension members – Application in the design of prestressed cylindrical water tanks.

Module III (14 hours)
Analysis and design of statically indeterminate structures-continuous beams- con-cordancy and linear transformation- simple cases of cantilever beams and slabs.
Design criteria and manufacturing methods of uniformly pre-stressed members.
PC poles, pipes and railway sleepers (detailed design not expected).

Module IV (14 hours)
Composite beams –Analysis and design – Ultimate strength – applications, Elementary idea of composite construction for tee beams in bridges.

Partial pre-stressing- Definitions, principles and design approaches.

References:

1. Krishna Raju.N, "Prestressed Concrete", 4th Edition, Tata McGraw Hill Publishing Co. New Delhi 2000
2. Dayaratnam.P., "Prestressed Concrete", Tata McGraw Hill Publishing Co. New Delhi 2000
3. Sinha .N.C & S.K. Roy, "Fundamentals of Prestressed Concrete, S.Chand & Co., 1985
4. Rajagopalan.N. "Prestressed Concrete", Narosa Publishing House, New Delhi - 2002
5. Lin .T.Y. "Design of Prestressed Concrete Structures", John Wiley and Sons - Inc - 1960
6. Leonhardt.F. "Prestressed Concrete Design and Construction", - Second Edition Wilhelm Ernst & Sohn, Berlin, 1964
7. Guyon .V. "Limit State Design of Prestressed Concrete", - Vol - 1 & 2, Applied Science Publishers, London 1995
8. .Mallick and Rangaswamy., "Mechanics of PrestressedCocrete Design ", Khanna Publishers.
9. Pandit & Gupta., " Prestressed Concrete ", CBS
10. F.K. Hong & R.H. Evans., "Reinforced and Prestressed Concrete " Tata McGraw Hill Co.

IS 1343-1980, IS 456-2000 are permitted to use in the examination.

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 301 (B) MECHANICS OF COMPOSITE MATERIALS

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To make students familiar with the concepts of analysis and design of composite structural elements.*

Prerequisite: -Nil

MODULE 1 (14 HOURS)

Introduction: - Composite beams- Elastic behaviour of composite beams- No interaction case-Full interaction case-Shear connectors-Characteristics of shear connectors-Ultimate load behaviour - Serviceability limits-Basic design considerations-Design of composite beams.

MODULE II (12 HOURS)

Composite floors: - Structural elements-Profiled sheet decking-Bending resistance-Serviceability criteria - Analysis for internal forces and moments.

MODULE III (14 HOURS)

Composite columns: - Materials-Structural steel - Concrete-Reinforced steel-Composite column design -Fire resistance - Combined compression and uniaxial bending

MODULE IV (14 HOURS)

Continuous beams and slab - hogging moment regions of composite beams-Vertical shear and moment- Shear interaction - Global analysis of continuous beams- Design strategies

References

1. Johnson,R.P, Composite Structures of Steel and Concrete,Vol.1Beams,Slabs,Columns and Frames in Buildings, Oxford Blackwell Scientific Publications, London.
2. INSDAG teaching resource for structural steel design, Vol 2, INSDAG, Ispat Niketan, Calcutta.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 301 (C) HIGH RISE BUILDINGS

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: To impart students with basic knowledge on analysis and design philosophy, structural systems and their structural behaviour applied to high rise buildings.

Module I (14HOURS)

Design philosophy- materials: RCC, steel, PSC - loading- Gravity loading- Wind loading- Earthquake loading-blast
Loading. Structural planning of tall building - Building frames- rigid frames, braced frames, infilled frames, shear walls, coupled shear walls; Frame-shear wall combo; other structural forms -tubular, cores, hybrid mega system.

Module II (16HOURS)

Behaviour of various structural systems- factors affecting growth, height and structural form- Temperature stress in buildings.
Analysis and design: modeling for approximate analysis, Accurate analysis and reduction techniques. Analysis of building as total structural systems considering overall integrity and major subsystem interaction, Analysis for member forces, drift and twist, computerised general three dimensional analysis. Structural elements: Sectional shapes, properties and resisting capacity, deflection, cracking.

Module III (12HOURS)

Shear wall frame interaction- basic design of shear walls- design of tall buildings for differential movement, creep, and shrinkage effects, temperature effects and fire resistance. Use of prestressing. Construction techniques - safety devices.

MODULE IV (12HOURS)

Stability of tall buildings - Overall buckling analysis of frames- P- Delta analysis- Translational, torsional instability, out of plumb effects, effect of foundation rotation.

References

1. Taranath , B.S., Structural Analysis and design of Tall Building, Tata McGraw Hill.,
2. Wilf gang Schuller, High Rise Building Structures, John Wiley and Sons.
3. Lynn S. Beedle, Advances in Tall Buildings, CBS Publishers and Distributers, Delhi,
4. Brayan Stafford Smith, Alex coull, Tall Building Structures, Analysis and Design, John Wiley and Sons, 1991
5. M. Fintal, “Handbook of Concrete Structures”

Internal continuous assessment: 100 marks
Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

End semester Examination: 100 marks
Question pattern
Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 302 (A) DESIGN OF INDUSTRIAL STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objectives:

1. *To familiarize with the design of special structures widely used in industrial plants.*
2. *To reinforce the fundamental courses in structural design in the perspective of industrial applications.*

Module I (13 hours)

Functional design of industrial buildings:

Classification of industrial structures-layout planning requirements –Guidelines from factories act – Lighting- Illumination levels – Principles of day lighting /artificial lighting design – Natural / Mechanical ventilation – Fire safety requirements – Corrosion protection – Protection against noise – Cladding systems- vibration isolation techniques - Industrial floors.

Introduction to diverse types of industrial structures: General overview of Thermal power plant/Nuclear power plant structures / Process plant steelwork – conveyor structures – Boiler supporting structures-Substation structures.

Module II (15 hours)

Structural Design of Industrial Buildings:

Braced Industrial buildings – Unbraced Industrial frames – Gantry girders – analysis and design

Machine foundations – Strength and deformation of soil under dynamic loads; dynamic coefficients for soils, shear modulus and elastic constants of soil; Types-Design Requirements-Analysis and design of block type machine foundations (IS 2974 method) design of foundation for reciprocating and rotary machines, foundation for impact type loading-simple design exercises; vibration isolation technique.

Module III (14 hours)

Design of Reinforced concrete bunkers and silos as per IS: 4995.

Tall Chimneys (RCC) –Types-Chimney sizing parameters- Overview of wind and temperature effects-Design principles of Reinforced concrete chimneys as per IS: 4998. principles of design for seismic loads.

Module IV (12 hours)

Cooling Towers –Types and functions- Design principles of RC natural draught cooling towers as per IS: 11504

Transmission line Towers- Types-Design loadings-Analysis and design concepts- Description of Tower construction- tower foundations.

Textbooks:

1. Proceedings of an advanced course on industrial structures, SERC – 1982.
2. S.N.Manohar, Tall Chimneys-Design and Construction, Tata Mc Graw Hill.
3. P.Dayaratnam, Design of steel structures, Wheeler Publishing Co.
4. Ramchandra, Design of steel structures, Vol. 1 and 2, Standard Book house Delhi.
5. Srivasulu and Vaidyanathan, Handbook of machine foundations-Tata McGraw Hill.
6. Murthy and Santhakumar, Transmission Line structures, McGraw Hill

References:

1. SP: 32–1986,Hand book on functional requirements of Industrial buildings (Lighting and ventilation).
2. G.W.Owens, P.R.Knowles and P.J.Dowling- Steel Designers' manual – 5th edition – Blackwell scientific publications.
3. V.Kalayanaraman, Advances in steel structures. Tata McGraw Hill
4. Krishnaraju N., Advanced Reinforced concrete design, CBS Publishers.
5. K.K.Mc Kelvey and Maxey Brooke, The Industrial Cooling Tower, Elsevier Publishing Co.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES10 302 (B) PROBABILITY METHODS IN CIVIL ENGINEERING

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To provide the students the concept and an understanding of probability and random processes. It also helps to understand the Design of experiments. Emphasis shall be given to problems in Civil Engineering.*

Module I (16 Hours)

Random Variables - Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a Random Variable.

Joint distributions – Marginal and Conditional distributions – Functions of two dimensional random variables – Regression Curve – Correlation, Analytical problems based on Civil Engineering context-eg. sampling and quality control.

Module II (16 Hours)

Estimation Theory - Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation - Curve fitting by Principle of least squares – Regression Lines

Testing of Hypothesis - Sampling distributions - Type I and Type II errors - Tests based on Normal, t, Chi-square and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit. Analytical problems based on Civil Engineering context-eg. Characteristic strength, load.

Module III (11 Hours)

Multivariate analysis - Covariance matrix – Correlation Matrix – Multivariate Normal density function – Principal components – Sample variation by principal components – Principal components by graphing- Analytical problems based on Civil Engineering context – eg. problems on reliability.

Module IV (11 Hours)

Design of experiments- Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design- Analytical problems based on Civil Engineering context.

Text books

1. Richard Johnson. "Miller & Freund's Probability and Statistics for Engineers", Prentice – Hall of India, Private Ltd.,, New Delhi, 7th Edition, 2007.
2. Benjamin J R and Cornell C A, "Probability, statics, and Decision for Civil Engineers", McGraw Hill Book Company. New York, 1970
3. Douglas C., Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, 3rd Edition, Wiley India, 2007.
4. A.H.S. Ang and W. H. Tang, "Probability Concepts in Engineering Planning and Design", Volume I and II.

Reference books

1. Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", Pearson Education, Asia, 5th Edition, 2002.
2. Gupta, S.C. and Kapoor, V.K. "Fundamentals of Mathematical Statistics", Sultan and Sons, New Delhi, 2001.
3. Jay L. Devore, "Probability and statistics for Engineering and the Sciences", Thomson and Duxbbury, Singapore, 2002.
4. Dallas E Johnson et al., "Applied multivariate methods for data analysis" Thomson and Duxbbury press, Singapore, 1998.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 302 (C) STRUCTURAL OPTIMIZATION AND RELIABILITY ANALYSIS

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objectives:

1. To impart students with various techniques of structural optimization
2. To familiarize students with the applications of probability analysis and reliability techniques in structural engineering

Module I (12 hours)

Optimisation methods in civil engineering- Problem formulation with examples- **Linear programming problems:** statement of an optimisation problem - linear and nonlinear programming problems - standard form of linear programming problems - simplex algorithm - degeneracy, duality, transportation problem, assignment problem.

Module II (14 hours)

Applications of linear programming problems in civil engineering - limit design of steel portal frames.
Introduction to Dynamic programming, Geometric programming.
Introduction to Genetic Algorithms- basic concept - problem formulation - operations-convergence criteria.

Module III (14 hours)

Concepts of structural safety- Probability theory:- Introduction, random events, random variables, functions of random variables, moments and expectation, common probability distributions. Resistance distributions and parameters: - Introduction, Statistics of properties of concrete, steel and other building materials, statistics of dimensional variations, characterization of variables, allowable stresses based on specified reliability.

Module IV (14 hours)

Basic structural reliability:- Introduction, computation of structural reliability.
Level 2 Reliability methods: Introduction, basic variables and failure surface, first order second moment methods (FOSM). System reliability-series and parallel systems modeling.
Reliability based design: Introduction, determination of partial safety factors, development of reliability based design criteria.

References

1. Sastry S.S., Introductory Methods of Numerical Analysis, Prentice Hall of India
2. Scarborough J.B., Numerical Mathematical Analysis, Oxford and IBH
3. Rao S.S., Engineering Optimization-Theory and Applications, New Age International Publishers
4. Krishnamoorthy E.V. and Sen S.K., *Numerical Algorithms,* Affiliated East West Press
5. Kirsch U., *Optimum Structural Design*, McGraw Hill
6. Fox R.L., *Optimization Methods for Engineering Design,* Addison Wesley
7. Singiresu S. Rao, Engineering Optimization (Theory and Practice) 3rd Edition, New Age International (P) Ltd.
8. Press W.H., et al. Numerical Recipes in C – The art of Computation, Cambridge Press
9. Goldberg D.E., Genetic Algorithms in Search, Optimisation and Machine Learning, Addison Wesley Publishing Company.
10. R. Ranganathan., Reliability Analysis and Design of Structures, Tata McGraw Hill, 1990.
11. Ang, A. H. S & Tang, W. H., Probability Concepts in Engineering Planning and Design, Vol. I Basic Principles, John Wiley & Sons, 1975.
12. Ang, A. H. S & Tang, W. H., Probability Concepts in Engineering Planning and Design, Vol. II Decision, Risks and Reliability, John Wiley & Sons, 1984.
13. Jack R. Benjamin & C. Allin Cornell., Probability, Statistics and Decision for Engineers, McGraw-Hill.
14. H. O. Madsen, S. Krenk & N. C. Lind, Methods of Structural Safety, Prentice-Hall, 1986.
15. R. E. Melchers. Structural Reliability - Analysis and prediction, Ellis Horwood Ltd, 1987.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 302 (D) FORENSIC ENGINEERING AND REHABILITATION OF STRUCTURES

Credits: 4

Teaching Scheme: 3 hours Lecture and 1 hour tutorial per week

Objective: *To provide the students the concept and applications of forensic engineering to failure analysis and damage mitigation of structures. Structural retrofitting and rehabilitation techniques are also presented.*

Module I (12hours)

Failure of Structures: Review of the construction theory – performance problems – responsibility and accountability – case studies – learning from failures – causes of distress in structural members – design and material deficiencies – over loading

Module II (16hours)

Diagnosis and Assessment of Distress: Visual inspection – non destructive tests – ultrasonic pulse velocity method – rebound hammer technique – ASTM classifications – pullout tests – Bremor test – Windsor probe test – crack patterns- crack detection techniques – case studies – single and multistorey buildings – Fibre optic method for prediction of structural weakness assessments

Module III (13hours)

Environmental Problems and Natural Hazards: Effect of corrosive environments, chemical and marine environments – pollution and carbonation problems – detection and measurement of corrosion, durability of RCC structures – damage due to earthquakes and strengthening of buildings – provisions of BIS 1893 and 4326

Module IV (13hours)

Modern Techniques of Retrofitting: Structural elements - first aid after a disaster – guniting, jacketing – use of chemicals in repair – application of polymers – ferrocement, fiber composites and fiber reinforced concretes as rehabilitation materials – strengthening by pre-stressing – case studies – bridges – water tanks – cooling towers – heritage buildings – high rise buildings.

References

1. Dovkaminetzky, Design and Construction Failures, Galgotia Publication, New Delhi,2001
2. Jacob Feld and Kenneth L Carper, Structural Failures, Wiley Europe.
3. Raikar R.N., Diagnosis and treatment of Structures in Distress
4. Raina V.K., Bridge Rehabilitation
5. Ransom W.H., Building Failures – Diagnosis and Avoidance –
6. Kenneth and Carper, Forensic Engineering.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7: 20 marks
Question 2 : 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 Marks

CES 10 303(P) INDUSTRIAL TRAINING

Credit: 1

Teaching Scheme: 1 hour per week

The students have to arrange and undergo an industrial training of minimum two weeks in an industry during the semester break after semester 2 and complete within 15 calendar days from the start of semester 3. (The venue of training may also be a construction site of any sizeable structure or design office or a combination of both, approved by the Head of the Department.). The students are required to submit a report of the training undergone and present the contents of the report before the evaluation committee constituted by the department. Evaluation committee will award the marks of end semester examination based on quality of training undergone, contents of the report and presentation.

End semester examination: Marks 50

CES 10 304(P) MASTERS RESEARCH PROJECT PHASE I

Credits: 6

Teaching scheme: 22 hours per week

Objective: *To improve the professional competency and research aptitude by touching the specific areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry/field and current research*.

The project work can be analysis and design projects of innovative nature or experimental investigation or numerical simulations or a combination of these. Appropriate software developments with sufficient literature contributions can also be taken up. Each student will be allotted with a faculty as guide. In specific cases student may consult with an external guide with the prior consents of internal guide and head of the department. In this semester, students are expected to finalize appropriate topic of research, complete the required literature survey and about 25% of the objectives of their intended research.

Internal continuous assessment: 300 marks

The marks of internal continuous assessment will be based on interim reviews/evaluations by the guide along with evaluation committee consisting of two other internal faculty members.

	Guide :	Evaluation committee
First review	50	50
Second review	100	100

SEMESTER 4

CES 10 401(P) MASTERS RESEARCH PROJECT PHASE II

Credits: 12

Teaching scheme: 30 hours per week

Master Research project phase II is a continuation of project phase I started in the third semester. Towards the end of the semester there would be a pre-submission presentation to the evaluation committee to assess the quality and quantum of the work done. This would be a pre-qualifying exercise for the students for getting approval by the departmental committee for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conference. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external.

Internal Continuous assessment: 300 marks

	Guide	Evaluation committee
First review	50	50
Second review	100	100

Semester End Examination: 300 marks

Project Evaluation by external examiner: 150 marks

Viva Voce by external and internal examiner: 150 marks (75 marks each)

Total: 600 marks
