# M.E. (Structural Engineering)

# 2018 Regulations, Curriculum & Syllabi


**BANNARI AMMAN INSTITUTE OF TECHNOLOGY**

(An Autonomous Institution Affiliated to Anna University, Chennai
Approved by AICTE - Accredited by NAAC with 'A' Grade )
**SATHYAMANGALAM – 638 401 Erode District Tamil Nadu**
Phone : 04295 226000 Fax : 04295 226666
Web:www.bitsathy.ac.in E-mail : stayahead@bitsathy.ac.in

# CONTENTS

# REGULATIONS 2018
# (CHOICE BASED CREDIT SYSTEM)

(Common to all M.E./M.Tech. Degree Programmes)

***NOTE:*** *The regulations given hereunder are subject to amendments as may be decided by the Academic Council of the Institute from time to time. Any or all such amendments will be effective from such date and to such batches of students including those already in the middle of the programme as may be decided by the Academic Council.*

## 1. ELIGIBILITY FOR ADMISSION

(i) Candidates seeking admission to the First Semester of M. E. / M. Tech. degree programmes will be required to satisfy the eligibility criteria for admission thereto prescribed by the Directorate of Technical Education, Chennai and Anna University, Chennai.

(ii) Part - time candidates should satisfy conditions regarding experience, sponsorship, place of work and other requirements that may be prescribed by the Directorate of Technical Education, Chennai and Anna University, Chennai from time to time, in addition to satisfying requirements as in Clause 1 (i).

## 2. DURATION OF THE PROGRAMME

(i) **Minimum Duration:** Master of Engineering (M.E.) / Master of Technology (M.Tech.) extends over a period of two years. The two academic years (Part-time three academic years) will be divided into four semesters (Part-time six Semesters) with two semesters per year.

(ii) **Maximum Duration**: A candidate shall complete all the passing requirements of M. E. / M. Tech. programmes within a maximum period of 4 years / 8 semesters in case of full-time programme and 6 years / 12 semesters in case of part-time programme, these periods being reckoned from the commencement of the First semester to which the candidate was first admitted, regardless to the break-of-study availed.

## 3. BRANCHES OF STUDY

Following M.E. / M.Tech. Programmes are offered by the Institute

**M.E. Programmes**

1. Applied Electronics
2. CAD/CAM
3. Communication Systems
4. Computer Science and Engineering
5. Embedded Systems
6. Engineering Design
7. Industrial Automation and Robotics
8. Industrial Safety Engineering
9. Instrumentation Engineering
10. Power Electronics and Drives
11. Software Engineering
12. Structural Engineering

13. VLSI Design

**M. Tech. Programme**

14. Biotechnology

## 4. STRUCTURE OF PROGRAMMES

(i) **Curriculum:** Every Post Graduate Programme will have a curriculum with syllabi consisting of theory and practical courses that include **Professional Core** (core courses relevant to the chosen specialization), **Professional Electives** (elective courses) and **Employability Enhancement Courses** (Practical courses, Project Work, Internship, Miniproject and Industrial / Practical Training).

(ii) **Project Work:** Every student, individually, shall undertake Dissertation Phase - I during the third semester (fifth semester for part-time programme) and Dissertation Phase - II during the fourth semester (Sixth semester for part-time programme) under the supervision of a qualified faculty (faculty members with Ph.D. or P.G. with a minimum of 3 years of teaching experience). The Dissertation Phase - II shall be a continuation work of the Dissertation Phase - I. The project work can be undertaken in an industrial / research organization or Institute in consultation with the faculty guide and the Head of the Department. In case of project work at industrial / research organization, the same shall be jointly supervised by a faculty guide and an expert from the organization.

(iii) **Elective Courses: Seven Elective** courses are offered to the students admitted in various disciplines as prescribed in the curriculum to widen their knowledge in their specialization area.

(iv) **Online Courses:** A Student may be permitted to credit online courses with the approval of a Departmental Consultative Committee constituted by the Head of the Department, subject to a maximum of three credits. Such students may be exempted from attending the classes, if such course(s) are offered in the semester. Summary of such on-line courses, taken by the students, along with the offering agency shall be presented to the Academic Council for information and further suggestions. However, the student needs to obtain certification from the agency offering the course to become eligible for writing or seeking exemption from the End Semester Examination. In case of credits earned through online mode from the Institute / University, the credits may also be transferred directly after due approval from the Departmental Consultative Committee and the Office of the Controller of Examinations.

(v) **Industrial Training:** Every full-time student shall take-up training in the industry / research laboratories, under the supervision of a faculty guide during summer / winter vacation till pre-final semester of the programme subject to the evaluation prescribed in the Clause 15. Credits of such courses will be indicated for the course in the Grade Sheet if the student passes, but it will not be considered for computing CGPA.

(vi) **Mini Project**: A Mini Project shall be undertaken by the students individually in consultation with the respective faculty and Head of the Department, as specified in the curriculum. A student is expected to make a presentation about the mini-project during the final evaluation as given in the Clause 15.

(vii) **Value Added / Certificate Courses:** Students can opt for any one of the Value added Courses in II and III semester, approved by the Academic Council. A separate Certificate will be issued on successful completion of the Course by the Controller of Examinations.

(viii) **Credit Assignment:** Each course is normally assigned a certain number of credits with 1 credit per lecture hour per week, 1 credit for 2 hours of practical per week, 1 credit for 1 hours of tutorial per week, The exact numbers of credits assigned to the different courses of various programmes are decided by the respective Boards of Studies.

(ix) **Minimum Credits:** For the award of the degree, the student shall earn a minimum number of total credits as prescribed by the respective Board of Studies as given below:

| S.No. | **M.E./M. Tech. Programmes** | **Total Credits** |
|---|---|---|
| 1. | M.E. Applied Electronics | 69 |
| 2. | M.E. CAD / CAM | 70 |
| 3. | M.E. Communication Systems | 70 |
| 4. | M.E. Computer Science and Engineering | 70 |
| 5. | M.E. Embedded Systems | 70 |
| 6. | M.E. Engineering Design | 70 |
| 7. | M.E. Power Electronics and Drives | 69 |
| 8. | M.E. Software Engineering | 70 |
| 9. | M.E. Structural Engineering | 69 |
| 10. | M.E. VLSI Design | 70 |
| 11. | M.E. Industrial Safety Engineering | 70 |
| 12. | M.E. Industrial Automation and Robotics | 69 |
| 13. | M.E. Instrumentation Engineering | 69 |
| 14. | M.Tech. Biotechnology | 69 |

## 5. COURSE ENROLLMENT AND REGISTRATION

5.1 Each student, on admission shall be assigned to a Faculty Advisor (vide Clause 7) who shall advise / counsel the student about the details of the academic programme and the choice of courses considering the student's academic background and career objectives.

5.2 Every student shall enroll for the courses of the succeeding semester, in the current semester. However, the student shall confirm the enrolment by registering for the courses within the first five working days after the commencement of the semester concerned.

5.3 After registering for a course, a student shall attend the classes, satisfy the attendance requirements, earn Continuous Assessment marks and appear for the End Semester Examinations.

5.3.1 Each student on admission to the programme shall register for all the **courses prescribed in the curriculum** in the **first Semester of study**.

5.3.2 The enrolment for all the courses of the Semester II will commence 10 working days prior to the last working day of Semester I. The student shall confirm the enrolment by registering for the courses within the first five working days after the commencement of the Semester II.

5.3.3 If a student wishes, the student may drop or add courses (vide Clause 5.5) within **five** working days after the commencement of the semester concerned and complete the registration process duly authorized by the PG coordinator of the programme. In the case, if a student fails in a course, he / she may be permitted to register the course in the subsequent semester or when it is offered.

5.3.4 A student who has passed all the courses prescribed in the curriculum for the award of the degree shall not be permitted to re-enroll to improve the student's marks in a course or the aggregate marks / CGPA.

**5.4 Minimum Credits to Register for Project work**

The Project work for M.E. / M.Tech. consists of Dissertation Phase - I and Dissertation Phase - II. The Dissertation Phase - I is to be undertaken during III semester (V semester for part-time programme) and Dissertation Phase - II, which is a continuation of Phase – I is to be undertaken during IV semester (VI semester for part-time programme). Minimum 24 credits are required to be earned to enroll the Dissertation Phase - I.

If a student fails to earn the requisite minimum credits, the student cannot enroll for the Dissertation Phase - I. In such a case, the student can enroll for the project work in a subsequent semester, after earning the minimum credits specified.

**5.5 Flexibility to Add or Drop courses**

5.5.1 A student has to earn the total number of credits specified in the curriculum of the respective Programme of study in order to be eligible to obtain the degree. However, if a student wishes, the student is permitted to earn more than the total number of credits prescribed in the curriculum of the student's programme by opting for additional courses.

5.5.2 From the II to final semesters, the student has the option of registering for additional courses or dropping existing courses. Total number of credits of such courses cannot exceed 6. In such cases, the attendance requirement as stated Clause 6 is mandatory.

**5.6 Reappearance Registration**

5.6.1 If a student fails in a theory course, the student shall do reappearance registration for that course in the subsequent semester or when it is offered next.

5.6.2 On registration, a student may attend the classes for the reappearance registration courses, if the student wishes. However, the attendance requirement (vide Clause 6) is not compulsory for such courses.

5.6.3 The student who fails in any practical / Miniproject or any other EEC courses shall register for the same in the subsequent semester or when offered next, and **repeat** the course. In this case, the student shall attend the classes, satisfy the attendance requirements (vide Clause 6) and earn Continuous Assessment marks.

5.6.4 The student who fails in Dissertation Phase I / II shall register for the same in the subsequent semester or when offered next, and **repeat** the course. In this case, the student shall attend the classes, satisfy the attendance requirements (vide Clause 6), earn Continuous Assessment marks and appear for the End Semester Examinations. Reappearance Registration is not available for such courses.

5.6.5 If a student is prevented from writing the end semester examination of a course due to lack of attendance, the student has to register for that course again, when offered next, attend the classes and fulfil the attendance requirements as per Clause 6.

## 6. REQUIREMENTS FOR APPEARING FOR THE END SEMESTER EXAMINATION OF A COURSE

A student who has fulfilled the following conditions (vide clause 6.1 and 6.2) shall be deemed to have satisfied the attendance requirements for appearing for End Semester Examination of a particular course.

Each semester shall normally consist of 75 working days or 540 periods of each 50 minutes duration, for full-time mode of study or 250 periods for part-time mode of study.

6.1 Ideally every student is expected to attend all the periods and earn 100% attendance. However, a student shall secure not less than 80% attendance (Physical presence) course wise taking into account the number of periods required for that course as specified in the curriculum.

6.2 If a student secures attendance between 70% and 79% in any course in the current semester due to medical reasons (prolonged hospitalization / accident / specific illness) or participation in Institution/ University/ State/ National/ International level extra and co-curricular activities, with prior permission from the Head of the Department, shall be permitted to appear for the current semester examinations subject to the condition that the student shall submit the medical certificate / participation certificate attested by the Head of the Department. Such certificates shall be forwarded to the Controller of Examinations for verification and for the permission to attend the examinations.

6.3 A student shall normally be permitted to appear for End Semester Examination of a course if the student has satisfied the attendance requirements (vide Clause 6.1 –

6.2) and has registered for examination in those courses of that semester by paying the prescribed fee.

6.4 A Student who does not satisfy clause 6.1 and 6.2 and who secure less than 70% attendance in a course will not be permitted to write the End-Semester Examination of that course. The student has to register and repeat this course in the subsequent semester or when it is offered next (vide clause 5.6.4).

6.5 A student who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of grades / marks.

## 7. FACULTY ADVISOR

To help the students in planning their courses of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a Faculty member of the Department who shall function as Faculty Advisor for those students. The Faculty Advisor shall advise and guide the students in registering of courses, reappearance of courses, monitor their attendance and progress and counsel them periodically. If necessary, the Faculty Advisor may also discuss with or inform the parents about the progress / performance of the students concerned.

## 8. COMMITTEES

### 8.1 Class Committee Meeting

(i) For all the courses taught, prescribed in the curriculum, Class Committee meeting shall be convened twice in a semester, comprising members of the faculty handling all the courses and two student representatives from the class.

(ii) One of the members of the faculty (not handling any courses to that class), nominated by the Head of the Department, shall coordinate the activities of this Committee. During these meetings, the student members shall meaningfully interact and express their opinions and suggestions of all the students to improve the effectiveness of the teaching-learning process. It is the responsibility of the student representatives to convey the proceedings of these meetings to all other students.

## 9. ASSESSMENT AND PASSING REQUIREMENTS

### 9.1 Assessment

The assessment will comprise Continuous Assessment and End Semester Examination, carrying marks as specified in the scheme (Clause 15). All assessments will be done on absolute marks basis. However, for the purpose of reporting the performance of a student, Letter Grades and Grade Points will be awarded as per Clause 9.4.

### 9.2 End Semester Examinations

End Semester Examinations will normally be conducted as per the time table circulated by the Office of the Controller of Examination. A student will be permitted to appear for the End Semester Examination of a semester only if he/she

completes the study of that semester satisfying the requirements given in Clause 5 and 6, and registers simultaneously for the examinations of the highest semester eligible and the courses, pertaining to that semester, that need reappearance.

**9.3 Employability Enhancement Courses**

Every candidate shall submit reports on Industrial training / Mini-project, Dissertation - Phase I and Dissertation - Phase II on dates announced by the Institute / Department through the faculty guide to the Head of the Department. If a candidate fails to submit the reports of any of these courses not later than the specified date, he/she is deemed to have failed in it. The reports /papers shall be orally presented by the student before a team of expert consisting of an internal examiner, usually the supervisor, and an external examiner, appointed by the Head of the Institution.

A candidate is permitted to register for the Dissertation -Phase II, only after passing the Dissertation - Phase I. A candidate who fails in Industrial training / Mini-project, Dissertation - Phase I or Dissertation - Phase II shall register for redoing the same at the beginning of a subsequent semester.

**9.4 Letter Grade and Grade Point:** The Letter Grade and the Grade Point are awarded based on percentage of total marks secured by a candidate in an individual course as detailed below:

| Range of Percentage of Total Marks | Grade Point | Letter grade |
|---|---|---|
| 91 to 100 | **10** | O (Outstanding) |
| 81 to 90 | **9** | A + (Excellent) |
| 71 to 80 | **8** | A (Very Good) |
| 61 to 70 | **7** | B + (Good) |
| 50 to 60 | **6** | B (Above average) |
| 0 to 49 | **0** | RA (Reappearance) |
| Incomplete | **0** | I |
| Withdrawal | **0** | W |
| Absent | **0** | AB |

'RA' - Reappearance registration is required for that particular course

'I' - Continuous evaluation is required for that particular course in the subsequent examinations.

After completion of the evaluation process, Semester Grade Point Average (SGPA) and

Cumulative Grade Point Average is calculated using the formula:

$$SGPA/CGPA = \frac{\sum_1^n C_i * g_i}{\sum_1^n C_i}$$

where

$C_i$ : Credit allotted to the course.

$g_i$ : Grade Point secured corresponding to the course.

n : number of courses successfully cleared during the particular semester in the case of SGPA and all the semesters, under consideration, in the case CGPA.

**9.5** A student can apply for revaluation of his / her semester examination answer paper in a theory course, within 3 working days from the declaration of results, along with prescribed application to the Controller of Examinations through the Head of Department. Revaluation is not permitted for laboratory courses, industrial training and project works.

**9.6 Passing a Course**

A candidate who secures Grade Point 6 or more in any course of study will be declared to have passed that course, provided, if secures a minimum of 50% of the total mark in the End Semester Examination of that course. The Continuous Assessment (CA) marks obtained by the candidate in the first appearance shall be retained and considered valid for one subsequent attempt, except Clause 5.6.3 & 5.6.4. However, from the third attempt onwards the candidate shall be declared to have passed the course if he/she secures a minimum of 6 Grade Points in the course prescribed during the End Semester Examination alone.

**9.7** Besides satisfying the above Clauses, a student shall present a technical paper, based on the courses of study, in a National or an International conference before the completion of semester IV.

## 10. REJOINING THE PROGRAMME

A candidate who has not completed the study of any semester as per Clause 6 or who is allowed to rejoin the programme after the period of discontinuance or who on his/her own request is permitted to repeat the study of any semester (break of study), may join the semester which he /she is eligible or permitted to join, only at the time of its normal commencement for a regular batch of candidates and after obtaining the approval from the Director of Technical Education and Anna University, Chennai. In such case, earlier Continuous Assessment in the repeated courses will be disregarded. No candidate will however be allowed to enroll in more than one semester at any point of time.

## 11. QUALIFYING FOR THE AWARD OF THE DEGREE

A candidate will be declared to have qualified for the award of the M.E. / M.Tech. Degree provided:

(i) he/she has successfully completed the course requirements and has passed all the prescribed courses of study of the respective programme listed in Clause 3 within the duration specified in Clause 2.

(ii) No disciplinary action is pending against the candidate.

## 12. CLASSIFICATION OF DEGREE

**12.1 First Class with Distinction**:

A student who satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

***M.E. / M.Tech., (Full Time)***

- Should have passed the examination in all the courses of all the four semesters in the student's First Appearance within three years, which includes authorised break of study of one year. Withdrawal from examination (vide Clause 13) will not be considered as an appearance.
- Should have secured a CGPA of not less than 8.50.
- Should NOT have been prevented from writing end Semester examination due to lack of attendance in any of the courses.

***M.E. / M.Tech. (Part Time)***

- Should have passed the examination in all the courses of all the six semesters in the student's First Appearance within four years, which includes authorised break of study of one year. Withdrawal from examination (vide Clause 13) will not be considered as an appearance.
- Should have secured a CGPA of not less than 8.50.
- Should NOT have been prevented from writing end Semester examination due to lack of attendance in any of the courses.

**12.2 First Class**:

A student who satisfies the following conditions shall be declared to have passed the examination in First class:

***M.E. / M.Tech. (Full Time)***

- Should have passed the examination in all the courses of all four semesters within three years ,which includes one year of authorized break of study (if availed) or prevention from writing the End Semester Examination due to lack of attendance (if applicable).
- Should have secured a CGPA of not less than 6.50

***M.E. / M.Tech. (Part Time)***

- Should have passed the examination in all the courses of all six semesters within four years, which includes one year of authorized break of study (if availed) or prevention from writing the End Semester Examination due to lack of attendance (if applicable).
- Should have secured a CGPA of not less than 6.50

**12.3 Second Class:** All other students who qualify for the award of Degree shall be declared to have passed in Second Class.

## 13. WITHDRAWAL FROM EXAMINATION

13.1 A student may, for valid reasons, be granted permission by the Head of the Department to withdraw from appearing in the examination in any course(s) of only once during the entire duration of the degree programme.

13.2 Withdrawal application shall be valid only, if the student is eligible to write the examination as per Clause 6 and, if such request for withdrawal is made prior to the submission of marks of the Continuous Assessment of the course(s) with the recommendations from the Head of the Department.

13.3 Withdrawal shall not be construed as an opportunity for appearance in the examination for the eligibility of a candidate for First Class with Distinction or First Class.

## 14. AUTHORIZED BREAK OF STUDY FROM A PROGRAMME

14.1 A student is permitted to go on break of study for a maximum period of one year either as two breaks of one semester each or a single break of one year.

14.2 A student who would like to avail the break of study, on account of short term employment / Medical treatment / personal reasons) shall apply to the Head of the Institution through concerned Head of the Department, (application available with the Controller of Examinations), in any case, not later than the last date for registering for the semester.

14.3 The students permitted to rejoin the programme after break of study / prevention due to lack of attendance, shall be governed by the Curriculum and Regulations in force at the time of rejoining. A committee constituted by the Head of the Institution shall prescribe additional / equivalent courses, if any, from the regulation in-force, so as to bridge the requirement between curriculum in-force and the old curriculum.

14.4 The total period for completion of the programme reckoned from the commencement of the first semester to which the student is admitted shall not exceed the maximum period specified in the Clause 2, irrespective of the period of break of study in order that he / she may be eligible, for the award of the degree (vide Clause 11 and 12).

14.5 In case of any valid reasons for the extension of break-of-study, such extended break-of-study may be granted by the Head of the Institution for a period not more than one year in addition to the earlier authorized break of study. Such extended break-of-study shall be counted for the purpose of classification of degree (vide clause 12).

14.6 If a student does not report back to the Institute, even after the extended Break of Study, the name of the student shall be deleted permanently from the college enrolment. Such candidates are not entitled to seek readmission under any circumstances.

## 15. SCHEME OF ASSESSMENT

| | | |
|---|---|---|
| **I** | **THEORY COURSES** | **Marks** |
| | **Continuous Assessment** | **50** |
| | **Distribution of marks for Continuous Assessment:** | |
| | Periodical Test I (20) | |
| | Periodical Test II (20) | |
| | Term Paper Report (5) & Presentation (5) | |
| | **End Semester Examination** | **50** |
| | **Total Marks** | **100** |

| | | |
|---|---|---|
| **II** | **THEORY COURSES WITH LAB COMPONENT** | **Marks** |
| | **Continuous Assessment** | **50** |
| | **Distribution of marks for Continuous Assessment:** | |
| | Periodical Test I (15) | |
| | Periodical Test II (15) | |
| | Final Lab Examination (10) | |
| | Viva-voce (10) | |
| | **End Semester Examination** | **50** |
| | (QP pattern as per (I)) | |
| | **Total Marks** | **100** |

| | | |
|---|---|---|
| **III** | **PRACTICAL COURSES** | **Marks** |
| | **Continuous Assessment** | **100** |
| | **Distribution of marks for Continuous Assessment:** | |
| | Conduct of Experiment | |
| | i. Preparation (10) | |
| | ii. Experiment and Analysis of Results (20) | |
| | iii. Record (5) | |
| | Self-Learning Experiment (15) | |
| | Test - Cycle I (15) | |
| | Test - Cycle II (15) | |
| | Final Viva-voce (20) | |
| | **Total Marks** | **100** |

| | | |
|---|---|---|
| **IV** | **DISSERTATION PHASE - I** | **Marks** |
| | **Continuous Assessment** | **50** |
| | ***Distribution of marks for Continuous Assessment:*** | |
| | Presentation I | |
| | Identification of topic and Justification (10) | |
| | Literature Survey (10) | |
| | Presentation II | |
| | Work plan & Approach (10) | |
| | Progress, Results and Discussion (20) | |
| | **End Semester Examination** | |
| | Presentation and Demonstration (20) | **50** |
| | Report (10) | |
| | Viva Voce (20) | |
| | **Total Marks** | **100** |

| V | **DISSERTATION PHASE - II** | **Marks** |
|---|---|---|
| | **Continuous Assessment** | **50** |
| | **Distribution of marks for Continuous Assessment:** | |
| | Presentation I | |
| | *Work plan & Approach (10)* | |
| | Presentation II | |
| | *Progress, Results and Discussion (20)* | |
| | Journal Publication (20) | |
| | **End Semester Examination** | |
| | Presentation and Demonstration (20) | **50** |
| | Report (10) | |
| | Viva Voce (20) | |
| | **Total Marks** | **100** |

| VI | **MINI PROJECT** | **Marks** |
|---|---|---|
| | **Continuous Assessment** | **100** |
| | **Distribution of marks for Continuous Assessment:** | |
| | Review I (25) | |
| | Review II (25) | |
| | Report Presentation & Viva voce (50) | |
| | **Total Marks** | **100** |

| VII | **INDUSTRIAL TRAINING / INTERNSHIP (CONTINUOUS ASSESSMENT ONLY)** | **Marks** |
|---|---|---|
| | Presentation and Viva-voce I | **25** |
| | Presentation and Viva-voce II | **25** |
| | Review at the Industry | **20** |
| | Case study / Report | **30** |
| | **Total Marks** | **100** |

| VIII | **VALUE ADDED COURSES / CERTIFICATE COURSES (CONTINUOUS ASSESSMENT ONLY)** | **Marks** |
|---|---|---|
| | Test | 50 |
| | Final Evaluation / Test | 50 |
| | Grades (Excellent / Good / Satisfactory) | |

***Optional Test:*** *A student becomes eligible to appear for the one optional test conducted after the Periodical Test II, only under the following circumstances, if absent for Test I or Test II or both, on account of (i) medical reasons (hospitalization / accident / specific illness) (ii) participation in the College / University / State / National / International level Sports events with prior permission from the Head of the Institution and (iii) on satisfying the conditions (i) or (ii), the student should have registered for the Optional Test, through the concerned faculty member who handles the course or through the respective Head of the Department, submitted to the Controller of Examinations. Such Optional Tests are not conducted for the courses under the categories III, IV, V, VI, VII and VIII listed above.*

## 16. DISCIPLINE

A student is expected to follow the rules and regulations laid down by the Institute and the affiliating University, as published from time to time. Any violations, if any, shall be treated as per the procedures stated thereof.

If a student indulges in malpractice in any of the End Semester / Continuous Assessments, he / she shall be liable for punitive action as prescribed by the Institution / University from time to time.

The Question Paper Pattern (Theory Examination) for PG course is given below:

| **Type** | **Questions** | **Marks** |
|---|---|---|
| Part A | 2 Mark Questions (10 x 2 Marks) | 20 |
| Part B | 12 Mark Questions either or pattern (5 x 12 Marks) | 60 |
| Part C | Comprehensive Type- 20 Mark Question (1 x 20 Marks) | 20 |
| | Total | 100 |

## M.E. – STRUCTURAL ENGINEERING

## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. Graduates will have a thorough knowledge in the latest developments of construction materials, their properties and practical applications, design and construction of RC, steel, pre-stressed concrete structures, prefabricated structures including substructures, making use of all relevant codes of practice and software packages.

II. Graduates will have a clear idea on the concepts and principles involved in the analysis of stresses and strains in 2D and 3D cases by classical and finite element approaches and to analyse structures subjected to static and dynamic loads.

III. Graduates will actively engage in repair and rehabilitation of structures, strength and stability of structures, testing procedures to evaluate the strength and behaviour of structural components.

IV. Graduates will be a leading researcher and effective in team work.

## PROGRAMME OUTCOMES (POs)

a) Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b) Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c) Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
d) Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.
e) Use modern software packages for analysis and design of structures and use of modern instrumentations for experimental investigations.
f) Carry out independent and multidisciplinary scientific research in the area of design and construction of structures and demonstrate the capability for self-management and teamwork.
g) Demonstrate knowledge and understanding of engineering and management principles and manage projects related to the field of Structural Engineering efficiently.
h) Comprehend the practical applications of structural engineering and communicate to the society through effective reports and presentations particularly in the area of transfer of technology.
i) Engage in independent life-long learning, to improve knowledge and competence in the area of structural engineering.
j) Acquire ethics of learning and research, to contribute to the community for sustainable development of society by introducing innovations in the planning and design of various types of structures.
k) Observe and examine critically the outcomes of one's actions related to the planning and designing of various types of structures and make corrective measures subsequently if necessary.

## MAPPING OF PEOs AND POs

| PEOs | PROGRAMME OUTCOME (s) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (i) | (j) | (k) |
| I | X | X | X | | X | X | X | X | X | X | X |
| II | X | X | X | | X | | X | | | X | |
| III | X | | | | | | | | | | X |
| IV | X | | | X | | X | X | X | X | X | X |

**M.E: STRUCTURAL ENGINEERING**

***Minimum credits to be earned: 69.0***

| **FIRST SEMESTER** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **Objectives & Outcomes** | | **L** | **T** | **P** | **C** |
| | | **PEOs** | **POs** | | | | |
| 18ST11 | ADVANCED REINFORCED CONCRETE DESIGN | I,II,III,IV | a,b,c,d,e | 3 | 0 | 0 | 3 |
| 18ST12 | STRUCTURAL DYNAMICS | I,II,IV | b,h | 3 | 0 | 0 | 3 |
| 18ST13 | COMPUTER AIDED ANALYSIS OF STRUCTURES | I,II,IV | c,f | 2 | 0 | 2 | 3 |
| 18ST14 | APPLIED ELASTICITY AND PLASTICITY | I,II,III,IV | a,b,d,e,h,i | 3 | 0 | 0 | 3 |
| | ELECTIVE I | | | 3 | 0 | 0 | 3 |
| | ELECTIVE II | | | 3 | 0 | 0 | 3 |
| 18ST17 | STRUCTURAL ENGINEERING LABORATORY | I,II,III,IV | a,b,c,d,e,i | 0 | 0 | 2 | 1 |
| | | | **Total** | **17** | **0** | **4** | **19** |
| **SECOND SEMESTER** | | | | | | | |
| **Code No.** | **Course** | **Objectives & Outcomes** | | **L** | **T** | **P** | **C** |
| | | **PEOs** | **POs** | | | | |
| 18ST21 | ADVANCED STEEL DESIGN | I,II,IV | b,f,g | 3 | 0 | 0 | 3 |
| 18ST22 | FINITE ELEMENT ANALYSIS | I,II,IV | b,d,e | 3 | 0 | 0 | 3 |
| 18ST23 | STABILITY OF STRUCTURES | I,II,III,IV | a,b | 3 | 0 | 0 | 3 |
| 18ST24 | EARTHQUAKE RESISTANT DESIGN OF STRUCTURES | I,II,IV | b,d,e,f | 3 | 0 | 0 | 3 |
| | ELECTIVE III | | | 3 | 0 | 0 | 3 |
| | ELECTIVE IV | | | 3 | 0 | 0 | 3 |
| 18ST27 | ADVANCED COMPUTER AIDED ANALYSIS AND DESIGN LABORATORY | I,II,IV | c,d,f | 0 | 0 | 2 | 1 |
| 18ST28 | MINIPROJECT | IV | c,e,h,j | 0 | 0 | 2 | 1 |
| | AUDIT COURSE I | | | 2 | 0 | 0 | 0 |
| | | | **Total** | **20** | **0** | **4** | **20** |
| **THIRD SEMESTER** | | | | | | | |
| **Code No.** | **Course** | **Objectives & Outcomes** | | **L** | **T** | **P** | **C** |
| | | **PEOs** | **POs** | | | | |
| 18ST31 | DESIGN OF INDUSTRIAL STRUCTURES | I,II,III,IV | a,b,c | 3 | 0 | 0 | 3 |
| | ELECTIVE V | | | 3 | 0 | 0 | 3 |
| | ELECTIVE VI | | | 3 | 0 | 0 | 3 |
| | ELECTIVE VII | | | 3 | 0 | 0 | 3 |
| 18ST35 | DISSERTATION PHASE I | IV | c,e,h,j | 0 | 0 | 12 | 6 |
| | AUDIT COURSE II | | | 2 | 0 | 0 | 0 |
| | | | **Total** | **14** | **0** | **12** | **18** |
| **FOURTH SEMESTER** | | | | | | | |
| **Code No.** | **Course** | **Objectives & Outcomes** | | **L** | **T** | **P** | **C** |
| | | **PEOs** | **POs** | | | | |
| 18ST41 | DISSERTATION PHASE II | IV | c,e,h,j | 0 | 0 | 24 | 12 |
| | | | **Total** | **0** | **0** | **24** | **12** |

| **LIST OF CORE ELECTIVES** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **Objectives & Outcomes** | | **L** | **T** | **P** | **C** |
| | | **PEOs** | **Pos** | | | | |
| 18ST51 | RESEARCH METHODOLOGY AND IPR | I,II,III,IV | a,c,d,f,h | 3 | 0 | 0 | 3 |
| 18ST52 | DESIGN OF STRUCTURAL FOUNDATION | I,II,IV | b,i | 3 | 0 | 0 | 3 |
| 18ST53 | CONSTRUCTION ENGINEERING AND MANAGEMENT | I,IV,II | h,j | 3 | 0 | 0 | 3 |
| 18ST54 | DESIGN OF STEEL-CONCRETE COMPOSITE STRUCTURES | I,II,III,IV | a,b,c | 3 | 0 | 0 | 3 |
| 18ST55 | REPAIR AND REHABILITATION OF STRUCTURES | I,II,III,IV | a,b,c,d,e | 3 | 0 | 0 | 3 |
| 18ST56 | DESIGN OF BRIDGES | I,II,III,IV | a,b,c | 3 | 0 | 0 | 3 |
| 18ST57 | RISK AND RELIABILITY OF STRUCTURES | I,II,IV | c,d,i | 3 | 0 | 0 | 3 |
| 18ST58 | PREFABRICATED STRUCTURES | I,II,III,IV | a,b,c,e | 3 | 0 | 0 | 3 |
| 18ST59 | ADVANCED CONCRETE TECHNOLOGY | I,II,III,IV | a,d,g,h,i | 3 | 0 | 0 | 3 |
| 18ST60 | FIRE-RESISTANT DESIGN OF STRUCTURES | I,II,III,IV | a,b,c,j | 3 | 0 | 0 | 3 |
| 18ST61 | STRUCTURAL HEALTH MONITORING | I,II,III,IV | a,b,c,d | 3 | 0 | 0 | 3 |
| 18ST62 | THEORY OF PLATE AND SHELLS | I,II,III,IV | a,b,c | 3 | 0 | 0 | 3 |
| 18ST63 | STRUCTURAL OPTIMIZATION TECHNIQUES | I,II,III,IV | a,b,c,g | 3 | 0 | 0 | 3 |
| 18ST64 | ANALYSIS AND DESIGN OF TALL BUILDINGS | I,II,IV | b,e,i | 3 | 0 | 0 | 3 |
| 18ST65 | EXPERIMENTAL STRESS ANALYSIS AND TECHNIQUES | I,II,III,IV | a,c,d,e,f,g | 3 | 0 | 0 | 3 |
| 18ST66 | SOFT COMPUTING IN STRUCTURAL ENGINEERING | I,II,III,IV | a,b,c,g | 3 | 0 | 0 | 3 |
| 18ST67 | DESIGN OF PRESTRESSED CONCRETE STRUCTURES | I,II,III,IV | a,b,c | 3 | 0 | 0 | 3 |
| 18ST68 | OFFSHORE STRUCTURES | I,II,III,IV | a,b,c,d | 3 | 0 | 0 | 3 |
| 18ST69 | MECHANICS OF COMPOSITE MATERIALS | I,II,III,IV | a,b,c,d,e,g | 3 | 0 | 0 | 3 |
| 18ST70 | NONLINEAR ANALYSIS OF STRUCTURES | I,II | b,c,e | 3 | 0 | 0 | 3 |

| **LIST OF OPEN ELECTIVES** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **Objectives & Outcomes** | | **L** | **T** | **P** | **C** |
| | | **PEOs** | **POs** | | | | |
| 18GE01 | BUSINESS ANALYTICS | IV | h ,i ,j ,k | 3 | 0 | 0 | 3 |
| 18GE02 | INDUSTRIAL SAFETY | IV | g,h,i,j,k | 3 | 0 | 0 | 3 |
| 18GE03 | HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT (HSE) | IV | g ,h ,i ,j , k | 3 | 0 | 0 | 3 |
| 18GE04 | COST MANAGEMENT OF ENGINEERING PROJECTS | IV | g ,h ,i ,j , k | 3 | 0 | 0 | 3 |
| 18GE05 | COMPOSITE MATERIALS | I,II,III,IV | a,c,g,h,i,j,k | 3 | 0 | 0 | 3 |
| 18GE06 | WASTE TO ENERGY | I,II,III,IV | a , c , g ,h ,i ,j , k | 3 | 0 | 0 | 3 |

| **LIST OF AUDIT COURSE I** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **Objectives & Outcomes** | | **L** | **T** | **P** | **C** |
| | | **PEOs** | **POs** | | | | |
| 18XE11 | RESEARCH PAPER WRITING | IV | h ,i ,j ,k | 2 | 0 | 0 | 0 |
| 18XE12 | TRADITIONAL TECHNICAL KNOWLEDGE | IV | h ,i ,j ,k | 2 | 0 | 0 | 0 |
| 18XE13 | VALUE EDUCATION | IV | h ,i ,j ,k | 2 | 0 | 0 | 0 |

| **LIST OF AUDIT COURSE II** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **Objectives & Outcomes** | | **L** | **T** | **P** | **C** |
| | | **PEOs** | **POs** | | | | |
| 18XE21 | STRESS MANAGEMENT | IV | h ,i ,j ,k | 2 | 0 | 0 | 0 |
| 18XE22 | DISASTER MANAGEMENT | IV | h ,i ,j ,k | 2 | 0 | 0 | 0 |
| 18XE23 | PEDAGOGY STUDIES | IV | h ,i ,j ,k | 2 | 0 | 0 | 0 |

## 18ST11 ADVANCED REINFORCED CONCRETE DESIGN

**3 0 0 3**

**Course Objectives**

- To impart knowledge on the limit state design of RC Structural components
- To enhance the confidence level of students to design the special structural elements as per Indian standard code of practices.

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.
e. Use modern software packages for analysis and design of structures and use of modern instrumentations for experimental investigations.

**Course Outcomes (COs)**

1. Design of RC beam for serviceability conditions and design of column as per IS 456
2. Design and detailing of special RC elements
3. Analysis of RC slab using yield line theory and design of flat slab and grid floor
4. Design of RC walls and concepts of ductile detailing
5. Evaluate the RC section with moment redistribution and ultimate load analysis

**UNIT I** **9 Hours**

**LIMIT STATE DESIGN OF BEAMS AND COLUMNS**

Design of beam section subjected to the combined action of bending moment, transverse shear and torsion. Parameters considered in limit state of serviceability - Calculation of deflections in beams under working loads - Calculation of crack width in beams. Design of columns subjected to axial, uniaxial and biaxial moment using interaction charts.

**UNIT II** **9 Hours**

**DESIGN OF SPECIAL R.C. ELEMENTS**

Design and detailing of Deep beams - Corbels - Spandrel beams - Continuous beams. Approximate analysis and design of beams circular in plan.

**UNIT III** **9 Hours**

**DESIGN OF SLABS AND YIELD LINE THEORY**

Yield line theory of slabs - Virtual work method - Equilibrium methods -Hillerborg method of design. Design of flat slabs - Design of grid floors as per I.S.456.

**UNIT IV** **9 Hours**

**DESIGN OF RC WALL AND DUCTILE DETAILING**

Design of RC walls - Shear walls. Concepts of ductility- Factors influencing ductility - Design principles and codal provisions.

**UNIT V** **9 Hours**

**ULTIMATE LOAD ANALYSIS AND INELASTIC BEHAVIOUR**

Whitney's theory - Ultimate load analysis - Moment redistribution and moment rotation characteristics of a R.C. section - Plastic hinges check for rotation capacity of sections. Concept of moment - rotation curves.

**Total: 45 Hours**

**Reference(s)**

1. S. Unnikrishna Pillai and DevadosMenon, Reinforced Concrete Design, Tata McGraw Hill Education, 2011
2. P.C. Varghese, Advanced Reinforced Concrete Design, Prentice Hall International Edition, 2006
3. N. Krishnaraju, Advanced Reinforced Concrete Design, CBS Publishers and Distributors, 2000
4. R. Park and T. Paulay, Reinforced Concrete Structures, John Wiley Sons, 2008
5. Gambhir, M.L. Design of Reinforced Concrete Structures, Prentice Hall of India, 2012
6. S.N. Sinha, Handbook of Reinforced Concrete Design, Tata McGraw Hill Education, 2004

## 18ST12 STRUCTURAL DYNAMICS 3 0 0 3

**Course Objectives**

- To expose the students the principles and methods of dynamic analysis of structures.
- To prepare them for designing the structures for wind, earthquake and other dynamic loads.

**Programme Outcomes (POs)**

b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
h. Comprehend the practical applications of structural engineering and communicate to the society through effective reports and presentations particularly in the area of transfer of technology.

**Course Outcomes (COs)**

1. Outline the structural dynamics in which degree of freedom, D Alembert's principle, Free and forced vibration.
2. Determine the two degree of freedom and multi degree of freedom under the forced and free vibration with iteration methods and in applications.
3. Evaluate four series expression loading by Duhamel s Integral, vibration analysis by Rayleigh Ritz method and Earthquake response analysis of Multi DOF system.
4. Describe the vibration of springs for free flexural and free longitudinal vibration of simply supported beam and other end conditions with finite element method.
5. Compute damping and vibration parameter in MDOF system with Direct integration method, central difference method, Wilson method and New mark .

**UNIT I** **9 Hours**

**PRINCIPLES OF STRUCTURAL DYNAMICS**

Overview of Structural Dynamics: Degree of freedom -Simple harmonic motion - Newton's second law of motion - D-Alembert's principle -Energy method - Equation of motion for SDOF system - Damped and un - damped free vibrations and forced vibration -Logarithmic decrement.

**UNIT II** **9 Hours**

**MULTI DEGREE OF FREEDOM SYSTEMS**

Dynamics of Multi-Degree of Freedom Systems - Lagrange's equations-equations of motion for MDOF systems-Algebraic eigenvalue problem and free vibration analysis; Undamped and damped normal modes; Mode -superposition method for dynamic analysis of linear systems; Mode-truncation and correction for the missing mass.

**UNIT III** **9 Hours**

**RESPONSE TO GENERAL DYNAMIC LOADING**

Fourier series expression for loading (blast or earthquake) - Duhamel's integral, vibration analysis by Rayleigh's method, Rayleigh - Ritz method - Earthquake response analysis of Multi - DOF systems subjected to earthquake ground motion -Idealization of multi- storeyed frames.

**UNIT IV** **9 Hours**

**DYNAMIC RESPONSE OF CONTINUOUS SYSTEMS**

Vibration of springs -Free longitudinal vibration of a bar -Free flexural vibration of simply supported beams and beams with other end conditions -Vibration analysis using finite element method for beams and frames.

**UNIT V** **9 Hours**

**DIRECT INTEGRATION METHODS FOR DYNAMIC RESPONSE**

Introduction -Damping in MDOF systems - Nonlinear MDOF systems -Direct integration methods - The central difference method -Wilson method -New mark's method -measurement of damping and vibration techniques - Application of structural dynamics in the design of block and frame foundations.

**Total: 45 Hours**

**Reference(s)**

1. Roy R.Craig, Jr, Andrew J. Kurdila, "Fundamentals of Structural Dynamics", John Wiley& Sons. 2011.
2. S. Chandrasekaran and Gaurav. 2017. Analysis and design of structures under special loads including fire-resistant design, Springer, Singapore
3. S. Chandrasekaran, Federico Carannante, Giorgio Serino. 2009. Design aids of RC structures under Seismic loads, CRC Press, Florida.
4. Mario Paz, Structural dynamics, CBS Publishers 1987.
5. Anil K. Chopra, Dynamics of structures: Theory and applications to earthquake Engineering, PHI Ltd., 1997.
6. Manickaselvam, V.K., "Elementary Structural Dynamics", Dhanapat R ai& Sons, 2001.

## 18ST13 COMPUTER AIDED ANALYSIS OF STRUCTURES

**2 0 2 3**

**Course Objectives**

- To educate the students to analyze by flexibility and stiffness method pin jointed trusses, continuous beams, grids and rigid jointed frames.
- To educate the students with the available latest software packages used practically for analysis of structures

**Programme Outcomes (POs)**

c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
f. Carry out independent and multidisciplinary scientific research in the area of design and construction of structures and demonstrate the capability for self-management and teamwork.

**Course Outcomes (COs)**

1. Characterize the behavior of structures using Stiffness and flexibility methods
2. Analyze structural systems using matrix methods
3. Create computer programs for stiffness method
4. Create computer programs for flexibility method
5. Develop computer programs for direct stiffness method

**UNIT I** **9 Hours**

**REVIEW OF FUNDAMENTAL CONCEPTS**

Indeterminacy-Static Kinematic -Generalised measurements- degrees of freedom-Constrained measurements-Behaviour of structures-Principle of superposition- Equilibrium, Compatibility and Force displacement relations. Stiffness and flexibility matrices in Single, two and n-coordinates; structures with Constrained measurements; stiffness and flexibility coefficients-Basic Stiffness and basic Flexibility method applied to spring models. Introduction to MATLAB-Practice problems

**UNIT II** **9 Hours**

**ENERGY CONCEPTS AND TRANSFORMATION OF INFORMATION**

Strain energy - Strain energy in terms of stiffness and flexibility matrices - Betti's Law and it's application -Transformation of System force to element forces - Transformation of Element Flexibility to System Flexibility - Transformation of System Displacement to Element Displacement - Transformation of Element Stiffness matrix to system stiffness matrix -Normal coordinates and orthogonal coordinates.

**UNIT III** **9 Hours**

**FLEXIBILITY METHOD**

Flexibility method applied to Statically Determinate and Statically Indeterminate Structures: Choice of redundant Primary structure-General formulation-Structures flexibility matrix using force transformation matrix-Internal forces due to thermal expansion and lack of fit. Application of MATLAB problems in structures

**UNIT IV** **9 Hours**

**STIFFNESS METHOD**

Development of the stiffness method - Stiffness method for beams, frames and trusses sung displacement transformation matrix and coordinate transformation matrix-Internal forces due o thermal expansion and lack of fit- Application of MATLAB problems in structures

**UNIT V** **9 Hours**

**SPECIAL TOPICS**

Matrix Displacement Methods: Static condensation Technique - Substructure Technique -Transfer Matrix method - Symmetry & Anti symmetry of structures. Direct Stiffness Method: Discrete system - Direct stiffness approach - Application to two and three dimensional pin-jointed trusses - plane frames - Grids - Three dimensional space frames.

**1** **2 Hours**

## SOLUTION OF LINEAR EQUATIONS USING CREAMERS RULE

Write a matlab program for solving equations using cramers rule

**2** **2 Hours**

## PLOT A GRAPH USING MATLAB

With the help of Matlab, plot the following
A=x sinh (x)
Y=x cos tetha
Z=x son thetha
Plot x, y, a

**3** **2 Hours**

## FIND INVERSE OF A MATRIX

Write a script to find the inverse of a 3x3 matrix

**4** **1 Hours**

## ADDITION OF TWO MATRIX

Write a script file to find the addition of a 4x4 matrix

**5** **1 Hours**

## MULTIPLICATION OF MATRIX

Write a script file to find the multiplication of a 4x4 matrix

**6** **1 Hours**

## ANALYSIS OF A BEAM USING MATLAB

Write a script file to the bending moment of a simply supported beam using stiffness method

**7** **1 Hours**

## ANALYSIS OF A BEAM USING FLEXIBILITY METHOD

Write a script file to the bending moment of a simply supported beam using flexibility method

**8** **1 Hours**

## DESIGN OF A BEAM

Write a script file to the design a simply supported beam using matlab

**9** **2 Hours**

## DESIGN OF CIRCULAR COLUMN

Write a script file to the design a circular column using matlab

**10** **2 Hours**

**DESIGN OF A RECTANGULAR FOOTING**

Write a script file to the design a rectangular using matlab

**Total: 60 Hours**

**Reference(s)**

1. F. M. Rubinstein, Matrix Computer Methods of Structural Analysis, Prentice Hall, 1966
2. Dr.Devadas menon," Advanced Structural Analysis", Narosa Publishing House, New Delhi, 2009
3. S. Rajasekaran, Computational methods of Structural mechanics, Prentice Hall, 2006.
4. McGuire and R. H. Gallagher, Matrix Structural Analysis, John Wiley, 1999
5. J. R. William Weaver and James M. Gere, Matrix Analysis of Framed Structures, CBS Publishers & Distributors, 2004
6. C. K. Wang, Intermediate Structural Analysis, McGraw Hill International Editions, 1984.

## 18ST14 APPLIED ELASTICITY AND PLASTICITY 3 0 0 3

**Course Objectives**

- To understand the concept of 3D stress-strain analysis and its applications to simple problems
- To give an exposure on the plastic behavior of materials

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.
e. Use modern software packages for analysis and design of structures and use of modern instrumentations for experimental investigations.
h. Comprehend the practical applications of structural engineering and communicate to the society through effective reports and presentations particularly in the area of transfer of technology.
i. Engage in independent life-long learning, to improve knowledge and competence in the area of structural engineering.

**Course Outcomes (COs)**

1. Analyze the stress and strain for two and three dimensional structures
2. Discriminate the Equilibrium equations in terms of displacements - compatibility equations for different degree of polynomial
3. Examine the displacements for symmetrical stress distribution and Bending of a curved bar
4. Evaluate the torsional moment of shafts of circular and noncircular and various elements
5. Analyse the structure by theories of failures and calculate stress distribution of elasto-plastic problems of beams

**UNIT I** **9 Hours**

**ANALYSIS OF STRESS AND STRAIN**

Analysis of stress (two and three dimension)- Body force, surface force - Uniform state of stress - Principal stresses - stress transformation laws - Differential equations of equilibrium. Analysis of strain (two and three dimension) Strain displacement relations - state of strain at a point - strain transformation - principal strain - principle of superposition. Stress - strain relations- Compatibility equations - generalized Hooke's law - Lame's constants

**UNIT II** **9 Hours**

**TWO DIMENSIONAL PROBLEMS IN CARTESIAN COORDINATES**

Methods of formulation of elasticity problems - Equilibrium equations in terms of displacements - compatibility equations - Boundary value problems. Plane stress and Plane strain problems - Airy's stress function - polynomials Direct method of determining Airy's polynomial stress function - solution of Biharmonic equation - St. Venant principle- two dimensional problems in Cartesian Co-ordinates-bending of a cantilever loaded at end

**UNIT III** **9 Hours**

**TWO DIMENSIONAL PROBLEMS IN POLAR COORDINATES**

Equilibrium equations in polar coordinates - stress distribution symmetrical about an axis - pure bending of curved bars - strain components in polar coordinates - displacements for symmetrical stress distribution - Rotating Disc - Bending of a curved bar by force at the end - Effect of circular hole on stress distribution - concentrated force at a point of a straight boundary - Forces on wedges - A circular disc with diametric loading.

**UNIT IV** **9 Hours**

**TORSION OF PRISMATIC BARS**

General solutions of the problem by displacement (St. Venant's warping function) and force (Prandtl's stress function) approaches - Membrane analogy-Torsion of shafts of circular and noncircular (elliptic, triangular and rectangular) cross sectional shapes. Torsion of thin rectangular section - Torsion of thin walled single and multicelled sections.

**UNIT V** **9 Hours**

**INTRODUCTION TO PLASTICITY**

Introduction to stress-strain curve - Visco elastic material - Ideal plastic body - criterion of yielding - Theories of failure - yield surface - Flow rule (plastic stress- strain relation) PrandtlReuss equations - Plastic work - Plastic potential - uniqueness of stress distribution - Elastoplastic problems of beams in bending- thick hollow spheres and cylinders subjected to internal pressure - General relations - plastic torsion -Nadai's sand heap analogy.

**Total: 45 Hours**

**Reference(s)**

1. S. Timoshenko and J. N. Goodier, Theory of Elasticity, McGraw Hill Book Co., 2007
2. Sadhu Singh, Theory of Elasticity, Khanna Publishers, New Delhi, 2005.
3. Sadhu Singh, Theory of Plasticity, Khanna Publishers, New Delhi, 2008.
4. P. C. Chow and N. J. Pagano, Elasticity, Tensor, Dyadic and Engg. Approaches, D.Vannostrard Co., New York, 1992
5. L. S. Srinath, Advanced mechanics of solids, Tata McGraw Hill Publishing Company Ltd, 2006
6. T. Chakrabarthy, Theory of Plasticity, McGraw Hill Book Co., New Delhi, 2006

## 18ST17 STRUCTURAL ENGINEERING LABORATORY

**0 0 2 1**

**Course Objectives**

- To impart training to student on concrete mix design, and determination of properties of concrete in fresh and hardened states
- To impart training on NDT Testing of concrete
- To study the strength and behaviour of RC Beams
- To study the behaviour of model structural components subjected to vibration

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.
e. Use modern software packages for analysis and design of structures and use of modern instrumentations for experimental investigations.
i. Engage in independent life-long learning, to improve knowledge and competence in the area of structural engineering.

**Course Outcomes (COs)**

1. Impart the knowledge about the properties of concrete making materials and their testing methods
2. Design the concrete mix for field requirements
3. Demonstrate the properties of concrete in fresh and hardened state
4. Characteristic behaviour of self-compacting concrete by using various methods
5. Investigate the steel frame under vibration by using shake table

**1** **3 Hours**

**EXPERIMENT 1**

Mix design for high strength concrete and properties of fresh concrete

**2** **3 Hours**

**EXPERIMENT 2**

Tests on mechanical properties of hardened concrete

**3** **5 Hours**

**EXPERIMENT 3**

Tests on durability of concrete

**4** **4 Hours**

**EXPERIMENT 4**
Method of manufacture and test on self-compacting concrete

**5** **3 Hours**

**EXPERIMENT 5**
Method of manufacture and test on self-curing concrete

**6** **3 Hours**

**EXPERIMENT 6**
Effect of different types of curing on strength of concrete

**7** **3 Hours**

**EXPERIMENT 7**
Casting and testing of simply supported reinforced concrete beam for strength and deflection behavior

**8** **3 Hours**

**EXPERIMENT 8**
Non-destructive testing of concrete using
i. Rebound hammer
ii. Ultra sonic pulse velocity method

**9** **3 Hours**

**EXPERIMENT 9**
Tests on the behaviour of model frames under vibration

**Total: 30 Hours**

## 18ST21 ADVANCED STEEL DESIGN 3 0 0 3

**Course Objectives**

- To impart knowledge in the design of bolted and welded connections.
- To impart knowledge in the design of industrial structures, transmission towers and light gauge Section.
- To impart knowledge on the plastic analysis and design of hyper static steel structures.

**Programme Outcomes (POs)**
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
f. Carry out independent and multidisciplinary scientific research in the area of design and construction of structures and demonstrate the capability for self-management and teamwork.
g. Demonstrate knowledge and understanding of engineering and management principles and manage projects related to the field of Structural Engineering efficiently.

**Course Outcomes (COs)**

1. Design the bolted and welded connections at the junctions.
2. Analyze include all different loads acting on structure and design the multistoried industrial building.
3. Compute the internal forces and design the special steel structural elements.
4. Analyze the cold formed steel sections and design by effective width method
5. Identify the plastic hinge location and design members by plastic hinge mechanism

**UNIT I** **9 Hours**

**DESIGN OF STRUCTURAL ELEMETS AND CONNECTIONS**

Design of high strength function grip bolts -Design of bolted connections at the junctions of beams and columns in frames -Design of un-stiffened & stiffened seat connections -Welded connections - eccentric connections -Beam end connections -Direct web fillet welded connections -Direct web Butt welded connection -Double plate web connection -Double angle web connection -Un-stiffened and stiffened seat connection -Moment resistant connection -T stub connections.

**UNIT II** **9 Hours**

**INDUSTRIAL BUILDING**

Industrial building frames -wind load analysis-Calculation of wind load and its combination-Framing Roof Bracing -Crane girders and columns -Analysis of Trussed bents -Design example -Design of rigid joints knee for gable frames. Structure of Multi-storeyed Buildings -Bracing systems of multistorey frames. Design of plate girder - Design of column base plate.

**UNIT III** **9 Hours**

**ANALYSIS AND DESIGN OF SPECIAL STRUCTURES**

Design of steel bunkers and silos -Janssen's theory -Airy's theory -design parameters-design criteria. Design and detailing of self-supporting and guyed steel chimneys. Transmission line towers. Types of towers and design of foundation -tower configuration, Load analysis and design of members

**UNIT IV** **9 Hours**

**LIGHT GAUGE SECTIONS**

Concepts -Design of cold formed sections -effective width -stiffened sections -multiple stiffened sections -design of light gauge beams and columns - Torsion & Flexural buckling -composite decks

**UNIT V** **9 Hours**

**PLASTIC ANALYSIS AND DESIGN**

Concept of plastic analysis-Theory of plastic bending -Plastic hinge -redistribution of moments - failure mechanisms -plastic analysis and design of fixed beams, continuous beams and portal frames by mechanism method.

**Total: 45 Hours**

**Reference(s)**

1. N. Subramanian, Steel Structures Design and Practice, Oxford University Press 2011.
2. S. K. Duggal, Limit State Design of Steel Structures, McGraw Hill, 2014.
3. IS 800 - 2007, General Construction in Steel - Code of Practice (Third revision).
4. IS 811 - 1987, Specification for cold formed light gauge structural steel sections
5. IS 9178 (Part 1) - 1989, Design and construction of steel chimney code of practice.
6. IS 9178 (Part 2) - 1979, Criteria for design of steel bins for storage of bulk materials.

## 18ST22 FINITE ELEMENT ANALYSIS 3 0 0 3

**Course Objectives**

- To impart fundamental knowledge on the Finite Element Method and its applications
- To train the students to carry out dynamic analysis of beams and frames using finite elements

**Programme Outcomes (POs)**

b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.
e. Use modern software packages for analysis and design of structures and use of modern instrumentations for experimental investigations.

**Course Outcomes (COs)**

1. Predict the displacement, stress and strain of elements after idealizing by finite element method
2. Analyze the internal forces for beams, frames and trusses subjected to different boundary conditions by discretizing the members into small elements.
3. Analyze 2-D and 3-D structures for complex geometry problems.
4. Apply the finite element method to form the stiffness matrix for plates and shells.
5. Recommend the appropriate mesh shape and size for reliable results

**UNIT I** **9 Hours**

**INTRODUCTION TO FINITE ELEMENT ANALYSIS**

Differential equations- Boundary conditions- Method of weighted residuals- Variational principles and approximate solutions- Convergence of approximate solutions- Concept of finite element method as extension of method of weighted residuals to piecewise continuous approximation- Rules of domain discretization- Discretization errors.

**UNIT II** **9 Hours**

**FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL**

Continuity requirement-Truss/rod/shaft, beam bending- Locking in shear deformable beam elements and solution -Modelling of framed structures- Skewed boundary conditions; constraint equations- Rules for monotonic convergence of the finite element solution

**UNIT III** **9 Hours**

**FINITE ELEMENT ANALYSIS OF TWO / THREE DIMENSIONAL**

Equations of 3-D elasticity-Plane stress, plane strain and axi-symmetric idealizations; Triangular and rectangular elements; Interpolation functions; Degree of complete polynomial; Pascal's triangle; Evaluation of domain and surface integrals; Tetrahedral and brick elements; Incompatible modes; Patchtest.Isoparametric Elements and Axisymmetric Elements: Sub - iso - super parametric elements - Shape functions mapping - Linear iso-parametric quadrilateral - Simple problems - Axisymmetric stress analysis

**UNIT IV** **9 Hours**

**APPLICATION TO PLATES AND SHELLS**

Plate Bending Problems: Basic concepts - Derivation of element stiffness matrix - Four noded, eight noded rectangular and iso-parametric element - BFS element - Effect of shear deformation in plates - Introduction to finite strip method - Application to folded plates.
Shell elements: Concepts of shell elements - Degenerated shell elements - Derivation of stiffness matrix for degenerated shell elements.

**UNIT V** **9 Hours**

**TIME DIMENSION**

Consistent mass matrix; Lumping procedures; Algebraic eigenvalue problem; Time-marching schemes; Adequacy of the finite element mesh

**Total: 45 Hours**

**Reference(s)**

1. Daryl L Logan, A First Course in the Finite Element Method, Cengage Learning, 2010
2. K. J. Bathe, Finite Element Procedure, Prentice Hall of India, and New Delhi, 2007
3. O. C. Zienkiewinz, The Finite Element method Vol. 1 & 2, TMH, New York, 2002
4. C. S. Krishnamoorthy, Finite Element Method - Theory and Programming, Tata McGraw Hill Publishing Company, New Delhi, 1994.
5. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall of India Pvt. Ltd., New Delhi, 2002
6. S. Rajasekaran, Finite Element Analysis in Engineering Design, S. Chand Publishing, 1999

## 18ST23 STABILITY OF STRUCTURES 3 0 0 3

**Course Objectives**

- To understand the behaviour of structures based on the concept of strength and stability
- To impart Knowledge in phenomenon of buckling and its effects on structural components

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.

**Course Outcomes (COs)**

1. Identify the type of equilibrium and failure pattern in structures
2. Calculate the critical load of columns at different end conditions by various methods
3. Analyse the beam/column joint in structure by various methods
4. Calculate the lateral buckling behaviour of various elements by differential equations
5. Propose the failure pattern in thin and thick plates

**UNIT I** **9 Hours**

**FUNDAMENTAL CONCEPTS OF STABILITY**

Criterion for design of structures: strength, stability and stiffness - Concepts of Equilibrium, Energy and Dynamic approaches -South well Plot - Stability of Link models.

**UNIT II** **9 Hours**

**BUCKLING OF COLUMNS**

Governing differential equations - Higher order differential equations -Analysis for various boundary conditions - Behaviour of imperfect column - initially bent column - eccentrically loaded column - Energy method - Rayleigh Ritz, Galerkin methods - Effect of shear on buckling - Large deflection analysis of columns.

**UNIT III** **9 Hours**

**BUCKLING OF BEAM -COLUMN**

Buckling of beam column - Derivation of stability function for standard cases of beam columns: Beam - columns with concentrated lateral loads - distributed loads - effect of axial loads on bending stiffness. Buckling of frames: Mode of buckling- Single storey frames with sway and no sway; Buckling analysis of frames with various methods: Slope deflection and Stiffness methods.

**UNIT IV** **9 Hours**

**LATERAL STABILITY OF BEAMS**

Differential equations for lateral buckling - lateral buckling of beams in pure bending -lateral buckling of cantilever and simply supported I beams. Buckling of Thin Walled Open Sections: Introduction - torsional buckling - torsional flexural buckling - Equilibrium and energy approaches.

**UNIT V** **9 Hours**

**STABILITY OF PLATES**

Governing Differential equation -Equilibrium, energy concepts- Buckling of rectangular plates for various edge conditions -Finite difference method - post -buckling strength. Introduction to inelastic buckling - Double modulus theory (reduced modulus) - tangent modulus theory- Shanley's theory determination of double modulus for I section and rectangular section. Application: Review of relevant codal provisions for the design of steel, concrete and masonry structures incorporating buckling phenomenon.

**Total: 45 Hours**

**Reference(s)**

1. A. Chajes, Principles of Structural Stability Theory, Prentice Hall, 2008.
2. N.G.R. Iyengar, Structural Stability of Columns and Plates, Affiliated East West press Pvt. Ltd, New Delhi -1988.
3. D.O.Brush, and B.O. Almorth, Buckling of Bars, Plates and Shells, McGraw Hill, 2006
4. S.O. Timoshnko and J.M. Gere, Theory of Elastic Stability, McGraw Hill, 2009.
5. M.S. El Naschies, Stress, Stability and Chaos in Structural Engineering: An Energy Approach, McGraw Hill International Editions, 1999.
6. AshwiniKukar, Stability of Structures, Allied Publishers LTD, New Delhi, 2003.

## 18ST24 EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

**3 0 0 3**

**Course Objectives**

- To study the effects of earthquake, analysis and design of Earthquake resistant design of structures
- To understand the concept of providing ductility to structures for making it earthquake resistant

**Programme Outcomes (POs)**

b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.
e. Use modern software packages for analysis and design of structures and use of modern instrumentations for experimental investigations.
f. Carry out independent and multidisciplinary scientific research in the area of design and construction of structures and demonstrate the capability for self-management and teamwork.

**Course Outcomes (COs)**

1. Interpret the performance and response of the structure during earthquake.
2. Attribute the design philosophies on strength and serviceability factors by considering the building irregularity.
3. Analyze the structures subjected to earthquake loading by different methods
4. Design the RCC structures as earthquake resistant based upon the strong column weak beam concept.
5. Design the various elements of steel structures as earthquake resistant.

**UNIT I** **9 Hours**

**EARTHQUAKE AND GROUND MOTION**

Seismic performance of structures and structural components during earthquakes; Ground motion parameters; Response spectrum, design spectrum.

**UNIT II** **9 Hours**

**SEISMIC DESIGN PHILOSOPHY**

Concept of strength, over strength and ductility-Concept of equal displacement and equal energy principles, capacity design-seismic design consideration in buildings with irregularities.

**UNIT III** **9 Hours**

**SEISMIC ANALYIS OF BUILDINGS**

Equivalent static analysis, response spectrum analysis, mode superposition method; Time history analysis; modelling concept of reinforced concrete building.

**UNIT IV** **9 Hours**

**SEISMIC DESIGN OF BUILDING COMPONENTS**

Seismic resistant properties of reinforced concrete- Seismic behaviour and design of linear reinforced concrete Elements- Seismic behavior of planar reinforced concrete elements, codal provisions.

**UNIT V** **9 Hours**

**SEISMIC PROVISIONS FOR STRUCTURAL STEEL BUILDINGS**

Materials, connections joints and fasters- Columns, ordinary, intermediate and special moment resisting Frame- Concentrically and eccentrically braced frames.

**Total: 45 Hours**

**Reference(s)**

1. Bruce A Bolt,"Earthquakes" W H Freeman and Company, New York, 2004.
2. C. A. Brebbia,Earthquake Resistant Engineering Structures VIII,WIT Press, 2011
3. Mohiuddin Ali Khan ,Earthquake-Resistant Structures: Design, Build and Retrofit, Elsevier Science & Technology, 2012
4. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, Prentice Hall of India, 2009.
5. Paulay,T and Priestley, M.J.N., Seismic Design of Reinforced Concrete and Masonry buildings, John Wiley and Sons, 1992.
6. S K Duggal, Earthquake Resistant Design of Structures, Oxford University Press, 2007

## 18ST27 ADVANCED COMPUTER AIDED ANALYSIS AND DESIGN LABORATORY

**0 0 2 1**

**Course Objectives**

- To acquire knowledge in the application of computer softwares for the analysis and design of structures
- To train the students in the application of programming for the analysis and design of structures

**Programme Outcomes (POs)**

c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.
f. Carry out independent and multidisciplinary scientific research in the area of design and construction of structures and demonstrate the capability for self-management and teamwork.

**Course Outcomes (COs)**

1. Produce coding for analysis and design of RC structural components
2. Analyze different types of structures using software packages
3. Design different types of structures using software packages
4. Compute finite element analysis for structural elements with and without meshes
5. Analyze the structures subjected to earthquake and wind forces

**1** **2 Hours**

**EXPERIMENT 1**

Design of Singly reinforced beams

**2** **2 Hours**

**EXPERIMENT 2**

Design of doubly reinforced beams

**3** **2 Hours**

**EXPERIMENT 3**
Design of Rectangular Columns

**4** **2 Hours**

**EXPERIMENT 4**
Design of Raft foundations

**5** **2 Hours**

**EXPERIMENT 5**
Computer aided analysis and Design of a 2D steel truss

**6** **2 Hours**

**EXPERIMENT 6**
Computer aided analysis and Design of a 3D steel truss

**7** **2 Hours**

**EXPERIMENT 7**
Computer aided analysis and Design of a Single-storey building frame

**8** **2 Hours**

**EXPERIMENT 8**
Computer aided analysis and Design of a 3D Multi-storey building frame

**9** **2 Hours**

**EXPERIMENT 9**
T-beam Bridge subjected to moving load.

**10** **2 Hours**

**EXPERIMENT 10**
Multi-storey building frame subjected to wind forces

**11** **2 Hours**

**EXPERIMENT 11**
Multi-storey building frame subjected to seismic forces

**12** **2 Hours**

**EXPERIMENT 12**
Finite Element Analysis of deep beams

**13** **3 Hours**

**EXPERIMENT 13**
Finite Element Analysis of trusses

**14** **3 Hours**

**EXPERIMENT 14**

Finite Element Analysis of frames subjected to earthquake loading

**Total: 30 Hours**

## 18ST31 DESIGN OF INDUSTRIAL STRUCTURES 3 0 0 3

**Course Objectives**

- To enable the students to plan engineering, chemical and textile industries
- To familiarize them the design of folded plate and shell structures and other industrial structures

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.

**Course Outcomes (COs)**

1. Design of RCC beam and slender column; determine the deflection, mode of failures and crack width under limit state method as per specified in IS 456.
2. Compute the Reinforcement detailing of continuous frame and substitute frame under the different loading condition.
3. Analyze the braced and unbraced wall and design the deep beam and Corbels.
4. Use yield line theory, hillerberg, virtual and equilibrium method in slab and design the flat slab.
5. Evaluate the R.C section with moment rotation, moment redistribution and ultimate load analysis by mechanism method.

**UNIT I** **9 Hours**

**GENERAL**

Classification of Industries and Industrial Structures - Specific requirements for Industries like Engineering, Textiles, Chemicals, etc. - Site layout and external facilities required.

**UNIT II** **9 Hours**

**FUNCTIONAL REQUIREMENTS**

Nature and artificial lighting protection from the sun light - Services Electrical wiring fixtures - cable and pipe bridge - Electrical installation -substations - Effluent disposal - Heating and Ventilation - Air conditioning - Fire expanse and chutes - fire alarm, extinguishers and hydrants - Guidelines from factories act.

**UNIT III** **9 Hours**

**INDUSTRIAL STRUCTURES**

Design and detailing of R.C. gable frames, corbels and nibs, bunkers, silos and Gantry girders - North light shell roofs and folded plates - Application of prefabrication techniques.

**UNIT IV** **9 Hours**

**POWER TRANSMISSION STRUCTURES**

Cables -Transmission line towers - Substation Structures - Tower Foundation - Testing of tower.

**UNIT V** **9 Hours**

**POWER PLANT STRUCTURES**

Types of power plants - Design of Turbo generator foundation - containment structures - Machine foundations - R.C.C chimney.

**FOR FURTHER READING**

Application of software packages for design of Industrial Structures.

**Total: 45 Hours**

**Reference(s)**

1. P. Dayaratnam, Design of Steel Structures, A.H. Wheeler &Co., Ltd., Allahabad, 2008 S.N. Manokar, Tall Chimneys -Design and Construction, Tata McGraw Hill,1986
2. A.R. Santhakumar and S.S. Murthy, Transmission Line Structures, Tata McGraw Hill, 1992.
3. IS: 9178 Criteria for design of Steel bins for Storage of Bulk materials Part I - General Requirements and Assessment of Loads and Part II - Design Criteria. IS: 3483 Code of Practice for Noise Reduction in Industrial Buildings.
4. IS: 6060 Code of Practice for Day lighting of Factory buildings.

## 18ST51 RESEARCH METHODOLOGY 3 0 0 3

**Course Objectives**

- Understand the basic concepts of engineering research and its methodologies
- Identify various sources of information for literature review and data collection
- Implement various procedures to formulate research problem and design of experiments

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.
f. Carry out independent and multidisciplinary scientific research in the area of design and construction of structures and demonstrate the capability for self-management and teamwork.
h. Comprehend the practical applications of structural engineering and communicate to the society through effective reports and presentations particularly in the area of transfer of technology.

**Course Outcomes (COs)**

1. Infer the significance of scientific methodology for doing research
2. Formulate experimental design and planning for experiments
3. Select appropriate sampling methodology and sample size for a required level of precision
4. Implement statistical data analysis and modeling techniques for classified datasets
5. Summarize the techniques of scientific writing and publishing of research documents

**UNIT I** **9 Hours**

**OVERVIEW OF RESEARCH**

Purpose of scientific research - Types of research- exploratory, descriptive, conclusive, modelling, algorithmic - Concept of applied and basic research - Quantitative research techniques - Research process- steps - Identification of gaps in knowledge - Novel interpretation of existing knowledge - Literature survey and patent search - Experimental skills - Modelling skills - Creativity in research - Concept of research design.

**UNIT II** **9 Hours**

**EXPERIMENTAL DESIGN**

Introduction to experimental design principles - Concepts of precision, reproducibility, reliability and accuracy - Planning experiments - Simple comparative experiments - Laboratory and field experiments - Internal and external validity - Scales and measurements of variables - Types of scales - Validity testing of scales

**UNIT III** **9 Hours**

**SAMPLING METHODS**

Types of data- primary and secondary - Sources of data - Guidelines for questionnaire design - Probabilistic sampling methods - simple random sampling, stratified sampling, cluster sampling - Non-probabilistic sampling - convenience sampling, judgment sampling, quota sampling - Precision and confidence in determining sample size - Determination of optimal sample size.

**UNIT IV** **9 Hours**

**DATA ANALYSIS AND MODELLING TECHNIQUES**

Principle of least squares - Fitting of linear equations - Analysis of classified data - Statistical analysis using R -Estimation of parameters - Hypotheses test procedures for Chi square, t- and F tests - Correlation and regression analysis - Covariance analysis - Modeling techniques for sequential processes- Markov model and basic queuing model.

**UNIT V** **9 Hours**

**SCIENTIFIC WRITING AND PUBLISHING**

Types of reports- technical reports and thesis -Layout, structure and components of scientific reports - Steps in the preparation - Illustrations and tables - Bibliography, referencing and footnotes - Technical Presentations - Use of ICT - Importance of effective communication - Planning, preparation and practice -Collaborative authoring - Ethics in reporting and publishing.

**Total: 45 Hours**

**Reference(s)**

1. C.R. Kothari and Gaurav Garg. Research Methodology, Fourth edition, New Age International Publishers, New Delhi, 2018
2. Donald H. McBurney and Theresa L. White. Research Methods, Seventh edition, Wadsworth Publishing, USA, 2006
3. R. Panneerselvam. Research Methodology, First edition, PHI Learning, New Delhi, 2009.
4. C.F.J. Wu and M. Hamada, Experiments: Planning, Analysis and Parameter Design Optimization, second Edition, John Wiley publications, 2009
5. S.C. Gupta and V.K. Kapoor. Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi, 2014

## 18ST52 DESIGN OF STRUCTURAL FOUNDATION 3 0 0 3

**Course Objectives**

- To impart knowledge on the selection of best foundation solutions for different types of soils and structures
- To equip the students to evaluate the load carrying capacity of piles and well foundation
- To impart the knowledge on stability analysis and design of retaining structures

**Programme Outcomes (POs)**

b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
i. Engage in independent life-long learning, to improve knowledge and competence in the area of structural engineering.

**Course Outcomes (COs)**

1. Select and design a particular type of shallow foundation using and theoretical methods and penetration tests conducted in the field.
2. Select and design the suitable pile foundation based on the load carrying capacity
3. Use the earth retaining structures in underground construction & critical earth excavations
4. Select and design a special type of foundation for poor soil characteristics
5. Analyze the machine vibrations and design the machine foundation

**UNIT I** **9 Hours**

**INTRODUCTION**

Soil investigation report for foundation structure - Types and selection of suitable foundation -Basic requirement of foundation-Bearing Capacity-Theoretical methods (Terzaghi's, Meyorhof's,Vesic's) - IS method-Penetration tests-SPT,SCPT& DCPT-Plate load test-Types of shallow foundations - General principle of design of raft foundation - Introduction to Floating foundation. Demonstration of SPT and Cone penetration test.

**UNIT II** **9 Hours**

**DEEP FOUNDATIONS**

Introduction - Load carrying capacity of different types of piles and pile groups according to IS:2911-2010 - Pile load test -Settlement of piles- Negative skin friction-Lateral load resistance of piles - Design of Piles and Pile cap and detailing of reinforcements-Design of well foundation (IRC approach). Case studies on deep foundations

**UNIT III** **9 Hours**

**EARTH RETAINING STRUCTURES**

Sheet pile structures-Cantilever sheet pile walls in granular soils and cohesive soils-Anchored Bulk head- Free earth support method- Fixed earth support method -Construction of diaphragm walls.

**UNIT IV** **9 Hours**

**SPECIAL FOUNDATIONS**

Expansive Soils-Introduction-Identification of expansive soils-Swell potential and swelling pressure-Foundations on expansive soils - Under reamed pile foundation -Reinforced Earth - Introduction-Basic Mechanism of reinforced earth-Choice of soil and reinforcement-Reinforced earth retaining walls - Design and check for stability-Case studies on reinforced soil.

**UNIT V** **9 Hours**

**MACHINE FOUNDATIONS**

Introduction-Fundamentals of soil dynamics-Types of machine foundations-General criteria for design of machine foundation-Design of foundation for Reciprocating Machines and Impact machines-Vibration isolation-Construction aspects of machine foundations. Study experiment - Block vibration test.

**Total: 45 Hours**

**Reference(s)**

1. V.N.S. Murthy, Advanced Foundation Engineering, CBS Publisher, 2007
2. Das, B.M. Principles of Foundation Engineering, 8th Edition, Cengage Learning, 2015
3. P.C.Varghese, Foundation Engineering, Prentice-Hall of India Private Ltd, New Delhi,2006
4. Swami Saran, Soil Dynamics and Machine Foundations, Galgotia Publications Private Ltd, 1999.
5. Poulos, H. G. and Davis, E. H. (1980). Pile Foundation analysis and design, John Willey and Sons, Inc., New York.
6. Robert M. Koerner, Designing with Geo synthetics, 6th Edition, Vol. 1, Xlibris Corporation, USA, 2012.

## 18ST53 CONSTRUCTION ENGINEERING AND MANAGEMENT

**3 0 0 3**

**Course Objectives**

- To enhance the knowledge on construction planning management and execution
- To introduce the concepts of resource planning and allocation and control To introduce the concepts of resource planning and allocation and control

**Programme Outcomes (POs)**

h. Comprehend the practical applications of structural engineering and communicate to the society through effective reports and presentations particularly in the area of transfer of technology.
j. Acquire ethics of learning and research, to contribute to the community for sustainable development of society by introducing innovations in the planning and design of various types of structures.

**Course Outcomes (COs)**

1. Identify the characteristics of Project Life Cycle the owner's perspective
2. Apply value engineering practices and measures to improve job site productivity
3. Construct scheduling of activity in a construction project
4. Identify the resources allocation available for a project
5. Compute the cash flow and monitor the profit and loss account of an organization

**UNIT I** **9 Hours**

**THE OWNERS PERSPECTIVE**

Introduction-Project Life Cycle-Types of Construction-Selection of Professional Services-Construction Contractors-Financing of Constructed Facilities-Legal and Regulatory Requirements-Changing Environment of the Construction Industry-Role of Project Managers

**UNIT II** **9 Hours**

**ORGANIZING 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.

**UNIT III** **9 Hours**

**CONSTRUCTION PLANNING AND SCHEDULING BILLING**

Development of construction plans - Defining work tasks and their relationship - Estimating activity duration and resource requirements - Work Breakdown Structure - coding systems. Relevance of Construction schedules - Bar charts - The Critical Path Method - float calculations - PERT - Scheduling with uncertain duration - Precedence Network Analysis - Crashing and Time/cost trade-offs

**UNIT IV** **9 Hours**

**MATERIALS AND EQUIPMENT MANAGEMENT**

Planning - Identification, Procurement and Inventory Control - Resource Allocation, Resource Leveling - Linear Programming - Transportation Problem - System approach in resource management - ABC analysis, VED analysis.

**UNIT V** **9 Hours**

**COST CONTROL AND SOFTWARE APPLICATIONS**

The cost control problem - The Project Budget - Forecasting for Activity cost Control - Financial accounting systems and cost accounts - Control of project cash flows - Schedule control - Schedule and Budget updates - Relating cost and schedule information - Software applications - Project Management Software - Planning, Scheduling and Resource analysis - Recording and operations - Project accounting, costing and finance

**Total: 45 Hours**

**Reference(s)**

1. Punmia.B.C and Khandelwel.K.K,"Project planning and control with PERT/CPM",Laxmi publications ,New Delhi,1987
2. Seetharaman .S ,"Construction Engineering Management", Dhanpat Rai Publications, Pune, 2005
3. Vazrani . V.N. and Chandola.S.P, "Construction Management and counts",Khanna Publishers,Delhi,1986
4. Sangareddi.S. and Meiyappan.P.L,-Construction Management Kumaran Publications, Coimbatore, 2000
5. Sharma J.L,"Construction Managment and Accounts",Sathyaprakasam, New Delhi, 2006
6. Chitkara, K.K,"Construction Project Management: Planning, Scheduling and Control", Tata McGraw-Hill Publishing Company, New Delhi, 1998

## 18ST54 DESIGN OF STEEL-CONCRETE COMPOSITE STRUCTURES

**3 0 0 3**

**Course Objectives**

- To develop an understanding of the behaviour and design procedure of steel - concrete composite elements and structures.
- To give an exposure on case studies related to steel-concrete composite construction.

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.

**Course Outcomes (COs)**

1. Identify the different types of steel-concrete composite structures.
2. Design the composite beam and column.
3. Apply the studs in Roofs and Slabs and predict the cracking pattern.
4. Analyze the various bridges and design the economical one.
5. Discuss about historical Steel concrete composite construction and seismic behavior of the structures.

**UNIT I** **9 Hours**

**INTRODUCTION**

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

**UNIT II** **9 Hours**

**DESIGN OF COMPOSITE BEAMS AND SLABS**

Behaviour of composite beams - Design of composite beams including shear connector - Behaviour and design of composite columns and composite slab

**UNIT III** **9 Hours**

**COMPOSITE TRUSSES**

Introduction - Stud shear connectors - Effective Concrete Slab - Design consideration: Preliminary design, detailed analysis and design - Design of studs - Partial shear - Concrete cracking - Practical considerations - Cost implications - Design problems.

**UNIT IV** **9 Hours**

**COMPOSITE BRIDGES**

Introduction - design of composite bridge deck - Composite box girder bridges - Behaviour of composite box girder bridges - Design concepts

**UNIT V** **9 Hours**

**GENERAL**

Case studies on steel - Concrete composite construction -Seismic behavior of composite structures.

Total: 45 Hours

**Reference(s)**

1. N. Krishna Raju, "Design of Bridges", Oxford & IBH Publishing Company Pvt. Ltd, New Delhi. Fourth edition 2015.
2. R. P. Johnson, Composite Structures of Steel and Concrete, Blackwell Scientific Publications, UK, 1994.
3. D.J. Oehlers and M.A. Bradford, "Composite Steel and Concrete Structural Members", Fundamental behaviour, pergamon press, Oxford,1995.
4. G. W. Owens and P. Knowels, Steel Designers Manual, Steel Concrete Institute (UK), Oxford Blackwell Scientific Publications, 1992.
5. INSDAG Hand book on Composite Construction - Institute for Steel Development and Growth Publishers, Calcutta

## 18ST55 REPAIR AND REHABILITATION OF STRUCTURES

**3 0 0 3**

**Course Objectives**

- To emphasize the importance of maintenance and inspection of structures
- To impart fundamental knowledge on various repairing strategies

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.
e. Use modern software packages for analysis and design of structures and use of modern instrumentations for experimental investigations.

**Course Outcomes (COs)**

1. Demonstrate the various types of distress in concrete structures.
2. Identify the effects due to climate, temperature, chemicals, wear and erosion on structures.
3. Analyze the failures in structures due to design and construction errors
4. Identify and suggest the techniques for repairing of concrete structures
5. Analyze and suggest the suitable repair techniques

**UNIT I** **8 Hours**

**INTRODUCTION**

General Consideration - Distresses monitoring- Causes of distresses - Assessment procedure for evaluating a damaged structure - Quality assurance - Defects due to climate, chemicals, wear and erosion - Inspection - Structural appraisal - Economical appraisal.

**UNIT II** **9 Hours**

**BUILDING CRACKS**

Causes - diagnosis - remedial measures - Thermal and Shrinkage cracks - unequal loading - Vegetation and trees - Chemical action - Foundation movements - Techniques for repair - Epoxy injection.

**UNIT III** **9 Hours**

**MOISTURE PENETRATION**

Sources of dampness - Moisture movement from ground - Reasons for ineffective DPC - Roof leakage - Pitched roofs - Madras Terrace roofs - Leakage of Concrete slabs -Dampness in solid walls - condensation - hygroscopic salts- remedial treatments - Ferro-cement overlay - Chemical coatings - Flexible and rigid coatings

**UNIT IV** **10 Hours**

**REPAIRS TO MATERIAL (POLYMERS) AND STRUCTURES**

Methods of repair - repairing, spalling and disintegration - Repairing of concrete floors and pavements. Steel Structures: Types and causes for deterioration - preventive measures - Repair procedure- Brittle fracture - Lamellar tearing - Defects in welded joints - Mechanism of corrosion - Design to protect against corrosion - Design and fabrication errors - Distress during erection. Masonry Structures: Discoloration and weakening of stones - Biocidal treatments - Preservation -Chemical preservatives - Brick masonry structures - Distresses and remedial measures - Definition of Structural Health Monitoring - Motivation for Structural health monitoring

**UNIT V** **9 Hours**

**STRENGTHENING OF STRUCTURES FRP WRAPING**

General principle - relieving loads - Strengthening super structures - plating-Conversion to composite construction - post stressing - Jacketing - bonded overlays- Reinforcement addition - strengthening the substructures - under pinning-Increasing the load capacity of footing- Repair of structures distressed due to earthquake- Design for rehabilitation.

**Total: 45 Hours**

**Reference(s)**

1. Dension, C. Alien and H. Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical, UK, 1991.
2. B. A. Richardson, Remedial Treatment of Buildings, Construction Press, London, 1995.
3. R. T. Alien and S. C. Edwards, Repair of Concrete Structures, Blakie and Sons, UK, 1994.
4. S. M. Johnson, Deterioration, Maintenance and Repair of Structures, McGraw-Hill Book Company, Newyork, 1965.
5. P. K. Guha, Maintenance and Repairs of Buildings, New Central Book Agency (P) Ltd, Calcutta, 2011.
6. SP25-84 Hand Book on Causes and Prevention of Cracks on Buildings, Indian Standards Institution, New Delhi, 1984

## 18ST56 DESIGN OF BRIDGES 3 0 0 3

**Course Objectives**

- To emphasize the importance of maintenance and inspection of structures
- To impart fundamental knowledge on various repairing strategies

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.

**Course Outcomes (COs)**

1. Classify and design different types short span RC bridges
2. Design long span RC bridges
3. Analyze and design steel girders, suspension bridge and cable stayed bridges
4. Design a pre-stressed concrete bridge structures
5. Identify and design suitable support structures for bridges

**UNIT I** **9 Hours**

**GENERAL INTRODUCTION AND SHORT SPAN RC BRIDGES**

Types of bridges and loading standards-Choice of type-I.R.C. specifications for road bridges-Design of RCC solid slab bridges-analysis and design of slab culverts , Tee beam and slab bridges

**UNIT II** **9 Hours**

**LONG SPAN R.C BRIDGES**

Design principles of continuous girder bridges, box girder bridges, balanced cantilever bridges-Arch bridges-Box culverts-Segmental bridges

**UNIT III** **9 Hours**

**STEEL BRIDGES**

General- Railway loadings- Dynamic effect-Railway culvert with steel beams-Design of Plate Girder Bridges and Steel Trussed bridges - Design principles of cable stayed and suspension bridges

**UNIT IV** **9 Hours**

**PRESTRESSED CONCRETE BRIDGES**

Introduction - Design of Post - tensioned prestressed Concrete Slab Bridge deck - Design of Post - tensioned prestressed Concrete Tee beam and Slab Bridge deck

**UNIT V** **9 Hours**

**BEARINGS AND SUBSTRUCTURES**

Bearings - Types of bearings - Design of bearings - Design of Piers and abutments - Foundations: Types of bridge foundations - Design of Pile Foundation and Well foundation - Caisson Foundation

**Total: 45 Hours**

**Reference(s)**

1. N. Krishna Raju, Design of Bridges, Oxford & IBH Publishing Company Pvt. Ltd, New Delhi. Fourth edition 2015.
2. T.R. Jagadeesh and M.A. Jayaram., "Design of Bridge Structures", Prentice Hall of India Pvt.Ltd. Second edition 2014
3. S.Ponnuswamy, Bridge Engineering, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second edition 2008
4. D. Johnson Victor, Essentials of Bridge Engineering, Oxford and IBH Publishing Co., New Delhi, Sixth Edition, 2014
5. Raina V.K. "Concrete Bridge Practice", Tata McGraw Hill Publishing Company, New Delhi, 2007.
6. IRC: 6, 18, 21, 22, 24, 78 & 83.

## 18ST57 RISK AND RELIABILITY OF STRUCTURES 3 0 0 3

**Course Objectives**

- To introduce the basics of structural reliability and analysis procedures
- To impart knowledge on reliability based design and principles underlying code calibration
- To understand the importance of safety and reliability issues of offshore facilities during analysis,design,inspection and planning

**Programme Outcomes (POs)**

c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.
i. Engage in independent life-long learning, to improve knowledge and competence in the area of structural engineering.

**Course Outcomes (COs)**

1. Relate the different approaches to quantify uncertainties and plausible reasoning
2. Analyse the structural reliability and environmental loads acting on structure by sampling estimates
3. Analyse the reliability by error estimation and examine the failure patterns
4. Propose a mechanical model for reliability analysis and studies on behaviour of tubular joints
5. Analyse and manage risk by Fault Tree Analysis Event Tree Analysis

**UNIT I** **9 Hours**

**PROBABILITY AND PLAUSIBILITY**

Introduction - Types of uncertainties- Probability - Probabilistic and non-probabilistic methods - Modular Bayesian Approach - Frequensitic Approach - Rules of probability - Plausible reasoning - Quantitative rules

**UNIT II** **9 Hours**

**MODELLING RANDOM VARIABLES AND SAMPLING ESTIMATES**

Probability distribution - Random variables - Sampling estimates - Modelling of environmental loads - Structural reliability - variables in reliability analysis

**UNIT III** **9 Hours**

**RELIABILITY ANALYSIS**

Components of reliability analysis-Levels of Reliability-Error estimation-Reliability methods-System Reliability-Failure domains - Application problems

**UNIT IV** **9 Hours**

**MECHANICAL MODELS AND FATIGUE RELIABILITY**

Codes on structural reliability - Mechanical models in Reliability analysis-Stochastic process-Fatigue reliability-Design SN curve-Simplified Fatigue Assessment-Short term fatigue damage-Behaviour of tubular joints-Experimental studies on Tubular joints

**UNIT V** **9 Hours**

**RISK AND RELIABILITY**

Risk Assessment-Logical Risk Analysis-Risk Analysis of Mechanical Systems-FMEA-Fault Tree Analysis-Event Tree Analysis-Consequence Analysis-Risk Acceptability-Risk and Hazard Assessment-Risk Management

**Total: 45 Hours**

**Reference(s)**

1. Chakrabarti, S.K. 1990. Non-linear Method in Offshore Engineering, Elsevier Science Publisher, The Netherlands
2. Chandrasekaran, S. and Bhattacharyya, S.K. 2011. Analysis and Design of Offshore Structures. HRD Center for offshore and Plant Engineering (HOPE), Changwon National University, Republic of Korea, pp. 285.
3. Cowell RG, Dawid AP, Lauritzen SL, Spiegelhalter DJ. Probabilistic networks and expert systems. New York: Springer; 1999.
4. Gelman A, Carlin JB, Stern HS, Rubin DB. Bayesian data analysis. London: Chapman & Hall; 1995. pp 1-526.
5. Halder, A. and Mahaderan, S., "First order and Second order Reliability Method" Probabilistic Structural Mechanics Hand Book, Edited by C. (Raj) Sundararajan, Chapman and Hall, PP. 27-52, 1995.
6. Srinivasan Chandrasekaran. 2016a. Offshore structural engineering: Reliability and Risk Assessment.CRC Press, Florida, ISBN:978-14-987-6519-0

## 18ST58 PREFABRICATED STRUCTURES 3 0 0 3

**Course Objectives**

- To impart Knowledge on pre fabricated elements and the technologies used in fabrication and erection
- To give an exposure on the applications of Pre - Engineered Buildings in construction.

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
e. Use modern software packages for analysis and design of structures and use of modern instrumentations for experimental investigations.

**Course Outcomes (COs)**

1. Apply the basic principles to compare monolithic construction and prefabrication
2. Classify the types of prefabricated elements.
3. Identify the production and hoisting technology for prefabricated structures.
4. Design the prefabricated elements
5. Identify the advantages of - Pre Engineered Buildings

**UNIT I** **10 Hours**

**GENERAL PRINCIPLES OF FABRICATION**

Comparison with monolithic construction - Types of prefabrication - site and plant fabrication - Economy of prefabrication - Modular coordination - Standardization - Planning for Components of prefabricated structures - Disuniting of structures - Handling and erection stresses - Elimination of erection stresses- Beams,columns-Symmetrical frames.

**UNIT II** **10 Hours**

**PREFABRICATED ELEMENTS**

Roof and floor panels, ribbed floor panels - wall panels - footings - Joints for different structural Connections - Effective sealing of joints for water proofing - Provisions for non - structural fastenings - Expansion joints in pre-cast construction.

**UNIT III** **9 Hours**

**PRODUCTION AND HOISTING TECHNOLOGY**

Choice of production setup - Manufacturing methods - Stationary and mobile production - Planning of production setup - Storage of precast elements - Dimensional tolerances - Acceleration of concrete hardening. Equipment for hoisting and erection - Techniques for erection of different type of members like Beams, Slabs, Wall panels and Columns - Vacuum lifting.

**UNIT IV** **9 Hours**

**APPLICATIONS**

Designing and detailing of precast unit for factory structures - Purlins, Principal rafters, roof trusses, lattice girders, gable frames - Single span single storeyed frames - Single storeyed buildings: slabs, beams and columns, Application of prestressed concrete in prefabrication.

**UNIT V** **7 Hours**

**PRE - ENGINEERED BUILDINGS**

Introduction - Advantages - Pre Engineered Buildings Vs Conventional Steel Buildings-Design procedure of Pre Engineered Buildings (PEB) Applications

**Total: 45 Hours**

**Reference(s)**

1. L. Mokk, Prefabricated Concrete for Industrial and Public Structures, Publishing House of the Hungarian Academy of Sciences, Budapest, 2007.
2. T. Koncz, Manual of Precast Concrete Construction, Vol.I, II, III & IV, Berlin, 1971
3. B. Lewicki, Building with Large Prefabricates, Elsevier Publishing Company, Amsterdam, London, New York, 1998.
4. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the use of Precast Concrete, Netherland Betor Verlag, 2009.
5. Hass, A.M. Precast concrete design and Applications, Applied Science Publishers, 1983.

## 18ST59 ADVANCED CONCRETE TECHNOLOGY 3 0 0 3

**Course Objectives**

- To provide a good understanding of a range of topics within the field of concrete technology including constituent materials and mixture proportioning, properties of concrete in the fresh and hardened state, microstructure, volume changes and durability.
- The emphasis throughout the course is on understanding the key physical and chemical processes influencing the behavior and performance of concrete in service.

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.
g. Demonstrate knowledge and understanding of engineering and management principles and manage projects related to the field of Structural Engineering efficiently.
h. Comprehend the practical applications of structural engineering and communicate to the society through effective reports and presentations particularly in the area of transfer of technology.
i. Engage in independent life-long learning, to improve knowledge and competence in the area of structural engineering.

**Course Outcomes (COs)**

1. List various materials for making the concrete
2. Explain different tests for identifying the properties of fresh concrete
3. List different factors affecting the durability of concrete
4. Design the concrete mix by using IS, ACI and Euro codes
5. Apply the usage of special concretes

**UNIT I** **9 Hours**

**CEMENT, AGGREGATES**

Cement-Composition and properties of Portland cement-tests on cement -hydration of cement-consistency-setting time-soundness-strength-cements of different types-composition -IS code Specifications for cement-Aggregates-classification- Tests on aggregates- Different types of fine aggregates (River sand, Manufactured sand, Eco sand, Artificial Sand) - properties - tests-IS code specifications. Admixtures-Accelerators-Retarders-Water reducing agents-Plasticizers-Air entraining Agents - water proofing agents.

**UNIT II** **9 Hours**

**FRESH CONCRETE**

Rheology of mortar and concrete - workability-Factors affecting workability-Tests for workability-segregation-Bleeding-Mixing of concrete-Compaction of concrete-Methods of compaction-Hardening of concrete-Factors affecting strength of concrete-Types of curing-Maturity of concrete-Shrinkage-creep of concrete- Factors affecting creep and shrinkage of concrete-Micro structure of concrete-micro cracking.

**UNIT III** **9 Hours**

**DURABILITY OF CONCRETE**

Permeability-chemical attack-sulphate attack-Quality of water-marine atmosphere-Methods to improve durability-Thermal properties of concrete-Fire resistance-Reinforcement corrosion-Testing of hardened concrete-Compression test- Split tensile test-Flexural test-Test for bond strength-Is code provisions-Factors affecting strength-Accelerated strength tests-Stress strain characteristics-Determination of modulus of elasticity-Electro dynamic method, Pulse Velocity method -In situ strength determination.

**UNIT IV** **9 Hours**

**CONCRETE MIX DESIGN**

Basic consideration - Factors in the choice of mix proportions-Mix design methods-A.C.I method-I.S method- British method -Correction for moisture content- Bulk- Yield of concrete-Mix Design for nominal concrete- Design of High strength concrete -Design of Self Compacting Concrete by using EFNARC Specifications - Design of concrete mix using mineral admixtures- Design mix for pump ability and effect of super plasticizers in water reduction.

**UNIT V** **9 Hours**

**SPECIAL CONCRETES**

Method of Manufacture, properties and applications - Lightweight concrete-Aerated concrete- No fines concrete -Heavy weight concrete- Fibre reinforced concrete -Polymer concrete -High volume fly ash concrete-High performance concrete- Self compacting concrete- Concrete using waste material - Roller compacted concrete- Ready mixed concrete - Pumping of concrete.

**Total: 45 Hours**

**Reference(s)**

1. M.S. Shetty, Concrete Technology, S. Chand & Co., 2005
2. Raft Siddique, Spacial Structural Concrete, Galgotia Publication, 2000
3. A.R. Shantha Kumar, Concrete Technology, Oxford University Press, 2007
4. A.M Neville, J.J.Brooks, Concrete Technology, Pearson Education, 2010
5. P. Kumar Mehta, Paulo J.M. Monteiro Concrete: Microstructure, Properties and Materials, 3rd edition, MC Graw Hill -2006
6. M.L. Gambhir, concrete Technology, Dhanpatrai& Sons, 1992

## 18ST60 FIRE-RESISTANT DESIGN OF STRUCTURES

**3 0 0 3**

**Course Objectives**

- To impart knowledge on the response behavior of offshore structures under special loads such as ice, wind, shock and impact waves
- To familiarize with the advanced structural analysis methods
- To expose the students to fundamentals of fire resistant design concepts

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
j. Acquire ethics of learning and research, to contribute to the community for sustainable development of society by introducing innovations in the planning and design of various types of structures.

**Course Outcomes (COs)**

1. Classify the offshore platforms and explain the characteristics, merits and demerits of offshore platforms.
2. Explain the method of analysis and design requirements for special loads acting on a structure.
3. Enumerate the applications of curved beams, Marine risers and other special structures
4. Outline the Fire damage and its control by identifying the suitable fire protection systems.
5. Explain the design approach for the behaviour of structural members and offshore platforms under fire.

**UNIT I** **9 Hours**

**OFFSHORE STRUCTURES AND ENVIRONMENTAL LOADS**

Introduction - Types of offshore platforms - Fixed, Compliant and Floating structures - Novelty of offshore structures - New generation offshore platforms - Response Characteristics - Merits and demerits

**UNIT II** **9 Hours**

**SPECIAL LOADS**

Wave loads - Wind loads - Ice loads - Earthquake loads - Impact and Non-impact wave loads - Estimation of loads and methods of analyses - General Design Requirements - Application to offshore platforms

**UNIT III** **9 Hours**

**ADVANCED STRUCTURAL ANALYSIS**

Unsymmetrical bending - Shear Centre - Curved beams - Rings and Chains - Marine risers - Application problems - Vortex induced vibration - Suppression systems for VIV

**UNIT IV** **9 Hours**

**FIRE SAFETY AND BLAST RESISTANCE**

Fire safety overview - Objective of fire resistance - Potential fire risks - Fire ratings - Fire damage and control - Explosion - Fire protection - Fire protection system design - Blast resistance

**UNIT V** **9 Hours**

**FIRE RESISTANCE DESIGN**

Overview - Fire and explosion characteristics of materials - Types of fire - Behaviour of structural members under fire - Design Approach - Complications in the fire resistant design of offshore platforms

**Total: 45 Hours**

**Reference(s)**

1. Eurocode 3. 2005. Design of steel structures, Part 1-2, General rules: Fire resistant design, Document CEN, European Comm. of Standardization, U.K.
2. Malhotra, H.L. 1982. Design of fire-resistant structures, Surrey University Press, Glasgow
3. Malhotra, H.L. 1987. Fire safety in buildings, Garston
4. Srinivasan Chandrasekaran and A.K.Jain. 2016c. Ocean structures: Construction, Materials and Operations, CRC Press, Florida, ISBN: 978-14-987-9742-9.
5. Srinivasan Chandrasekaran. 2015. Advanced Marine structures, CRC Press, Florida (USA), ISBN 9781498739689.
6. Srinivasan Chandrasekaran. 2016a. Offshore structural engineering: Reliability and Risk Assessment.CRC Press, Florida, ISBN:978-14-987-6519-0.

## 18ST61 STRUCTURAL HEALTH MONITORING 3 0 0 3

**Course Objectives**

- To introduce the concepts involved in the assessment, evaluation and technical diagnosis of different structural systems of strategic importance
- To impart knowledge on both elementary and advanced applications of SHM with case studies

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.

**Course Outcomes (COs)**

1. Understand the structural health monitoring process
2. Identify Structural Health Monitoring Methods.
3. Analyze the damage identification methods
4. Identify the sensor networking in structures based on damage level
5. Apply the structural health monitoring strategy to various structures

**UNIT I** **9 Hours**

**INTRODUCTION TO STRUCTURAL HEALTH MONITORING**

Introduction - Necessity - Components - Challenges - Advantages - Components of SHM process - SHM issues applied to concrete structures - Level of uncertainties in SHM process

**UNIT II** **9 Hours**

**STRUCTURAL HEALTH MONITORING METHODS**

Short term and Long term Monitoring - Local and Global Monitoring - Static and Vibration based SHM - SHM planning and Management - SHM Methods

**UNIT III** **9 Hours**

**DAMAGE IDENTIFICATION METHODS**

Damage Identification - Visual Inspection - Comparison of damage identification methods - Non Destructive testing and Evaluation - Vibration based damage detection

**UNIT IV** **9 Hours**

**SENSOR NETWORKING**

Sensor Technologies - Fibre optic sensors - Smart Sensing for SHM - Sensing requirements in special structures - Sensor requirements and Data Acquisition - Acquisition system and Networking for SHM - Wireless Sensor Networking - MEMS - Artificial Intelligence in SHM

**UNIT V** **9 Hours**

**APPLICATIONS OF SHM**

SHM layout design of offshore structures -SHM Design - Application of SHM in bridges, buildings and offshore structures - Application in structural control strategies - Future of SHM

**Total: 45 Hours**

**Reference(s)**

1. Balageas, D., Fritzen, C.P. and Guemes, A. eds., 2010. Structural health monitoring (Vol. 90). John Wiley & Sons.
2. Chandrasekaran, S. 2016. Offshore structural engineering: Reliability and Risk Assessment, CRC Press, Florida, ISBN:978-14-987-6519-0.
3. Chandrasekaran, S. 2017. Dynamic analysis and design of ocean structures, Springer, 2nd Ed., Singapore.Do, R., 2014
4. Passive and active sensing technologies for structural health monitoring. University of California, SanDiego.
5. Glisic, B. and Inaudi, D., 2008. Fibre optic methods for structural health monitoring. John Wiley & Sons
6. Nagayama, T. and Spencer Jr, B.F., 2007. Structural health monitoring using smart sensors. Newmark Structural Engineering Laboratory. University of Illinois at Urbana-Champaign.

## 18ST62 THEORY OF PLATE AND SHELLS 3 0 0 3

**Course Objectives**

- To impart knowledge about the behavior of plates and shells.
- To analyse the behaviour of plate and shells and to design as per codal recommendations

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.

**Course Outcomes (COs)**

1. Analyze the internal forces of rectangular plates for different support conditions by Naviers and Levys method.
2. Evaluate the symmetrical bending of simply supported circular plates for different loads acting on it.
3. Identify the behavior of folded plates and design them as per ACI and ASCE codes
4. Analyze the internal forces for various shaped shell members by idealizing the structure
5. Design the cylindrical shell and Reinforced hypar shell roof by ASCE and detailing the reinforcement

**UNIT I** **9 Hours**

**ANALYSIS OF RECTANGULAR PLATES**

Introduction- General Behavior of plates- Assumptions Small deflection theory of thin plates Governing differential equation for deflection of plate Boundary conditions. Bending of Isotropic Rectangular Plates: Navier solution for an all round simply supported rectangular plate subjected to uniformly distributed load sinusoidal load and point load Levys solution for a rectangular plate with different boundary conditions and subjected to uniformly distributed load.

**UNIT II** **9 Hours**

**ANALYSIS OF CIRCULAR PLATES**

Symmetrical bending of circular Plates Simply supported solid circular plate subjected to a uniformly distributed load, an end moment and partially distributed load.

**UNIT III** **9 Hours**

**ANALYSIS AND DESIGN OF FOLDED PLATES**

Structural behavior of folded plates Assumptions Analysis of folded plates Design of prismatic folded plate roofs as per ACI- ASCE task committee recommendations Reinforcements details.

**UNIT IV** **9 Hours**

**ANALYSIS OF SHELL STRUCTURES**

Structural behavior of thin Shells Classification of shells methods of generating the surface of different shells like conoid, hyperbolic and elliptic paraboloid Membrane Theory of shells Edge disturbances Geometry of hypar Shell Analysis of membrane forces forces in the edge members.

**UNIT V** **9 Hours**

**DESIGN OF SHELL STRUCTURES**

Design of cylindrical shells with edge beams using theory for long shells Design of cylindrical shell with ASCE manual No.31 coefficients Detailing of reinforcement in shells and edge beams Design of R.C. hypar shell roof of the inverted and tilted inverted umbrella type Design and detailing of RC spherical shell and conical shells Design examples.

**Total: 45 Hours**

**Reference(s)**

1. G.S.Ramaswamy, (1996), Design and construction of concrete shell roofs, CBS Publishers and distributors.
2. Timoshenko and Krieger, (2002), Theory of Plates and Shells, McGraw Hill Inc, New Delhi.
3. Chatterjee, (1996), Theory and Design of Concrete Shells, Oxford and IBH, New Delhi.
4. K.Chandrasekara, (1998), Analysis of Thin concrete Shells, Tata McGraw Hill Book Company

## 18ST63 STRUCTURAL OPTIMIZATION TECHNIQUES

**3 0 0 3**

**Course Objectives**

- To impart knowledge on conventional and non-conventional optimization techniques for engineering applications
- To impart knowledge on the solution of various using graphical and analytical method of optimization techniques

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
g. Demonstrate knowledge and understanding of engineering and management principles and manage projects related to the field of Structural Engineering efficiently.

**Course Outcomes (COs)**

1. Classify the optimization techniques.
2. Identify the suitable method for solving linear structural problem
3. Identify the suitable method for solving non-linear structural problem
4. Apply non-traditional optimization techniques to solve engineering problems
5. Design of structural elements using non-traditional optimization techniques

**UNIT I** **9 Hours**

**BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES**

Definition - Objective Function; Constraints - Equality and inequality - Linear and non-linear, Side, Non-negativity, Behaviour and other constraints - Design space - Feasible and infeasible - Convex and Concave - Active constraint - Local and global optima. Differential calculus - Optimality criteria - Single variable optimization - Multivariable optimization with no constraints - (Lagrange Multiplier method) - with inequality constraints (Khun - Tucker Criteria).

**UNIT II** **9 Hours**

**LINEAR PROGRAMMING**

Formulation of problems - Graphical solution - Analytical methods - Standard form - Slack, surplus and artificial variables - Canonical form - Basic feasible solution - simplex method - Two phase method -Penalty method - Duality theory -Primal - Dual algorithm

**UNIT III** **9 Hours**

**NON LINEAR PROGRAMMING**

One Dimensional minimization methods: Unidimensional - Unimodal function - Exhaustive and unrestricted search - Dichotomous search - Fibonacci Method - Golden section method - Interpolation methods. Unconstrained optimization Techniques.

**UNIT IV** **9 Hours**

**NON-TRADITIONAL TECHNIQUES**

Genetic Algorithm And Evolution Strategies: Introduction - Representation of design variables, objective function and constraints - Choice of population - Genetic operators - survival of the fittest - generation - generation history
Ant colony optimization: Probability - finding the shortest path - pheromone trail - travelling salesman problem.

**UNIT V** **9 Hours**

**STRUCTURAL APPLICATIONS**

Methods for optimal design of structural elements, continuous beams and single storeyed frames using plastic theory - Minimum weight design for trusses- Fully stressed design - Optimization principles to design of R.C. structures such as multi-storey buildings, water tanks and bridges.

**Total: 45 Hours**

**Reference(s)**

1. Smith,A.A., Hinton,E and Lewis, L.W., "Civil Engineering Systems", John Wiley and sons, 1985.
2. Rao,S.S. " Optimization Theory and Applications",Wiley Eastern, 1995.
3. Spunt,L., Ã¢??Optimum Structural Design Ã¢??, Prentice Hall, New Jersey, 1971.
4. Iyengar.N.G.R and Gupta.S.K, "Structural Design Optimization", Affiliated East West Press Ltd, New Delhi, 1997
5. Goldberg,D.E., "Genetic Algorithms in Search, Optimization and Machine Learning", Addison & Wesley ,1999.
6. Dorigo, M and Stutzle, T., "Ant Colony Optimization", Prentice Hall of India, 2004.

## 18ST64 ANALYSIS AND DESIGN OF TALL BUILDINGS

**3 0 0 3**

**Course Objectives**

- To impart knowledge on behaviour of tall multi-bay and multi storeyed structures.
- To learn to analyse and design such structures taking in to account the effects of creep, shrinkage, and P-delta effect

**Programme Outcomes (POs)**

b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
e. Use modern software packages for analysis and design of structures and use of modern instrumentations for experimental investigations.
i. Engage in independent life-long learning, to improve knowledge and competence in the area of structural engineering.

**Course Outcomes (COs)**

1. Compare the design philosophy of working stress and limit state methods with different combination of loadings.
2. Differentiate the structural behaviour of various systems using growth, height and structural form
3. Design of total structural systems and analyse the forces acting in 2D and 3D structures
4. Illustrate the losses in prestressing structural elements on different structural shapes
5. Evaluate the structural stability and its stiffness using approximate methods.

**UNIT I** **9 Hours**

**LOADING AND DESIGN PROCESS**

Loading- sequential loading, Gravity loading, Wind loading, Earthquake loading, - Equivalent lateral force, modal analysis - combination of loading, - Static and Dynamic approach - Analytical and wind tunnel experimental methods - Design philosophy - working stress method, limit state method and plastic design.

**UNIT II** **9 Hours**

**BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS**

Factors affecting growth, height and structural form. High rise behaviour, Rigid frames, braced frames, In filled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, outrigger - braced and hybrid mega systems.

**UNIT III** **9 Hours**

**ANALYSIS AND DESIGN**

Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of buildings as total structural system considering overall integrity and major subsystem interaction, Analysis for member forces, drift and twist - Computerized three dimensional analysis - Assumptions in 3D analysis - Simplified 2D analysis

**UNIT IV** **9 Hours**

**STRUCTURAL ELEMENTS**

Sectional shapes, properties and resisting capacity, design, deflection, cracking, prestressing, shear flow, Design for differential movement, creep and shrinkage effects, temperature effects and fire resistance.

**UNIT V** **9 Hours**

**STABILITY ISSUES**

Overall buckling analysis of frames, wall-frames, Approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first-order and P-Delta analysis, Translational, Torsional instability, out of plumb effects, stiffness of member in stability, effect of foundation rotation

**Total: 45 Hours**

**Reference(s)**

1. Bryan Stafford Smith and Alexcoull, Tall Building structures, Analysis and Design, John Wiley and Sons, Inc., 2005
2. P. Gupta, Proceedings National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities, New Age International Limited, Publishers, Nov. 1995.
3. S. B. Mehta, High Rise Buildings, M/S Skyline, 1978
4. Lynn S. Beedle, Advances in Tall Buildings, CBS Publishers and Distributors, Delhi, 1986.

## 18ST65 EXPERIMENTAL STRESS ANALYSIS AND TECHNIQUES

**3 0 0 3**

**Course Objectives**

- To familiarize the students about the measurement of strain and effects of vibrations and wind blow
- To make the students analyse the structure by non-destructive testing method and model analysis

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.
e. Use modern software packages for analysis and design of structures and use of modern instrumentations for experimental investigations.
f. Carry out independent and multidisciplinary scientific research in the area of design and construction of structures and demonstrate the capability for self-management and teamwork.
g. Demonstrate knowledge and understanding of engineering and management principles and manage projects related to the field of Structural Engineering efficiently.

**Course Outcomes (COs)**

1. Evaluate the Measurement system of strains in structural elements
2. Evaluate the different measurement method of vibrations
3. Analyse the construction and damage assessment of RC Structures
4. Determination of strength by using NDT testing
5. Apply the influence lines in model studies

**UNIT I** **9 Hours**

**STRAIN MEASUREMENT**

Methods of Measurement -Calibration-Load calibration of testing machines-I.S. Code provisions - Measurement system- Mechanical, Optical and Acoustical extensometers -Strain measurement-Electrical resistance strain gauges- Principle, Types, Performance, Uses- Strain Rosettes- Wheatstone Bridge-Electronic load cells-Proving rings

**UNIT II** **9 Hours**

**MEASUREMENT OF DISPLACEMENT VIBRATION**

Measurement of vibration- Vibration galvanometers- Vibrometer-Characteristics of Structural vibration-Pressure gauges-Velocity transducers- Seismic transducers - Linear Variable Differential Transformer-Cathode ray oscilloscope - X Y Plotter- Wind Tunnels-Flow meters- Venturimeter-Digital Data Acquisition systems

**UNIT III** **9 Hours**

**DISTRESS MEASUREMENT**

Diagnosis of distress in structures-Cracks in structures-Formation of cracks- Types of cracks-Causes of cracks- Crack measurement- Monitoring and measurement of crack movement- Corrosion of reinforcement in RCC- Half-cell-Construction and use-Damage assessment-Controlled blasting for demolition

**UNIT IV** **9 Hours**

**PHTOELASTICITY**

Photoelasticity-Two dimensional photo elasticity, Sources of light - photo elastic effects - stress optic law-Interpretation of fringe pattern- Compensation and separation techniques- Photo elastic materials. Introduction to three dimensional photo elasticity

**UNIT V** **9 Hours**

**MODEL ANALYSIS**

Model laws- Laws of similitude-Model materials- Model testing- Necessity for Model analysis-Advantages-Applications- Types of similitude- Scale effect in Models- Indirect model study- Direct model study-Limitations of model investigations- Structural problems that may demand model studies- Usage of influence lines in model studies

**Total: 45 Hours**

**Reference(s)**

1. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi, 2006
2. J. W. Dally and W. F. Riley, Experimental Stress Analysis, McGraw-Hill, Inc. New York, 1978
3. L. S. Srinath, Experimental Stress Analysis, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1984
4. C. S. Rangan, Instrumentation Devices and Systems, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1983.

## 18ST66 SOFT COMPUTING IN STRUCTURAL ENGINEERING 3 0 0 3

**Course Objectives**

- To familiarize the students with non-traditional optimization techniques and computer applications

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
g. Demonstrate knowledge and understanding of engineering and management principles and manage projects related to the field of Structural Engineering efficiently.

**Course Outcomes (COs)**

1. Apply the principle of Artificial intelligence, Genetic algorithm and Hybrid systems for the optimal design of structural elements
2. Predict the objective function for various types of structures
3. Relate the application of fuzzy logic in the design of structural elements
4. Compute the optimal design of structural elements by using genetic algorithm technique and differential equations
5. Use the analysis of composite structures using non-traditional optimization techniques

**UNIT I** **10 Hours**

**INTRODUCTION TO ARTIFICIAL INTELLIGENT SYSTEMS**

Neural Networks - Fuzzy logic - genetic algorithm.-Neural Networks: Basic Concepts - Artificial Neural Network (ANN) Architecture - Learning Methods -Back Propagation Network (BPN)- Single layer ANN - Multilayer Perception - Learning Method of Effect of tuning parameters - New technologies - application to Structural Engineering.

**UNIT II** **10 Hours**

**ASSOCIATIVE MEMORY AND ADAPTIVE RESONANCE THEORY**

Kosko's Discrete (Bi-directional Associative Memory) BAM - input normalization - Evolution Equation - vector quantization - simplified ART architecture - Architecture of ART1 and ART2 - Application to structural engineering problems.

**UNIT III** **10 Hours**

**FUZZY LOGIC**

Fuzzy sets and relations - Predicate logic - Fuzzy quantifiers - Fuzzy Rule based systems - Defuzzification method - Application to controllers- Application to Structural Engineering problems.

**UNIT IV** **8 Hours**

**GENETIC ALGORITHMS**

Basic concepts - incoding - Equation functions - genetic operators - reproduction - selection - cross over - mutation - convergence of GA - optimal design using GA - Application to structural engineering problems.

**UNIT V** **7 Hours**

**HYBRID SYSTEMS**

Neuro - Fuzzy Hybrids - Fuzzy genetic hybrids - Neuro genetic hybrid - Fuzzy BPN - Fuzzy Art Map - Fuzzy controlled GA.Support Vector Machines: Support vector regression - Classifications.

**Total: 45 Hours**

**Reference(s)**

1. Rajasekaran S and VijayalakshmiPai G A, "Neural Networks, Fuzzy Logic and Genetic Algorithms",Prentice Hall of India, New Delhi, 2011.
2. Adeli H, and Hung S L, "Machine Learning, Neural Networks, Genetic Algorithms and Fuzzy Systems, John Wiley and Sons, New York, 1995.
3. Goldberg D E, "Genetic Algorithms in Search Optimization and Machine Learning", Addison Wesley, Rading Mass, USA, 1989.
4. Zadeh, Loffi A, "Fuzzy Sets", Information Control, Vol.8, pp.338-353, 1965.
5. Gunn S R, "Support Vector Machines for Classification and Regression", Technical report ISIS-I-98 - University of Southampton, 1998.
6. Gunn S R, Support Vector Machines for Classification and Regression, Technical report ISIS-I-98 - University of Southampton, 1998.

## 18ST67 DESIGN OF PRESTRESSED CONCRETE STRUCTURES

**3 0 0 3**

**Course Objectives**

- Interpret the Basic concept of prestress concrete, materials, methods and factors influencing pre- stress.
- Implement the basic assumptions of elastic analysis and design prestressed flexural and shear members.
- Predict the stresses due to long term and short term deflection and design a prestress member accordingly.
- Determine the stresses in composite structures and find out how partial pre-stressing is done.

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.

c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.

**Course Outcomes (COs)**

1. Analyse the stresses in prestressed concrete member due to prestressing force and its variation due to losses.
2. Design the layout of cables for Type I and Type II beams based on calculation of moment of resistance.
3. Compute the deflections and anchorage zone stresses.
4. Implement the methods for achieving continuity in beams.
5. Evaluate the design of circular prestressing and the uses of non prestressed reinforcement.

**UNIT I** **9 Hours**

**INTRODUCTION**

Basic principles of Prestressing - Classification and types - Advantages over ordinary reinforced concrete - Materials - high strength concrete and high tensile steel - Methods of Prestressing - Freyssinet, MagnelBlaton, Lee Mc Call and Killick anchorage systems - Analysis of sections for stresses by stress concept, strength concept and load balancing concept - Losses of prestress

**UNIT II** **9 Hours**

**DESIGN FOR FLEXURE AND SHEAR**

Basic assumptions for calculating flexural stresses - Permissible stresses in steel and concrete as per I.S.1343 Code - Design of sections of Type I, Type II and type III post - tensioned and pre -tensioned beams - Check for strength limit state based on I.S.1343 Code - Layout of cables in post-tensioned beams - Location of wires in pre-tensioned beams - Design for shear based on I.S.1343 Code.

**UNIT III** **9 Hours**

**DEFLECTION AND DESIGN OF ANCHORAGE ZONE**

Factors influencing deflections - Short term deflections of uncracked members - Prediction of long term deflections due to creep and shrinkage - Check for serviceability limit state of deflection. Determination of anchorage anchorage zone stresses in post - tensioned beams by Magnel's method, Guyon's method and I.S.1343 code - Design of anchorage zone reinforcement.

**UNIT IV** **9 Hours**

**COMPOSITE BEAMS**

Types of R.C.C. - P.S.C composite beams - Analysis and design of composite beams and Continuous Beams - Methods of achieving Continuity in continuous beams - Analysis for secondary moments - Concordant cable and linear transformation - Calculation of stresses - Principles of design.

**UNIT V** **9 Hours**

**MISCELLANEOUS STRUCTURES**

Design of tanks, pipes, sleepers, tension and compression members - Use of non-prestressed reinforcement - Definition, methods of achieving, merits and demerits of partial Prestressing.

**Total: 45 Hours**

**Reference(s)**

1. Krishna Raju, N., "Prestressed Concrete", Tata McGraw Hill Publishing Company, New Delhi, 2008.
2. Lin, T.Y. and Ned.H.Burns, "Design of Prestressed Concrete Structures", John Wiley & Sons, New York, 2009.
3. Rajagopalan, N., "Prestressed Concrete", Narosa Publishing House, New Delhi,2008
4. Arthur H.Nilson,"Design of Prestressed Concrete", John Wiley & Sons Inc, New York, 2004.
5. Dayaratnam, P., "Prestressed Concrete Structures", Oxford and IBH, New Delhi, 1982.
6. Sinha, N.C.and Roy, S.K., "Fundamentals of Prestressed Concrete", S.Chand & Co.,Ltd.,

## 18ST68 OFFSHORE STRUCTURES 3 0 0 3

**Course Objectives**

- To study the concept of wave theories, forces and design of jacket towers, pipes and cables.

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.

**Course Outcomes (COs)**

1. Understand the principle of wave theories
2. Calculate various types of forces acting on the structures
3. Classify and model the off shore structures
4. Analyze the foundation of off shore structures using static and dynamic method
5. Design the various type of off shore structure

**UNIT I** **9 Hours**

**WAVE THEORIES**

Wave generation process, small, finite amplitude and nonlinear wave theories.

**UNIT II** **9 Hours**

**FORCES OF OFFSHORE STRUCTURES**

Wind forces, wave forces on small bodies and large bodies - current forces - Morison equation.

**UNIT III** **9 Hours**

**OFFSHORE SOIL AND STRUCTURE MODELLING**

Different types of offshore structures, foundation modeling, fixed jacket platform structural modelling

**UNIT IV** **9 Hours**

**ANALYSIS OF OFFSHORE STRUCTURES**

Static method of analysis, foundation analysis and dynamics of offshore structures.

**UNIT V** **9 Hours**

**DESIGN OF OFFSHORE STRUCTURES**

Design of platforms, helipads, Jacket tower, analysis and design of mooring cables and pipelines.

**Total: 45 Hours**

**Reference(s)**

1. API RP 2A-WSD, Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design - API Publishing Services, 2005
2. Chakrabarti, S.K., Handbook of Offshore Engineering by, Elsevier, 2005.
3. Chakrabarti, S.K., Hydrodynamics of Offshore Structures, WIT press, 2001.
4. Dawson.T.H., Offshore Structural Engineering, Prentice Hall Inc Englewood Cliffs, N.J. 1983.
5. James F. Wilson, Dynamics of Offshore Structures, John Wiley & Sons, Inc, 2003.
6. Reddy, D.V. and Arockiasamy, M., Offshore Structures, Vol.1 and Vol.2, Krieger Publishing Company, 1991

## 18ST69 MECHANICS OF COMPOSITE MATERIALS 3 0 0 3

**Course Objectives**

- To study the behaviour of composite materials and to investigate the failure and fracture characteristics.

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
d. Extract information pertinent to unfamiliar problems through literature survey, experimental investigations, interpretation and validation of results.
e. Use modern software packages for analysis and design of structures and use of modern instrumentations for experimental investigations.
g. Demonstrate knowledge and understanding of engineering and management principles and manage projects related to the field of Structural Engineering efficiently.

**Course Outcomes (COs)**

1. Classify different types of composite materials
2. Predict the value of stresses and strains for composite materials
3. Analyze laminated composite plates and sheets
4. Examine the failure pattern of composite structures
5. Design of composite structures with respect to joints

**UNIT I** **9 Hours**

**INTRODUCTION**

Introduction to Composites, Classifying composite materials, commonly used fiber and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites and Short Fiber Composites.

**UNIT II** **9 Hours**

**STRESS STRAIN RELATIONS**

Concepts in solid mechanics, Hookes law for orthotropic and anisotropic materials, Linear Elasticity for Anisotropic Materials, Rotations of Stresses, Strains, Residual Stresses

**UNIT III** **9 Hours**

**ANALYSIS OF LAMINATED COMPOSITES**

Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates Static, Dynamic and Stability analysis for Simpler cases of composite plates, Interlaminar stresses.

**UNIT IV** **9 Hours**

**FAILURE AND FRACTURE OF COMPOSITES**

Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics of Composites, Sandwich Construction.

**UNIT V** **9 Hours**

**APPLICATIONS AND DESIGN**

Metal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues

**Total: 45 Hours**

**Reference(s)**

1. Agarwal.B.D., Broutman.L.J., and Chandrashekara.K. Analysis and Performance of Fiber Composites, John-Wiley and Sons, 2006
2. Daniel.I.M., and Ishai.O, Engineering Mechanics of Composite Materials, Oxford University Press, 2005.
3. Hyer M.W., and White S.R., Stress Analysis of Fiber-Reinforced Composite Materials, D.Estech Publications Inc., 2009
4. Jones R.M., Mechanics of Composite Materials, Taylor and Francis Group 1999
5. Mukhopadhyay.M, Mechanics of Composite Materials and Structures, Universities Press, India, 2005

## 18ST70 NONLINEAR ANALYSIS OF STRUCTURES 3 0 0 3

**Course Objectives**

- To study the concept of nonlinear behaviour and analysis of elements and simple structures

**Programme Outcomes (POs)**

b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.
c. Think laterally and originally, and arrive at feasible, optimal solutions considering safety and environmental factors in the area of Structural Engineering.
e. Use modern software packages for analysis and design of structures and use of modern instrumentations for experimental investigations.

**Course Outcomes (COs)**

1. Distinguish determinate and indeterminate non linear analysis
2. Predict the type of analysis for flexural members
3. Outline the dynamic analysis for flexural members
4. Analyze the plates using elastic and inelastic theories
5. Demonstrate the non- linear analysis and failure pattern of beams

**UNIT I** **9 Hours**

**INTRODUCTION TO NONLINEAR ANALYSIS**

Material nonlinearity, geometric nonlinearity; statically determinate and statically indeterminate bar systems of uniform and variable thickness

**UNIT II** **9 Hours**

**INELASTIC ANALYSIS OF FLEXURAL MEMBERS**

Inelastic analysis of uniform and variable thickness members subjected to small deformations; inelastic analysis of bars of uniform and variable stiffness members with and without axial restraints

**UNIT III** **9 Hours**

**VIBRATION THEORY AND ANALYSIS OF FLEXURAL MEMBERS**

Vibration theory and analysis of flexural members; hysteretic models and analysis of uniform and variable stiffness members under cyclic loading

**UNIT IV** **9 Hours**

**ELASTIC AND INELASTIC ANALYSIS OF PLATES**

Elastic and inelastic analysis of uniform and variable thickness plates

**UNIT V** **9 Hours**

**NONLINEAR VIBRATION AND INSTABILITY**

Nonlinear vibration and Instabilities of elastically supported beams

**Total: 45 Hours**

**Reference(s)**

1. Fertis, D.G, Non-linear Mechanics, CRC Press, 1999.
2. Reddy.J.N, Non-linear Finite Element Analysis, Oxford University Press, 2008
3. Sathyamoorthy.M, Nonlinear Analysis of Structures, CRC Press, 2010.

## OPEN ELECTIVES

### 18GE01 BUSINESS ANALYTICS 3 0 0 3

**Course Objectives**

- Understand the role of business analytics within an organization
- Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making
- To become familiar with processes needed to develop, report, and analyze business data
- Use decision-making tools/Operations research techniques and Manage business process using analytical and management tools

**Course Outcomes (COs)**

1. Implement the knowledge of data analytics
2. Apply the ability of think critically in making decisions based on data and deep analytics.
3. Analyze the ability to use technical skills in predicative and prescriptive modeling to support business decision-making
4. Determine the ability to translate data into clear, actionable insights
5. Analyze the decision problems in business analytics

**UNIT I** **9 Hours**

**BUSINESS ANALYTICS AND STATISTICAL TOOLS**

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics-Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview

**UNIT II** **9 Hours**

**TRENDINESS AND REGRESSION ANALYSIS**

Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology

**UNIT III** **9 Hours**

**ORGANIZATION STRUCTURES OF BUSINESS ANALYTICS**

Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization

**UNIT IV** **9 Hours**

**FORECATING TECHNIQUES**

Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models

**UNIT V** **9 Hours**

**DECISION ANALYSIS**

Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making

**FOR FURTHER READING**

Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism

**Total: 45 Hours**

**Reference(s)**


1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press
2. Business Analytics by James Evans, persons Education

## 18GE02 INDUSTRIAL SAFETY 3 0 0 3

**Course Objectives**

- To study the principles of safety management system.
- To introduce the provisions contained in the industrial laws.
- To provide knowledge on safety requirements for engineering industry.
- To infer the safety requirement for chemical industry.
- To classify the various safety measures adopted in construction industries.

**Course Outcomes (COs)**

1. Demonstrate the safety management system of an industry.
2. Implement the provisions if acts and rules in industries.
3. Explain and review the safety performance followed in various industries.
4. Compare the safety appraisal of various industries.
5. Formulate safety reports on construction industries.

**UNIT I** **9 Hours**

**SAFETY MANAGEMENT**

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Investigation and Reporting - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

**UNIT II** **9 Hours**

**SAFETY AND LAW**

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, Building and other construction works act 1996, Motor Vehicle Rules, Explosive Act 1983, Boiler Act.

**UNIT III** **9 Hours**

**SAFETY IN ENGINEERING INDUSTRIES**

Safety in metal working machinery and wood working machines, principles, standards and codes - Principles of machine guarding - zero mechanical state (ZMS),types of guards, Personal protective equipment- Safety in handling industrial gases, storage and handling of gas cylinders- Safety in cold forming and hot working of metals- Power press, forging, safety in furnaces, Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

**UNIT IV** **9 Hours**

**SAFETY IN CHEMICAL INDUSTRIES**

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, non-destructive testing, vibration, corrosion Plant maintenance and emergency planning, management of maintenance HAZOP study, ALOHA, SOFTWARE.

**UNIT V** **9 Hours**

**SAFETY IN CONSTRUCTION INDUSTRY**

Causes of fatal accidents, Construction regulations, contractual clauses, permit to work, Quality assurance in construction- Education and training Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high rise buildings - Working at heights, Occupational Safety and Health Administration (OSHA) requirement for working at heights- Working on fragile roofs, work permit systems- Construction machinery, inspection and testing of cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, keys to safe demolition, health hazards from demolition, fire and explosion hazard- Safety in confined spaces.

**FOR FURTHER READING**

Case Studies- Major accidents at Flixborough, UK, Seveso, Italy, Victoria Dock, India, Bhopal, India.

**Total: 45 Hours**

**Reference(s)**


1. R.B.Blake, Industrial Safety, Prentice Hall, Incorporated, New Jersey,1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988.
3. V.Subramanian, The Factories Act, 1948, with Tamil Nadu Factories Rules , 1950, Madras.
4. Environmental Pollution Control Act, 1986.
5. BOCW Act,1996, Madras Book agency, Chennai-1.
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.

## 18GE03 OPERATIONS RESEARCH 3 0 0 3

**Course Objectives**

- To apply the dynamic programming to solve problems of discreet and continuous variables.
- To apply the concept of non-linear programming.
- To carry out sensitivity analysis
- To model the real world problem and simulate it

**Course Outcomes (COs)**

1. Explain the dynamic programming for discreet and continuous variables.
2. Demonstrate concept of non-linear programming
3. Identify the sensitivity analysis.
4. Formulate the real world problem and simulate it.

**UNIT I** **9 Hours**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

**UNIT II** **9 Hours**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

**UNIT III** **9 Hours**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

**UNIT IV** **9 Hours**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming

**UNIT V** **9 Hours**

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

**Total: 45 Hours**

**Reference(s)**


1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

## 18GE04 COST MANAGEMENT OF ENGINEERING PROJECTS

**3 0 0 3**

### Course Objectives

- To apply the decision making in cost management.
- To implement the execution of project and its contracts.
- To analyze cost behavior and profit planning marginal costing
- To apply activity-based cost management
- To explain quantitative techniques for cost management

### Course Outcomes (COs)

1. Explain the decision making in cost management.
2. Demonstrate concept of project and its contracts
3. Identify the cost behavior and profit planning marginal costing.
4. Formulate the quantitative techniques for cost management.

**UNIT I** **9 Hours**

**COST CONCEPTS IN DECISION-MAKING**

Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

**UNIT II** **9 Hours**

**PROJECT**

Meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance.

Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

**UNIT III** **9 Hours**

**COST BEHAVIOR AND PROFIT PLANNING MARGINAL COSTING**

Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning,

**UNIT IV** **9 Hours**

**TOTAL QUALITY MANAGEMENT AND THEORY OF CONSTRAINTS**

Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

**UNIT V** **9 Hours**

**QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT**

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

**Total: 45 Hours**

### Reference(s)


1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

## 18GE05 COMPOSITE MATERIALS 3 0 0 3

**9 Hours**

**Course Objectives**

- To explain the characteristics of composite materials.
- To implement the particle reinforcements.
- To analyze manufacturing of metal matrix composites
- To apply manufacturing of polymer matrix composites
- To explain strength design and stress concentration

**Course Outcomes (COs)**

1. Explain the characteristics of composite materials.
2. Demonstrate concept of particle reinforcements
3. Identify the manufacturing of polymer matrix composites.
4. Formulate the strength design and stress concentration.

**UNIT I** **9 Hours**

**INTRODUCTION**

Definition - Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance

**UNIT II** **9 Hours**

**REINFORCEMENTS**

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

**UNIT III** **9 Hours**

**MANUFACTURING OF METAL MATRIX COMPOSITES**

Solid State diffusion technique, Cladding - Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration - Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

**UNIT IV** **9 Hours**

**MANUFACTURING OF POLYMER MATRIX COMPOSITES**

Preparation of Moulding compounds and prepares - hand layup method - Autoclave method - Filament winding method – Compression moulding - Reaction injection moulding. Properties and applications

**UNIT V** **9 Hours**

**STRENGTH**

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

**Total: 45 Hours**

**Reference(s)**


1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials- K.K.Chawla
3. Composite Materials Science and Applications - Deborah D.L. Chung.
4. Composite Materials Design and Applications - Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

## 18GE06 WASTE TO ENERGY 3 0 0 3

**Course Objectives**

- To explain the characteristics of energy from waste.
- To implement the Biomass Pyrolysis.
- To analyze manufacturing of Biomass Gasification
- To apply manufacturing of Biomass Combustion
- To explain the properties and application of Biogas

**Course Outcomes (COs)**

1. Explain the characteristics of energy from waste.
2. Demonstrate concept of Biomass Pyrolysis
3. Identify the manufacturing of Biomass Combustion.
4. Formulate the properties and application of Biogas.

**UNIT I** **9 Hours**

**INTRODUCTION TO ENERGY FROM WASTE**

Classification of waste as fuel Agro based, Forest residue, Industrial waste - MSW Conversion devices Incinerators, gasifiers, digestors

**UNIT II** **9 Hours**

**BIOMASS PYROLYSIS**

Pyrolysis - Types, slow fast - Manufacture of charcoal - Methods – Yields and application - Manufacture of pyrolytic oils and gases, yields and applications.

**UNIT III** **9 Hours**

**BIOMASS GASIFICATION**

Gasifiers Fixed bed system Downdraft and updraft gasifiers Fluidized bed gasifiers Design, construction and operation Gasifier burner arrangement for thermal heating Gasifier engine arrangement and electrical power Equilibrium and kinetic consideration in gasifier operation.

**UNIT IV** **9 Hours**

**BIOMASS COMBUSTION**

Biomass stoves Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

**UNIT V** **9 Hours**

**BIOGAS**

Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion – Types of biogas Plants Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

**Total: 45 Hours**

**Reference(s)**


1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

## AUDIT COURSES

### 18XE11 RESEARCH PAPER WRITING 2 0 0 -

**Course Objectives**

- Understand that how to improve your writing skills and level of readability.
- Learn about what to write in each section.
- Recognize the skills needed when writing a Title.
- Ensure the good quality of paper at very first-time submission.

**UNIT I** **5 Hours**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

**UNIT II** **5 Hours**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

**UNIT III** **5 Hours**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

**UNIT IV** **5 Hours**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

**UNIT V** **5 Hours**

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

**UNIT VI** **5 Hours**

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

**Total: 30 Hours**

**Reference(s)**


1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

## 18XE12 TRADITIONAL TECHNICAL KNOWLEDGE

**2 0 0 -**

**Course Objectives**

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world.
- Learning of Sanskrit to improve brain functioning.
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects.
- Enhancing the memory power.
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

**Course Outcomes (COs)**

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in student

**UNIT I** **10 Hours**

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences

**UNIT II** **10 Hours**

Order, Introduction of roots, Technical information about Sanskrit Literature.

**UNIT III** **10 Hours**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics.

**Total: 30 Hours**

**Reference(s)**


1. "Abhyaspustakama" - Dr.Vishwas, Samskrita-Bharti Publication, New Delhi.
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.
3. "India's Glorious Scientific Tradition", Suresh Soni, Ocean books (P) Ltd., New Delhi.

## 18XE13 VALUE EDUCATION 2 0 0 -

**Course Objectives**

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.

**Course Outcomes (COs)**

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

**UNIT I** **8 Hours**

Values and self-development- Social values and individual attitudes-Work ethics- Indian vision of humanism- Moral and non- moral valuation-Standards and principles-Value judgements

**UNIT II** **7 Hours**

Importance of cultivation of values- Sense of duty Devotion- Self-reliance- Confidence-Concentration-Truthfulness- Cleanliness-Honesty- Humanity- Power of faith- National Unity- Patriotism- Love for nature-Discipline

**UNIT III** **8 Hours**

Personality and Behavior Development - Soul and Scientific attitude- Positive Thinking- Integrity and discipline-Punctuality- Love and Kindness- Avoid fault Thinking- Free from anger- Dignity of labour-Universal brotherhood and religious tolerance-True friendship-Happiness Vs suffering- love for truth-Aware of self-destructive habits-Association and Cooperation-Doing best for saving nature

**UNIT IV** **7 Hours**

Character and Competence -Holy books vs Blind faith, Self-management and Good health. Science of reincarnation, Equality, Nonviolence ,Humility, Role of Women. All religions and same message, Mind your Mind, Self-control. Honesty, Studying effectively.

**Total: 30 Hours**

**Reference(s)**

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi.

## 18XE21 STRESS MANAGEMENT BY YOGA 2 0 0 -

**Course Objectives**

- To achieve overall health of body and mind
- To overcome stress by practicing yoga

**Programme Outcomes (POs)**

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.

**Course Outcomes (COs)**

1. Develop healthy mind in a healthy body thus improving social health also.
2. Improve Efficiency of the body by practicing breathing exercises and yoga.

**UNIT I** **10 Hours**

Definitions of Eight parts of yoga. (Ashtanga)

**UNIT II** **10 Hours**

Yam and Niyam Do`s and Dont's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

**UNIT III** **10 Hours**

Asan and Pranayam i) Various yoga poses and their benefits for mind & body ii) Regularization of breathing techniques and its effects-Types of pranayam

**Total: 30 Hours**

**Reference(s)**


1. Yogic Asanas for Group Training-Part-I Janardan Swami Yogabhyasi Mandal, Nagpur. Model Curriculum of Engineering & Technology PG Courses [Volume-I][ 47 ].
2. Rajayoga or conquering the Internal Nature by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata.

## 18XE22 DISASTER MANAGEMENT 2 0 0 -

**Course Objectives**

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
- Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

**Course Outcomes (COs)**

1. Understanding the key concepts in disaster risk reduction and humanitarian response
2. Understand the strengths and weaknesses of disaster management approaches, planning and programming

**UNIT I** **5 Hours**

**INTRODUCTION**

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

**UNIT II** **5 Hours**

**REPERCUSSIONS OF DISASTERS AND HAZARDS**

Economic Damage, Loss of Human And Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks of Disease And Epidemics, War And Conflicts.

**UNIT III** **5 Hours**

**DISASTER PRONE AREAS IN INDIA**

Study of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

**UNIT IV** **5 Hours**

**DISASTER PREPAREDNESS AND MANAGEMENT**

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

**UNIT V** **5 Hours**

**RISK ASSESSMENT**

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

**UNIT VI** **5 Hours**

**DISASTER MITIGATION**

Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

**Total: 30 Hours**

**Reference(s)**


1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies " , New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi
3. Goel S. L. , "Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.
4. Model Curriculum of Engineering & Technology PG Courses [Volume-I][ 42 ]

## 18XE23 PEDAGOGY STUDIES 2 0 0 -

**Course Objectives**

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers
- Identify critical evidence gaps to guide the development.

**Course Outcomes (COs)**

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? verall personality

**UNIT I** **8 Hours**

**INTRODUCTION AND METHODOLOGY**

Aims and rationale- Policy background- Conceptual framework and terminology-Theories of learning-Curriculum- Teacher education-Conceptual framework- Research questions-Overview of methodology and Searching

**UNIT II** **7 Hours**

**THEMATIC OVERVIEW**

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education

**UNIT III** **8 Hours**

**EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES**

Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school, curriculum and guidance materials best support effective pedagogy?. Theory of change, Strength and nature of the body of evidence for effective pedagogical, practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies

**UNIT IV** **7 Hours**

**PROFESSIONAL DEVELOPMENT**

Alignment with classroom practices and follow up, Support Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

**Total: 30 Hours**

**Reference(s)**


1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272-282
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, "learning to read" campaign.