ANNAMALAI UNIVERSITY

DEPARTMENT OF CIVIL AND STRUCTURAL ENGINEERING

M.E. (STRUCTURAL ENGINEERING)

HAND BOOK

2017-18

DEPARTMENT OF CIVIL AND STRUCTURAL ENGINEERING

VISION

The Department of Civil and Structural Engineering came into existence in the year 1978 with a vision to serve the industry, the profession and the society in general. The prime focus is to bring into limelight the inborn and untapped potential of the student fraternity and prepare them to face challenges of the future with confidence, courage and faith.

MISSION

The ultimate goal of the Department of Civil and Structural Engineering is to provide quality education to prepare nationally competitive students and trend setters for the future generation in the realm of technical education. The student should be able to assimilate the available theories, explore new frontiers to propound new theories which will result in improving the quality of the life of the people. It will also to develop their personality in a healthy way and to provide opportunity to acquire knowledge in state-of-the-art research; and to provide service to the university, engineering profession, and the public through consultancy services.

M.E. (STRUCTURAL ENGINEERING)

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

The following program educational objectives are consistent with the university, college and department missions.

1. To develop the technical and engineering skills of the students and to train them in applying fundamental principles in the field of Structural Engineering domain feeding the needs of global expectations with professional competence.
2. To provide proficiency in the basic principles and advanced courses in Structural Engineering so that students are able to deal with confidence on the formulation, analysis and solve the societal problems for sustainable development related to structural Engineering.
3. To explore the students in the latest innovations and trends in the field of Structural Engineering both in theory and practice and tuning the academic programmes

periodically to make the students fit for a professional job, a research assignment or self-employment.

4. To impart communication, analytical and soft skills for the students towards either placing them in a comfort zone in their profession or a path to pursue graduate education master and doctoral degree.
5. To produce Structural Engineers who integrate and build on the program's core curricular concepts in the pursuit of professional leadership, teamwork, life-long learning, and successful career advancement.

PROGRAMME OUTCOMES (PO)

After the successful completion of M.E (Structural Engineering) degree programme the students should be able to;

PO 1: Rudimentary principles of mathematics, basic engineering sciences and their technology applications in the field of Structural engineering problems.

PO 2: Inculcate the analysis and design of concrete and steel structural multi-storeyed structures, bridge structures, special structures, structural joints etc., under extreme wind and seismic conditions using relevant codal standards.

PO 3: Analyze and to identify the various advancements in Structural engineering materials utilized in the construction industry and its technical knowhow. Also create special concretes with the different waste materials using recycling concept and to reduce the environment pollutions, implementation of suitable and proper water supply and sanitary systems for the betterment of society and to promote Clean India Movement.

PO 4: Know the basics and advancement in the elastic and plastic nature of variety of materials used in the structures and its related research will be tuned as per the needs of the society.

PO 5: Understand the fundamental principles in testing the structural members with proper testing techniques (static and dynamic), instrumentations and equipments for their behaviour and performances in structural engineering.

PO 6: The students must be able to formulate, analyse, design and execute the construction of various types of engineering structures with appropriate consideration for public health and safety and cultural, societal and environmental conditions.

PO 7: To expertise the students in the field of solving the structural problems using various classic and approximate methods including the finite element analysis procedures.

PO 8: Demonstrate and to conduct different experiments for checking the property and quality of materials, carryout analysis and design of structures using softwares, and exposure in taking up student dissertation works.

PO 9: Gain exposure on curricular, extracurricular activities, different social activities of professionally and ethically responsibility and to apply ethical reasoning to society in case of emergency.

PO 10: Gain knowledge latest and advanced topics in structural engineering like different concreting techniques, selection of concrete, methods of concrete and repair and rehabilitation methodologies and applications for the present and future scenario in the construction of structures.

Mapping PO with PEO										
POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
PEO1	✓	✓	✓	✓	✓	✓			✓	
PEO2	✓	✓	✓	✓	✓	✓	✓	✓		✓
PEO3		✓	✓		✓			✓		✓
PEO4		✓	✓				✓	✓	✓	✓
PEO5			✓	✓		✓	✓	✓	✓	✓

M.E. / M. Tech (Two-Year Full Time & Three-year Part Time)

DEGREE PROGRAMME

CHOICE BASED CREDIT SYSTEM (CBCS)

REGULATIONS

1. **Condition for Admission**
   Candidates for admission to the first year of the four-semester **M.E / M.Tech Degree programme in Engineering** shall be required to have passed B.E / B.Tech degree of Annamalai University or any other authority accepted by the syndicate of this University as equivalent thereto. They shall satisfy the condition regarding qualifying marks and physical fitness as may be prescribed by the syndicate of the Annamalai University from time to time. The admission for part time programme is restricted to those working or residing within a radius of **90 km** from Annamalainagar. The application should be sent through their employers.

2. **Branches of Study in M.E / M.Tech**
   The Branch and Eligibility criteria of programmes are given in Annexure 1

3. **Courses of study**
   The courses of study and the respective syllabi for each of the M.E / M. Tech programmes offered by the different Departments of study are given separately.

4. **Scheme of Examinations**
   The scheme of Examinations is given separately.

5. **Choice Based Credit System (CBCS)**
   The curriculum includes three components namely Professional Core, Professional Electives and Open Electives in addition to Thesis. Each semester curriculum shall normally have a blend of theory and practical courses.

6. **Assignment of Credits for Courses**
   Each course is normally assigned one credit per hour of lecture / tutorial per week and one credit for two hours or part thereof for laboratory or practical per week. The total credits for the programme will be 65.

7. **Duration of the programme**
   A student of **M.E / M.Tech** programme is normally expected to complete in four semesters for full-time / six semesters for part-time but in any case not more than four years for full-time / six years for part-time from the date of admission.

8. Registration for courses

A newly admitted student will automatically be registered for all the courses prescribed for the first semester, without any option. Every other student shall submit a completed registration form indicating the list of courses intended to be credited during the next semester. This registration will be done a week before the last working day of the current semester. Late registration with the approval of the Dean on the recommendation of the Head of the Department along with a late fee will be done up to the last working day. Registration for the Thesis Phase - I and II shall be done at the appropriate semesters.

9. Electives

The student has to select two electives in first semester and another two electives in the second semester from the list of Professional Electives. The student has to select two electives in third semester from the list of Open Electives offered by the department/ allied department. A student may be allowed to take up the open elective courses of third semester (Full Time program) in the first and second semester, one course in each of the semesters to enable them to carry out thesis in an industry during the entire second year of study provided they should register those courses in the first semester itself. Such students should meet the teachers offering those elective courses themselves-for clarifications. No specific slots will be allotted in the time table for such courses.

Further, the two open elective courses to be studied in III semester (Full Time programme) may also be credited through the SWAYAM portal of UGC with the approval of Head of the Department concerned. In such a case, the courses must be credited before the end of III Semester.

10. Assessment

The break-up of continuous assessment and examination marks for theory courses is as follows:

First assessment (Mid-Semester Test-I)	:	10 marks
Second assessment (Mid-Semester Test-II)	:	10 marks
Third Assessment	:	5 marks
End Semester Examination	:	75 marks

The break-up of continuous assessment and examination marks for Practical courses is as follows:

First assessment (Test-I)	:	15 marks
Second assessment (Test-II)	:	15 marks
Maintenance of record book	:	10 marks
End Semester Examination	:	60 marks

The thesis Phase I will be assessed for 40 marks by a committee consisting of the Head of the Department, the guide and a minimum of two members nominated by the Head of the Department. The Head of the Department will be the chairman. The number of reviews must be a minimum of three per semester. 60 marks are allotted for the thesis work and viva voce examination at the end of the third semester. The same procedure will be adopted for thesis Phase II in the fourth semester.

11. Student Counsellors (Mentors)

To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a member of the faculty who shall function as student counsellor for those students throughout their period of study. Such student counsellors shall advise the students, give preliminary approval for the courses to be taken by the students during each semester, monitor their progress in SWAYAM courses / open elective courses and obtain the final approval of the Head of the Department.

12. Class Committee

For each of the semesters of M.E / M.Tech programmes, separate class committees will be constituted by the respective Head of the Departments. The composition of the class committees from first to fourth semesters for Full time and first to sixth semesters for Part-time will be as follows:

- Teachers of the individual courses.
- A Thesis coordinator (for Thesis Phase I and II) shall be appointed by the Head of the Department from among the Thesis supervisors.
- A thesis review committee chairman shall be appointed by the Head of the Department
- One Professor or Associate Professor, preferably not teaching the concerned class, appointed as Chairman by the Head of the Department.
- The Head of the Department may opt to be a member or the Chairman.
- All counselors of the class and the Head of the Department (if not already a member) or any staff member nominated by the Head of the Department may opt to be special invitees.

The class committee shall meet **three** times during the semester. The first meeting will be held within two weeks from the date of class commencement in which the type of assessment like test, assignment etc. for the third assessment and the dates of completion of the assessments will be decided.

The second meeting will be held within a week after the completion of the first assessment to review the performance and for follow-up action.

The third meeting will be held after all the assessments but before the University semester examinations are completed for all the courses, and at least one week before the commencement of the examinations. During this meeting the assessment on a maximum of 25 marks for theory / 40 marks for practical and project work will be finalized for every student and tabulated and submitted to the Head of the Department for approval and transmission to the Controller of Examinations.

13. Temporary Break Of Study

A student can take a one-time temporary break of study covering the current semester and / or the next semester with the approval of the Dean on the recommendation of the Head of the Department, not later than seven days after the completion of the mid-semester test. However, the student must complete the entire programme within the maximum period of **four years for Full time / six years for Part time.**

14. Substitute Assessments

A student who has missed, for genuine reasons accepted by the Head of the Department, one or more of the assessments of a course other than the end of semester examination may take a substitute assessment for any one of the missed assessments. The substitute assessment must be completed before the date of the third meeting of the respective class committees.

A student who wishes to have a substitute assessment for a missed assessment must apply to the Head of the Department within a week from the date of the missed assessment.

15. Attendance Requirements

The students with 75% attendance and above are permitted to appear for the University examinations. However, the Vice Chancellor may give a rebate / concession not exceeding 10% in attendance for exceptional cases only on Medical Grounds.

A student who withdraws from or does not meet the minimum attendance requirement in a semester must re-register and repeat the same semester in the subsequent academic years.

16. Passing and declaration of Examination Results

All assessments of all the courses on an absolute marks basis will be considered and passed by the respective results passing boards in accordance with the rules of the University. Thereafter, the controller of examinations shall convert the marks for each course to the corresponding letter grade as follows, compute the grade point average (GPA) and cumulative grade point average (CGPA) and prepare the mark sheets.

90 to 100 marks	Grade ‘S’
80 to 89 marks	Grade ‘A’
70 to 79 marks	Grade ‘B’
60 to 69 marks	Grade ‘C’
55 to 59 marks	Grade ‘D’
50 to 54 marks	Grade ‘E’
Less than 50 marks	Grade ‘RA’
Withdrawn from the Examination	Grade ‘W’

A student who obtains less than 30 / 24 marks out of 75 / 60 in the theory / practical examinations respectively or is absent for the examination will be awarded grade RA.

A student who earns a grade of S, A, B, C, D or E for a course is declared to have successfully completed that course and earned the credits for that course. Such a course cannot be repeated by the student.

A student who obtains letter grade RA / W in the mark sheet must reappear for the examination of the courses.

The following grade points are associated with each letter grade for calculating the grade point average and cumulative grade point average.

S - 10; A - 9; B - 8; C - 7; D - 6; E - 5; RA – 0

Courses with grade RA / W are not considered for calculation of grade point average or cumulative grade point average.

A student can apply for re-totaling of one or more of his examination answer papers within a week from the date of issue of mark sheet to the student on payment of the prescribed fee per paper. The application must be made to the Controller of Examinations with the recommendation of the Head of the Department.

After the results are declared, mark sheets will be issued to the students. The mark sheet will contain the list of courses registered during the semester, the grades scored and the grade point average for the semester.

GPA is the sum of the products of the number of credits of a course with the grade point scored in that course, taken over all the courses for the semester, divided by the sum of the number of credits for all courses taken in that semester.

CGPA is similarly calculated considering all the courses taken from the time of admission.

17. Awarding Degree

After successful completion of the programme, the degree will be awarded with the following classifications based on CGPA.

For First Class with Distinction the student must earn a minimum of 65 credits within four semesters for full-time / six semesters for Part time from the time of admission, pass all the courses in the first attempt and obtain a CGPA of 8.25 or above.

For First Class, the student must earn a minimum of 65 credits within two years and six months for full-time / three years and six months for Part time from the time of admission and obtain a CGPA of 6.75 or above.

For Second class, the student must earn a minimum of 65 credits within four years for full-time / six years for Part time from the time of admission.

18. Ranking Of Candidates

The candidates who are eligible to get the M.E /M.Tech degree in First Class with Distinction will be ranked on the basis of CGPA for all the courses of study from I to IV semester for M.E / M.Tech full-time / I to VI semester for M.E / M.Tech part-time.

The candidates passing with First Class and without failing in any subject from the time of admission will be ranked next to those with distinction on the basis of CGPA for all the courses of study from I to IV semester for full-time / I to VI semester for M.E / M.Tech part-time.

19. Transitory Regulations

If a candidate studying under the old regulations M.E. / M.Tech could not attend any of the courses in his/her courses, shall be permitted to attend equal number of courses, under the new regulation and will be examined on those subjects. The choice of courses will be decided by the concerned Head of the department. However he/she will be permitted to submit the thesis as per the old regulations. The results of such candidates will be passed as per old regulations.

The University shall have powers to revise or change or amend the regulations, the scheme of examinations, the courses of study and the syllabi from time to time.

ANNEXURE - 1

S.No.	Department		Programme (Full Time & Part time)	Eligible B.E./B.Tech Programme *
1	**Civil Engineering**	i.	Environmental Engineering	B.E. / B.Tech – Civil Engg, Civil & Structural Engg, Environmental Engg, Mechanical Engg, Industrial Engg, Chemical Engg, BioChemical Engg, Biotechnology, Industrial Biotechnology, Chemical and Environmental Engg.
		ii.	Environmental Engineering & Management	
		iii.	Water Resources Engineering & Management	B.E. / B.Tech – Civil Engg, Civil & Structural Engg, Environmental Engg, Mechanical Engg, Agricutural anf irrigation Engg, Geo informatics, Energy and Environmental Engg.
2	**Civil & Structural Engineering**	i.	Structural Engineering	B.E. / B.Tech – Civil Engg./Civil & Structural Engg.
		ii.	Construction Engg. and Management	
		iii.	Geotechnical Engineering	
		iv.	Disaster Management & Engg.	
3	**Mechanical Engineering**	i.	Thermal Power	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Mechanical Engg (Manufacturing).
		ii.	Energy Engineering & Management	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Mechanical (Manufacturing) Engg, Chemical Engg
4	**Manufacturing Engineering**	i.	Manufacturing Engineering	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Manufacturing Engg, Production Engg, Marine Materials science Engg, Metallurgy Engg, Mechatronics Engg, Industrial Engg.
		ii.	Welding Engineering	

		iii.	Nano Materials and Surface Engineering	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Manufacturing Engg, Production Engg, Marine Materials science Engg, Metallurgy Engg, Chemical Engg
5	**Electrical Engineering**	i.	Embedded Systems	B.E. / B.Tech – Electrical and Electronics Engg, Electronics & Instrumentation Engg, Control and Instrumentation Engg, Information technology, Electronics and communication Engg, Computer Science and Engg
		ii.	Smart Energy Systems	B.E. / B.Tech – Electrical and Electronics Engg, Electronics and Instrumentation Engg, Control and Instrumentation Engg.
		iii.	Power System	B.E. / B.Tech – Electrical and Electronics Engg,
6	**Electronics & Instrumentation Engineering**	i	Process Control & Instrumentation	B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electronics Engg, Control and Instrumentation Engg, Instrumentation Engg
		ii.	Rehabilitative Instrumentation	B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electornics Engg, Electronics and communication Engg, Control and Instrumentation Engg, Instrumentation Engg, Bio Medical Engg, Mechatronics.
		iii.	Micro Electronics and MEMS	B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electronics Engg, Electronics and communication Engg, Control and Instrumentation Engg, Instrumentation Engg, Bio Medical Engg, Mechatronics, Telecommunication Engg

7	**Chemical Engineering**	i.	Chemical Engineering	B.E. / B.Tech – Chemical Engg, Petroleum Engg, Petrochemical Technology
		ii.	Food Processing Technology	B.E. / B.Tech - Chemical Engg, Food Technology, Biotechnology, Biochemical Engg, Agricultural Engg.
		iii.	Industrial Bio Technology	B.E. / B.Tech - Chemical Engg, Food Technology, Biotechnology, Leather Technology
		iv.	Industrial Safety Engineering	B.E. / B.Tech – Any Branch of Engineering
8	**Computer Science & Engineering**	i.	Computer Science & Engineering	B.E. / B.Tech - Computer Science and Engineering, Information Technology, Electronics and Communication Engg, Software Engineering
9	**Information Technology**	i	Information Technology	B.E. / B.Tech - Computer Science and Engineering, Information Technology, Electronics and Communication Engg, Software Engineering
10	**Electronics & Communication Engineering**	i.	Communication Systems	B.E. / B.Tech - Electronics and Communication Engg, Electronics Engg.

*** AMIE in the relevant discipline is considered equivalent to B.E**

M.E. (STRUCTURAL ENGINEERING) - (FULL TIME) (Two Years)

Choice Based Credit System (CBCS)

Courses of Study and Scheme of Examinations

Sl. No	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits
		S e m e s t e r – I								
1	PC – I	STEC101	Applied Mathematics	4	-	-	25	75	100	3
2	PC – II	STEC102	Matrix Computer Methods of Structural Analysis	4	-	-	25	75	100	3
3	PC – III	STEC103	Dynamics of Structures	4	-	-	25	75	100	3
4	PC – IV	STEC104	Advanced Concrete Technology	4	-	-	25	75	100	3
5	PE – I	STEE105	Elective – I	4	-	-	25	75	100	3
6	PE – II	STEE106	Elective – II	4	-	-	25	75	100	3
7	PC Lab – I	STEP107	Advanced Structural Engineering Laboratory	-	-	3	40	60	100	2
			Total	**24**	**-**	**3**	**190**	**510**	**700**	**20**

Sl. No	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits
		S e m e s t e r – II								
1	PC – V	STEC201	Behaviour of Reinforced Concrete Structures	4	-	-	25	75	100	3
2	PC – VI	STEC202	Finite Element Analysis	4	-	-	25	75	100	3
3	PC – VII	STEC203	Earthquake Engineering	4	-	-	25	75	100	3
4	PC – VIII	STEC204	Advanced Steel Structures	4	-	-	25	75	100	3
5	PE – III	STEE205	Elective – III	4	-	-	25	75	100	3
6	PE – IV	STEE206	Elective – IV	4	-	-	25	75	100	3
7	PC Lab – II	STEP207	Computing Techniques Laboratory	-	-	3	40	60	100	2
8	Semin	STES208	Seminar	-	-	2	100	-	100	1
			Total	**24**	**-**	**5**	**290**	**510**	**800**	**21**

Sl. No	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits
		S e m e s t e r – III								
1	OE – I	STEE301	Open Elective – I	4	-	-	25	75	100	3
2	OE- II	STEE302	Open Elective – II	4	-	-	25	75	100	3
3	Thesis	STET303	THESIS Phase – I	-	4	-	40	60	100	4
4	Ind.Train.	STEI304	Industrial Training	-	-	*	100	-	100	2
			Total	**8**	**4**	**-**	**190**	**210**	**400**	**12**

Note: * Four weeks during the Summer vacation at the end of IInd Semester

Sl. No	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits
S e m e s t e r – IV										
1	Thesis	STET401	THESIS Phase – II	-	8	-	40	60	100	12
			Total	**-**	**8**	**-**	**40**	**60**	**100**	**12**

M.E. (STRUCTURAL ENGINEERING) - (PART TIME) (Three Years)

Choice Based Credit System (CBCS)

Courses of Study and Scheme of Examinations

Sl. No	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full time
S e m e s t e r – I											
1	PC – I	PSTEC 101	Applied Mathematics	4	-	-	25	75	100	3	STEC101
2	PC – II	PSTEC 102	Matrix Computer Methods of Structural Analysis	4	-	-	25	75	100	3	STEC102
3	PC – III	PSTEC 103	Dynamics of Structures	4	-	-	25	75	100	3	STEC103
			Total	**12**	**-**	**-**	**75**	**225**	**300**	**9**	
Sl. No	**Category**	**Course Code**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full time**
S e m e s t e r – II											
1	PC – IV	PSTEC 201	Behaviour of Reinforced Concrete Structures	4	-	-	25	75	100	3	STEC201
2	PC – V	PSTEC 202	Finite Element Analysis	4	-	-	25	75	100	3	STEC202
3	PC – VI	PSTEC 203	Earthquake Engineering	4	-	-	25	75	100	3	STEC203
			Total	**12**	**-**	**-**	**75**	**225**	**300**	**9**	

Sl. No	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full time
S e m e s t e r – III											
1	PC - VII	PSTEC 301	Advanced Concrete Technology	4	-	-	25	75	100	3	STEC 104
2	PE - I	PSTEE 302	Elective - I	4	-	-	25	75	100	3	STEE 105
3	PE - II	PSTEE 303	Elective - II	4	-	-	25	75	100	3	STEE 106
4	PC Lab-I	PSTEP 304	Advanced Structural Engg. Laboratory	-	-	3	40	60	100	2	STEP 107
			Total	**12**	**-**	**3**	**115**	**285**	**400**	**11**	

Sl. No	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full time
S e m e s t e r – IV											
1	PC – VIII	PSTEC 401	Advanced Steel Structures	4	-	-	25	75	100	3	STEE204
2	PC – III	PSTEE 402	Elective – III	4	-	-	25	75	100	3	STEE205
3	PC – IV	PSTEE 403	Elective – IV	4	-	-	25	75	100	3	STEE206
4	PC Lab-II	PSTEP 404	Computing Techniques Laboratory	-	-	3	40	60	100	2	STEP207
5	Semin	PSTES 405	Seminar	-	-	2	100	-	100	1	STES208
			Total	**12**	**-**	**5**	**215**	**285**	**500**	**12**	

Sl. No	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full time
			S e m e s t e r – V								
1	OE - I	PSTEE 501	Open Elective - I	4	-	-	25	75	100	3	STEE301
2	OE - II	PSTEE 502	Open Elective - II	4	-	-	25	75	100	3	STEE302
3	Thesis	PSTET 503	THESIS Phase - I	-	6	-	40	60	100	6	STET303
4	Ind.Train.	PSTEI 504	Industrial Training	-	-	*	100	-	100	2	STEI304
			Total	**8**	**6**	**-**	**90**	**210**	**300**	**12**	
Note: * Four weeks during the Summer vacation at the end of IVth Semester											
Sl. No	**Category**	**Course Code**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full time**
			S e m e s t e r – VI								
1	Thesis	PSTET 601	THESIS Phase - II	-	8	-	40	60	100	12	STET 401
			Total	**-**	**8**	**-**	**40**	**60**	**100**	**12**	

L - Lecture; P - Practical; T – Thesis; CA – Continuous Assessment; FE – Final Examination

PROFESSIONAL ELECTIVES (PE)

1. Theoretical & Experimental Stress Analysis with Instrumentation
2. Forensic Engineering and Retrofitting of Structures
3. Tall Structures
4. Behaviour of Pre-stressed Concrete Structures
5. Theory and Design of Plates
6. Design of Shell Structures
7. Theory of Elasticity and Plasticity
8. Advanced Foundation Design
9. Structural up gradation with Fibre Reinforced Polymer (FRP) Composites
10. Strength and deformation of Concrete members
11. Composites for Constructions using FRP Pultruded Profiles

OPEN ELECTIVES (OE)

1. Research Methodology
2. Experimental Techniques and Instrumentation
3. Contract Laws and Regulations
4. Structural Optimization
5. Prefabricated Structures
6. Soil Structure Interaction
7. Composite Structures
8. Special Concretes
9. GIS in Construction Engineering and Management
10. Bridge Engineering
11. Stability of Structures
12. Construction Planning and Scheduling
13. Shoring, Scaffolding and Formwork
14. Value Engineering and Valuation
15. Construction Personnel Management
16. Construction Workplace and Employees behaviour
17. Design of Nuclear Structures

STEC101	APPLIED MATHEMATICS	L	T	P
		4	0	0

COURSE OBJECTIVES:

- The course-work consists of the students actively investigating mathematical ideas.
- This mathematics course for engineering deals with advanced analytical and numerical techniques for solving engineering problems.
- To acquaint the student with the concepts in Calculus of variations, special functions boundary value problem and conformal mapping.

Matrices and Vector Space

Inverse of a matrix by elementary transformation method, partition methods, Choleski's method- Degeneration of a symmetric Matrix- Hermition form –Canonical form Unitary matrix - Orthogonal Matrix - Orthogonal system of vectors-Vector space-Linear independence -bases - sub space - dimensionality - Inner Product space.

Calculus of Variations

Maxima and Minima of functions of two variables - Lagrange Multipliers - Functional - Strong and weak variation - vibrational notations - Euler Lagrange Equation - Euler Lagrangian equations for functional with higher order derivatives - simultaneous Euler Lagrange Equation for functional with several independent variables subject to constraints.

Special Functions

BETA and GAMMA functions - Bessel's functions, Legendre Polynomials and their properties - expansion of an arbitrary function in terms of Bessel functions and Legendre Polynomials.

Storage of Large Number of Equations

Introduction - Solution of large number of equations - Sky line storage, band form - Band width reduction - Algorithm due to Grooms - Solution of large number of equations - Band solver, Frontal Solver, Cholesky LU decomposition in sky line storage - Substructure concept - Sub matrix equation solver.

Boundary Value Problems

Review of Finite Difference operations - Solution of Elliptic, Parabolic and Hyperbolic Equations - Applications of beams, Columns & Plates. **Conformal Mapping and Applications -** Introduction to conformal mappings and bilinear transformations – Schwarz Christoffel transformation – Transformation of boundaries in parametric form – Physical applications: Fluid flow and heat flow problems.

REFERENCES:

1. M.K.Venkataraman , *Higher Mathematics for Engineers,* National Publishing Co., 1986
2. S.Rajasekaran, *Numerical Methods for Initial & Boundary Value Problems,* A.H. Wheeler &Co., 1987.
3. E.L.Wilson andK.J. Bathe*, Numerical Methods in Finite Element Analysis*: Prentice Hall, 1995.
4. Dennis G. Zill, Michael R. Cullen, *Advanced Engineering Mathematics:* Jones & Bariett Publication, 2006.
5. Greyszig *, Advanced Engineering Mathematics:* John Wiley & Sons Inc., 2005.
6. Michael D. Greenberg, *Advanced Engineering Mathematics,* Prentice Hall, 1997.
7. Gupta, A.S., *Calculus of Variations with Application*, Prentice Hall of India Pvt. Ltd. NewDelhi, 1997.
8. Spiegel, M.R., *Theory and Problems of Complex Variables and its Application (Schaum's Outline Series)*, McGraw Hill Book Co. 1981

COURSE OUTCOMES:

At the end of the course students will be able

1. to acquire basic understanding of the concepts in the topics mentioned above
2. to learn some methods of solving problems.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓	✓			✓				
CO2	✓	✓	✓		✓	✓				✓

STEC102	**MATRIX COMPUTER METHODS OF STRUCTURAL ANALYSIS**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- This course is a prelude to the finite element analysis, a very versatile tool for solving complex Structural problems.
- Basic knowledge regarding the formulation of stiffness matrices at the element level as well as at the system level is included in the course.

Rudimentary Concepts

Introduction–Types of Framed structures –Deformations in framed structures–Actions and Displacements–Equilibrium–Compatibility–Superposition–Static and Kinematic

Indeterminacy–Structural mobilities–Strain Energy due to axial force, Bending, Shear and Torsion – Maxwell's Theorem- Betti's law–Method of consistent deformation–Action and Displacement Equations – Flexibility and Stiffness of members – Flexibility and Stiffness matrices–relationship between flexibility and stiffness matrices–Strain Energy in terms of stiffness and flexibility matrices.

Characteristics of Structure Stiffness and Flexibility

Introduction to structure with single coordinate – Two coordinates-Flexibility and Stiffness Matrices in Coordinates–Examples–Symmetric Nature of Matrices – Stiffness and Flexibility Matrices in Constrained Measurements – Stiffness and Flexibility of Systems and Elements – Computing Displacements and Forces form Virtual Work–Computing Stiffness and Flexibility Coefficients.

Transformation Concepts

Determinate and Indeterminate Structures–Transformation of system forces to element forces-Element Flexibility to System Flexibility–System Displacement to Element Displacement-Element Stiffness to System Stiffness–Transformation of forces and displacements in general stiffness and flexibility in general–Normal Coordinates and Orthogonal Transformation–Principle of Contragredience.

Flexibility Method

Flexibility Equation –Member end actions– Flexibility coefficients – Member and system Flexibility Matrices – Transformation Matrix – Equivalent Joint Loads – Solution procedure – choice of redundant leading to ill and well–Conditioned Matrices–Internal forces due to thermal expansion, prestrains, support settlements and flexural hinges –Reducing the Size of flexibility matrix- application to Pin-Jointed Plane truss– continuous beams– plane frames–Grids.

Develop computer programs for storing data; assembling stiffness and flexibility matrices; load vectors; displacement vectors. Develop computer programs for analysis of framed structure. Modelling and analysis of real-life structure using professional softwares.

Stiffness Method

Stiffness Equation –Member stiffness Matrix–Stiffness Matrix for Structures with zero Force at some Coordinates-Analogy between Flexibility and Stiffness-Lack of Fit-Stiffness Matrix with Rigid Motions-Application of Stiffness Approach to Pin Jointed Plane Trusses-Continuous Beams- Frames-Grids-Space Trusses and Frames-Introduction Only-Static Condensation Technique- Choice of Method-Stiffness or Flexibility.

Develop computer programs for storing data; assembling stiffness and flexibility matrices; load vectors; displacement vectors. Develop computer programs for analysis of framed structure. Modelling and analysis of real-life structure using professional softwares.

REFERENCES:

1. W.Weaver and J.Gere, *Matrix Analysis of Framed Structures,* CBS Publishers and Distributors, 1990.
2. G.S.Pandit and S.P.Gupta, *Structural Analysis- A Matrix Approach,* Tata McGraw Hill Publishing Company, 1981.

3. H.C. Martin, *Introduction to Matrix Methods of Structural Analysis*, McGraw-Hill, 1966.
4. J.L. Meek, *Computer Methods in Structural Analysis,* Spon Press, 1991.
5. W. M. Jenkins*, Matrix and Digital Computer Methods in Structural Analysis,* MC Graw Hill1969.
6. K. Rubinstein. F. M., *Matrix Computer Methods of Structural Analysis*, Prentice Hall, Inc. N.J., 1966
7. Dr. Devadas Menon., *Advanced Structural Analysis*, Narosa Publishing House, New Delhi, 2009
8. Reddy C.S., "*Basic Structural Analysis*", Tata Mc Graw-Hill Publishing Company Limited, New Delhi,1997

COURSE OUTCOMES:

At the end of the course students will be able to

1. To analyze the indeterminate structures like beams, frames, etc. with different end conditions through various advanced and modern methods.
2. To solve the structural problems with matrix approach.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓					✓			
CO2	✓	✓	✓				✓			

STEC103	**DYNAMICS OF STRUCTURES**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- As modern structures are becoming more slender and light, they are also becoming more susceptible to dynamic loadings.
- Examples of real- life dynamic problems that frequently confront civil engineers include: aerodynamic stability of long-span bridges, earthquake response of multi-storey buildings, impact of moving vehicles on highway structures, *etc.,*
- The traditional engineering solutions to these problems, based on "static force" and "static response", are no longer valid in most cases.
- Many of these problems have to be tackled by applying knowledge of structural dynamics.
- Thus, a basic understanding of the dynamic behaviour of structures as well as the underlying principles is essential for structural engineers

Dynamics systems; mass, stiffness and damping elements, Degrees of Freedom, Discrete and continuous systems, Principles of Structural dynamics. Free, Forced, Un-damped, Damped, Linear, Non-linear, Deterministic and Random Vibrations. Vibration analysis: Harmonic analysis. Structural idealization with multi mass points. Identification of mass, stiffness and damping in a conventional structural systems. Classification of damping present in the dynamic systems with suitable examples.

Discrete systems: Analysis of Single Degree of freedom systems with damping without damping: Formulation of equation of motions using direction equilibrium concept and principle of conservation of energy. Equations of motion and solutions- logarithmic decrement – energy dissipation in viscous damping. Free vibration with coulomb damping, Free vibration with hysteretic damping.

Discrete systems: Forced vibration analysis of Single Degree of freedom systems with damping without damping under harmonic excitations: Formulation of equation of motions. Forced vibration with viscous damping – steady state solutions, constant force, harmonic exciting force of constant amplitude, harmonic exciting force with rotating mass type excitations, Harmonic response curves showing band-with and half power points – Natural frequencies and resonant frequencies. Analysis of forced vibration analysis using Impedance method. Forced vibration response to harmonic base excitation. Force Transmitted to base – Transmissibility in terms of displacement and force - simple problems on base isolation. Simple Vibration measuring instruments. Forced vibration with coulomb damping, Forced vibration with hysteretic damping. Self excited systems and stability.

Force vibrations due to general periodic excitations. Response due to Non-periodic force-Convolution Integral method or Duhamel's Integral method - impulse response functions – Response to an arbitrary Excitation, step excitation, Impulse length ratio shock spectrum – Simple Problems. Free vibration analysis of multi Degrees of freedom systems: Formulation of equation of motions. Orthogonally of normal – Modal analysis – Un-damped system – Damped system using proportional damping – modes. Force vibration analysis of multi Degrees of freedom systems(restricted to three degrees of freedom only) – Formulation of equation of motions – Expressions in matrix form –solution of MDOF systems – Numerical methods for solution of MDOF systems.

Continuous systems: Vibrations of elastic beams and columns. Formulation of equations of motion. Vibration in elastic media. Kinematics of waves- longitudinal vibrations in a rod, impulse excitations of free bar. Finite element formulations for truss and beam elements using lumped parameter concept.

REFERENCES:

1. Anil k Chopra, *Dynamics of Structures,* McGraw-Hill International Edition, 1998.
2. Clough, R.W. and Penzien, J., *Dynamics of Structures, Second Edition,* McGraw-Hill International Edition, 1993.
3. Kameswara Rao, *Vibration Analysis and Foundation Dynamics,* Wheeler Publishing, 1998.
4. Humar.L., *Dynamics of Structures, Second Edition,* McGraw-Hill International Edition, 1989.

5. Thomson and M.Dillon Dahleh, *Theory of Vibration with Application*, Prentice Hall, 5th Editon, 1997.
6. R.R.Craig, An *Introduction to Computer Methods – Structural Dynamics,* Wiley, 1981.
7. D.J.Inman, *Engineering Vibrations,* Prentice Hall, 2000

COURSE OUTCOMES:

At the end of the course students will be able
1. To understand the dynamic properties.
2. To gain knowledge about the earthquake occurrence and resistance.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓			✓	✓	✓			
CO2	✓	✓			✓					

STEC104	**ADVANCED CONCRETE TECHNOLOGY**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- This course provides the advanced knowledge of concrete technology which covers the properties of fresh and hardened concrete and the concept of durability.
- New concrete making materials and recent advancements in concrete technology such as High strength concrete, High performance concrete, Fiber reinforced concrete and self-compacting concrete.

Constituents of concrete - Portland cement – composition – types – codal standards – hydration – structure of hydrated cement paste – factors influencing cement quality – supplementary Cementitious materials and their characterization – admixtures - construction chemicals - classification - mechanism – performance – application – aggregates - shape – properties – absorption – chemical stability – packing characteristics – effect of aggregate on concrete properties – conventional and non-conventional aggregates – light weight and heavy weight aggregates – significance of aggregate characterization.

Concrete mixture proportion - concrete constituents – relevant parameters – relationships of mix Composition and properties of concrete – Principles of concrete mix design, Methods of concrete mix design, IS Method, ACI Method, DOE Method– Statistical quality control–Sampling and acceptance criteria. High Performance – Entropy and Shack lock's Empirical graphs –particle packing theory.

Properties of fresh concrete - Workability – factors influencing – loss of workability – setting – hardening – plastic and thermal cracking – Interfacial Transition Zone – fracture strength – mechanical properties – shrinkage – creep – temperature effects - Durability of concrete - basic considerations – stability of constituents – permeation characteristics – testing – chemical attack – freeze and thaw action – efflorescence - Testing of fresh and hardened concrete – non-destructive testing.

Special concretes -Fibre reinforced concrete – aerated concrete – no fines concrete – SIFCON – SIMCON - spun concrete – polymer concrete – lightweight concrete – high density concrete – high performance concrete (HPC) – self compacting concrete (SCC)– vacuum concrete. Fly ash concrete, Fibre reinforced concrete, Sulphur impregnated concrete, Polymer Concrete–High performance concrete. High performance fiber reinforced concrete, Self- Compacting-Concrete, Geo-Polymer Concrete, Waste material based concrete–Ready mixed concrete – Testing methods –Codal standards –principle – mechanism – properties – applications

Process of manufacturing of ready mix concrete, methods of transportation, placing and curing. Extreme weather concreting, special concreting methods. Vacuum dewatering–Underwater Concrete.

REFERENCES:

1. Mehta, P.K., and Montero, P.J.M., *Concrete Microstructure, Properties and Materials*, Indian Concrete Institute Chennai, 1999.
2. Neville, A.M., *Properties of Concrete*, 4th Edition, Longman, 1995.
3. Mindess and Young, *Concrete,* Prentice Hall, 1998.
4. John Newman and Ban Seng Choo, *Concrete Technology*, *Vol. I to IV*, Elsevier, 2003.
5. Francois de Larrard, *Concrete Mixture Proportioning – Scientific Approach* E &FN SPON, London, 1999.
6. Jan P. Skalny, *Material Science of Concrete*, *Vol. I to IV*, The American Ceramic Society, Inc. Westerville, OH., 1989.
7. Krishna Raju, N, *Design of Concrete Mixes*, CBS Publishers, Delhi, 2000.

COURSE OUTCOMES:

1. On completion of this course the students will know various tests on fresh, hardened concrete.
2. Making of special concrete and the methods of manufacturing of concrete.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓	✓		✓					✓
CO2		✓	✓		✓			✓		✓

STEP107	ADVANCED STRUCTURAL ENGINEERING LABORATORY	L	T	P
		0	0	3

COURSE OBJECTIVES:

- This course enables the students in studying and understanding the behaviour of steel reinforcement, non – prismatic sections, concrete etc.,

Utilization of mechanical and electrical resistance strain gauges-studying the behaviour of concrete elements –studying the behaviour steel beams.

1. Model analysis
   a. Concrete beam
   b. Portal frame
2. Beams of various cross sections.
3. Continuous beam.
4. Sand heap analogy
5. E for concrete
6. Euing's Extensometer
7. Mechanical strain gauge
8. Unsymmetrical bending
9. Concrete durability test
   a. RCPT
   b. Sorptivity test
   c. Soundness of aggregate test
   d. Acid resistance test
   e. Sea water resistance
   f. Corrosion resistance
10. Preparation of HPC and test on HPC using construction chemicals.

REFERENCES:

1. Dr. Sadhu Singh, *Experimental Stress Analysis,* Khanna Publishers, 2009.
2. Dr. Srinath.L.S, *Experimental Stress Analysis,* Tata McGraw Hill Publications, 1984.
3. Ray.T.K, *Experimental Stress Analysis,* Tata McGraw Hill Publications.
4. Dr. Sadhu Singh, *Applied Stress Analysis,* Tata McGraw Hill Publications, 1983.
5. Dally & Riley, *Experimental Stress Analysis,* Tata McGraw Hill Publications, 1980.
6. Vazrani&Chandola, *Experimental Stress Analysis,* Tata McGraw Hill Publications, 1980.
7. DurelliA.J, A*pplied Stress Analysis,* Prentice Hall of India, 1970.
8. Mehta,P.K., and Monteiro, P.J.M., *Concrete, Microstructure, Properties and Materials*, Indian Concrete Institute, 1997.
9. Shetty, M.S., *Concrete Technology*, S.Chand & Co., New Delhi, 2002.

COURSE OUTCOMES:

At the end of the course students will be able

1. To gain knowledge on Steel elements for practical application.
2. To get experience in Modal analysis.
3. To understand the development of concrete durability

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓		✓			✓		✓
CO2	✓		✓	✓	✓			✓		✓
CO3				✓	✓			✓		✓

STEC201	**BEHAVIOUR OF REINFORCED CONCRETE STRUCTURES**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- The objective of this course is to provide basic knowledge relating to the behaviour of concrete under flexure, shear and torsion in isolation and in combination.
- The serviceability issues are also included in the course.

Stress–Strain relationships for concrete and steel – Behaviour of concrete under uni-axial compression, Tension and Combined stresses. Behaviour of concrete under static and dynamic loads– Behaviour of concrete under sustained loading over a period of time (Creep) Behaviour of concrete under Shrinkage and temperature changes. Design philosophy– Working Stress Method – Ultimate Load Method – Limit State Method –Load resistance Factor Design Method.

Behaviour of Beams and slabs for flexure uncracked phase-cracked phase – stages leading to limit state of collapse – analysis at service loads- analysis at ultimate limit state – moment-versus curvature relationships. Behaviour of concrete in shear – mechanism of shear resistance of concrete due to aggregate interlock, dowel and with web reinforcement – critical sections for shear – relationship between tensile stress with shear stress– interaction of flexure, shear and axial forces.

Behaviour of concrete in torsion – equilibrium and compatibility torsion – combined flexure and torsion – combined shear and torsion – torsional stiffness– Torsion versus twist relationship for concrete members.

Bond and anchorage – mechanisms of bond resistance – type of bond – bond failure mechanisms –anchorage requirements – splicing of reinforcement. Deflection and cracking –factors influencing deflection-short-term deflection – control of deflection–calculation of deflection-Long-Term deflection-Deflection due to temperature, creep and shrinkage– limits on deflection – causes of cracking-factors influencing crack width in flexure-mechanisms of flexural cracking-control of flexural cracking in design.

Detailing of reinforcements – Beams – Columns – beam- column connections –corbels – deep beams. Concrete cover-Fire Rating as per IS specification.

REFERENCES:

1. Robert Park & Thomas Paulay,*Reinforced Concrete Structures,* John Wiley & Sons, 1975
2. S. UnnikrishnaPillai and Devdas Menon, *Reinforced Concrete Design,* Tata McGraw Hill,1999.
3. Branson, Dan.E., *Deformation of Concrete Structures,* McGraw Hill,1977.
4. Wang, C.K & Salmon, C.G, *Reinforced Concrete Design,* John Willey & Sons, 2002.
5. Edward G.Nawy, *Reinforced Concrete, A Fundamental Approach,* Prentice Hall, 1995.
6. Hiroyuki Aoyama, *Design of Modern High Rise RC Structures, World Scientific Publishing Company,* 1st Edition, 2002.
7. George A. Hool*, Concrete Engineer's Handbook,* McGraw Hill, 1918.
8. Allan Williams, *Reinforced Concrete Structures, Kalplan AEC Education,* 3rdEdition, 2005.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Understand the behaviour of concrete under uni-axial compression, Tension and Combined stresses
2. Understand the behaviour of concrete under bond and anchorage.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓	✓			✓				✓
CO2		✓	✓			✓				✓

STEC202	**FINITE ELEMENT ANALYSIS**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- This course provides an introduction to the finite element method, from engineering rather than a purely mathematical point of view.
- However, the mathematical foundations of the methods are presented along with their physical interpretations.
- The basic theory and several applications of the finite element method, as well as the standard procedures taken in developing stand-alone finite element computer codes or

applying larger public domain or commercial finite element software packages to analyze particular problems, are presented.

Introduction - Finite Element Formulation – Steps involved - Advantages and Disadvantages - Applications - Two Dimensional Elasticity problems - Plane Stress and Plane Strain - Equilibrium equations -Strain-displacement equations - Compatibility equations - Constitutive equations - Boundary conditions.

Finite Element types – Displacement Function – Relationship between the nodal degrees of freedom and generalized coordinates– Convergence requirements – Natural Coordinates – Shape Functions –Element strains and stresses– Shape functions for truss elements in local and global coordinates - Shape function for beam and frame elements.

Triangular elements (CST and LST elements), Rectilinear elements –Iso-parametric elements– Iso-parametric elements–Four noded Iso - parametric elements–Eight Noded Iso-parametric elements–Incompatible displacements models– Patch test–Reinforced Concrete Element– Element stiffness formulation for truss elements in local and global coordinates, beams, LST, CST elements, Solid Elements, Load vectors for gravity, surface and body forces.

Numerical Integration for evaluation of element stiffness – Load vectors- Computation of stresses. Use of Static Condensation Techniques, Axi-symmetric elements, Plate bending and shell elements– Plate Elements–Shear deformation in plate element–Solid elements–Shell Elements–Bilinear degenerated Shell Element– Finite Element for heat conduction– Finite Element for hydrostatic pressures – Finite Element for soil pressures.

Pre and Post Preprocessing – Modelling techniques – Sub-structuring techniques – Error estimation – Regular and Adoptive meshing techniques. Complete algorithms with flow chart for solving FEM problems - Solution Techniques – Linear analysis-Non-linear analysis both material and geometric non-linearity – Application of Finite element software packages such as ANSYS, SAP 2000N, STAAD Pro, ETABS, ABAQUS, MSC/NASTRAN, etc.

REFERENCES:

1. Dr.Krishnamoorthy.C.S, *Finite Element Analysis - Theory and Programming,* Tata McGraw Hill Publications, New Delhi, 1995
2. Seshu P, *Finite Element Analysis,* Prentice Hall of India, 2005.
3. Chandrupatla, T.R. and Belegundu, A.D, *Introduction to Finite Element in Engineering*, Prentice Hall, India, 2003.
4. Reddy J.N, *An Introduction to Finite Element Method*, McGraw Hill, International Edition, 2006.
5. Dr. Rajasekaran.S, *Finite Element Analysis in Engineering Design,* S.Chand and Co., New Delhi, 2014
6. Cook.R.D, *Concepts and Applications of Finite Element Analysis,* Tata McGraw Hill Publications, New Delhi,1989
7. Desai.C.S&Abel.J.F, *Introduction to the FEM,* Affiliated East West Press, 1972.
8. Rao.S.S, *The Finite Element Method in Engineering*, Butters worth-Heinemann Publishing.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Solve physical problems using finite element software's.
2. Develop computer coding for any structural problem and creating software packages.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓	✓				✓			
CO2		✓	✓				✓			

STEC203	**EARTHQUAKE ENGINEERING**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- Wind and earthquake excitations are two major dynamic loadings to be considered for many modern civil engineering structures.
- An improved understanding of these loadings will enable design engineers to ensure the safety and serviceability of structures.

Elements of Engineering Seismology: Earthquake occurrence in the world causes of earthquake, plate tectonics, earthquake mechanism, seismic zoning map of India & its use. Earthquake Effects: Land and rock slides, liquefaction, fires, tsunamis, floods, release of poisonous gases and radiation.

Earthquake Phenomenon - focus epicenter, seismic waves, magnitude, intensity, intensity scale and its correlation with ground acceleration, characteristics of strong ground motions and attenuation, earthquake recording instruments. Do's and Don'ts for protection of life and property Introduction to theory of vibrations: Single degree un-damped and damped systems, elastic response to simple load functions & earthquake response spectra.

Response Spectrum Analysis- Response spectrum function - Load combination Rule. Equivalent static lateral earthquake force on building (IS:1893): Equivalent static method - Seismic coefficients-evaluation, estimation off undamental time period, base shear and its distribution. Dynamic analysis using mode superposition concept - Push over analysis.

Analysis of Infill shear wall. Modelling of Infill masonry and shear waif - Effect of openings - Strength of equivalent strut Local crushing failure - Shear failure. Introduction to a seismic design of Structures: Philosophy and principles of earthquake resistance design- Strength and stiffness, ductility design and detailing (15:13920), design of energy absorbing devices, concepts of seismic base isolation and seismic active control. Building forms and architectural design concepts-Horizontal and vertical eccentricities due to mass and stiffness distribution, structural redundancy and setbacks.

Performance of building and Structures: Main causes of damage-Intensity of earth quake forces, lack of strength and integrity in buildings, quasi resonance, lack of ductility, lack of detailing. Lessons learnt from the past earthquakes: - case studies of important Indian earthquakes, major world earthquakes, earthquake catalogue, assessment of damage. Use of relevant codes. Building deficiencies - Local and Global refit strategies.

REFERENCES:

1. Dowrick, D.J., *Earthquake Resistant Design,* John Wiley & Sons, Winchester, U.K., 1977
2. Paulay, T. and Priestley, M.J.N., *Seismic Design of Reinforced and Masonry Buildings,* John Wiley & Sons, Inc., New York, 1992.
3. Anil k Chopra, *Dynamics of Structures,* McGraw-Hill International edition, 1998.
4. Clough, R.W. and Penzien, J., *Dynamics of Structures, Second Edition,* McGraw-Hill International Edition, 1993.
5. Arnold, C. and Reitherman, R., *Building Configuration and Seismic Design,* John Wiley & Sons, Inc., New York, 1982.
6. Kiyoshi Muto, *Earthquake Resistant Design of Tall Buildings in Japan*, University of California, 1973.
7. D.E. Beskos*, Computer Analysis & Design of Earthquake Resistant Structures - A Handbook Advances in Earthquake Engineering,* Computational Mechanics Inc, 1997.
8. Hiroshi Akiyama, *Earthquake Resistant Limit State Design for Buildings*, University of Tokyo Press, 1985.

LIST OF IS CODES:

1. **IS 1893 : 2002** — *Criteria for Earthquake Design of Structures*, Bureau of Indian Standards, New Delhi.
2. **IS 4236 : 1976** — *Code of Practice for Earthquake Resistant Design and Construction of Buildings*, Bureau of Indian Standards, New Delhi.
3. **IS 13920: 199**3 — *Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces* — Code of Practice, Bureau of Indian Standards, New Delhi.
4. *Explanatory Handbook on Codes for Earthquake Engineering*, Special Publication SP 22, Bureau of Indian Standards, New Delhi.
5. *Explanatory Handbook on Indian Standard Code of Practice for Plain and Reinforced Concrete (IS 456:2000)*, Special Publication SP: 24, Bureau of Indian Standards, New Delhi.

COURSE OUTCOMES:

At the end of the course students will be able

1. To understand the dynamic properties.
2. To gain knowledge about the earthquake occurrence and resistance.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓	✓		✓	✓				✓
CO2		✓	✓		✓	✓				✓

STEC204	**ADVANCED STEEL STRUCTURES**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- This course will focus on the issues relating to the analysis and design of industrial building bents, towers and pre-engineered building systems.

Behaviour of Industrial Bends

Design of members subjected to lateral loads and axial loads - Analysis and Design of industrial building bents - cranes Gantry Girders and Crane columns - Bracing of Industrial Buildings and Bents. **Behaviour of Tall Steel Frames-**Analysis & Design of Steel Towers, Trestles & Masts Subjected to wind and earthquake forces.

Plastic Analysis

Introduction - Shape factors - moment redistribution - static - Kinematic and uniqueness theorems- combined mechanisms - Analysis of single bay and two bay portal frames -Methods of plastic moment distribution - Effect of Axial force and Shear force on plastic moment - connections -moment resisting connection.

Cold Formed Sections

Types of cross sections - Design of cold formed thin walled members - local Buckling and post buckling strength - Beams - Columns -beam columns - connections.

Pre Engineered Building

Introduction-Rigid frame End -Post and beam End -Design of Purlins and girders subjected to different load conditions - Limitations of pre-engineered buildings-Ad vantages Comparison with Conventional Steel Buildings.

Structural Detailing

Base plate with anchor bolt details - columns with battened plate and lacing - Column splice plate -Column with cap plate details - Gantry supporting columns -Stepped columns - Beam and

column connections - Beam to beam connections - Roof truss details - Vertical and Horizontal bracings with gusset plates.

REFERENCES:

1. Dayaratnam, *Design of Steel Structures*, A.H.Wheeler, 1990.
2. A.S.Arya, *Design of Steel Structures*, New Chand & Co, 1982
3. Hronc,M.R. and Morn's L.J. Plastic, Design of Low-Rise Frames, Granada Publishing Ltd.,New York, 1981.
4. Salmon,C.G.,and Johnson, J.E. , *Steel Structures Design and Behaviour*, Harper and Row, 1980.
5. Wie-Wen Yu, *Cold-Formed Steel Structures*, McGraw Hill Book Company, 1973.

COURSE OUTCOMES:

At the end of this course students

1. Will be in a position to design bolted and welded connections in industrial structures.
2. Will know the plastic analysis and design of light gauge steel structures.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓		✓	✓	✓			✓	✓
CO2		✓		✓	✓	✓			✓	✓

STEP207	**COMPUTING TECHNIQUES LABORATORY**	**L**	**T**	**P**
		0	0	3

COURSE OBJECTIVES:

- This course gives an exposure to the students in utilizing sophisticated computer aided tools for analysis and design.

Introduction to STADD PRO and Etabs Softwares

Plate 1. Analysis of Symmetrical Building Frames (Gravity Load Only) using STADD PRO Software.

Plate 2. Analysis of Symmetrical Building Frames (Wind Load Only) using STADD PRO Software.

Plate 3. Analysis of Symmetrical Building Frames (Earthquake Load Only) using STADD PRO Software.
Plate 4. Analysis of Un-Symmetrical Building Frames (Gravity Load Only) using STADD PRO Software.
Plate 5. Analysis of Un-Symmetrical Building Frames (Wind Load Only) using STADD PRO Software.
Plate 6. Analysis of Un-Symmetrical Building Frames (Earthquake Load Only) using STADD PRO Software.
Plate 7. Analysis of Symmetrical Building Frames (Gravity Load Only) using Etabs Software.
Plate 8. Analysis of Symmetrical Building Frames (Wind Load Only) using Etabs Software.
Plate 9. Analysis of Symmetrical Building Frames (Earthquake Load Only) using Etabs Software.
Plate 10. Analysis of Un-Symmetrical Building Frames (Gravity Load Only) using Etabs Software.
Plate 11. Analysis of Un-Symmetrical Building Frames (Wind Load Only) using Etabs Software.
Plate 12. Analysis of Un-Symmetrical Building Frames (Earthquake Load Only) using Etabs Software.

REFERENCES:

1) *STADD PRO and Etabs Software Working Manuals.*
2. Dr. Krishnaraju.N, *AdvancedR.C.Design*,CBS Publishers & Distributors Pvt Ltd, 2012.
3. Dr. Punmia.B.C, et al, *R.C.Structures- Vol.I& II,* Laxmi Publications (P) LTD, 1995
4. Mallick.S.K&Gupta.A.P,*Reinforced Concrete*, Oxford I B H, 1987.
5. Park and Paulay**.** T**,** *R.C.Structures*, Tata McGraw Hill Publications, 1975.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Know how to model the symmetrical and unsymmetrical frames.
2. Do finite element analysis of structural problems with ease

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1					✓	✓	✓	✓		✓
CO2					✓	✓	✓	✓		✓

STES208	SEMINAR	L	T	P
		0	0	3

COURSE OBJECTIVES:

- To work on a technical topic related to Structural Engineering and acquire the ability of written and oral presentation
- To acquire the ability of writing technical papers for Conferences and Journals

The students will work for two periods per week guided by student counsellor. They will be asked to present a seminar of not less than fifteen minutes and not more than thirty minutes on any technical topic of student's choice related to Structural Engineering to engage in discussion with audience. They will defend their presentation. A brief copy of their presentation also should be submitted. Evaluation will be done by the student counsellor based on the technical presentation and the report and also on the interaction shown during the seminar.

COURSE OUTCOMES:

1. The students will be getting the training to face the audience and to interact with the audience with confidence.
2. To tackle any problem during group discussion in the corporate interviews.

Course objectives	Mapping with Programme Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓				✓	✓				
CO2			✓		✓			✓	✓	✓	

STET303	THESIS PHASE – I	L	T	P
		0	4	0

COURSE OBJECTIVES:

- This course gives an all-round exposure to the students on the courses studied in the previous Semesters.

A thesis work on a specialized topic in Structural Engineering should be taken at the beginning of the Third Semester in consultation with the Head of the Department. A report must be submitted at the end of the Third semester and there will be a Viva Voce examination on the thesis.

COURSE OUTCOMES:

At the end of the course students will be able to
1. do the project related to structural engineering.
2. Do the analysis on materials and check the quality and its application.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1			✓					✓		✓
CO2			✓					✓		✓

CEMI304	**INDUSTRIAL TRAINING**	**L**	**T**	**P**
		0	**0**	*

COURSE OBJECTIVES:

- To train the students in the field work related the Structural Engineering and to have a practical knowledge in carrying out Structural Engineering field related works.
- To train and develop skills in solving problems during execution of certain works related to Structural Engineering.

The students individually undergo a training program in reputed concerns in the field of Structural during the summer vacation (at the end of second semester for full – time / fourth semester for part – time) for a minimum stipulated period of four weeks. At the end of the training, the student has to submit a detailed report on the training he had, within ten days from the commencement of the third semester for Full-time / fifth semester for part-time. The students will be evaluated by a team of staff members nominated by head of the department through a viva-voce examination.

COURSE OUTCOMES:

1. The students can face the challenges in the practice with confidence.
2. The student will be benefited by the training with managing the situation arises during the execution of works related to Structural Engineering.

Course objectives	Mapping with Programme Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓				✓	✓				
CO2			✓		✓			✓	✓	✓	

STET401	THESIS PHASE – II	L	T	P
		0	8	0

COURSE OBJECTIVES:

- This course gives an all-round exposure to the students on the courses studied in the previous semesters.

The thesis work on a specialized topic in Structural Engineering already selected in the Third Semester will be continued in the fourth semester. A report must be submitted at the end of the Fourth semester and there will be a Viva Voce examination on the thesis.

COURSE OUTCOMES:

At the end of the course students will be able to

1. do the thesis related to structural engineering.
2. Frames and materials testing and design
3. Software applications to structural related research problems

	Mapping with Programme Outcomes									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1			✓				✓	✓		✓
CO2			✓				✓	✓		✓
CO3			✓				✓	✓		✓

PROFESSIONAL ELECTIVES

STEEXXX	THEORETICAL & EXPERIMENTAL STRESS ANALYSIS WITH INSTRUMENTATION	L	T	P
		4	0	0

COURSE OBJECTIVES:

- The objective of the course is to provide in-depth knowledge on advanced theoretical and experimental techniques of displacement and load measurements.
- The course deals specifically with all building materials and its behaviour. Emphasis is placed on design and fabrication of devices with attention to specifications, environment and length of application.
- In-depth consideration is given to the device as well as associated data acquisition.

Part-A Theoretical Stress Analysis

Basic concepts of deformation of deformable Bodies, Notations for stress and strain in two and three dimensions. Stress transformation laws - Differential equations of equilibrium in two and three dimensions in Cartesian coordinates, Generalised Hooke's law -Lame's constants.

Plane stress and plane strain problems - examples- Airy's stress function - polynomials – direct method of determining Airy's stress function. Two dimensional problems in rectangular coordinates -(a) bending of a cantilever loaded at free end (b) bending of a beam by uniform load. Equation of Equilibrium in polar coordinates - Two dimensional problems in polar coordinates for curved beam, thick cylinders and plate with holes.

Energy principle - theorem of minimum potential energy Hamiltan's principle - Castigliano's least work theorem - Castigliano's theorem on deflection - Maxwell's reciprocal law. Torsion of various shaped bars - Prandle's membrane analogy - sand heap analogy - Torsion of thin walled sections and hollow shafts.

Part-B Experimental Stress Analysis with Instrumentation

Basic concepts in stress and strain analysis - Two dimensional, three dimensional and plane stress problems - stress analysis using equilibrium equations and load relaxation techniques – Strain measurements using mechanical, optical and electrical gauges for static and dynamic stress analyses - Whole field methods, Photo-elasticity - stress optic law – plane and circular polariscope - Isoclinics -Isochromatics - compensation methods of separation of stresses - Three dimensional photo-elasticity, stress freezing and slicing techniques - Photostress techniques.

Analogies-Membrane Analogy - Sand heap analogy- Electrical analogy. Basic characteristics and dynamic response measuring instruments -sensing elements -transducer -measuring and transmission methods -indicating and recording means.

Applied measurements; Displacement measurements - measurement of force and torque- load cells- cantilever beams and torque tubes -stress-strain measurements and strain bridges –

measurementsof temperature and pressure - Electronic measuring instruments -Recorders, oscillographs and oscilloscopes - sonic and ultrasonic testers - data loggers. Microprocessors - selection and use.

REFERENCES:

1. James.W.Dally& William F.Riley– *Experimental Stress Analysis,* McGraw Hill, 1991.
2. C. Rangan, G.R.Sarma, V.S.V. Mani*, Instrumentation: Devices and Systems,* Tata McGrawHill, Ed2, 1995.
3. Sadhu Singh, *Experimental Stress Analysis,* Khanna Publishers, 1985.
4. L.F.Adams, *Engineering Measurements and Instrumentation,* The English University Press Ltd.
5. James.W.Dally and William F.Riley, *Instrumentation for Engineering.*
6. H.WIERINGA, *Experiment Stress Analysis,* Springer, 2002.
7. Timoshenko and Goodier, *Theory of Elasticity*, McGraw Hill, 1988.
8. Sadhu Singh, *Theory of Elasticity*, Khanna Publishers, 1988

COURSE OUTCOMES:

At the end of the course students will be able to
1. understand about plane stress problems
2. understand about polariscope and to use it.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1					✓	✓		✓		✓
CO2					✓	✓		✓		✓

STEEXXX	**FORENSIC ENGINEERING AND RETROFITTING OF STRUCTURES**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- To provide students with a basic knowledge regarding the causes of failure of concrete structures, methods of condition assessment in field and techniques of repair and retrofitting of civil engineering systems.

Durability and Deterioration of Concrete

Plastic Shrinkage - Plastic Settlement - Drying Shrinkage - Thermal Movement - Freez and Thaw - Weathering - Carbonation - Sulphate Action - Alkali-Aggregate Reaction.

Acids - Crazing - Honey Combing - Popouts - Creep - Abrasion - Erosion and Cavitation - Fire - Sub-grade Movement - Formwork Movement - Premature Removal of Forms / Shores - Rebar Corrosion - Poor Design Details - Errors in Design.

Investigation and Diagnosis

General Considerations - Observation - Questioning - Field and Laboratory Testing - Destructive Testing - Non-Destructive Testing - Rebound Hammer - Ultrasonic Pulse Velocity - Pachometer - Semi-Destructive Testing - Probe Test - Pull-Out Test - Pull-Off Test - Break-Off Test - Core Test - Half-Cell Potential Measurements - Resistivity Measurements - Dust Sampling - Carbonation Depth Testing - Tests for determining cement content, chloride content and sulphate content.

Repair Materials

Patching Materials - Resurfacing Materials - Sealing Materials - Water-Proofing Materials - Admixtures - Substrate Preparation.

Refurbishment and Protection Techniques

Routing and Sealing - Stitching - External Stressing - Resin Injection - Grouting - Blanketing - Overlays - Sprayed Concrete - Prepacked Concrete – Dry packing - Jacketing - Plate Bonding - Protective Coatings - Autogenous Healing - Vacuum Impregnation - Chloride Extraction - Realkalization of Concrete - Cathodic Protection.

REFERENCES:

1. Peter H.Emmons, *Concrete Repair and Maintenance*, Galgotia Publishers, 2001.
2. S.Champion, *Failure and Repair of Concrete Structures*, John Wiley & Sons, 1990.
3. Ted Kay, *Assessment and Renovation of Concrete Structures*, Longman Scientific & Technical, 1992.
4. R.T.L.Allen and S.C.Edwards, *The Repair of Concrete Structures*, Blackie & Son Ltd.V.K.1987.
5. Sidney M.Johnson, *Deterioration, Maintenance and Repair of Concrete Structures*, McGraw-Hill Book Company, 1992.
6. P.H.Perkins, *Repair, Protection and Waterproofing of Concrete Structures*, E & FN Spon, 1997.
7. R.N.Raikar, *Diagnosis and Treatment of Structures in Distress*, Structwel D & C Pvt. Ltd.
8. N.P.Mailvaganam, *Repair and Protection of Concrete Structures*, CRC Press, 1992.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Upon completion of this course, the students can able to understand about the damages, damage assessments, repair materials and rehabilitation of concrete structures.
2. Perfectly analyze the damage by testing methods, suggestion and recommendations for different rehabilitation techniques.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1		✓				✓		✓	✓	✓
CO2		✓				✓		✓	✓	✓

STEEXXX	**TALL STRUCTURES**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- This course covers different structural systems used for tall structures. Also an understanding of the types and principles of analysis and design is essential to be a successful structural engineer.

Design Criteria

General – Factors affecting growth, height and Structural systems – Design philosophy – Loads: Gravity and lateral (Wind and Earthquake) – Load combinations – Strength and serviceability criteria – Stability and Drift limitations – Human comfort criteria – Creep, temperature, Fire and Foundation settlement effects – Effects of Soil Structure interaction.

Structural Action

Structural systems – Structural and non-structural systems – Structural system idealizations - Floor slab systems (wall supported slab system, Beam supported slab system, Ribbed slab system, Flat slab system). Vertical framing system (Columns, concrete walls, transfer girders, Suspenders) – Composite floor systems.

Modelling for gravity and lateral loads – Assumptions – Modelling for approximate analyses – Modelling for accurate analysis. Lateral load resisting systems – Behaviour of Rigid frames, Behaviour of Braced Rigid frames, Behaviour of shear wall with Rigid frames, Behaviour of framed-tubes , Behaviour of tube in tube, Behaviour of bundled tubes – Behaviour of In-filled frame structures

Analysis Concepts
Analysis and design concepts of Rigid frames, Rigid frames with bracings, Rigid frames with shear walls, framed-tubes, tube in tube and bundled tubes.

Stability
Stability of tall buildings – Overall buckling analysis of frames (Rigid frames, Rigid frames with bracings, Rigid frames with shear walls, framed-tubes, tube in tube and bundled tubes) using approximate methods — Second order effects– P-delta effects – Torsional instability – Effects of foundation settlements – Pounding effects – Temperature effects – Tunnelling effects.

REFERENCES:

1. Bryan Stafford Smith, Alexcoull, *Tall Building Structures, Analysis and Design*, John Wiley and Sons, Inc.,1991.
2. Taranath B.S., *Structural Analysis and Design of Tall Buildings*, McGraw Hill, 2011.
3. Lin.T.Y, StotesBurry.D, "*Structural Concepts and systems for Architects and Engineers*", John Wiley, 1988.
4. Lynn S.Beedle, *Advances in Tall Buildings*, CBS Publishers and Distributors, Delhi, 1986.
5. Wolfgang Schueller, *High Rise Building Structures*, John Wiley and Sons, New York, 1977.

COURSE OUTCOMES:

At the end of this course the students are expected
1. to gain the behaviour of tall buildings subjected to lateral loads and their stability.
2. to know the design of tall buildings as per the existing codes.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1		✓	✓			✓		✓	✓	✓
CO2		✓	✓			✓		✓	✓	✓

STEEXXX	**BEHAVIOUR OF PRESTRESSED CONCRETE STRUCTURES**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- To inculcate the basics of pre-stressing techniques to understand the design concepts used for design of bridge structures.

Behaviour of Reinforced Cement Concrete (RCC) and Pre-stressed Concrete (PSC) sections. Acceptability criterion for Pre-stressed Concrete sections – Pre and Post tensioning methods –

Parts of PSC sections – Tendons, strands, concrete, end anchorages – Systems and methods of pre-stressing- Analysis of sections – Stress concept – Strength concept – Load balancing concept. Effect of loading on the tensile stresses in tendons – Effect of tendon profile on deflections – Factors influencing deflections – Calculation of deflections – Short term and long term deflections - Losses of pre-stress – Estimation of crack width**.**

Flexural strength – Simplified procedures as per codes – Strain compatibility method – Basic concepts in selection of cross section for bending - Design of sections as per code for pre-tensioned and post-tensioned rectangular beams – Check for strength limit based on IS:1343-2012 – Design for shear based on IS1343-2012

Analysis of rectangular, T and composite sections under varying tendon profiles – Estimation of deflections – Flexural and shear strength of composite members–Shear key.
Factors influencing deflections – Short term deflections of un-cracked members – Prediction of long term deflections due to creep and shrinkage – Check for serviceability limit state of deflection.

Behaviour of Redundant Beams-Method of achieving continuity– Analysis-Concordant cable and linear transformation – Behaviour of T Beam and I Beam girder bridges, Behaviour of Segmental girder bridges – Behaviour of Box girder bridges.

Behaviour of concrete pipes – Circular tanks – poles – Rail way sleepers – Stress distribution in end block, Behaviour of end blocks and their reinforcement pattern as per code – Partial pre-stressing – Applications.

REFERENCES:

1. Krishna Raju N., *Prestressed concrete*, 5th Edition, Tata McGraw Hill Company, New Delhi, 2012.
2. Pandit.G.S. and Gupta.S.P. *Pre-stressed Concrete*, CBS Publishers and Distributers Pvt. Ltd, 2012.
3. Rajagopalan.N, *Prestressed Concrete*, Narosa Publishing House, 2002.
4. Dayaratnam.P., *Prestressed Concrete Structures*, Oxford and IBH, 2013.
5. Lin T.Y. and Ned. H. Burns, *Design of prestressed Concrete Structures*, Third Edition, Wiley India Pvt. Ltd., New Delhi, 2013.
6. IS1343:1980, *Code of Practice for Prestressed Concrete*, Bureau of Indian Standards, New Delhi, 2012.
7. IS-3370-1(2009), *Concrete structures for storage of Liquids* - Code of practice.

COURSE OUTCOMES:

At the end of the course students will be able
1. To gain knowledge on methods of pre-stressing
2. To design various Pre-stressed concrete structural elements.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓			✓		✓	✓	✓
CO2			✓			✓		✓	✓	✓

STEEXXX	**THEORY AND DESIGN OF PLATES**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- Plate members are indispensable for structural systems. The main objective of this course is to provide students with a rational basis of the analysis and design of reinforced concrete plate members through advanced understanding of material and structural behavior. The subject will be approached by looking into the behavior of reinforced concrete plate elements at material level, element level and structural level and systems level.

Thin Plates with Small Deflections
Laterally loaded thin plates - governing differential equations various boundary conditions

Rectangular Plates and Circular Plates
Simply supported rectangular plates - Navier`s solution and Levy's method Rectangular plates with various edge conditions. Symmetrical bending of circular plates - plates on Elastic foundation

Special and Approximate Methods
Energy methods - Finite difference and Finite Element Methods

Anisotropic Plates
Orthotropic plates & grids. Large Deflection Theory

Folded Plates
Folded plate structures - structural behaviour - various types -Design by ACI, ASCE - Task committee method-Winter Pie method

REFERENCES:

1. Dr.N.K. Bairagi, *Plate Analysis,* Khanna Publishers, 1981.
2. Rudolph Szilard, *Theory and Analysis of Plates; Classical and Numerical Methods,* Prentice – Hall (1973)

3. J.N.Reddy, *Mechanics of Laminated Composites Plates and Shells, CRC Publishers,* 2nd Edition, 2003
4. G.E.O, Widra, Chung.H., D.Hui, *Design and Analysis of Plates and Shells,* Amer Society of Mechanical, 1986.
5. T.K.Varadan, K,Bhaskar, *Analysis of Plates: Theory and Problems,* Alpha Science International, Ltd., 1999.
6. Philip L Gould, *Analysis of Shells and Plates,* Prentice Hall, 1998.
7. Timoshenko.S & S.W. Krieger, *Theory of Plates & Shells*, McGraw Hill & Co., New York, 1990.
8. Ramaswamy.G.S, *Design and Construction of Concrete Shell Roofs*, CBS Publishers, 1986.
9. K.Varadhan and K.Baskar, *Analysis of Plates (Theory & Problems),*Naraosa Publishing House,1999.

COURSE OUTCOMES:

1. Students can able to understand the concept of plates
2. Able to analyse the plate structures and design to the need

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓				✓	✓			
CO2		✓				✓	✓			

STEEXXX	**DESIGN OF SHELL STRUCTURES**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- Shells have become indispensable for long span roofing systems at public buildings like auditoria. The main objective of this course is to provide students with a rational basis of the analysis and design of reinforced concrete shell members and structures through advanced understanding of material and structural behavior.

Classification of shells - types of shells - Structural action - shells of revolution & shells of translation - examples - membrane theory - limitation of membrane theory

Flexure theory - Design of cylindrical shell by D.K.J. Method -other theories of analysis - use of ASCE manual for the design of cylindrical shells - prestressing of shells

Beam method of analysis of cylindrical shell by Lundgren - limitations - Detailed design of cylindrical shells -

Hyper shells & Conoidal shells. Element of Buckling of shells & shell structures

Software for the analysis of various types of shells.

REFERENCES:

1. Dr.N.K. Bairagi, *Shell Analysis,* Khanna Publishers, 1990.
2. *Design of Cylindrical Concrete Shells*, No.31, ASCE Manual of Engineering Practice.
3. Rudolph Szilard, *Theory and analysis of Plates; Classical and Numerical Methods, Prentice – Hall (1973).*
4. G.E.O, Widra, Chung.H., D.Hui, *Design and Analysis of Plates and Shells,* Amer Society of Mechanical, 1986.
5. T.K.Varadan, K,Bhaskar, *Analysis of Plates; Theory and Problems,* Alpha Science International, Ltd., 1999.
6. Philip L Gould, *Analysis of Shells and Plates,* Prentice Hall, 1998.
7. Ramaswamy.G.S, *Design and Construction of Concrete Shell Roofs,* CBS Publishers, 1986.
8. Timoshenko.S & S.W.Krieger , *Theory of Plates & Shells*, McGraw Hill and Co

COURSE OUTCOMES:

1. Students can able to understand the concept of curved structures
2. Able to analyse the shell structures and design to the need

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓				✓	✓			
CO2		✓				✓	✓			

STEEXXX	**THEORY OF ELASTICITY AND PLASTICITY**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- Theory of Elasticity and Plasticity forms the basis for the analysis of the macroscopic behavior of solids, liquids and gases under the influence of external effects due to surface loads, body forces, and heating. As such it is central to the scientific disciplines of

mechanical engineering and applied mechanics and forms a common basis for further study and analysis of structural systems.

Part - A Elasticity

Basic concepts of deformation of deformable Bodies, Notations for stress and strain in two and three dimensions. Stress transformation laws - Differential equations of equilibrium in two and three dimensions in Cartesian coordinates, Generalised Hooke's law -Lame's constants.

Plane stress and plane strain problems - examples- Airy's stress function - polynomials - direct method of determining Airy's stress function. Two dimensional problems in rectangular coordinates -(a) bending of a cantilever loaded at free end (b) bending of a beam by uniform load .

Equation of Equilibrium in polar coordinates - Two dimensional problems in polar coordinates for curved beam, thick cylinders and plate with holes.

Energy principle - theorem of minimum potential energy Hamiltan's principle - Castigliano's least work theorem - Castigliano's theorem on deflection - Maxwell's reciprocal law.

Torsion of various shaped bars - Prandle's membrane analogy - sand heap analogy - Torsion of thin walled sections and hollow shafts.

Part - B Plasticity

Introduction - physical assumptions, yield criteria of metals, graphical representation of yield criteria, Flow rule (plastic stress - strain relation) - Prandle Reuss equation - Levy Mises equation – Lower bound, upper bound and uniqueness Theorems.

Application to simple problems in tension - compression, Torsion solution of Elastic Plastic problems.

REFERENCES:

1. Arthur P Boresi, Ken P.Chong, *Elasticity in Engineering Mechanics*, John Wiley & Sons, 2000.
2. Chenn, W.P. and Henry D.J, *Plasticity for Structural Engineers* ,Springer Verlag, Newyork, 1988.
3. Stuart Antman, *Nonlinear Problems of Elasticity*, Springer Publication, 2nd Edition 2005.
4. William S. slaughter, *The Linearized Theory of Elasticity,* Birkhauser publication 1 Edition, 2001.
5. Santor Kaliszhy, *Plasticity, Theory & Engineering Applications,* Elsevier Publishes, 1989.
6. Akhtar S.Khan, Sujian huang, *Continuum Theory of Plasticity,* Wiley – Nescience, 1995.
7. L.M.Kachanob, *Fundamentals of the Theory of Plasticity,* Dover Publication, 2004.
8. Timoshenko and Goodier, *Theory of Elasticity*, McGraw Hill, 1988.
9. Sadhu Singh, *Theory of Elasticity*, Khanna Publishers, 1988

COURSE OUTCOMES:

1. Students can understand the concepts of elastic behaviour of materials.
2. Students can understand and analyse he materials with its plasticity

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓		✓		✓	✓			
CO2		✓		✓		✓	✓			

STEEXXX	**ADVANCED FOUNDATION DESIGN**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- The analysis and design of various types of foundations are dealt with in this course so that the structural engineers design foundation systems based both on the soil and structural aspects of the performance of foundations.

Classification of foundation - soil design parameters -Terzaghi's bearing capacity theory - settlement - loads for design - depth of foundation - depth of soil exploration - related IS codes - proportioning of footing dimensions.

Shallow foundations in clay - footings in clay - rafts in clay -shallow foundations in sand - soil design of footing in sand – soil design of rafts in sand - soil design of continuous footings-soil design in c-ϕ soils - survey of relevant IS codes.

Flexible analysis of shallow foundations by the theory of sub grade reaction - individual footings - soil pressure for structural design - structural design of square footings - plain concrete footings - circular footings - rectangular footings - continuous footings - pile caps - footings subjected to moments - footings subjected to tension. Structural design of cantilever footings, rafts, grid foundation-circular and annular rafts.

Deep foundations - piles - analysis of individual and group of piles - structural design - under reamed piles - prestressed concrete piles - driven precast piles. Piers - analysis & design of flexible piers. Caissons - stability analysis, structural design.

Earth retaining structures - flexible & rigid retaining structures- R.C.C Cantilever retaining wall - cantilever sheet pile wall and anchored bulkheads - structural analysis - Rowe's moment reduction factors - reinforced earth - prestressed ground anchors.

Foundation design for machines - problems of vibrating foundations- theory of vibrations - design of vibrating foundations - wave propagation beahviour of non-soil materials - static and dynamic modulii for soils-vibration isolation.

REFERENCES:

1. I.K. Lee, *Soil Mechanics*: *Selected Topics*, Butterworths, 1968.
2. P.J.Moore, *Analysis and Design of Foundations for Vibrations*, Oxford and IBH Publishing Co., New Delhi, 1985.
3. S.Prakash, V.K.Puri, *Foundation for machines, Analysis & Design,* J.Wiley Publications, 1988.
4. Nainan P. Kurian, *Design of Foundation Systems: Principles and Practices*, Narosa Publishing House, 1992.
5. J.Bowles, *Foundation Analysis & Design*, McGraw Hill Publication, 1988, 4th Edition

COURSE OUTCOMES:

1. Students can understand and propose the suitable foundation for a particular depth
2. Students can design the foundation.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1		✓	✓	✓		✓	✓			
CO2		✓	✓	✓		✓	✓			

STEEXXX	**STRUCTURAL UP GRADATION WITH FIBRE REINFORCED POLYMER (FRP) COMPOSITES**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- To develop an understanding of the behavior and design study of Steel concrete composite elements and structures.

Structural Deficiencies: Structural deficiencies in concrete structures - Structural deficiencies in metallic structures - Structural deficiencies in masonry structures - Structural deficiencies in timber structures.

Constituent Materials, Properties, Installation: Contractor competency - Temperature, humidity and moisture considerations - Equipment - Substrate repair and surface preparation - Mixing of resins - Application of constituent materials - Alignment of FRP materials - Multiple plies and lap splices - Curing of resins - Temporary protection.

Flexural Strengthening of Beams: Failure modes - Flexure strength of an FRP plated section - Interfacial stresses - Bond Behaviour - Strength models for debonding failures - Design Procedure. **Shear Strengthening of Beams:** Shear strengthening schemes - Shear failure modes - Shear strength of FRP strengthened RC beams - Design Procedure.

Strengthening of Reinforced Concrete (RC) Columns: Behaviour of FRP confined concrete - Design oriented stress - strain models for FRP confined concrete - Analysis oriented stress strain models for FRP confined concrete **-** Section analysis - Design of FRP confined reinforced concrete columns.

Design guidelines for FRP Strengthening:
Strengthening of Reinforced Concrete (RC) Structures: Material Properties - Characteristics and design values - Flexural strengthening - Shear strengthening - Strengthening of column with FRP wraps. **Strengthening of Metallic Structures:** Critical issue in the design of FRP strengthening for metallic structures - Selection of strengthening materials - Design of flexural strengthening. **Strengthening of Masonry Structures:** General aspects of FRP strengthening of masonry structures - Bond of FRP system to masonry - Strengthening of masonry panels under in- plane loads - Strengthening of lintels and floor belts - Strengthening of arches and vaults - Confinement of concrete columns.

REFERENCES:

1. L.C.Hollaway and T.G.Teng, *Strengthening and Rehabilation of Civil Infrastructure using Fibre Reinforced Polymer (FRP) Composites*, Woodhead Publishing Ltd., 2008.
2. Lawrence.C.Bank, *Composites for Construction : Structural Design with FRP Materials*, John Wiley & Sons. Inc., 2006.
3. ACI 440.2R-02, *Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures*, ACI Committee 440, 2007.

COURSE OUTCOMES:

1. Students explores with the FRP applications
2. Students can design the members with FRP profiles

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓			✓		✓		✓
CO2			✓			✓		✓		✓

STEEXXX	STRENGTH AND DEFORMATION OF CONCRETE MEMBERS	L	T	P
		4	0	0

COURSE OBJECTIVES:

- This course provides the advanced knowledge of concrete technology which covers the properties of fresh and hardened concrete and the concept of durability.
- New concrete making materials and recent advancements in concrete technology such as High strength concrete, high performance concrete, Fiber reinforced concrete and self-compacting concrete.

Behaviour of concrete - Uni-axial Stress Behaviour - Combined Stress Behaviour - Concrete confinement by Reinforcement - Monotonic Stress Behaviour - Repeated Stress Behaviour - Reversed Stress Behaviour.

Strength and Deformation of Members with Flexure - Moment - Curvature Relationships - Ductility of Unconfined Beam Sections - Ductility of Unconfined Column Sections - Flexural Deformation of Members - Deformation of Members with Cyclic Loading.
Strength and Deformation of Members with Shear - Mechanism of Shear Resistance in RC Beams without and with Shear Reinforcement - Interaction of Shear and Flexure - Interaction of Shear, Flexure and Axial Forces - Shear Deformations - Effects of Repeated and Cyclic Loadings on shear Strength.

Strength and Deformation of Members with Torsion - Beams subjected to Torsion and Flexure without Web Reinforcement - Beams subjected to Torsion and Shear without and with Web Reinforcement.

Bond and Anchorage - Mechanisms - Bond Failure Modes - Factors influencing Bond Strength - Flexural Bond - Anchorage Bond.

Service Load Performance - Deflection - Need for Deflection Control - Methods of Deflection Control - Calculation of Deflections - Cracking - Need for Crack Control - Calculation of crack width - Control of Flexural Cracks in Design.

REFERENCES:

1. Park, R. and Paulay, T., *Reinforced Concrete Structures*, John Wiley & Sons,New York, 1975.
2. Unnikrishna Pillai, S. and DevdasMenon, *Reinforced Concrete Design,* Tata McGraw-Hill Publishers, New Delhi, 2004.
3. Nilson, A.H., *Design of concrete Structures*, McGraw - Hill Company, Inc., New York, 1997.
4. Mosely, W.H. and Bungey, J.H., *Reinforced Concrete Design*, Macmillan Ltd.,London, 1990.

COURSE OUTCOMES:

1. On completion of this course the students will know various tests on fresh, hardened concrete, special concrete and the methods of manufacturing of concrete.

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓			✓		✓		✓
CO2			✓			✓		✓		✓

STEEXXX	**COMPOSITES FOR CONSTRUCTION USING FRP PULTRUDED PROFILES**	**L**	**T**	**P**
		4	0	0

COURSE OBJECTIVES:

- To develop an understanding of the behavior and design study of FRP pultruded sections.

Pultrusion process – profile design – specification – properties – Thermoset resins and reinforcements for pultrusion.

Application of pultrusion profiles in construction – Cable ways – Cooling tower – fencing – flooring – bridges – Leisure – Rock-soil support application – stagings and walkways – water and sewage treatment plants.

Properties of pultruded profiles – Design basis for FRP pultruded structures – Performance based design – Stresses in flexural members – lateral Torsional buckling – local buckling due to in plane compression – in-plane shear – web crushing and web buckling – flange and web material failure – shear failure – design procedure for flexural members.

Deformation of concentrically loaded compression members – axial shortening – global Torsional buckling – local buckling due to axial loads – design procedure for concentrically loaded compression and tension members.

Design philosophy for structural composite member and connections – behavior of bolted composite joints – design of bolted composite joints – structural adhesives – design of bonded composite joints – combined joints.

REFERENCES:

1. *Pultrusion for engineers* – Edited by Trevor F Starr – Wood head publishing Limited, Cambridge, England.

2. Lawrence C. Bank, *Composites for Construction – Structural design with FRP materials*, John Wiley & Sons Inc., Noboken, New Jersey.
3. Ayman S. Mosallam,"*Design guide for FRP composite connections*", American Society of Civil Engineers, (ASCE Manuals and reports on Engineering Practice No.102)

COURSE OUTCOMES:

At the end of the course students will be able to
1. Know about the FRP pultruded sections.
2. Design and construct the composite structures

Mapping with Programme Outcomes										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓			✓		✓		✓
CO2			✓			✓		✓		✓

OPEN ELECTRIVES

STEEXXX	RESEARCH METHODOLOGY	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To study and understand the research methodology in future research

Introduction to Research

Meaning of research - types of research- process of research- Sources of research problem- Criteria / Characteristics of a good research problem- Scope and objectives of research problem- Significance of Research- Research Methods versus Methodology- Research and Scientific Method -Errors in selecting a research problem- Criteria of Good Research - Problems Encountered- formulation of research hypotheses- Search for causation.

Developing a Research Proposal

Format of research proposal- Individual research proposal- Institutional research proposal- Significance- objectives- methodology- Funding for the proposal- Different funding agencies- Framework for the planning.

Design, Sampling Design, Measurement and Scaling Techniques

Meaning of Research Design- Need for Research Design- Features of a Good Design- Different Research Designs- Steps in Sampling Design -Measuring, - Selecting a Sampling Procedure- Different Types of Sample Designs- How to Select a Random Sample- Complex Random Sampling Designs- Measurement- attitude measurement and scaling- Sources of Error in Measurement- Scale Classification- Important Scaling Techniques- Scale Construction Techniques

Data Collection and Analysis

Collection of Primary Data - Observation Method- Interview Method- Collection of Data through Questionnaires- Collection of Data through Schedules - Difference between Questionnaires and Schedules- Some Other Methods of Data Collection- Collection of Secondary Data- Selection of Appropriate Method for Data Collection- Elements/Types of Analysis - Measures of Dispersion- Approaches to qualitative and quantitative data analysis- Case study.

Report Writing, Presentation of Research

Need of effective documentation- importance of report writing- types of reports- report structure- report formulation- Plagiarism- Research briefing- presentation styles- impact of presentation- elements of effective presentation- Writing of research paper- presenting and publishing paper- patent procedure.

REFERENCES:

1. Deepak Chawla and Neena Sondhi, *Research Methodology: Concepts and Cases*, Vikas Publishing House Pvt.Ltd.
2. Dr. C. R. Kothari, *Research Methodology: Methods and Trends*', New Age International Publishers.
3. Wayne Goddard and Stuart Melville, *Research Methodology: An Introduction*'

COURSE OUTCOMES:

1. On completion of this course the students will know methodology of research in thesis work.

STEEXXX	EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION	L	T	P
		4	0	0

COURSE OBJECTIVES:

- The objective of the course is to provide in-depth knowledge on advanced theoretical and experimental techniques of displacement and load measurements.
- The course deals specifically with all building materials and its behaviour. Emphasis is placed on design and fabrication of devices with attention to specifications, environment and length of application.
- In-depth consideration is given to the device as well as associated data acquisition.

Principles of measurements, Accuracy, Sensitivity and range of measurements. Mechanical, Electrical extensometers and their uses, Advantages and disadvantages.

Principle of operation and requirements, Types and their uses, Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.

Two dimensional photo elasticity, Concept of light – photo elastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials.

Fundamentals of NDT, Radiography, ultrasonic, magnetic particle inspection, Fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique.

Instrumentation Techniques for structural components: slabs, beams, columns and bean column connections – Instrumentation for collecting and storing data.

REFERENCES:

1. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra,n K., *Experimental Stress Analysis*, Tata McGraw-Hill, New Delhi, 1984.
2. Dally, J.W., and Riley, W.F., *Experimental Stress Analysis*, McGraw-Hill Inc., New York, 2005, edition.
3. Hetyenyi, M., *Hand book of Experimental Stress Analysis*, John Wiley and Sons Inc., New York, 1972.
4. Sadhu Singh – *Experimental Stress Analysis*, Khanna Publishers, New Delhi, 1996.
5. S.Sirohi, HC Radhakrishna, *Mechanical Measurements*, New Age International (P) Ltd.1997
6. F.K Garas, J.L. Clarke and GST Armer, *Structural Assessment*, Butterworths, London,1987.
7. D.E. Bray & R. K.Stanley, *Non-destructive Evaluation*

COURSE OUTCOMES:

At the end of the course students will be able to

1. understand about plane stress problems
2. understand about polariscope.

STEEXXX	CONTRACT LAWS AND REGULATIONS	L	T	P
		4	0	0

COURSE OBJECTIVES:

- This course provides a thorough knowledge in various types of construction contracts and their legal aspects and provisions, tenders, arbitration, legal requirement, and labor regulations in national and international construction Projects.

Construction Contracts

Indian Contracts Act – Elements of Contracts – Types of Contracts – Features – Suitability – Design of Contract Documents – International Contract Document – Standard Contract Document – Law of Torts.

Tenders

Prequalification – Bidding – Accepting – Evaluation of Tender from Technical, Contractual and Commercial Points of View – Contract Formation and Interpretation – Potential Contractual Problems – World Bank Procedures and Guidelines – Tamilnadu Transparency in Tenders Act.

Arbitration
Comparison of Actions and Laws – Agreements – Subject Matter – Violations – Appointment of Arbitrators – Conditions of Arbitration – Powers and Duties of Arbitrator – Rules of Evidence – Enforcement of Award – Costs.

Legal Requirements
Insurance and Bonding – Laws Governing Sale, Purchase and Use of Urban and Rural Land – Land Revenue Codes – Tax Laws – Income Tax, Sales Tax, Excise and Custom Duties and their Influence on Construction Costs – Legal Requirements for Planning – Property Law – Agency Law – Local Government Laws for Approval – Statutory Regulations.

Labour Regulations
Social Security – Welfare Legislation – Laws relating to Wages, Bonus and Industrial Disputes, Labor Administration – Insurance and Safety Regulations – Workmen's Compensation Act – Indian Factory Act – Tamilnadu Factory Act – Child Labor Act - Other Labor Laws.

REFERENCES:

1. Gajaria G.T., *Laws Relating to Building and Engineering Contracts in India*,
2. Jimmie Hinze, *Construction Contracts*, McGraw Hill, 2001.
3. Joseph T. Bockrath, *Contracts and the Legal Environment for Engineers and Architects*, McGraw Hill, 2000.
4. Kwaku, A., Tenah, P.E. Jose M.Guevara, P.E., *Fundamentals of Construction Management and Organisation*, Printice Hall, 1985.M.M.Tripathi Private Ltd., Bombay, 1982.
5. Patil. B.S, *Civil Engineering Contracts and Estimates*, Universities Press (India) Private Limited, 2006.

COURSE OUTCOMES:

1. Students can able to know about the contracts and their legal aspects and provisions, tenders, arbitration, legal requirement, and labour regulations in national and international construction Projects.

STEEXXX	STRUCTURAL OPTIMIZATION	L	T	P
		4	0	0

COURSE OBJECTIVES:

- The course provides basic knowledge with regard to linear and non linear optimization methods.

Introduction
Introduction to optimization techniques, Problem formation and merit function. Linear optimization Geometry of linear programming-Simple algorithm-Duality in Linear Programming.

Non-Linear Optimization-I
One dimensional minimization methods -Exhaustic search, Dichoto- mous search and direct root methods

Non-Linear Optimization-II
Direct Search method - random search methods-Descent methods -Steepest Descent method-Fletcher-Reeves method, Davidon-Fletcher- Powell method.

Linear Constrained Optimization
Cutting plane method and penalty function methods. Geometric plane programming-Dynamic Programming and integer programming.

Application of Optimization techniques for simple structures of homogeneous materials-Problemformulation for structures of non-homogeneous materials. Minimum Weight design of structuresusing plastic Theory.

REFERENCES:

1. S.S.Rao, Optimization: *Theory & Applications*, Wiley Eastern Ltd., New Delhi,1977.
2. Urikirsch, *Optimum Structural Design*, McGraw Hill, 1981.
3. Spunt., *Optimum Structural Design*, Civil Engineering and Engineering Mechanics, Prentice Hall, 1971.
4. Richard Bronson, *Operations Research*, Schaum's Outlines, McGraw Hill Ltd,1983.
5. Morris,AJ, *Foundations of Structures Optimization*, John Wiley, 1982.
6. Atreck E, Gallagher, R.H.Rapsdull K M &Zienkilwicz, *New Directions in Optimum Structural Design*, John Willey, 1984.
7. JabbirArora, *Introduction to Optimum Design,* Second Edition, Academic Press, 2004.

COURSE OUTCOMES:
At the end of the course students will be able to
1. know about optimization techniques for simple structures
2. know about one dimensional minimization methods.

STEEXXX	PREFABRICATED STRUCTURES	L	T	P
		4	0	0

COURSE OBJECTIVES:

- Prefabricated construction has developed rapidly and continues to grow in importance.
- It is used in all major types of structures.

- The course aims to address issues related to types of prefabrication, loads for their design, design principles and detailing of joints in prefabrication construction

RC Prefabricated Structures

Long wall & cross wall large panel buildings - one way and two way prefabricated slabs – Framed buildings with partial and curtain walls, single storey industrial buildings with trusses and shells - crane - gantry systems

Functional Design principles

Modular coordination - standardization - Disuniting , Diversity of prefabricates - production - transportation - erection - stages of loading and codal provisions - safety factors - material properties - Deflection control - Lateral load resistance - Location and types of shear walls

Floors, Stairs and Roofs

Types and floor slabs - analysis and design example of cored and panel types and two-way systems - staircase slab design, Types of roof slabs and insulation requirements description of joints, their behaviours and requirements, Deflection control for short term and long term loads – ultimate strength calculations in shear and flexure.

Walls

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

Industrial buildings

Components of single storey industrial sheds with crane gantry systems - Design of R.C. Roof Trusses Roof panels Design of R.C Crane -Gantry Girders - corbels and columns - Wind bracing design

Design of shell roofs for Industrial sheds

Cylindrical, Folded plate and hyper prefabricated shell, Erection and joining , joint design – hand book based design

REFERENCES:

1. B.Lewicki, *Building with Large Prefabrication*, Elsevier Publishing Co., Amsterdam / London / New York, 1966.
2. SERC, *Design & Construction of Prefabricated Residential &Industrial Buildings*, Organized by SERC, Chennai.
3. Marashev.V.I, Sigalov.E.Y, Baikov.U.N, *Design of RC Structures*, Mir Publishers, Moscow, 1968.

COURSE OUTCOMES:

At the end of the course students will be able to

1. design some of the prefabricated elements and also have the knowledge of the construction methods in using these elements.

STEEXXX	SOIL STRUCTURE INTERACTION	L	T	P
		4	0	0

COURSE OBJECTIVES:

- No structural design will be complete without consideration of the response of the supporting soil.
- As the soil and the structure mutually influence one another, interactive analysis and design is paramount to the safety and performance of both the super structure and the foundation.

Introduction

Soil behaviour - Elasticity, Plasticity, viscoelasticity - Non-linear behaviour - Strain hardening-Dilatancy-Classification of Interaction problems.

Modulus of Subgrade Reaction

Vertical and horizontal modulus of subgrade reaction - Determination of modulii - Factors affecting them.

Beams and slabs

Winkler foundation - Modified Winkler models-Two parameter formulations of Vlasov and Leontey- Elastic continuum-Baker's method for rafts.

Piles

Elastic analysis of axial, torsional and laterally loaded piles-Yielding of piles under axial and lateral loads-p-y-curves.

Pile Groups

Displacement of pile groups under axial and lateral loads. Pile - raft systems.

REFERENCES:

1. Desai.C. and Christian, J.T., *Numerical methods in Geotechnical Engineering*, McGraw - Hill Book Co., 1977.
2. Selvadurai.APS, *Elastic Analysis of Soil Foundation Interaction*, Elsevier Publishers, 1979.
3. Edmund S. Melerski, *Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundations,* Taylor& Francis Publications, 1st Edition 2000.
4. Glyn Jones*, Analysis of Beams on Elastic Foundation, Analysis Society of Civil Engineers,*1997.

5. K.T. Sundara Raja Iyangar**,** *Design Tables for Beams on Elastic Foundations and Related Structured Problems,* Applied Science Publications 1979.

COURSE OUTCOMES:

At the end of the course students will be able to

1. to know about Soil behaviour
2. to know about Vertical and horizontal modulus of subgrade reaction.

STEEXXX	COMPOSITE STRUCTURES	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To develop an understanding of the behavior and design study of Steel concrete composite elements and structures.

Introduction to composite construction – Basic concepts – Types of composite materials - Application of composite construction in Civil Infrastructure – Durability – Physical and Mechanical properties of composite structures – Influence of moisture at consistent level in composite structure – Construction of composite structures.

Introduction – Fabrication Process – Quality Control during Manufacture – Testing Methodologies – Destructive and Non destructive testing - Mitigation Strategies – Materials and their properties – Stiffness properties – Strength properties – Manufacture of composite materials.

Introduction – Combustion of Polymer Composites – Fire reaction properties of Polymer Composites – Fire resistant Polymer Composites – Structural properties of Polymer Composites in Fire – Fire protection coatings – Predictive Modelling of Fatigue – Descriptive Modelling of Fatigue.

Analysis of composite beams – Composite floor – Girders – Slabs - Composite column subjected to axial loads and moment – Shear connectors: functions and types – Maximum stress theory – Maximum strain theory – Stress strain relations - Analysis procedures of building for gravity and lateral loads - Study of IS: 11384 , IRC – 22 and their applications.

Introduction – Classes of joints – Bonded joints – Stress distribution – Modes of failure – Merits and demerits – Mechanical joints – Failure mode – Merits and demerits – Design of bonded and bolted joints – Bending failure – Tension failure – Multi bolt joints and its design.

REFERENCES:

1) Madhujitmukhopadhyay; *Mechanics Of Composite Materials And Structure,* Universities press, 2004.
2) Jones ,R.M. , *Mechanics of Composite Materials* , Mc Graw hill, Tokyo, 1998.
3) Lawrance C Bank , C*omposite* C*onstruction* , John Weiley sons & inc, 2006
4) Carlo Pelleqrino ,Josesena , Cruz, *Design Procedure For The Use Of Composites In Strengthening Of Reinforced Concrete Structures*, Springer ; 2016.
5) Ravindra k. Dhir , Kelvin A Paine , Moray D. Newlands, *Composites materials in concrete construction ,* ice publishing , 2012.
6) Vistasp M. Karbhari, *Durability of Composites for Civil Structure Applications,* Wood head Publishing, 2012.

COURSE OUTCOMES:

At the end of the course students will be able

1. To gain knowledge on the composites and its applications.

STEEXXX	SPECIAL CONCRETES	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To provide students with a basic knowledge regarding the Micro structures, types of concretes.

Introduction

Micro structure aspect of cement paste - Hydrated Portland cement gel mechanism - Application and specification of admixtures & other cement replacement materials – Difference between quarry dust and M sand - concrete made with M sand - Physical and chemical properties - Properties of fresh and hardened concrete - Durability study on M sand concrete - Manufacture of Concrete – Properties of materials used – Fresh and Hardened Concrete.

Steel Slag Concrete

Cementitious properties of steel slag powder - Steel slag as fine & coarse aggregate – Properties of fresh and hardened concrete- Durability study on steel slag concrete - **Glass Concrete -** Cementitious properties of glass powder - Glass waste as fine & coarse aggregate – Properties of fresh and hardened concrete - Durability study on Glass concrete - **Fibre Reinforced Concrete -** Different types of fibres – Natural and Synthetic fibres - Aspect ratio – High fibre volume – Micro fibre system – Properties of fresh and hardened concrete.

Polymer and Geopolymer Concrete

Polymer concrete – Types – Polymer impregnated concrete – Polymer modified concrete – Properties – Stress – Strain relationship – Compressive strength – Durability – Applications.

Geopolymers – materials in geopolymer concrete- mix proportion – mixing, casting, compaction and curing of geopolymer concrete - Design of geopolymer concrete mixes-short term and long term properties – Durability studies – economic benefit of geopolymer concrete. Potential uses of different by product materials – Fly ash, Glass Waste, Steel slag, M sand, GGBS – Performance characteristics – Recommendations, Practice and Precautions in making of Geopolymer concrete.

Nano Concrete

Types of Nano materials- characterization-properties-pozzolanic reaction-filler action-microstructure of Nano concrete-properties of Nano concrete-fresh and hardened stage-Nano materials with admixtures-cementitious materials: fly ash-silica fume-GGBS-metakoalin. – advantages and disadvantages of nano concrete-application of nano concrete.

Other Concretes

Use of different industrial waste in concrete for filler- binder-characterization-mix proportions-High Strength and High Performance Concrete - Properties and mix proportioning of fly ash concrete, silica fume concrete, Self compacting concrete, Light weight concrete, Ultra high strength concrete, Ready mix concrete, High strength concrete, High Density Concrete, Recycled aggregate concrete, Bacterial concrete – **Ferrocement -** ferrocement Materials and properties - Admixtures- Casting technique - Hand plastering- Mechanised process – Guniting – Applications.

REFERENCES:

1. Gambhir, M.L., *Concrete Technology*, Tata McGraw Hill, New Delhi.
2. Shetty M.S., *Concrete Technology*, Chand & Co. Ltd, New Delhi.
3. Mehta P. Kumar and Monteiro, Paulo J.M., Concrete Micro structure, Indian Concrete Institute, Chennai
4. Neville Brooks, *Concrete Technology*, Addison – Wesley, England.
5. John Newman and Ban Seng Choo, *Concrete Technology*, Vol. I to IV, Elsevier, 2003.
6. Hardjito. D and Rangan. B. V (2005), *Development and properties Low calcium fly ashbased Geopolymer concrete*, Research Report, GC1, GC2, GC3, Faculty Engineering, Curtain University of Technology, Perth.

COURSE OUTCOMES:

1. On completion of this course the students will know various tests on fresh, hardened concrete,
2. Make the special concrete and the methods of manufacturing of concrete for specific purpose.

STEEXXX	GIS IN CONSTRUCTION ENGINEERING AND MANAGEMENT	L	T	P
		4	0	0

COURSE OBJECTIVES:

- This course provides the details of data collection and field modeling.
- This also provides the management of Natural Resources and their application.

Introduction to GIS

GIS – Definition – Components of GIS -Maps – Definition – Types of Maps – Characteristics of Maps – Map Projections — Hardware, Software and Organizational Context – GIS software

Types of Data

Data Types – Spatial and Non-Spatial – Spatial Data – Points, Lines and areas– Non-spatial data

Types of Map scale- Nominal, Ordinal, Interval and Ratio – Digitizer – Scanner – Editing and Cleaning – Geo reference data- File and data access.

Data Structure

Raster and Vector Data Structure – Raster data storage – Methods of data compression-Run length, Chain and Block Coding – Vector Data Storage – Topology – Topological Models – Arc Node Structure – Surface Data – DEM – Grid DEM and TIN structure Applications of DEM-Database Management system

Data Quality and Output

Reclassification – Measurement – Buffering – Overlaying – SQL for Queries – Neighborhood and Zonal operations – Data Quality – Components of data quality - Sources of errors in GIS – Meta data- Output – Maps, Graphs, Charts, Plots , Reports – Printers – Plotters– Fields of application- construction management Parcel based, AM/FM applications examples – Case study

REFERENCES:

1) Burrough P.A., *Principles of GIS for Land Resources Assessment*, Oxford Publication, 2008.
2) Robert Laurini and Derek Thompson, *Fundamentals of Spatial Information Systems*, Academic Press, 2006.
3) Anji Reddy, *Remote Sensing and Geographical Information Systems*, BS Publications 2001
4) Srinivas M.G. (Edited by), *Remote Sensing Applications*, Narosa Publishing House, 2001.
5) Rhind, D., *Understanding of GIS*, The ARC / INFO Method, ESRI Press. 2000.

COURSE OUTCOMES:

1) On completion of this course the students will know the development of construction planning, scheduling procedure and controls.

STEEXXX	BRIDGE ENGINEERING	L	T	P
		4	0	0

COURSE OBJECTIVES:

1. Bridge engineering is a specialized area in structural engineering practice.
2. In this course, the students are taught the IRC loading standards and analysis and design of different types of bridges.

IRC Loading standards – Positioning of IRC loads for maximum moment and shear- Analysis of slab culverts using Pigeaud's curves- Design of Slab culverts as per IRC: 6-2014 and IRC 21: 2000.

Pipe culverts - General features - Classification - Analysis and design of Pipe Culvert. Box culverts – General features - Analysis and design of Box culverts as per IRC: 6-2014 and IRC 21: 2000.

Analysis & Design of Tee beam and slab bridges - General features – Pigeaud's curves – Courbon's theory – Design and detailing as per IRC: 6-2014 and IRC 21: 2000 - Balanced cantilever bridges - Bowstring girder bridges - Advantages - General features - Design principles only.

Analysis & Design of Pre-stressed concrete bridges - Preliminary dimensions - Flexural and Torsional parameters – Design of girder section - Maximum and minimum pre-stressed forces - Eccentricity - Dead load and Live load moments and shears - Cable zone in girder - Check for stresses - Diaphragms - End block - Short-term and long-term deflections – Design and Detailing as per IS 1343:1980, IRC: 6-2014 and IRC 21: 2000.

Segmental bridges - Segmental bridge design, design for flexure Guidelines as per IRC 18-2000 and detailing as per SP-65:2005. Bridge bearings - Plate, Roller and Rocker bearings - Elastomeric bearings as per IRC: 83(Part I)-1999 and IRC 83(Part II)-1987).Design principles of continuous bridges - Box girder bridges - Balanced cantilever bridges. Handling, Hoisting & other Launching techniques of prestressed Girders.

REFERENCES:

1. N Krishna Raju ,*Design of Bridges*, Oxford &IBH, 2010.
2. S Ponnuswamy, *Bridge Engineering,* Tata McGraw-Hill, 1986.

3. D Johnson Victor, *Essentials of Bridge Engineering,* Oxford &IBH Pub. Co.,2001.
4. N.Rajagopalan, *Bridge Super Structure*, Narasa Publishing House Pvt. Ltd, First Edition, 2006.

STANDARDS:

1) IS 456: 2000, *Code of Practice for Plain and Reinforced Concrete*, Bureau of Indian Standards, New Delhi.
2) IS 13920: 1993, *Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces* - Code of Practice
3) SP 34: 1987, *Handbook on Concrete Reinforcement And Detailing.*
4) IRC: 6-2014, *Standard Specifications and Code of Practice for Road Bridges Section: II (Loads And Stresses).*
5) IRC 21: 2000, *Standard Specifications and Code of Practice for Road Bridges Section: III[Cement Concrete (Plain And Reinforced)*].
6) IS 1343:1980, *Code of Practice for Pre-stressed Concrete, Bureau of Indian Standards*, New Delhi, 2012.
7) IRC: 83(Part I)-1999, *Standard Specifications and Code of Practice for Road Bridges Section: IX, Part I (Metallic Bearings*).
8) IRC: 83(Part I)-1999, *Standard Specifications and Code of Practice for Road Bridges Section: IX, Part II (Elastromeric Bearings*).

COURSE OUTCOMES:

At the end of the course students will be able
1. To understand the behaviour of bridge structures.
2. To gain knowledge about the rudimentary principles of designing the bridges as per the existing codes.

STEEXXX	STABILITY OF STRUCTURES	L	T	P
		4	0	0

COURSE OBJECTIVES:

- A treatment of stability as it relates to actual behavior and design. Columns, frames, beams, and beam-columns are considered.
- Elastic and Inelastic theories are compared with actual behavior and design specifications.

Buckling of Columns
States of equilibrium – Classification of buckling problems- concept of equilibrium, energy, imperfection and vibration approaches to stability analysis-Eigen value problem. Governing equation for columns - Analysis for various boundary conditions-using Equilibrium, Energy methods.Approximatemethods-RayleighRitz,Galerkinsapproach-Numerical Techniques- Finite difference method-Effect of shear on buckling.

Buckling of Beam-Columns and Frames
Theory of beam column - Stability analysis of beam column with single and several concentrated loads, distributed load and end couples. Analysis of rigid jointed frames with and without sway– Use of stability function to determine the critical load.

Torsional and Lateral Buckling
Torsional buckling – Combined Torsional and flexural buckling - Local buckling. Buckling of Open Sections. Numerical solutions, Lateral buckling of Beams, Pure Bending of Simply supported and Cantilever Beams

Buckling of Plates and Inelastic Buckling
Governing differential equation – Buckling of thin plates, various edge conditions-Analysis by equilibrium and energy approach – Finite difference method.
Double modulus theory-Tangent modulus theory- Shanley's model-Eccentrically loaded inelastic column. Inelastic buckling of plates - Post buckling behaviour of plates.

Beam on Elastic Foundations
Beams on elastic foundation - foundation models - infinite and semi-infinite beams - Application -buckling of beams on elastic foundation

REFERENCES:

1. Timoshenko and Gere, *Theory of Elastic Stability,* McGraw Hill Book Co, 1961.
2. Aswinkumar*, Stability Theory of Structures,* Tata McGraw Hill, 1985.
3. AlexandarChajes, *Principles of Structural Stability Theory,* NavelandPrInc; Reprint Edition 1993.
4. Allen HG and Bulsen P.S., *Back Ground to Buckling,* McGraw Hill Book Co.,1980.
5. Brush and Almorth,*Buckling of Bars, Plates and Shells* ,McGraw Hill Book Co.,1975.
6. Seely and Smith, *Advanced Mechanics of Materials,* John Wiley &Sons, 1980.
7. Zoienek P. Bazant, Luigi Cedolin, *Stability of Structures, Dover Publication,* New Edition, 2003.
8. A.N. Kounadis&W.B. Kratzig, *Nonlinear Stability of Structures,* Springer Publication, 1st Edition, 2002.
9. Luis A. Godoy, *Theory of Elastic Stability,* Taylor & Francis Publication, 1st edition, 1999.

COURSE OUTCOMES:

On completion of this course student will know

1. the phenomenon of buckling and they are in a position to calculate the buckling load on column, beam–column, frames and plates using classical and approximate methods.

STEEXXX	CONSTRUCTION PLANNING AND SCHEDULING	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To study and understand the concept of planning, scheduling, cost in construction, organization and use of project information necessary for construction project.

Construction Planning

Basic Concepts in the Development of Construction Plans – Choice of Technology and Construction Method – Defining Work Tasks – Defining Precedence Relationships among Activities – Estimating Activity Durations – Estimating Resource Requirements for Work Activities – Coding Systems.

Scheduling Procedures

Construction Schedules – Critical Path Method – Scheduling Calculations – Float – Presenting Project Schedules – Scheduling for Activity-on-Node and with Leads, Lags, and Windows – Scheduling with Resource Constraints and Precedences.

Scheduling Techniques

Use of Advanced Scheduling Techniques – Scheduling with Uncertain Durations – Calculations for Monte Carlo Schedule Simulation – Crashing and Time/Cost Tradeoffs – Improving the Scheduling Process.

Cost Control, Monitoring and Accounting

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.

Organization and Use of Project Information

Types of Project Information – Accuracy and Use of Information – Computerized Organization and Use of Information – Organizing Information in Databases – Relational Model of Databases – Other Conceptual Models of Databases – Centralized Database Management Systems – Databases and Applications Programs – Information Transfer and Flow.

REFERENCES:

1. Calin M. Popescu, ChotchaiCharoenngam, *Project Planning, Scheduling and Control in Construction: An Encyclopedia of terms and Applications*, Wiley, New York, 1995.
2. Chitkara, K.K. *Construction Project Management: Planning, Scheduling and Control*, McGrawHill Publishing Company, New Delhi, 1998.
3. Chris Hendrickson and Tung Au, *Project Management for Construction – Fundamental Concepts for Owners, Engineers, Architects and Builders*, Prentice Hall, Pittsburgh, 2000.

COURSE OUTCOMES:

1. On completion of this course the students will know the development of construction planning, scheduling procedure and controls

STEEXXX	SHORING, SCAFFOLDING AND FORM WORK	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To study and understand the overall and detailed planning of formwork, plant and site equipment.
- To understand the Design and erection of forms for various elements such as slabs, beams, columns, walls, shells and tunnels.
- To know the latest methods of form construction.

Planning, Site Equipment & Plant for Form Work

Introduction - Forms for foundations, columns, beams walls etc., General objectives of formwork building - Planning for safety - Development of a Basic System - Key Areas of cost reduction - Planning examples. Overall Planning - Detailed planning - Standard units - Corner units - Pass units - Calculation of labour constants - Formwork hours - Labour Requirement - Overall programme - Detailed programme - Costing - Planning crane arrangements - Site layout plan - Transporting plant - Formwork beams - Scaffold frames - Framed panel formwork - Formwork accessories.

Materials Accessories Proprietary Products & Pressures

Lumber - Types - Finish - Sheathing boards working stresses - Repetitive member stress - Plywood - Types and grades - Jointing Boarding - Textured surfaces and strength - Reconstituted wood - Steel - Aluminum - Hardware and fasteners - Nails in Plywood - Allowable withdrawal load and lateral load. Pressures on formwork - Examples - Vertical loads for design of slab forms - Uplift on shores - Laterals loads on slabs and walls.

Design of Forms and Shores

Basic simplification - Beam formulae - Allowable stresses - Deflection, Bending - Lateral stability - Shear, Bearing - Design of Wall forms - Slab forms - Beam forms - Column forms - Examples in each. Simple wood stresses - Slenderness ratio - Allowable load vs length behaviour of wood shores - Form lining Design Tables for Wall formwork - Slab Formwork - Column Formwork - Slab props - Stacking Towers - Free standing and restrained - Rosett Shoring - Shoring Tower - Heavy Duty props.

Building and Erecting the Form Work
Carpentry Shop and job mill - Forms for Footings - Wall footings - Column footings - Sloped footing forms - Strap footing - Stepped footing - Slab form systems - Sky deck and Multiflex - Customized slab table - Standard Table module forms - Swivel head and uniportal head - Assembly sequence - Cycling with lifting fork - Moving with table trolley and table prop. Various causes of failures - ACI - Design deficiencies - Permitted and gradual irregularities.

Forms for Domes and Tunnels, Slip Forms and Scaffolds
Hemispherical, Parabolic, Translational shells - Typical barrel vaults Folded plate roof details - Forms for Thin Shell roof slabs design considerations - Building the forms - Placing concrete - Form removed -Strength requirements -Tunnel forming components - Curb forms invert forms - Arch forms - Concrete placement methods - Cut and cover construction - Bulk head method - Pressures on tunnels - Continuous Advancing Slope method - Form construction - Shafts. Slip Forms - Principles -Types - advantages - Functions of various components - Planning -Desirable characteristics of concrete - Common problems faced - Safety in slip forms special structures built with slip form Technique - Types of scaffolds - Putlog and independent scaffold -Single pole scaffolds - Truss suspended - Gantry and system scaffolds.

REFERENCES:

1. Austin, C.K., *Formwork for Concrete*, Cleaver -Hume Press Ltd., London, 1996.
2. Hurd, M.K., *Formwork for Concrete*, Special Publication No.4, American Concrete Institute, Detroit, 1996
3. Michael P. Hurst, *Formwork for Concrete* , Construction Press, London and New York, 2003.
4. Robert L. Peurifoy and Garold D. Oberlender, *Formwork For Concrete Structures*, McGraw - Hill , 1996.

COUSE OUTCOMES:

1. On completion of this course the students will know the design and erection of form work in construction projects.

STEEXXX	VALUE ENGINEERING AND VALUATION	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To study the various aspects of value engineering and valuation in construction

Value Analysis
Value - Meaning of value - basic and secondary functions - factor contributing to value such as aesthetic – ergonomic – technical - economic - identifying reasons or unnecessary costs -
Value Analysis - 10 Commandments of value analysis - value analysis team - principles of value analysis - elements of a job plan viz. orientation, Information, presentation. Implementation,

follow up action - benefits of value analysis, various applications - assessing effectiveness of value analysis.

Life Cycle Costing
Life cycle costing – Forecasting of Capital as well as operating & maintenance costs, time value - present worth analysis - DCF methods - ROR analysis - sensitivity analysis.

Methods
Different methods of performing value engineering.

Valuation
Types of value - purposes of valuation factors affecting value - Different methods of valuation for different types of assets such as land and building – horticulture - historical places.

Valuation Report
Valuation Report - contents, - standard formats - Case study of any one Report.

REFERENCES:

1. Del Younke *Value Engineering: Analysis And Methodology*
2. O.P.Khanna, *Industrial Engg. & Mgt*., Dhanpat Rai Publ.
3. T.R.Banga, S.C.Sharma, *Industrial Organization & Engg. Economics*, Khanna Publ.
4. B.N Dutta *Estimating and Costing in Civil Engineering: Theory and Practice* S. Dutta & Company, Lucknow.
5. M.Chakraborty, *Estimating, Costing Specifications & valuation in Civil Engineering*

COURSE OUTCOMES:

1. On completion of this course the students will know the application of value Engineering and valuation in construction projects.

STEEXXX	CONSTRUCTION PERSONNEL MANAGEMENT	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To study the various aspects of manpower management such as man power planning, organization, human relations, and welfare and development methods in construction.

Leadership, Interpersonal and Communication

Introduction to Leadership, Leadership Power, Leadership Styles, Leadership in Administration. Introduction to Interpersonal Relations, Analysis Relations of different ego states, Analysis of Transactions, Analysis of Strokes, Analysis of Life position. Introduction to Communication, Flow of Communication, Listening, Barriers of Communication, How to overcome barriers of communication. Group Dynamics - Importance of groups in organization, and Team Interactions in group, Group Building Decision Taking, Team Building, Interaction with the Team, How to build a good team.

Stress, Conflict, Performance

Introduction to Stress, Causes of Stress, Impact Management Stress, Managing Stress- Introduction to Conflict, Causes of Conflict, Management Managing Conflict- Introduction to Performance Appraisal, Appraisal Vertical Appraisal, Horizontal Appraisal, 360º Performance Appraisal, Methods of improving Techniques of Performance Appraisal.

Time and Motivation

Time as a Resource, Identify Important Time Management Wasters, Individual Time Management Styles, Techniques for better Time Management.- Introduction to Motivation, Relevance and types of Motivation, Motivating the subordinates, Analysis of Motivation.

Manpower Management

Human Resources Management- Importance of Human Resources, Sources of Personnel Staffing & Recruitments: Job Analysis, Job Specification, Recruitments Tests, Selection & Placement, Training: Need For Training, Training Objectives, Strategies and Methods Training Assessment, Performance Appraisal Compensation, Basic Pay, Variable Pay, Merit Rating, Job Evaluation. Human resources planning - Importance - HRP Process-Manpower -Evolution–difference between Personnel Management and HRM- Strategic HRM- role of a HR Manager - Estimation-Job analysis-Job Description-Job Specification. Recruitment-Sources of Recruitment-Selection Process-Placement and Induction-Retention of Employees.

Relations and Compensation Management & Training and Development

Strikes, Lockouts, Lay-Offs, Grievance Functions, Meaning, Grievance Redressal Procedures, Collective Bargaining, Trade Unions. Overview of Statutory Measures for Labour Welfare-Grievance Procedure-collective Bargaining-Settlement of Disputes. Compensation Management –Concepts and Components-Job Evaluation-Incentives and Benefits

Training and Development- Objectives and Needs-Training Process-Methods of Training–Tools and Aids - Evaluation of Training Programs. Labour Issues and Career Planning - Labour: Definition Of Labour And Labour Welfare, Contract Labour & Temporary Labour, Various Theories, Historical Development, Agencies For Labour Welfare. Career Planning- Succession Planning.

REFERENCES:

1. Carleton Counter II and Jill Justice Coulter, *The Complete Standard Hand Book of Construction Personnel Management* , Prentice Hall, Inc., New Jersey, 1989.
2. Memoria, C.B., *Personnel Management*, Himalaya Publishing Co., 1992.
3. Josy. J. Familaro, *Handbook of Human Resources Administration* , McGraw Hill International Edition, 1987.
4. Andrew Dainty, Martin Loosemore, *Human Resource Management in Construction Projects*, Routledge,2012
5. Sanjay Kumar and Pushpa Lata , *Communication Skills*, Oxford University Press.2011
6. Krishna Mohan, Meera Banerji, *Basic Managerial Skills*, E. H. McGrath, Eastern Economy Edition, Prentice hall India.2014

COURSE OUTCOMES:

1. On completion of this course the students will know the personnel manpower management such as man power planning, organization, human relations, and welfare and development methods in construction.

STEEXXX	CONSTRUCTION WORKPLACE AND EMPLOYEES BEHAVIOUR	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To Study work place and employer behavior of construction projects.

Industrial Health, Safety

Causes of Accidents - Prevention – Safety Provisions – Industrial Health and Hygiene – Importance – Problems – Occupational Hazards – Diseases – Psychological problems – Counseling.

Stress in the Workplace

Job Stress – Occupational Stresses – Self Assessment Exercise – Organizational Stressors – Individual Stressors in the Workplace – Environmental Stresses.

Common Stress Factors Time & Career Plateauing

Works Related Stress – Individual Stress – Reducing Stress – Burnout - Time Management – Techniques – Importance of planning the day – Time management schedule – Developing concentration – Organizing the Work Area – Prioritizing.

Individual Behaviour
Personality – types – Factors influencing personality – Theories – Types of learners – The learning process – Learning theories – Organizational behavior modification. Misbehavior – Types – Management Intervention. Emotions - Emotional Labour – Emotional Intelligence – Theories.

Group Behaviour
Organization structure – Formation – Groups in organizations – Influence – Group dynamics – Emergence of informal leaders and working norms – Group decision making techniques – Teambuilding - Interpersonal relations – Communication – Control.

REFERENCES:

1. Arun Monappa, Ranjeet Nambudiri, Patturaja Selvaraj. *Industrial relations & Labour Laws*. Tata
2. Fred Luthans, *Organisational Behavior*, McGraw Hill, 11th Edition, 2001.
3. House, New Delhi, 2007.
4. Mamoria C.B. and Sathish Mamoria, *Dynamics of Industrial Relations*, Himalaya Publishing
5. McGraw Hill. 2012
6. P.N.Singh, Neeraj Kumar, *Employee relations Management*, Pearson, 2011.
7. P.R.N Sinha, Indu Bala Sinha, Seema Priyardarshini Shekhar, *Industrial Relations, Trade Unions and Labour Legislation,* Pearson, 2004
8. Srivastava, *Industrial Relations and Labour laws*, Vikas, 2007.
9. Stephen P. Robins, *Organisational Behavior*, PHI Learning / Pearson Education, 11th edition, 2008.

COURSE OUTCOMES:

1. On completion of this course the students will know workers difficulties in working place and behavior at construction work.

STEEXXX	DESIGN OF NUCLEAR STRUCTURES	L	T	P
		4	0	0

COURSE OBJECTIVES:

- In this course, the effect of neutron damage in solids will be discussed extensively and the behavior of nuclear materials will be described. Students who take the course will be able to work in a specialized industry requiring qualified nuclear engineers.

Physics of Nuclear reaction and fundamentals of reactors - Nuclear fission chemical reaction - reactor materials - fuel - Moderator - reflect coolant - reaction classification - reactor problems -Location and problems on radiation hazards - shielding techniques

Design of Heavy weight concrete for radiation shielding - irradiation effects on steel & concrete - time - temperature - creep and shrinkage concrete - design aspects of R.C biological shield - effect of shape on temperature distribution and stress prestressed concrete pressure vessels and containment structures - classic and ultimate methods of design of structural models in design.

REFERENCES:

1. A.R Folts, R.L.Wright, Allyn and Bacon, *Basic Nuclear Engineering*.
2. Atomic Energy Regulatory Board - *AERB Safety Manual for Civil Engineering and Building Works of Nuclear Power Plants,*. Govt. of India
3. Frank J.Rahn, *A Guide to Nuclear Power Technology; A Resource for Decision Making,* Krieger Publishing Company, 1991.
4. Samuvel Glesstone, *Nuclear Reactor Engineering,* Krieger Pub. Co; Reprint edition 1991.
5. John A. Camara ,*101 Solved nuclear Engineering Problem*
6. Richard E.Faw, *Fundamentals of Nuclear Science and Engineering*
7. K.Sriram, *Basic Nuclear Engineering,* South Asia Book Publication, 1990.
8. Richard E.Faw, J,Kennath Shultis, *Fundamentals of Nuclear Science and Engineering* CRC 1st Editon, 2002.
9. S.Glasstone and A.Sesonske, *Nuclear Reactor Engineering*, CBS Publishers.
10. J.Weisman, *Elements of Nuclear Reactor Design*, Elsevier Publishers.
11. Marshall, *Nuclear Power Technology*, Oxford Press.

COURSE OUTCOMES:

1. Students can understand the effect of nuclear and the critical analysis on nuclear structure.
2. Able to design the nuclear structure.