DEPARTMENT OF APPLIED MECHANICS

SCHEME OF INSTRUCTIONS AND SYLLABUS FOR POST GRADUATE STUDIES

M. Tech. in Structural Dynamics & Earthquake Engineering

Visvesvaraya National Institute of Technology, Nagpur

July 2015

MISSION AND VISION
OF
VISVESVARAYA NATIONAL INSTITUTE OF TECHNOLOGY, NAGPUR

MISSION

The Mission of VNIT is to achieve high standards of excellence in generating and propagating knowledge in engineering and allied disciplines. V.N.I.T. is committed to providing an education that combines rigorous academics with joy of discovery. The Institute encourages its community to engage in a dialogue with society to be able to effectively contribute for the betterment of humankind.

VISION

To contribute effectively to the national endeavour of producing quality human resource of world class standard by developing a sustainable technical education system to meet the changing technological needs of the Country, incorporating relevant social concerns and to build an environment to create and propagate innovative technologies for the economic development of the Nation.

MISSION AND VISION
OF
DEPARTMENT OF APPLIED MECHANICS, V. N. I. T. Nagpur

MISSION

The mission of the department is to achieve excellence in structural and earthquake engineering education, research and professional service. It is endeavored to equip students to assume leadership positions in engineering practice, education, research and serve mankind with structures designed for safety, serviceability and economy.

VISION

The Department is committed to provide post graduate academic and research programs to produce high quality human resource with ability to meet the global challenges associated with built environment and to emerge as centre for advanced studies in the field of structural engineering.

Department of Applied Mechanics offers two M. Tech program, namely, ***M. Tech. in Structural Engineering*** *and* ***M. Tech. in Structural Dynamics & Earthquake Engineering***. These are four semester program, wherein student has to complete certain number of credits as indicated in Table 1. Each subject (or course) has certain number of credits. There are two types of subjects: Core and elective. Core courses are compulsory and some courses from electives are to be taken to complete the required credits.

TABLE 1. CREDIT REQUIREMENTS FOR POST GRADUTE STUDIES

Postgraduate Core (PC)		**Postgraduate Elective (PE)**	
Category	Credit	Category	Credit
Departmental Core (DC)	37	Departmental Electives (DE)	15
Basic Science (BS)	00	Other Courses (OC)	00
Total	37	Total	15
Grand Total PC + PE			52

The number of credits attached to a subject depends on number of classes in a week. For example a subject with 3-1-0 (L-T-P) means it has 3 Lectures, 1 Tutorial and 0 Practical in a week. This subject will have eight credits (3x1 + 1x1 + 0x1 = 4). If a student is declared pass in a subject, then he/she gets the credits associated with that subject. Depending on marks scored in a subject, student is given a Grade. Each grade has got certain grade points as follows:

Grades	AA	AB	BB	BC	CC	CD	DD	FF
Grade Points	10	09	08	07	06	05	04	Fail

The performance of a student will be evaluated in terms of two indices, viz. the Semester Grade Point Average (SGPA) which is the Grade Point Average for a semester and Cumulative Grade Point Average (CGPA) which is the Grade Point Average for all the completed semesters at any point in time. SGPA & CGPA are:

$$\boldsymbol{SGPA} = \frac{\sum_{semester}(Course\ credits\ X\ Grade\ points)\ for\ all\ courses\ except\ audit}{\sum_{semester}(Course\ credits\ )\ for\ all\ courses\ except\ audit}$$

$$\boldsymbol{CGPA} = \frac{\sum_{All\ semester}(Course\ credits\ X\ Grade\ points)\ for\ all\ courses\ with\ pass\ grade\ except\ audit}{\sum_{All\ semester}(Course\ credits\ )\ for\ all\ courses\ except\ audit}$$

Students can Audit a few subjects. i.e., they can attend the classes and do home work and give exam also, but they will not get any credit for that subject. Audit subjects are for self enhancement of students.

Details about Faculty members of Applied Mechanics Department

Name of Faculty Member	Designation	Qualifications	Areas of specialization
Bakre S V	Associate Professor	PhD	FE Analysis, Response control and Base Isolation
Borghate S B	Assistant Professor	M.Tech	RCC structures
Datta D	Assistant Professor	PhD	Structural Dynamics, Seismic Response of Structures, Structural Reliability
Gadve S S	Associate Professor	PhD	Repairs, Rehabilitation, RCC/PSC Structures, Concrete Technology, FE Analysis
Gupta L M	Professor	PhD	Steel Structures, pre stressing steel structure, Bridges Rehabilitation and Retrofitting of Structures.
Ingle R K	Professor	PhD	Bridge, Water tank, IS 13920/IS456, (Design of building), special structures
Jaiswal O R	Professor	PhD	Dynamic Analysis of Structures for wind and earthquake loads, Review of IS Code for Elevated Water Tank Staging, Structural Control
Khatri A P	Assistant Professor	M.Tech	Steel structures, Stability of structures, RCC Structures
Mahajan M M	Professor	PhD	Machine foundation, RCC structures
Ratnesh Kumar	Assistant Professor	PhD	Performance-Based Design, Seismic Evaluation and Retrofitting, Seismic Vulnerability and Risk Assessment
Ronghe G N	Professor	PhD	Structural Instrumentation
Sonparote S S	Associate Professor	PhD	Space Structures, Software Development, Soil-Structure Interaction, Machine foundation
Vyavahare A Y	Assistant Professor	M.Tech	NL FEM Analysis, Steel Structures, Steel connection.

Scheme of Instructions for M. Tech. in Structural Dynamics & Earthquake Engineering

I Semester				II Semester			
CORE				**CORE**			
Code	**Course**	**L-T-P**	**Cr**	**Code**	**Course**	**L-T-P**	**Cr**
AML421	Matrix method of structural analysis	3-1-0	4	AML501	Earthquake Resistant Design of RC structures	3-1-0	4
AML423	Theory of Elasticity and Elastic Stability	3-0-0	3	AML502	Earthquake Resistant Design of Steel Structure	3-1-0	4
AML427	Introduction to Earthquake Engineering	3-0-0	3	AML505	Earthquake Dynamics	3-0-0	3
AML424	Structural Dynamics	3-0-0	3				
AMP424	Structural Dynamics Laboratory	0-0-2	1				
ELECTIVE (Any one)				**ELECTIVE (Any two)**			
AML435	Computer Programming and Numerical Methods	3-1-0	4	AML431	Finite Element Method	3-1-0	4
CEL 413	Pre-stressed Concrete Structures	3-1-0	4	AML504	Wind Effects on Structures	3-1-0	4
AML428	Structural Instrumentation and Rehabilitation of Structures	3-0-2	4	AML512	Foundations subjected to Vibrations	3-1-0	4
CEL 406	Advanced Concrete Technology	3-1-0	4	AML432	Analysis & Design of Multistoried Buildings	3-1-0	4
AML422	Theory of Plates and Shells	3-0-0	3	AML507	Analysis and Design of Bridges and Retaining Walls	3-1-0	4
		18/17					**19**
III Semester				**IV Semester**			
AMD501	Project Phase-I		3	AMD502	Project Phase-II		**9**
ELECTIVE (Any one)							
AML506	Analysis and Design of Special str.	3-1-0	4				
AML509	Advanced Finite Element Method	3-1-0	4				
AML430	Analysis and Design of Industrial Buildings	3-1-0	4				
AML 514	Analysis and Design of Environmental Engineering Structures	3-1-0	4				
			7				**9**

Programme Educational Objectives of M. Tech. in Structural Dynamics & Earthquake Engineering

1. To expose students to fundamentals of dynamics of structure and to earthquake and wind environmental conditions of the country and world.
2. To impart knowledge of dynamic behaviour of various structural system using analytical, experimental, computer simulation methods and other modern engineering tools
3. To communicate design methods for earthquake and wind resistant structure including lifeline structure.
4. Student capacity buildings in upcoming areas of research in the field of earthquake and wind engineering
5. To empower students to serve society in disaster mitigation related to disaster due to earthquake and wind.

Programme Outcomes of M. Tech. in Structural Dynamics & Earthquake Engineering

a. Acquire knowledge of structural dynamics and earthquake engineering and be able to discriminate, evaluate, analyze and integrate existing and new knowledge
b. Be able to critically analyze and carry out independent research on complex problems of structural dynamics and earthquake engineering
c. Be able to conceptualize and design civil engineering structures considering various socio-economic factors
d. Be able to carry out systematic research, design appropriate experiments and tools, and interpret experimental and analytical data for development of technological knowledge in structural dynamics and earthquake engineering
e. Be able to create, decide and judiciously apply appropriate resources, tools & techniques in handling various problems in structural dynamics and earthquake engineering
f. Be able to function productively with others as part of collaborative and multi-disciplinary team
g. Be able to understand critical issues for professional practice such as detailing work and the interaction with contractors during construction phase of a project
h. Be able to communicate effectively with written, oral and visual means, the design and research outcomes to the stakeholders
i. Be able to recognize state-of-the-art need and will be able to engage in life-long learning
j. Be able to understand professional and ethical responsibility while carryout out research and design activities
k. Be able to critically analyze, scrutinize and rectify one's decisions and actions and apply self corrective measures

Course Name: AML 421 – MATRIX METHOD OF STRUCTURAL ANALYSIS

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-1-0); Credits: 4]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:

Introduction to stiffness and flexibility approach, Stiffness matrix for spring, Bar, torsion, Beam (including 3D), Frame and Grid elements, Displacement vectors, Local and Global co-ordinate system, Transformation matrices, Global stiffness matrix and load vectors, Assembly of structure stiffness matrix with structural load vector, Solution of equations, Gauss elimination method, Cholesky Decomposition method, Analysis of spring and bar assembly, Analysis of plane truss, plane frame, plane grid and space frames subjected to joint loads, Analysis of Structures for Axial Load.

Analysis for member loading (self, Temperature & Imposed) Inclined supports, Lack of Fit, Initial joint displacements. Finite (Rigid & flexible) size joint, Effect of shear deformation, internal member end releases.

Use of MATLAB/MATHCAD / other software.

Effect of axial load on stiffness of members, Analysis of building systems for horizontal loads, Buildings with and without rigid diaphragm, various mathematical models, Buildings with braces, shear walls, non-orthogonal column members.

Advanced topics such as static condensation, substructure technique, constraint equations, Symmetry and antisymmetric conditions, Modeling guidelines for framed structures.

REFERENCES

1. Cheng, F. Y. “Matrix Analysis of Structural Dynamics”, M. Dekke, NY, 2000.
2. Kanchi, M.B. “Matrix Analysis of Structural Analysis”, John Willey & Sons, 2nd Edition 1999.
3. Bathe K.J. “Finite Element Procedures”, Springer; 2nd Edition, 2002.
4. Kasmali Aslam “Matrix Analysis of Structures”, Brooks/Cole Publishing Co., 1999.
5. Cook, R.D.et.al “Concept and Applications of Finite Element Analysis”, John Willey & Sons, NY, 1995.
6. Gere, W. and Weaver, J.M “Matrix Analysis of Structural Analysis 3rd Edition”, Van Nostrand Reinhold, NY, 1990.
7. Martin, H.C. “Introduction to Matrix Method of Structural Analysis”, McGraw Hill Book Co., 1996.

Course Name: AML 422 -THEORY OF PLATES AND SHELLS

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

A. To understand the behavior and basic concepts of analytical methods for 2 dimensional Structural Engineering problems

B. To develop the ability for mathematical modeling of structural Systems

C. To understand the Governing differential equations of thin rectangular Plates with various

D. To communicate effectively the concepts for analysis and design

E. To use and spread the knowledge about 2D structural engineering concepts in professional or academic field

Course Outcomes:

i. Developed skill in understanding the behavior of plates and analytical techniques to solve the 2 Dimensional structural engineering problems

ii. Ability to construct the mathematical models of structural systems

iii. Can understand the application of differential equations for the response of 2 D problem

iv. Can work as a structural designer or in the field of teaching

Syllabus:

Governing differential equations of thin rectangular Plates with various boundary conditions and loadings.

Bending of long thin rectangular plate to a cylindrical surface, Kirchhoff plate theory, Introduction to orthotropic plates.

Circular plates with various boundary conditions and loadings.

Numerical methods for solution of plates, Navier's, Levy's solutions.

General shell geometry, classifications, stress resultants, equilibrium equation, Membrane theory for family of Shells (Parabolic, Catenary, Cycloid, Circular, hyperbolic).

Classical bending theories of cylindrical shells with and without edge beams such as approximate analysis of cylindrical shells.

Reference Books/ Material:

2. Timoshenko, S.P. &Kriegar, W., "Theory of Plates & Shells", McGraw Hill, NY, 1970.
3. Szilard, R. "Theory and Analysis of Plates", Prentice Hall, 1974.
4. Novozhilov, V.V, "Thin Shells", Noordho of Groningen, 1964.
5. Ramaswamy, G. S "Design of Concrete Shells", Krieger Publ. Co, 1984.
6. Chandrashekhar, K. "Theory of Plates", University Press India Ltd., Hyderabad, 1st Edition, 2001.

7. Bairagi, N. K. a Text book of Plates Analysis.
8. Chattergee, B.K., "Theory and Design of Concrete Shells.

Course Name: AML423- THEORY OF ELASTICITY AND ELASTIC STABILITY

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

The main objective of studying the course of 'Theory of Elasticity and Elastic Stability' is to understand the theoretical concepts of material behavior with particular emphasis on their elastic properties.

- **A.** To understand the basics of stresses, strains, equilibrium and compatibility, and introduction to three-dimensional problems.
- **B.** To provide the student with the tools and an understanding of the use of vectors and tensors in describing the deformation and motion of elastic solids, the formulation of the governing equations using physical laws, and the solution of simple linear elasticity problems using various analytical techniques.
- **C.** To understand the fundamental principles of structural stability, to become familiar with common types of bifurcation and buckling phenomena.
- **D.** To address the specific problem of column and beam design, taking account of initial imperfections, coexistent end-moments, residual stresses and material inelasticity.

Course Outcomes:

At the completion of this course, the student should able to

i. Define 3D state of stress and strains, equilibrium and compatibility.
ii. Derive the governing equations and their solutions for application to problems in plane stress state, plane strain state, torsion, bending.
iii. Determine elastic critical loads for simple structures by eigenvalue analysis, and the limitations of such analysis.
iv. Understand how elastic stability may be determined from the total potential energy
v. Apply approximation methods based on energy to determine the stability of simple systems.
vi. Understand second-order beam theory, using s and c functions.

Syllabus:

Stress at a point, relationship between stresses and strains, Elastic modulii, Basic equations of theory of Elasticity. Plane stress-strain, Airy's stress function, strain-displacement relationship, Principal Planes and Principal stresses in three dimensions, equilibrium and compatibility in rectangular coordinates and other coordinate systems. Simple applications in tension, bending and torsion.

Concept of Stability, Axial buckling of columns by Energy Criteria of Stability & approximate methods, lateral torsional buckling of beams and beam columns, Coupled axial torsion and flexural buckling. Buckling of rectangular thin plates.

References:

1. Timoshenko, S.P., "Theory of Elasticity", McGraw Hill, 3rd Edition, NY, 1970.
2. Irving Shames "Advanced Solid Mechanics"
3. Popov and Balan "Mechanics of Solids"
4. Timoshenko, S.P., "Theory of Elastic Stability", McGraw Hill, 2rd Edition, NY, 1961.

5. AswiniKumar “Stability, Theory of Structures” Tata McGraw Hill
6. Trahair, N.S., “Flexural Torsional Buckling of Structures”, E & FM SPON, London.
7. Chen, W.F., “Theory of Beam-Columns-Space Behaviour and Design”, 2nd Vol., McGraw Hill
8. NPTEL Lecture Notes: IIT, Madras.

Course Name: AML424- STRUCTURAL DYNAMICS

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

A. Introduce fundaments of vibrations of SDOF system
B. Introduce damped and undamped system
C. Introduce free and forced vibration
D. Introduced free and forced vibration of MDOF system
E. Introduced free and forced vibration of continuous system

Course Outcomes:

At the completion of this course, the student should able to

i. Convert structure into SDOF system
ii. Find response of free and force vibration (harmonic, periodic and transient) of SDOF system
iii. Find natural frequency and mode shapes of MDOF system
iv. Carry out modal analysis of MDOF system
v. Performe experiments and computer simulation of vibrating system

Syllabus:

Sources of vibration, types of excitations, Principle and working of piezoelectric transducers, Spring action and damping; Degrees of freedom; Application of Newton’s laws, D’Alembert’s principle, Single degree of freedom systems; Mathematical model of physical systems; Free vibrations of undamped and viscously damped systems;

Coulomb damping material and radiation damping. Response of viscously damped SDOF systems to harmonic excitation; Vibration Isolation, Force transmissibility and base motion; Principle of vibration measuring instruments; Equivalent viscous damping; structural damping, Response of an undamped SDOF to short duration impulse; unit impulse response.

Response of undamped system of rectangular, triangular and ramp loading; response to general dynamic excitation; Duhamel integral method. Response spectra, Numerical evolution of dynamic response of linear systems, Frequency domain analysis, Fast Fourier Transform

Multiple degree of Freedom system: Vibration of undamped 2 DOF systems; Response of 2 DOF to harmonic excitation, mode superposition, vibration absorber, Lagrange equation and their application to lumped parameter models of MDOF (up to 3 DOF). Free vibration of MDOF (up to 3 DOF) systems, methods of solving eigen value problems; iteration methods. Dynamic response of MDOF (2 DOF) systems-modal superposition method. Vibration of Continuous Systems: Free vibrations of Continuous systems-axial and transverse vibration of bars / beams. Response of continuous systems to dynamic loads. Energy Principle, Rayleigh-Ritz method.

Reference Books/Material:

1. Chopra, A.K., “Dynamics of Structures”, Prentice Hall, 3rd Edition, NY, 1970.
2. Clough, R.W. &Penzin, J., “Dynamics of Structures”, McGraw Hill, 1993.
3. Humar, J.L., “Dynamics of Structures”, Prentice Hall, 1990.

4. Mario, Paz, “Structural Dynamics”, CBS Publ. N-Delhi, 1995.
5. Timoshenko, S., “Advanced Dynamics”, McGraw Hill Book Co, NY, 1948.
6. Meirovitch, L., “Elements of Vibration Analysis”, 2nd Edition, McGraw Hill International Edition, Singapore, 1986.
7. Biggs, J.M., “Introduction of Structural Dynamics”, McGraw Hill, NY, 1964.

Course Name: AMP424- STRUCTURAL DYNAMICS LABORATORY

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(0-0-2); Credits: 1]

Type of Course: Core

Course Assessment Method: Continuous Evaluation

Course Objectives:

A. Introduce fundaments of vibrations of SDOF system
B. Introduce damped and undamped system
C. Introduce free and forced vibration
D. Introduced free and forced vibration of MDOF system
E. Introduced free and forced vibration of continuous system

Course Outcomes:

At the completion of this course, the student should able to

i. Appreciate the theory of vibrations
ii. Computer simulation of structure subjected to dynamic load

List of experiments:

1. To find the time period of compound pendulum
2. To study instrumentations in structural dynamics
3. To find natural frequency of SDOF system
4. To find natural frequency of two DOF system
5. To find natural frequency of three system
6. To observe liquifaction of soil
7. To observe phenomenon of vibration absorption
8. To carry out parametric study

Course Name: AML425- ADVANCED DESIGN OF STEEL STRUCTURES

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-1-0); Credits: 4]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

A. To introduce the various method for design of steel structures with loading standards as per codal provision.

B. To qualify the students for elementary design of beam, beam-column, plate girders.

C. To disseminate the knowledge for design of workshop buildings along with concept of use of cranes.

D. To qualify the students for design of various connections.

E. Introduction of steel-concrete composites for bridges and buildings

Course Outcomes:

i. Capable of using all National as well as International loading and design methods for steel structures.
ii. Capable of design of elements for steel construction.
iii. Able to provides the design of industrial sheds with or without cranes, connections
iv. Capable of providing the design of bridges using composite construction.
v. Competent enough to scrutinize the analysis and design of steel structures

Syllabus:

Introduction to Allowable Stress Design, Plastic design, Load and Resistance Factor Design (LFRD). Loadings as per IRC, IRS, IS (IS:800, IS:875 part 1-V, IS:1893) applicable to various steel structures. Design of Beams, Beam-column, Plate Girders, Open web structures and Space structures.Bridges, Industrial Buildings including crane girders.Welded and riveted connections.Composite structures.

Reference Books/Material:

1. N. Subramanian, “Steel structure design practice”, Oxford university press-2010.
2. R. Englekirk, “Steel Structures controlling behavior through design”, John wiley& sons, 1994
3. Johnson, R.P. “Composite Structures of Steel and Concrete”, Vol-I, Granado Publishing Ltd., London, 1994.
4. “Steel Design Manual”, ELBS and Granada Publishers, London, 1990.

Course Name: AML426- ADVANCED DESIGN OF REINFORCED CONCRETE STRUCTURES

Pre-requisites: Nil

Offered in:II Semester (Even Semester)

Scheme and Credit:[(3-1-0); Credits: 4]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives :

A. To impart knowledge on Prestressed Civil Engineering Structures

B. To expose students to state-of-the-art Prestressed concrete design

C. To familiarize students with the Indian codes/Standards for Limit State Design of RC members and Prestressed concrete

D. To inculticate aptitude for mathematical modeling of RC structures and Confinement of concrete, ductile detailing

Course Outcomes:

Student will be familiarized with:

i. The present methods of Prestressed Civil Engineering Structures

ii. To identify preliminary sizing for mathematical modeling of RC structures

iii. Indian codes/Standards for RCC and PSC structures

iv. Techniques for unbonded and bonded prestressed concrete

Syllabus :

Review of Limit State Design of RC members. Confinement of concrete, ductile detailing.

Beams (Flexural, Shear and torsion)

Uni-axial and biaxial Beam-column (Axial, shear and moments)

Slabs (one way & two way) and slabs on grades. Preliminary sizing and modeling of RC structures.

Basics of Prestressed concrete Design, Material, Prestressing systems, Losses, Stress checks, Strength check, Deflection of prestressed concrete beams, Prestressed slabs and Beams, Behavior of unbonded and bonded prestressed concrete beams, Shear and Torsional resistance of the prestressed concrete members , Analysis and design of End blocks,

Reference Books / Material:

1. Paulay, T. and Prestiley, M.J.N.; Seismic design of R C & Masonry Buildings; John Willey & Sons; 2nd Edition; 1999
2. Booth, E.; Concrete Structures in Earthquake Regions; Longman Higher Education; 1994
3. Raynolds, C.E.; Reinforced Concrete Design Handbook; 9th Edition; Rupa& Company; Calcutta; 1981
4. Raynolds, C.E.; Basic Reinforced Concrete Design; Vol.-II; Conc. Publications Ltd.; 1962
5. Fintel, M.; Handbook of Concrete Engineering; 2nd Edition; CBS Publishers, Delhi; 1986
6. Park and Paulay; Reinforced Concrete Structures, John Wiley and Sons
7. Krishna Raju, N.; Prestressed Concrete Structures; TMH; Delhi; 1981

8. Lin, T.Y. and Burns, N.H.; Design of Prestressed Concrete Structures; 3rd Edition; John Wiley & Sons; NY; 1981
9. Chen, W.F. and Duan, L. Bridge engineering Handbook; CRC Press; 1999.

Course Name: AML427- INTRODUCTION TO EARTHQUAKE ENGINEERING

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

A. To expose students to fundamentals of earthquake engineering and environmental conditions of the country and world.
B. To learn method of deterministic seismic hazard analysis.
C. To train the students to analyze earthquake characteristics and associated effects on structures.
D. To communicate the concepts of dynamic analysis for civil engineering applications.
E. To teach the various methods for strength, stress and load-resistant design.
F. To impart the basic principles for seismic design and construction of structures in accordance with the provisions of Indian Standard Codes**.**

Course Outcomes:

i. To understand the fundamentals of earthquake engineering and seismicity conditions of the country and world.
ii. To perform site specific deterministic seismic hazard analysis.
iii. To analyze earthquake characteristics and associated effects on structures, including linear responses.
iv. To understand the concepts of dynamic equations of motion and perform analysis for dynamic systems in civil engineering applications.
v. To evaluate the magnitude and distribution of seismic loads for strength, stress and load-resistant design.
vi. To apply the basic principles for seismic design and construction of structures in accordance with the provisions of Indian Standard Codes.

Syllabus:

Origin of earthquakes, Engineering geology, Seismicity of the world, Faults, Propagation of earthquake waves. Quantification of earthquake (magnitude, energy, intensity of earthquake), Measurements of earthquake (accelerograph, accelogram recording), Determination of magnitude, Epicental distance, focal depth, etc. Ground motion and their characteristics, Factors affecting ground motions.

Concept of response spectra, generation of site-specific spectrum, Estimation of PGA, Earthquake design spectrum and inelastic spectra.

Concept of earthquake Resistant design, design philosophy, Four virtues of EQRD: Stiffness, Strength, ductility and Configurations, Introduction to Capacity design concepts, Introduction to IS:1893, Codal Coefficient and Response Spectrum Method.

Reference Books/Material:

1. Dowrick, D. L. “Earthquake Resistance Design for Engineers and Architects”, John Willey & Sons, 2nd Edition, 1987.
2. Housner, G. W. &Jenning, P.C. “Earthquake Design Criteria”, Earthquake Engineering Research Institute, Oakland, California, USA, 1982.
3. Newmark, N. M. & Hall, W.J. “Earthquake Spectra & Design , Earthquake Design Criteria”, Earthquake Engineering Research Institute, Oakland, California, USA, 1982.
4. Wakabayashi, M. “Design of Earthquake Resistance Buildings”, McGraw Hill Books Company, 1986.
5. Okamoto, S. “Introduction to Earthquake Engineering”, University of Tokyo press, 2nd Edition, 1984.
6. Kramer, S. L. “Geotechnical Earthquake Engineering”, Prentice Hall, New Jersey, 1996.

7. Bolt, B. A. “Earthquakes”, W. H. Freeman & Company, NY, 1988.

Course Name: AML428- STRUCTURAL INSTRUMENTATION AND REHABILITATION OF STRUCTURES

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-0-2); Credits: 4]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives :

A. To impart knowledge on laboratory / field testing of Civil Engineering Structures

B. To expose students to state-of-the-art Instrumentation for Structural analysis results and techniques for Rehabilitation of RC, Steel and Masonry structures

C. To familiarize students with the Indian codes/Standards for proof load / non-destructive testing

D. To inculticate aptitude for quality control and strengthening of civil structures

Course Outcomes:

Student will be familiarized with:

i. The present methods of laboratory / field testing of Civil Engineering Structures
ii. To identify cracks in buildings: causes and remedial measures
iii. Indian codes/Standards for non-destructive / design impose load testing
iv. Techniques for rehabilitation / strengthening of RC, Steel and Masonry structures

Syllabus :

Study of various transducers, Principle of their working, displacement, velocity, acceleration etc, strain gauge & piezoelectric type of transducers.

Strain measurements, strain gauges (static and dynamic), calculation of stresses and loads from measurements of strains and deflections.

Special concrete constructions: fibre reinforced concrete; fibre wrapping, Special concrete like lightweight concrete, ferro cement, fly ash concrete, High performance concrete, concrete admixtures.

Corrosion of steel and concrete: Theory and prevention.

Cracks in buildings: causes and remedial measures.

Techniques for Rehabilitation of RC, Steel and Masonry structures.

Non-destructive testing of concrete, steel structures, Various NDT tests, codal provisions, Proof Load testing.

Reference Books / Material:

1. Singh, Sadhu; Experimental Stress Analysis, Khanna Publishers.
2. Soisson, H.E.; Instrumentation in Industry; John Willey & Sons; NY; 1975
3. Boomfield, J.P.; Corrosion of Steel in Concrete; E& FN SPON; 1997
4. Ganesan, T.P.; Model Analysis of Structures; University Press; 2000
5. IS: 13935; Repair and Seismic Strengthening of Bulidings- Guidelines; Bureau of Indian Standard; New Delhi; 1993

6. SP: 25; Causes and Prevention of Cracks in Buildings; Bureau of Indian Standard; New Delhi; 1984

Course Name: AML429- SUBSTRUCTURE AND FOUNDATION DESIGN

Pre-requisites: Nil

Offered in:II Semester (Even Semester)

Scheme and Credit:[(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

A. To prepare a student for a carrier in foundation engineering.

B. To analyze and design various substructural components of bridges.

C. To analyze and design all types of foundations and/or their components

Course Outcomes:

On completion of the course students shall be able to:

i. To select appropriate foundation type based on various criteria.

ii. To check the stability of various components of foundation.

iii. To analyze and design all types of foundations.

Syllabus:

Analysis and design of Piers, Abutments and Retaining walls. Shallow foundations: Individual and combined footings for axial and bending loads (Uniaxial and biaxial), Loss of contacts. Rafts, Annular Footings, Rigid and flexible foundations, Beams and slabs on elastic foundations. Deep Foundations: Piles and Wells foundations. Design of Machine Foundations.

Reference Books / Material:

1. Hetenyi, M. “Beam on Elastic Foundation”, University of Michigan Press, 1946.
2. Bowles, J. E. “Foundation Analysis & Design”, McGraw Hill, 5th Edition, 1996.
3. Swami Saran, “Soil Dynamics and machine Foundations”, Galgotia Publications (P) Ltd, New Delhi, 1999.
4. Srinivasulu, P., Vaidyanathan C.V. “Handbook of Machine Foundation”.
5. Kurian, N. P. “Modern Foundations-Introduction to Advanced Techniques”.

Course Name: AML430- ANALYSIS AND DESIGN OF INDUSTRIAL BUILDINGS

Pre-requisites: Nil

Offered in:III Semester (Odd Semester)

Scheme and Credit:[(3-1-0); Credits: 4]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

A. To qualify the students to analyze and design of various types of industrial buildings

B. To introduce the fast track construction using metal deck floors and steel-concrete composite building.

C. To disseminate the complete knowledge to design of storage bins for industry.

D. To introduce the analysis and design of storage tanks for liquids other than water.

Course Outcomes:

i. Capable of design of industrial buildings with and without crane girders.

ii. Able to provide the method to early completion of multistory building.

iii. Competent to analysis and design the pressure vessels and storage bins as per industrial requirement.

iv. Competent enough to scrutinize the analysis and design of various industrial structures.

v. Capable to provide the quick solutions for retrofitting and rehabilitation of industrial structures.

Syllabus:

Design of Industrial building, Crane, Gantry Girder, North Light and Lattice girder structure, Multistory steel building (Maximum 2 bay and four storey), including composite construction. Design of Bunker and Silo (Rectangular or Square or Circular). Design of Pressure vessels and storage tanks (Circular and Square) IS 1893 Part IV.

Reference Books/Material:

1. N. Subramanian, “Steel structure design practice”, Oxford university press-2010.
2. Reimburt M.L., Reimburt A.M., “Silos theory and practice”, vol.1, No.3, Trans Tech Publications, 1976.
3. Johnson, R.P. “Composite Structures of Steel and Concrete”, Vol-I, Granado Publishing Ltd., London, 1994.
4. Owen G.W., Knowles P.R., “Steel Design manual”, Blackwell, 1994.
5. K. Rajugopalan, “Storage Structures”, Oxford & IBH Publishing co. pvt. Ltd., 1989.

Course Name: AML431- FINITE ELEMENT METHOD

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit:[(3-1-0); Credits: 4]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives :

The objectives of this course are to:

A. Understand the purposes and uses of the finite element analysis process in industry and the possible roles of the structural engineering technologist in that process.

B. Learn basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.

C. Enable the students to formulate the design problems into FEA.

D. Enable the students to perform engineering simulations using commercially available

E. Finite element analysis programs and software's.

F. Interpret one's analytical and graphical results, check one's work and report one's findings.

G. Enable the students to understand the ethical issues related to the utilization of FEA in the industry.

Course Outcome:

Upon completing this course, the students will be able to:

i. Identify mathematical model for solution of common engineering problems.

ii. Develop comprehensive knowledge in the fundamental mathematical and physical basis of FEM.

iii. Know how to do build FEM models of physical problems and apply appropriate constraints and boundary conditions along with external static and dynamic loads followed by an analysis.

iv. Derive element matrix equation by different methods by applying basic laws in mechanics and integration by parts.

v. Use professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer and communicate effectively to the society, stakeholders and industries.

vi. Develop and exercise critical thinking in interpreting results from FEM analysis. This will include the ability to identify bad results by looking at deflected shapes, stress contours.

vii. Appreciate the importance of professional responsibility and ethical issues pertaining to the effective utilization of FEA for analysis, design and research.

Syllabus:

Introduction to Finite element method, History, Applications, Introduction to Rayleigh Ritz Method, Stress strain relationship, strain displacement relationship, Equilibrium equations (Total potential approach, Virtual work approach)

Shape function, Stiffness matrix, load vector for 2-D elements (Plane stress, Plane strain &Axi-symmetric) using Displacement formulation. Cartesian and Iso-parametric element formulation.Numerical Integration, convergence study.

Formulation of 1-D elements (BAR, TORSION, BEAM) and 3-D solid elements.

Computer Implementation of FEM procedure for plane truss, Plane stress, plane strain and Axi-symmetric problems.

Constraint Equations (Penalty method, Lagrangian method), Patch test, mathematical modeling of structures.

Reference Books / Material:

1. Zienkiewicz, O. C. & Taylor, R. L., "Finite Element Method", Vol-I, II & III; Elsevier, 2000.
2. Hughes, T .R. J., "Finite Element Method", Dover Publication, 2000.
3. Bathe, K.J., "Finite Element Procedures", Pringor; 2nd Edition, 2002.
4. Reddy, J. N., "Finite Element Method", John Willey & Sons, 1982.
5. Buchanan, G.R, "Finite Element Analysis", McGraw Hill Publ.; NY, 1995.
6. Belegundu, A.D. &Chandrupatla, T.R., "Finite Element Method in Engineering", Prentice Hall India, 1991.
7. Pilkey, W.D. &Wunderlich, W., "Mechanics of Structures, Variation and Computational Methods", CRC Press, 2nd Edition.
8. Cook, R. D., "Concepts and Applications of Finite Element Analysis", John Willey & Sons; NY, 1995.
9. Prathap, G., "Finite Element Method", Kluwer Academic Publ, Dordrecht; 1993.
10. Irons, B. & Ahmad, S., "Techniques of Finite Elements", Elliswood London, 1980.

Course Name: AML432- ANALYSIS AND DESIGN OF MULTISTORIED BUILDINGS

Pre-requisites: Nil

Offered in:II Semester (Even Semester)

Scheme and Credit:[(3-1-0); Credits: 4]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives :

A. To impart knowledge on static and dynamic wind analysis, design of multistoried buildings

B. To expose students to state-of-the-art multistoried / high-rise buildings

C. To familiarize students with the Indian codes/Standards for static and dynamic wind analysis, design and design for Fire Resistant

D. To inculticate aptitude for mathematical modeling with and without diaphragms, infill wall etc.

Course Outcomes:

Student will be familiarized with:

i. The present methods of static and dynamic wind analysis of multistoried buildings

ii. To identify preliminary sizing for mathematical modeling of RC/steel structures

iii. Indian codes/Standards for RCC and PSC structures

iv. Various shear wall analysis

Syllabus:

Building frames, frame-shear wall buildings, Braced Buildings, Mathematical modeling of buildings with different structural systems with and without diaphragms,

Earthquake, wind and other (i.e. blast, snow) load calculations along with dead load and live loads and their combinations.

Special aspects in Multi-storeyed buildings: Effect of torsion, flexible first story, P-delta effect, soil-structure interaction on building response, drift limitation.

Analysis and Design of multi-storeyed buildings with masonry infills, Sequential analysis for multistoried buildings.

Design for Fire Resistant, Creep, Shrinkage and Thermal stresses.

Reference Books / Material:

1. FarzadNaeim, "Handbook on Seismic Analysis and Design of Structures", Kluwer Academic Publisher; 2001
2. Paulay, T. &Prestiley, M.J.N., "Seismic design of R C & Masonry Buildings", John Willey & Sons, 2nd Edition; 1999
3. Booth, E., "Concrete Structures in Earthquake Regions", Longman Higher Education, 1994
4. Park, R. & Paulay, T., "Reinforced Concrete Structures", John Willey & Sons, 2nd Edition, 1975
5. Fintel, M., "Handbook of Concrete Engineering", 2nd Edition, CBS Publ.Delhi, 1986

AML 435 - COMPUTER PROGRAMMING AND NUMERICAL METHODS
[(3-1-0); Credits: 8]
Objective:
To empower students with programming skill and application of various numerical methods to solve large scale computation heavy problems
Syllabus:
Computer programming Fortran /C–Programming fundamentals, Introduction to algorithm development, Computer Implementation of Matrices, Guidelines for development of a large sized problem.
NUMERICAL METHODS-Solution of Linear Simultaneous equations – Method of Gauss Elimination, Cholesky''s, 1 Gauss – Seidel method of Iteration, Solution based on Band width and its Variants. Numerical Integration – Trapezoidal, Simpson's and other Newton – Cotes formulae, Method of Gauss Quadrature. Interpolation (Lagrange Interpolation, Taylor series expansion, Extrapolation) 2 Solution of non Linear Equations, Newton Raphson schemes. Eigen value and Eigen vectors. Problems associated with choice and implementation of solution techniques in the eigen solution of large problems arising in dynamic systems. Initial and boundary value problem, Euler's, Runge-kutta, Milne's etc, Computer oriented Algorithms. 1 Jacobi iteration, 2 Regression

REFERENCES
1. Scarborough J. B., "Numerical Mathematical Analysis", Oxford and IBH publishers, 1966.
2. Gerald C. F., "Applied Numerical Analysis", Addison – Wesley Publishing Company, 1970.
3. Jain M. K., Iyengar S. R. K. and Jain R. K, "Numerical Methods for Scientific and Engineering Computations", John Wiley – New Age International Limited, 1993.
4. Balgurusamy E., "Numerical Methods", Tata McGraw Hill, New Delhi, Fifth Edition, 2001.
5. Rajaraman, V., "Fortran-95", Prentice Hall of India, 1988.
6. McCormic J. M. and Salvadori M. G., "Numerical Methods in FORTRAN", Prentice Hall of India, New Delhi, 1966.
7. Press, W.H; Tenkolsky, S.A.; Vetterling, W.T.; & Flannery, B.P., "Numerical Recipes-the art of scientific Computing; 2nd Edition", Cambridge University Press, 1993.
8. Kanetkar Y. P., "Let us C", BPB Publication, New Delhi.
9. Bathe, K. J., "Finite Element Procedures", Springer, 2nd Edition, 2002

Course Name: AML501- EARTHQUAKE RESISTANT DESIGN OF RC STRUCTURES

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-1-0); Credits: 4]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

- **A.** To integrate information from various engineering and scientific disciplines such as engineering seismology, architecture, structural dynamics and analysis and design of structures in order to provide a rational basis for the design of earthquake-resistant RC structures
- **B.** To introduce effect geometric and modeling irregularities in planning and design of RC structures based on observations of behavior from past earthquakes
- **C.** To review various national and international design codes for RC structures
- **D.** To introduce philosophy of seismic design with emphasis on strength, stiffness and ductility effects
- **E.** To qualify students in modeling, analysis and design of RC structures for seismic forces
- **F.** To introduce concepts and performance based design and pushover analysis

Course Outcomes:

Upon completing this course, the students will be:

i. Capable to correlate information from various engineering and scientific discipline to understand complex behavior of RC structure subjected to seismic forces
ii. Apply capacity design principle
iii. Capable to design RC structures in accordance with the provisions of Indian and International Building Codes considering seismic forces
iv. Capable to use performance based design framework and nonlinear analysis techniques

Syllabus:

Review of Limit State Method (LSM), Confinement of Concrete, Ductility, Capacity Design of RC Members,
Design of Beams, Beam-Column, Shear wall with ductile detailing.
Performance of RC buildings, behaviors of RC buildings in past earthquakes, influence of unsymmetry, infill walls, foundations, soft story, Strong Column –Weak Beams etc.
Preliminary sizing and Modelling of RC Buildings, Ductility and factors affecting ductility of RC members.
Design for Strong column & weak beam, Design of Beam-Column Joints.
Pushover analysis of Buildings. Concepts of Performance based design.

Reference Books/Material:

1. FarzadNaeim, "Handbook on Seismic Analysis and Design of Structures", Kluwer Academic Publisher, 2001.
2. Paulay, T. &Prestiley, M.J.N., "Seismic design of R C & Masonry Buildings", John Willey & Sons, 2nd Edition; 1999.
3. Dowrick, D. J., "Earthquake Resistant Design for Engineers & Architects", John Willey & Sons, 2nd Edition; 1987.
4. Booth, E., "Concrete Structures in Earthquake Regions", Longman Higher Education, 1994.
5. Park, R. &Paulay, T., "Reinforced Concrete Structures", John Willey & Sons, 2nd Edition; 1975.

6. NEHRP Guidelines for the Seismic Rehabilitation of Buildings (FEMA 356), FEMA/ASCE, Washington DC, 1997.

Course Name: AML502- EARTHQUAKE RESISTANT DESIGN OF STEEL STRUCTURES

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-1-0); Credits: 4]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

A. To introduce the students to the fundamental concepts and principles required for the seismic design of steel structures.

B. To enable the student to develop an understanding of the seismic behaviour of steel members, connections and systems under typical earthquake loading conditions.

C. To apply the knowledge in practical earthquake resistant design of common forms of steel structures according to modern codified regulations, with particular emphasis on the Indian Standard Code IS 800:2007.

Course Outcomes:

i. To determine seismic actions on typical steel structures using simplified methods of analysis.

ii. To identify suitable lateral resisting systems which are capable of providing effective earthquake resistance for steel building structures.

iii. To understand the response characteristics of typical steel members and connections under cyclic and earthquake loads.

iv. To appreciate the typical damage patterns that are observed in steel structures on the basis of experience from previous seismic events.

v. To apply the main design rules and detailing requirements for moment resisting and braced steel systems according to the provisions of Indian Standard, IS 800:2007.

Syllabus:

Basics of Steel Design, Introduction to plastic analysis and design, Design philosophy for steel structures.

Performance of steel structures in past earthquakes, Capacity design concept, Ductility of steel buildings, Seismic behaviour of steel structures, Stability considerations,

Seismic Design and detailing of Moment Resistant Frames (MRFs): Beams and Columns.

Seismic design and detailing of MRFs: Panel Zones and Connections.

Seismic design and detailing of Concentric Brace Frames (CBFs), Introductions to Eccentric Brace Frames (EBFs) and Special Truss Moment Frames (STMFs).

Reference Books/Material:

1. Englekirk, R, “Steel Structures Controlling Behaviour Through Design”, John Wiley& Sons Inc, 2003.
2. Bruneau, M.; Uang, C.M.; & Whittaker, A, “Ductile Design of Steel Structures”, McGraw Hill.
3. Mazzolani, F.M.; & Piluso, “V.; Theory and Design of Seismic Resistant Steel Frames”, E&FN Spon.

Course Name: AML504- WIND EFFECTS ON STRUCTURES

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-1-0); Credits: 4]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

A. To introduce concept of wind flow
B. To give knowledge on static and dynamic wind load analysis
C. To give exposure to Indian Standard code for wind
D. To enable students to do static wind load based design
E. To introduce students to wind tunnels
F. To perform experiments on wind effects on structures

Course Outcomes:

i. In depth knowledge of IS - 875(Part 3), Indian Standard Code for wind load on structures
ii. Knowledge about wind tunnels and various aspects of wind flow
iii. Ability to do static and dynamic analysis for wind loading
iv. Ability to design a structure for different types of wind induced loadings.

Syllabus:

Wind Characteristics: Variation of wind velocity, atmospheric circulations – pressure gradient force, coriolis force, frictionless wind balance, geostrophic flow, boundary layer. Extra ordinary winds – Foehn, Bora, Cyclones, Tornadoes etc., Static wind effects and building codes with particular reference to IS 875 (Part-III), wind speed map of India, introduction to the proposed revisions of IS 875 (Part III).
Dynamic wind effects: Wind induced vibrations, flow around bluff bodies, along wind and across wind response, flutter, galloping, vortex shedding, locking, ovalling; analysis of dynamic wind loads, codal provisions – gust factor, dynamic response factor; vibration control and structural monitoring; exposure toperturbation method, averaging techniques, Wind tunnel testing : Open circuit and closed circuit wind tunnels, rigid and aeroelastic models, wind tunnelmeasurements and instruments along with site visit.
Case studies: low rise buildings, parking sheds, workshop building, multistory building, water tanks, towers, chimneys, bridges.

Reference Books/Material:

1. EmilSimiu and R. H. Scanlan, "Wind Effects on Structures – An Introduction to Wind Engineering", John Wiley and Sons, New York, 986.
2. C. Scruton, "An Introduction to Wind Effects on Structures", Oxford University Press, Oxford,UK, 1981.
3. Peter Sachs, "Wind Forces in Engineering", Pergamon Press. Oxford UK, 1972.
4. Lawson T. V., "Wind Effects on Buildings", Applied Science Publishers, London, UK, 1980.
5. Cook, N. J., "The designer's guide to wind loading of building structures. Part 1 Background,damage survey, wind data and structural classification. Building Research Establishment", Butterworths, U. K., 1985.
6. Cook, N. J., "Designer's guide to wind loading of building structures. Part 2: Static structures. Building Research Establishment", Butterworths, U. K., 1990.
7. Simiu, E., Scanlan, R. H., "Wind Effects on Structures: fundamentals and applications to design",3rd Edition, John Wiley & Sons, New York, 1996.
8. Dyrbye, C., Hansen, S. O., "Wind loads on structures", John Wiley, New York, 1997.

9. Holmes, J. D., “Wind loading on Structures”, Spon Press, London, U. K., 2001.
10. Nayfeh, E.H., “Introduction to perturbation techniques”, Wiley-Interscience
11. Blevins, R.D., “Flow induced vibration”, Van Nostrand Reinhold

Course Name: AML505- EARTHQUAKE DYNAMICS

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:

Equation of Motion for SDOF and MDOF system subjected to base excitation, Response spectrum analysis and Time history analysis.

Modal superposition & Step by step integration for MDOF system, Numerical evaluation of dynamic response, Computer implementation.

Response spectrum analysis, Modal participation factor, Mass Participation factor, Modal combination rules, missing mass correction.

Analysis of Secondary systems, Evaluation of floor response spectra.

Response of elasto-plastic system, Effect of yield force, ductility, use of NONLIN software.

Earthquake response of multistory buildings, Torsional response of buildings.

Reference Books/Material:

1. Chopra, A. K, “Dynamics of Structures”, Prentice Hall, 1995.
2. Clough, R.W.; Penzin, J., “Dynamics of Structures”, McGraw Hill, 1993.
3. Humar, J. L., “Dynamics of Structures”, Prentice Hall, 1990.
4. Timoshenko, S., “Advanced Dynamics”, McGraw Hill Book Co; NY, 1948.
5. Paz M, “Structural Dynamics”, CBS Publishers; N-Delhi, 1995.

Course Name: AML506- ANALYSIS AND DESIGN OF SPECIAL STRUCTURES

Pre-requisites: Nil

Offered in:III Semester (Odd Semester)

Scheme and Credit:[(3-1-0); Credits: 4]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

To introduce mathematical modelling and analysis techniques special structures viz. Water Tanks, Masonry Structures, Industrial Structures, Chimneys& Dams.

A. To review various national and international code provision for design of special structures.

B. To qualify students to design of Masonry buildings, Industrial structures, Chimneys, Dams.

Course Outcomes:

Upon completing this course, the students will be able to:

i. Develop mathematical models for various special structures
ii. Apply various analysis techniques for special structures
iii. Apply the principles and provisions for seismic design and detailing for special structures
iv. Initiate research on water tanks and masonry structures

Syllabus:

Earthquake analysis of overhead, underground, ground supported water tanks, Single mass and two mass systems, various mathematical modeling, IS code recommendations.

ERD and detailing of Masonry buildings, Industrial structures, Chimneys, Dams.

Reference Books/Material:

1. FarzadNaeim, "Handbook on Seismic Analysis and Design of Structures", Kluwer Academic Publisher, 2001.
2. IS 4326, "Earthquake Resistant Design and Construction of Buildings - Code of Practice", Bureau of Indian Standard; New Delhi, 1993.
3. Jain, S.K. &Jaiswal, O.R., "Guidelines for Seismic Design of Liquid Storage Tanks", NICEE, IITK, 2004.
4. Fintel, M., "Handbook of Concrete Engineering", CBS Publishers Delhi, 1986.
5. Witendry, A., "Structural Masonry", Macmillan Press Ltd..
6. Drysdale, R.; Hamid, R.; & Baker, L., "Masonry Structures - Behavior & Design", Prentice Hall, 2nd Edition; 1994.

Course Name: AML507- ANALYSIS AND DESIGN OF BRIDGES AND RETAINING WALLS

Pre-requisites: Nil

Offered in:II Semester (Even Semester)

Scheme and Credit:[(3-1-0); Credits: 4]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:

Types of bridge superstructure and introduction to their design, sub-structure, bearings, IRC / IRS Bridge loadings and other codal recommendations, Performance of Bridges in past earthquakes.

Seismic design philosophy for Bridges, State of art Modelling of bridges, Seismic Design of Substructures, Capacity design of substructures and ductile detailing, Seismic design of well and pile foundations, Modelling soil flexibility.

Earthquake behavior and Design of retaining wall and Abutments, IS code recommendations.

Design of Bearings (Free, Guided and Restrained).

Reference Books/Material:

1. Chen, W.F. and Duan, L, "Bridge Engineering Handbook", CRC Press, 1999.
2. Fintel, M., "Handbook of Concrete Engineering" 2nd Edition, CBS Publishers Delhi, 1986.

Course Name: AML509- ADVANCED FINITE ELEMENT METHOD

Pre-requisites: Nil

Offered in: III Semester (Odd Semester)

Scheme and Credit: [(3-1-0); Credits: 4]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

A. To introduce advanced element used in FE analysis.
B. To introduce nonlinear analysis of structure.
C. To introduce formulation of dynamic problems in FEM
D. To built the ability to model and to solve complex problems in engineering.

Course Outcomes:

After successfully completion of this course, the student shall be able to demonstrate knowledge and understanding of-

i. Plate bending element, shell element, axisymmetric element etc.
ii. Non-linear problems using FEA
iii. Problems involving dynamics using FEA
iv. Application of FEA for complex problem

Syllabus:

Plate elements (Kirchoff theory, Mindlin plate element, triangular and rectangular, conforming & nonconforming elements), Shell elements (flat faced triangular and rectangular elements, Degenerated shell elements), Axisymmetric plate & shell elements, Ring elements. Advanced elements- Mixed formulation, Infinite elements.
Formulation for Geometrical Nonlinear problems.Formulation for Material Nonlinear problems.Formulation of Dynamic problems, Consistent and lumped mass matrices.
Implicit and Explicit numerical integration.

Reference Books/Material:

1. Zienkiwicz O.C., Taylor R.L., Zhu J.Z., 'The Finite Element Method: Its Basis and Fundamentals', sixth edition, McGraw Hill, 2005
2. R.D. Cook, D.S. Makus and M.F. Plesha, 'Concept and Applications of Finite Element Analysis', John Wiley and Sons, 1981.
3. T. R. Chandrupatla, A. D. Belegundu, 'Introduction to Finite Elements in Engineering', third edition, Printice Hall of India Pvt. Ltd., New Delhi, 2002
4. Daryl L. Logan, 'A First Course in the Finite Element Method', Cengage Learning India Pvt. Ltd., New Delhi, 2008.
5. S. S. Rao, 'The Finite Element Methods in Engineering', fourth edition, Elsevier Science & Technology Books, 2004
6. S. Krishnamoorthy, 'Finite Element Analysis, Theory and Programming', Tata McGraw-Hill, Publishing Company Ltd., New Delhi, 1987.
7. Y. Nakasone, S. Yoshimoto, T. A. Stolarski, 'Engineering Analysis With ANSYS Software', Elsevier, Burlington, 2006

8. Thomas J. R. Hughes, 'The Finite Element Method- Linear Static and Dynamic Finite Element Analysis', Dover Publication, Inc., New York, 2000.

Course Name: AML512- FOUNDATIONS SUBJECTED TO VIBRATIONS

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-1-0); Credits: 4]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

A. To understand the behavior and basic concepts for the Design of foundation subjected to vibrations

B. To develop ability for mathematical modeling of Foundation systems

C. To understand the theory of Dynamic and dynamic properties of soil with special reference to Foundation subjected to vibrations

D. To communicate effectively the concepts for analysis and design

E. To use and spread the knowledge about 2D structural engineering concepts in professional or academic field

Course Outcomes:

On completion of the course students

i. Developed skill in understanding the basics of vibration

ii. Developed the understanding for type and principles for machine foundations

iii. get exposure to Dynamic soil properties and soil testing methods in laboratory and on field

iv. Can understand the importance of huge machine foundations in power plants

v. Can work as a structural designer or in the field of teaching

Syllabus:

Introduction to Foundation Vibration, Dynamic Soil Properties, Field Test and Laboratory Techniques, Elastic Modulus and Elastic Constants.

Wave Propagation in Elastic Homogeneous and Isotropic Materials, Vibration of Elastic Media, Elastic Waves

General Principle of Machine Foundation, Analysis and Design, Type of Machine Foundation, Block Type Foundation, Foundation for Impact Type Machine, Reciprocating Machine Framed Foundation

Introduction to IS Codes, Design of Different Machine Foundations based on IS Code Method

Elastic Half Space Method, Analysis based on Elastic Half Method, Different Methods based on Elastic Half Space.

Bearing Capacity of Shallow Foundation, Pile Foundation under Dynamic Load, Vibration Isolation

Reference Books/Material:

1. Krammer., "Earthquake Geotechnical Engineering".
2. Bowles, J. E., "Foundation Analysis & Design", McGraw Hill, 5th Edition, 1996.
3. Richart; F.E.; Hall, Jr. J.R. & Wood, R.D., "Vibrations of Soil & Foundations", Prentice Hall; New Jersey, 1970.
4. Prakash; S., "Soil Dynamics", McGraw-Hill Book Co.; New York, 1981.
5. Wolf, J.P., "Dynamic soil structure interaction", Prentice-Hall, Inc. Eaglewood Cliffs, N. J., 1985.

6. Swami Saran, “Soil Dynamics and Machine Foundations”, Galgotia Publications (P) Ltd, New Delhi, 1999.
7. Bhatia K. A., “Foundation for Industrial Machine”, D-CAD Publishers, New Delhi, 2008.

Course Name: AML514- ANALYSIS AND DESIGN OF ENVIRONMENTAL ENGINEERING STRUCTURES

Pre-requisites: Nil

Offered in:III Semester (Odd Semester)

Scheme and Credit:[(3-1-0); Credits: 4]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:

Analysis of circular water tanks with various boundary conditions at base slab, variation of hoop tension, moment and deflection of wall with various H/RT ratios, deep and shallow tanks.

Analysis of rectangular water tanks with various boundary conditions at base slab, variation of moments with respect to height/span ratio.

Design (un-cracked and cracked design) of water tank sections subjected to moment, Moment and compression, moment and tension.

Earthquake Analysis of water tanks on ground and over head tanks,

SDOF and MDOF model.

Analysis and design of jack well, WTP units and GSR etc.

Analysis and design of ESR (container and staging)

Reference Books/Material:

1. Jain, S.K., Jaiswal, O.R., “Guidelines for seismic design of liquid storage tanks”, NICEE, IITK, 2004.
2. Anchor, R.D., “Design of liquid retaining concrete structure”, Edward Arnold, London, 1992.
3. BIS, IS 3370, “Indian Standard code of practice for concrete structures for the storage of liquids”, Part I to IV.
4. Ghali, A, “Circular Storage Tanks and Silos”, E & F N Spon, London. 1979.

CEL413 – PRESTRESSED CONCRETE STRUCTURES [(3-1-0); Credits: 4]

Design of high strength concrete mixes. Loss of prestress in single span and continuous beams. Use of IS 1343-1980, Analysis Limit State Design of beams for Tension Type II and III problems, Cracking moment, untensioned reinforcement, Partial prestressing, Stress Corrosion.

Transfer of prestress by bond, Transverse tensile stresses, End zone reinforcement. Behaviour of Bonded and unbounded prestress concrete beams.
Deflection of Prestressed concrete members, short and long term, control of deflections. Crack width considerations. Flexural strength of prestressed concrete sections: Types of flexural failures, Limit state concept.
Shear resistance of prestressed concrete members: Principal stresses and ultimate shear Resistance, Design of shear reinforcement, prestressed concrete, members in Torsion, Design of reinforcement in torsion shear and bending.
Stress distribution in end block, Analysis and Anchorage Zone reinforcement. Composite Construction of prestressed precast and cast in situ concrete. Statically Indeterminate structures: Continuous beams, primary and secondary moments, Continuity, concordant cable profile, Analysis and Design of continuous beams.
Prestressed concrete pipes and poles.Design of Prestressed concrete tanks. Prestressing of dams and bridges: Method of construction. Stage prestressing, Dynamic and Fatigue behaviour of prestressed concrete.

REFERENCES

1. Nigel R Hewon, “Prestressed Concrete Bridge, Design and construction”, Thomas Telford London, 2003.
2. Devid A.Sheppard & William R. Phillps,“Plan Cast Precast and Prestressed concrete (A Design Guide)” , Mcgraw Hill Publication Co., 1989.
3. N. Krishnaraju, “Prestressed Concrete”, Tata McGraw Hill, 3rd Edition, 1981.
4. Lin T.Y,Burns N.H, “Design of Prestressed Concrete Structures”, John Wiley & sons, 3rd Edition,1982.

CEL 406 - ADVANCE CONCRETE TECHNOLOGY AND CONSTRUCTION

[(3-1-0); Credits: 4]

Review of properties of cement, their physical and chemical properties, special purpose cements, Classification and properties of aggregates, soundness of aggregates, alkali aggregate reaction, thermal properties of aggregates, Importance of shape and Surface area and grading, gap graded and aggregates. Admixtures & construction chemicals, Use of Fly Ash, Silica Fumes, Metakaolin & GGBS in concrete Rheological behavior of concrete, requirements of workability of concrete, Durability & Effect of environmental conditions, Strength & maturity of hardened concrete, Impact, Dynamic and fatigue behaviour of concrete, shrinkage and creep of concrete, behaviour of concrete under fire.

Permeability and Durability of concrete, Parameters of durability of concrete, chemical attack on concrete, Production of concrete; batching mixing, transportation, placing, compaction of concrete. Special methods of concreting and curing, Hot weather and cold weather concreting, Guniting (Shotcreting)
Concrete mix design, Basic considerations and choice a mix proportions, various methods of mix designs including IS Code method. Quality control and quality assurance of concrete, Acceptance criteria, Quality management in concrete construction, Inspection and testing of concrete. Non-destructive testing of concrete, core test and load test.
Special concrete such as high strength, Lightweight, heavy weight, vacuum processed concrete, Mass concrete, high performance concrete, Pumpable concrete, Self Compacting concrete, Air entrained concrete, Ferro cement, fiber reinforced concrete, Polymer impregnated concrete. Jet concrete. Recycling & re-use of industrial waste material. Deterioration and repair technology of concrete, Distress and type of repairs, crack sealing techniques

REFERENCES

1. Gambhir M.L., “Concrete Technology”, Tata McGraw Hill, 2nd Edition, 1995.
2. M.S.Shetty, “M.S.Shetty”, S.Chand & Company New Delhi, 2005.
3. P.Kumar Mehata, Paulo & J.M. Monteiro, “Concrete microstructure, properties & materials”, Prentice Hall INC & Mcgraw Hill USA.
4. Short & Kenniburg, “Light Weight Concrete”, Asia Publishing House, Bombay, 1963.
5. Orchard D.F, “Concrete Technology -Vol I. & II”, Applied Science Publishers, 4th Edition, 1979.
6. Neville A.M., J.J.Brook, “Properties of Concrete”, Addison Wesley, 1999.