KERALA TECHNOLOGICAL UNIVERSITY

ERNAKULAM WEST (06) CLUSTER

DRAFT

SCHEME AND SYLLABI

FOR

M. Tech. DEGREE PROGRAMME

IN

GEOMECHANICS AND STRUCTURES

(2015 ADMISSION ONWARDS)

SEMESTER-1

Exam Slot	Course No:	Name	L- T – P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06 CE6015	Advanced Design of Concrete Structures	4-0-0	50	50	3	4
B	06 CE6025	Mechanics of Geomaterials	4-0-0	50	50	3	4
C	06 CE6035	Geotechnical Investigations and Field Testing	3-0-0	50	50	3	3
D	06 CE6045	Applied Mathematics for Civil Engineers	3-0-0	50	50	3	3
E	06 CE6X55	Elective I	3-0-0	50	50	3	3
	06 CE6065	Research Methodology***	1-1-0	100	0	0	2
	06 CE6075	Seminar-1	0-0-2	100	0	0	2
	06 CE6085	Advanced Geotechnical Laboratory	0-0-2	100	0	0	1

Credits: 22

	Elective I (06 CE6X55)
06 CE6155	Advanced Concrete Technology*
06 CE6255	Theory of Elasticity and Plasticity**
06 CE6355	Earthquake Resistant Design

* Common with CEAM, SECM

**Common with SECM

***Common with SECM, CASE, CEAM, ENVT

SEMESTER-II

Exam Slot	Course No:	Name	L- T – P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06 CE6016	Advanced Steel Structures	4-0-0	50	50	3	4
B	06 CE6026	Foundation Analysis and Design	4-0-0	50	50	3	4
C	06 CE6036	Prestressed Concrete Structures*	3-0-0	50	50	3	3
D	06 CE6X46	Elective II	3-0-0	50	50	3	3
E	06 CE6X56	Elective III	3-0-0	50	50	3	3
	06 CE6066	Mini Project	0-0-4	100	0	0	2
	06 CE6076	Design Studio	0-0-2	100	0	0	1

Credits:20

Elective II - (06 CE6X46)		Elective III- (06 CE6X56)	
06 CE6146	Bridge Engineering**	06 CE6156	Earth Retaining Structures
06 CE6246	Finite Element Methods	06 CE6256	Geotechnical Earthquake Engineering
06 CE6346	Analysis of Plates and shells***	06 CE6356	Computational Geotechnics

*Common with CASE, SECM

**Common with CASE, SECM

*** Common with SECM

SEMESTER-III

Exam Slot	Course No:	Name	L- T – P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06 CE7X15	Elective IV	3-0-0	50	50	3	3
B	06 CE7X25	Elective V	3-0-0	50	50	3	3
	06 CE7035	Seminar-2	0-0-2	100	0	0	2
	06 CE7045	Research Project (Phase 1)	0-0-8	50	0	0	6

Credits: 14

Elective-IV**(**06 CE7X15**)**		Elective-V**(**06 CE7X25**)**	
06 CE7115	Geosynthetics and Reinforced Soil Structures	06 CE7125	Structural Design of Foundations and Earth retaining Structures
06 CE7215	Ground Modification Methods	06 CE7225	Repair and Rehabilitation of Concrete Structures
06 CE7315	Marine Geotechnical Engineering	06 CE7325	Dynamics of Structures

SEMESTER-IV

Exam Slot	Course No:	Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
	06 CE7016	Research Project (Phase 2)	0-0-21	100	0	0	12

Credits: 12

Total Credits for all semesters: 68

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6015	ADVANCED DESIGN OF CONCRETE STRUCTURES	4-0-0-4	2015
Pre-requisites	• Analysis of reinforced concrete structural systems under gravity and lateral loads • A general understanding of the behaviour and design of reinforced concrete members like beams, slabs and columns.		

Course Objectives

1.To understand the different sources of cracking in concrete structures and understand the mechanisms causing flexural and shrinkage cracking, the design guidance in current codes of practice and the use and limitations of such methods in design.
2. To understand and apply the design guidance used in current codes of practice for the design of slender columns, shear walls ,corbels, deep beams ,flat slabs etc.

Syllabus

Estimation of deflection and crack width, Design of special RC elements such as slender columns, RC and shear walls, deep beams,corbels,flat slabs etc., Yield line theory of slabs, Redistribution of moments, Design of cast in-situ beam column joints, Ductile detailing of RC frames.

Course Outcome

On successful completion of this course,it is expected that students should be able to
1. Calculate short term and long term deflections for RC elements.
2. Analyse the flexural and shear capacity of special RC elements.
3. Calculate the ductility of a reinforced concrete section.
4. Design special RC structures as per current codes of practice.

Textbooks

1.Unnikrishna Pillai and Devdas Menon “Reinforced concrete Design’, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2006.

2.Varghese, P.C, “Advanced Reinforced Concrete Design”, Prentice Hall of India, 2005. 4. Purushothaman, P, “Reinforced Concrete Structural Elements : Behaviour Analysis and Design”, Tata McGraw Hill, 1986

3.Dr.B.C.Punmia,Ashok Kumar Jain,Arun Kumar Jain,”Limit State Design of Reinforced Concrete,Laxmi Publications Pvt Ltd,2010

References

1. 1. Varghese, P.C., “Limit State Design of Reinforced Concrete”, Prentice Hall of India, 2007.
2. Park.R & Paulay T, "Reinforced Concrete Design", John Wiley & Sons, NewYork, 1975

3. M.L Gambir , "Design of Reinforced Concrete Structures",PHI Learning Pvt.Ltd,Delhi

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I REVIEW -Limit state design of beams, slabs and columns according to IS Codes. Calculation of deflection of beams according to IS 456-2000-Short term and long term deflection of Cantilevers, continuous beams, slabs etc, - and Measures for reducing deflection. Crack width-Factors affecting crack width in beams-Mechanism of flexural cracking-Estimation of crack width in beams by IS 456 method.	14	**25**
Module II SPECIAL RC ELEMENTS - Slender columns – Slenderness limits for columns-methods of design of slender columns-design of braced and unbraced slender columns. RC walls – Design of plain concrete walls carrying axial load and horizontal loads. Shear walls –Classification of shear walls-Principle of shear wall analysis-Design considerations-Design of rectangular and flanged shear walls. Deep beams- IS 456 recommendations- Design of RC deep beams. Corbels or brackets- Strut and tie method of analysis -Design of corbels	14	**25**
Module III FLAT SLABS –Components of flat slab construction-Recommendations according to IS 456-2000,Direct Design method and Equivalent frame method-Shear in flat slab-Effect of openings in flat slab-Comparison of flat slab with two way slabs. Design of spandrel beams YIELD LINE THEORY AND DESIGN OF SLABS-Characteristic features of yield lines-Moment capacity along an yield line –Analysis by virtual work method and Equilibrium method	14	**25**
Module IV REDISTRIBUTION OF MOMENTS-Limit analysis-Moment curvature relationship-Recommendations of IS 456-2000 –Bending moment envelope-Application to continuous beams and one way continuous slabs. CAST IN-SITU BEAM-COLUMN JOINTS-Types of cast in-situ joints,Forces acting on joints-Design of joints for strength-Anchorage-Confinement of core of joint-Corner or knee joints. DUCTILE DETAILING OF RC FRAMES FOR SEISMIC FORCES-General Principles-Factors increasing ductility-Requirements for ductile detailing of beams,coulmns and frame members.	14	**25**

End Semester Exam

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6025	**MECHANICS OF GEOMATERIALS**	**4-0-0-4**	**2015**
Pre-requisites	**NIL**		

Course Objectives

- To give the students an integrated understanding of the nature and characteristics of different types of geomaterials their similarities and differences
- To develop a sound understanding of the mechanical behavior of geomaterials

Syllabus

Origin classifications and identification of Geomaterials – soils, rocks and intermediate geomaterials, soil particle characteristics and state variables, sedimentary and residual soils, rock mass classification systems, intermediate geomaterials; Water in soils, principle of effective stress for saturated and unsaturated soils, suction, steady state flow, theories of consolidation; Initial and induced stresses in the ground, laboratory stress-deformation-strength tests; laboratory and field stress paths, stress deformation characteristics of geomaterials, Failure of geomaterials, Mohr-Coulomb failure criterion, shear strength of coarse grained and fine grained soils, drained and undrained conditions, strength of intact rock and rock masses, strength of IGM's

Course Outcome

On successfully completing this course, students will be able to:

- Classify geomaterials into soils, rocks and IGMs by acquiring a good understanding of their typical characteristics
- Apply the principle of effective stress and to analyze steady state flow and consolidation problems.
- Demonstrate a sound understanding of stress-deformation and strength characteristics of geomaterials
- Interpret the results of laboratory tests to evaluate geotechnical design parameters for deformation and stability problems.

Textbooks

1. Holtz, R.D., Kovacs, W.D., and Sheahan, T.C., *An introduction to Geotechnical Engineering*, second edition, Pearson.

2. Das, B.M., *Advanced Soil Mechanics*, Taylor and Francis

3. Budhu, M. *Soil Mechanics and foundations*, John Wiley & Sons Inc., 2011

4. Mitchel, J.K., Soga, K., *Fundamentals of Soil Behaviour,* John Wiley & Sons Inc., 2005

References

1. Atkinson, J. *Mechanics of Soils and Foundations*, Taylor & Francis, 2007

2. Sabatini P.J., Bachus R.C., Mayne P.W., Schneider J. A. and Zettler T.E., *Evaluation of soil and rock properties,* Geotechnical Engineering circular No. 5, US dept. of transportation, Federal highway administration.

3. Wesley, L.D., *Geotechnical Engineering in Residual Soils*, John Wiley & Sons Inc., 2010

4. Goodman, R.E., *Introduction to Rock Mechanics*, John Wiley & Sons Inc., 1989

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module 1 Origin and classification of geomaterials - soils, rocks and intermediate geomaterials (IGM); Differences in the behaviour of soils, rocks and IGMs and approaches for the solution of practical engineering problems; Soil particle characteristics - mineralogy, grain size and shape, clay minerals, clay-water interactions; state variables governing soil behavior – fabric, degree of saturation, state of stress, stress history, cementation, ageing; Typical characteristics of coarse-grained and fine-grained sedimentary and residual soils; Classification of rocks – based on geology, compressive strength and intensity of weathering, discontinuities in rocks, intact rock versus rock mass, engineering rock mass classification – RQD, Rock mass rating, Q system, Geological strength index; Overview of intermediate geomaterials (IGM) – hard soils, weak rocks, laterites, saprolites, completely and highly weathered rocks.	14	25
Module 2 Occurrence of water in soils, principle of effective stress for saturated and unsaturated soils, capillarity, swelling and shrinking, frost, introduction to behavior of unsaturated soils – water tension and suction; Fundamentals of fluid flow in porous media; Darcy's law – assumptions, limitations, applications; Hydraulic conductivity – factors influencing, laboratory and field methods; Steady state two dimensional flow problems – Laplace's equation, boundary conditions, solution using flow nets, Consolidation of soils - Theory of one and two dimensional consolidation, assumptions, initial and boundary conditions, degree of consolidation.	14	25
Module 3 State of stress at a point – total and effective stress tensor, hydrostatic and deviatoric stress, initial state of stress in the ground, stress changes in the ground due to geotechnical constructions, drained and undrained behavior; Overview of laboratory stress-deformation-strength tests - unconfined compression, direct shear, triaxial compression/extension, simple shear, true	14	25

triaxial, hollow cylinder tests; Drained and undrained triaxial tests, pore-pressure parameters; Concept of stress path and its importance, stress path in Cambridge p-q space, total and effective stress paths in triaxial tests, field stress paths; Stress-deformation characteristics of soils for isotropic, one-dimensional and triaxial loading; drained and undrained stiffness of soils – factors influencing modulus, evaluation from laboratory and field tests; Deformation parameters for rock masses and intermediate geomaterials		
Module 4 Failure of soils, rocks and IGMs, Mohr-Coulomb failure criterion; Shear strength of granular soils - factors influencing the shear strength, friction and dilatancy, peak and constant volume angle of shearing resistance, correlations with in-situ tests; Shear strength of fine grained soils – drained and undrained response, UU, CU and CD tests, stress path testing, total and effective shear strength parameters for stability analysis; Strength of intact rock - unconfined compressive strength and point load index tests; Estimation of shear strength parameters for rock masses from rock mass classification systems; Shear strength parameters for residual soils and IGMs from in-situ tests.	14	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6035	**GEOTECHNICAL INVESTIGATIONS AND FIELD TESTING**	**3-0-0-3**	**2015**
Pre-requisites	**NIL**		

Course Objectives

- To give the students a keen appreciation of the objectives and importance of geotechnical investigations and field testing and a sound understanding of the basic principles
- To develop in the students a sound understanding of the commonly used methods of exploration, sampling and field testing, their advantages and limitations and applicability to different subsurface conditions
- To introduce use of field instrumentation in geotechnical engineering
- To learn to analyze and interpret field borelogs, laboratory and filed test data, to develop a three dimensional representation of the ground conditions, to evaluate geotechnical design parameters and to prepare factual and interpretative reports.

Syllabus

Importance of geotechnical investigations, planning of investigations, phases of investigations,

overview of commonly used geophysical methods, methods of boring in soils and rocks, sampling soils, rocks and ground water, field identifications and description of soils and rocks, different field tests and their applications in geotechnical engineering, introduction to geotechnical instrumentation, derivation of ground profiles and geotechnical design parameters, preparation of geotechnical reports.

Course Outcome

On successfully completing this course, students will be able to:

- Plan geotechnical investigation programme for civil engineering projects
- Select appropriate techniques of investigations suitable for various site conditions
- Supervise field work including boring, sampling, field tests and instrumentation
- Identify and classify soils and rocks in the field
- Interpret field bore logs, laboratory and field test data to develop subsurface profiles and to evaluate geotechnical design parameters for various strata.

Textbooks

1. Simons N., Menzies B. and Matthews M., *A Short Course in Geotechnical Site Investigation*, Thomas Telford, 2002.
2. Sabatini P.J., Bachus R.C., Mayne P.W., Schneider J. A. and Zettler T.E., *Evaluation of Soil and Rock Properties*, Geotechnical Engineering circular No. 5, US dept. of transportation, Federal highway administration.
3. Bowles J.E., *Foundation Analysis and Design*, Mc.Graw Hill, NY, 1996

References

1. Nayak, N.V. *Foundation Design Manual*, Dhanpat Rai Publications, 2012.
2. Schnaid F., *In-situ testing in Geomechanics*, Taylor and Francis, 2009
3. Look B.G., *Handbook of Geotechnical Investigation and Design Tables*, CRC press, 2014.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module 1 Importance of geotechnical investigations, Planning of investigation programmes, methods of exploration – surface mapping, subsurface exploration and samples, preliminary investigations during planning phase and detailed investigations during design and construction phase, geophysical methods – electrical resistivity and seismic refraction, number, spacing, depth and diameter of bore holes	8	20
Module 2 Methods of boring in soil and rock, stabilization of boreholes, boring in difficult subsurface conditions; Soil sampling - disturbed and undisturbed samples, types of samplers and their requirements, disturbances during	13	30

sampling, preservation and handling of samples; Rock sampling- core barrels, core boxes, description of rock samples, core recovery, rock quality designation; ground water table level and sampling of ground water; field identification, classification and description of soils and rocks; field bore logs		
Module 3 Various types of field tests, equipment and procedure, corrections, interpretations and correlations with engineering properties - Standard penetration tests, Static Cone Penetration tests, Dynamic cone penetration tests, Dilatometer tests, Pressure meter test, field vane shear tests; field permeability test, plate load test; Dynamic soil properties - seismic down hole, up hole and cross hole tests, cyclic plate load tests and block vibration tests;	13	30
Module 4 Introduction to geotechnical instrumentation - Importance of field monitoring, measurement of total stress, pore pressure and deformation; Geotechnical investigation reports – factual and interpretative reports, structure, components, presentation; Development of subsurface profiles and ground models on the basis of data from investigations; Evaluation of design parameters for soils and rocks from laboratory and field test data – strength and deformation parameters for coarse grained soils, fine-grained soils, weak/weathered rocks and hard rocks.	8	20
End Semester Exam		

Course No.	**Course Name**	**L-T-P- Credits**	**Year of Introduction**
06 CE6045	**APPLIED MATHEMATICS FOR CIVIL ENGINEERS**	**3-0-0-3**	**2015**
Pre-requisites:	Knowledge of multiple integrals, differential equations, integral transforms, linear and non- linear algebraic equations, partial differential equations		

Course Objectives

1. To apply standard methods to know the importance of learning theories in mathematics.
2. To apply numerical techniques for solving practical problems in the field of engineering.

Syllabus

Beta and Gamma function, Bessel's function, Legendre equation, Laplace transforms, Fourier transforms, Tensor Analysis, Integral Equations, Partial differential equations, Numerical solution of linear & non-linear algebraic equations and Partial differential equations

Expected outcome

Students would be able to

1. Evaluate integrals using beta and gamma functions
2. Understand various functions arising out of series solution of differential equations
3. Understand tensor analysis and its importance
4. Solve integral and partial differential equations
5. Solve linear & non-linear algebraic equations
6. Find the numerical solution of partial differential equations

Textbooks

1. Erwin Kreyzig, "Advanced Engineering Mathematics", John Wiley & Sons, 1994
2. Dr. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 2008.
3. Santhi Swaroop, "Integral equations", Krishna Prakasan Media., 2011
4. Venkataraman, M.K, "Higher Engineering Mathematics", National Publishers, 1992

References

1. Sokol Nikof, "Tensor Analysis", John Wiley, Newyork, 1951
2. Sneddon I.N., "Partial Differential Equations", McGrawHill, 1957.
3. Chapra, S. C. and Canale, R. P., "Numerical Methods for Engineers", 5th Edition, Tata McGraw-Hill, 2007.
4. Rajasekharan S, "Numerical Methods for Initial and Boundary value problems". Wheeler and Co., Pvt. Ltd., 1987

Course Plan

Contents	Hours	Sem. Exam Marks
Module I Beta Gamma functions, Linear differential equations, Applications in vibratory motion. Bessel functions, recurrence relations, generating functions, Legendre's equation and Legendre's polynomials. Recurrence relations and orthogonality property.	10	25
Module II Integral transforms - Laplace transforms, application to differential equations- Fourier transforms, properties, derivatives, boundary value problems. Tensor Analysis- summation conventions- transformations of coordinates, basic transformations, Contra variant and mixed tensors.	10	25
Module III Integral Equations - Relation between integral and differential equations-	10	25

solutions by transforms of derivatives – solutions of initial and boundary value problems.Partial differential equations – Non-linear equations of second order, D'Alembert's method. Applications, wave equation, Laplace equation-solution-application.		
Module IV System of linear algebraic equations- elimination and factorization methods.Gauss-Siedal iteration, solution of non-linear equation-Newton Raphson method.Numerical Integration Gaussian quadrature, Newton – cotes open quadrature. Numerical method of solution of partial differential equations in two dimensions-finite differences-explicit and implicit methods- solution for irregular boundaries.	12	25
END SEMESTER EXAM		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6155	**ADVANCED CONCRETE TECHNOLOGY***	**3-0-0-3**	**2015**
Pre-requisites	**NIL**		

Course Objectives

1. To study the properties of concrete making materials such as cement, aggregates and admixtures
2. To acquire the practical knowledge on mix design principles, concepts and methods
3. To get an adequate knowledge about the special concretes and their applications in the diverse construction field

Syllabus

Concrete materials , Admixture in concrete, Performance of concrete, Special concretes Durability of concrete , Mix design

Course Outcome

1. Execute and test the concrete made with cement, aggregates and admixtures.
2. Describe the properties and durability of fresh and hardened concrete.
3. Execute mix proportioning of concrete and describe how the strength of concrete can be modified by changing the proportions.

4. Decide the correct concreting methods in the field depending upon the requirement and site conditions

Textbooks

1. Metha, P.K. and Monteiro, P.J.M, "Concrete, Microstructure, Properties and Materials", Fourth Edition, Tata McGraw- Hill Publishing company Limited, New Delhi, 2006.
2. Neville, A.M. and Brooks, J.J., "Concrete Technology", Pearson Education India, 2008.
3. Santhakumar, A.R., "Concrete Technology", First edition, Oxford University Press India, 2006.

References

1. Gambhir, M.L., "Concrete Technology", Third edition, Tata McGraw-Hill Education, 2004.
2. IS 10262-2009, Recommended guidelines for concrete mix design.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Concrete materials: Chemical Composition of OPC -- Hydration process of Portland cement - Structure of hydrated cement paste - Interfacial transition zone – Significance of interfacial transition zone – special cements – Testing of cement and aggregates- requirements and quality of water for concreting.	12	**25**
Module II Admixture in concrete: Supplementary cementitious materials (SCM) – Silica fume – Fly ash – Ground granulated slag – Rice husk ash – metakaolin – Chemical admixtures – Normal water reducers and high range water reducers – Air entraining admixtures – Miscellaneous admixtures. Performance of concrete: Properties of fresh concrete and hardened concrete - Strength –Elastic properties - Shrinkage - Creep – Rheological behavior of fresh concrete – Modified slump test.	10	**25**
Module III Special concretes: Structural light weight concrete – applications - High strength concrete – significance, materials used - Self compacting concrete – significance, materials used and testing of SCC – Fiber reinforced concrete – mechanics of fiber pull out – toughening and strengthening mechanism - application of FRC – Concrete containing	10	**25**

polymers – polymer concrete – latex modified concrete – polymer impregnated concrete – applications - Roller compacted concrete. Special concreting methods: General method of transporting concrete – Concrete pumping- Methods of curing and compaction -Vacuum dewatering process - Extreme weather concreting - Underwater concreting.		
Module IV Durability of concrete: Sulphate attack – Alkali aggregate reaction – Effect of fire on concrete - Corrosion of steel in concrete – Control of corrosion. Mix design: Factors affecting mix proportion –Variability of concrete strength – Statistical quality control – Sampling and acceptance criteria – Mix design of normal strength concrete by BIS 10262:2009 – Basic considerations in the mix proportioning of high strength concrete, fiber reinforced concrete and self compacting concrete.	10	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6255	**THEORY OF ELASTICITY AND PLASTICITY****	**3-0-0-3**	**2015**
Pre-requisites	Basic understanding of solid mechanics (UG level)		

Course Objectives

To enable the students to learn

- The fundamentals of stress, strain and displacement relationships, constitutional law, material characterization and Lami's parameters.
- Equilibrium equations, compatibility equations, stress functions, solution of two dimensional problems in Cartesian and polar coordinates.
- Torsion of circular bars.
- Fundamentals of Engineering Theory of Plasticity

Syllabus

Concept of Stress at a point. Strain and displacement. Constitutive equations Generalized Hooke's law. Equations of equilibrium. Compatibility equations. Stress functions. Two dimensional problems in Cartesian and Polar coordinates. Axis symmetrical problems and

their solutions. Torsion of non circular bars. Saint Venant's method. Multi cellular sections. Shear flow. Membrane analogy. Enginering theory of plasticity**.** Levy-Misces and Prandtl-Rauss equations. flow rule. Mohr – Coulomb yield criterion for concrete. Yield surface in 3 D space of Principal stresses- Testing of concrete stress strain curve. Flow rule.

Course Outcome

- On successful completion of the course one will be able to apply the principles of theory of elasticity to find solutions to the engineering problems related to the analysis and design of engineering structures and components. The determination of stress distributions will enable him to design satisfactorily the components.
- A student will also be able to use the principles of plasticity to be applied to solve simple problems and to design components.

Textbooks

1. Timoshenko S P and Goodier J. N, "Theory of Elasticity", Tata Mcgraw Hill International Student Edition.

2.Srinath L. S, "Advanced mechanics of solids", Tata McGraw– Hill Publishing Company Ltd., New Delhi

References

1**.**Akhtar Khan, Sujian Huang "Continuum Theory of Plasticity", Wiley Publications.

2.Wai-Fah Chen, "Plasticity in reinforced concrete", J-Ross Publishing

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Theory of Elasticity: Introduction to ToE-Equilibrium of a body subjected to forces-Continuum-Stress at a point-Stress Tensor-Stress matrix-Notations-Sign Conventions-Traction Vector on an oblique plane with arbitrary orientation-Stress Transformation rule-Normal Stress and Shear stresses on any plane- Principal Stresses and their directions-Stress invariants-Octahedral normal and shear stresses-Spherical and deviatoric stresses-Stress ellipsoid-Cauchy's stress quadric-One sheeted and two sheeted hyperboloids-Transformation equations in two and three dimensions-Mohr's Circle representations-Equilibrium equations(2D and 3D).	12	**25**

Introduction to strain-Kinematic or strain displacement equations-Normal strain-Shearing strain-Strain matrix formulation-Displacement components and strain-Pure deformation-Rotation in three dimensions-Principal strains-Strain along a line in terms of components of strain-Strain and rotation rates-Strain transformation rule(3D and 2D Cases)-Strain compatibility equations-physical meaning-Strain measurement-Rosette analysis-Rectangular, Star, Delta rosettes. Material characterization-Typical uniaxial stress strain curve for steel and concrete - Conventional and true values-Generalized Hooke's law-Anisotropic materials-Materials with elastic symmetries-Orthotropic and isotropic cases-Homogeneous materials-Lami's constants -Hooke's law for linear elastic isotropic solids.		
Module II Two dimensional stress–strain problems in elasticity: Formulation and method of solutions-Plane stress and plane strain problems–Equations of compatibility in stress- Airy's stress function-Boundary conditions-Polynomial solutions-Examples of loaded beams-2D problems in polar coordinates-Axis symmetrical problems-Stress distribution in a hollow cylinder subjected to uniform internal and external pressures-Pure bending of curved bars-Strain components in polar coordinates-Rotating discs-stress components-effects of circular hole on stress distribution of plates-Concentrated force on a straight boundary-Stress function and stress components.	10	**25**
Module III Torsion of non-circular straight bars: Saint Venant's semi inverse method-Assumed displacements-Warping function-Components of stress-Conditions satisfied by warping functions-Determination of stress function and its properties along the boundary of the cross section-Shearing stresses give torque-Solution for elliptic cross section and equilateral triangular cross section-Comparison of a closed tubular section and Slit tubular cross section-Multi cellular sections-Shear flow-Shear stresses-Torque-Membrane analogy and its applications to solution of torsional problems-Stress function contours and warping displacement contours for elliptical and triangular cross sections-Hollow thin walled sections-Shear stress, torque and angle of twist-Very thin rectangular sections-Stress function-Shear Stress-Torque for a composite section.	10	**25**
Module IV Engineering theory of plasticity: Introduction-foundation of plasticity-the criterion of yielding-representation in the principal stress space-the deviatoric stress vector-Tresca and Misces criterion-Plane stress yield locus-Strain hardening postulates-Rule of plastic flow-Plastic potential-	10	**25**

Plastic flow rule in the deviatoric plane-Associated flow rule-Stress increment and strain increment vector for a given state of stress-Regular yield surface-singular yield surface-constitutive equations. Levy-Misces and Prandtl-Rauss equations-Geometrical representations for work hardening material-Tresca's associated flow rule-Plastic strain increment vector associated with the Tresca and Misces criteria-Anisotropic flow rule-Uniaxial stress strain cycles in a cyclic hardening material. Mohr-Coulomb yield criterion for concrete-Yield surface in 3D space of principal stresses – Drucker- Prager yield surface Mohr – Coulomb strength criterion in the stress space and in the π plane. Testing of concrete – Uniaxial stress-strain curve, pre and post failure regime-Criteria of loading and unloading.-Elastic strain increment tensor-Flow rule- associated and non-associated-Uniqueness of solution and normality condition of flow.		
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6355	**EARTHQUAKE RESISTANT DESIGN**	**3-0-0-3**	**2015**
Pre-requisites	**NIL**		

Course Objectives

1. To make the students to understand the concepts of Engineering seismology

2.To analyse building for earthquake forces and introduce design concepts

3.To explain the design guidelines for earthquake resistant masonry and earthen buildings

Syllabus

Seismic Hazards, Earth And its Interior, Earthquake Size, Earthquake Ground Motion, Concept of Earthquake Resistant Design, Concept of capacity design, Ductile detailing, Provisions of IS: 1893-2002

Course Outcome

At the end of the course students will be able to

1.Describe ground motion and its relationship to seismic design of structures.

2. Include earthquake resistant features in masonry buildings.

3.Apply the Basic Principles of Conceptual Design for Earthquake resistant RC Buildings

Textbooks

1. Bruce A. Bolt, "Earth quakes", W.H. Freeman and Company, New York

2. Pankaj Agarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall of India Private Limited, New Delhi, India.

3. Steven L. Kramer, "Geotechnical Earthquake Engineering", Pearson Education, India. 4. S. K. Duggal, "Earthquake Resistant Design of Structures", Oxford University Press, New Delhi.

References

1.Murthy C. V. R, "Earthquake tips, Building Materials and Technology Promotion Council", NewDelhi, India.

2. Pauly. T and Priestley M.J.N , "Seismic Design of Reinforced Concrete and Masonry Buildings", John Wiley and sons Inc.

3. Repair and Strengthening of Reinforced Concrete, Stone and Brick Masonry Buildings, United Nations Industrial Development Organization, Vienna. 34

4. Anil K. Chopra, "Dynamics of Structures",. Pearson Education, India.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Seismic Hazards:- Need of special emphasis to earthquake engineering, Ground shaking, structural hazards, Liquefaction, Lateral spreading, Landslides, Life line hazards, Tsunami and Seiche hazards. The Earth And its Interior: - The Circulation, Continental drift, Plate tectonics, Plate boundaries, Faults and its geometry. The Earthquake: - Elastic rebound theory, Terminology like hypocenter, epicenter and related distances. Seismic Waves: - Terminology, Body waves: - P- waves and S- waves, Surface waves: – Love waves and Rayleigh waves. Calculation of wave velocity, measuring instruments, locating epicenter of earthquakes numerically from traces and wave velocity. Earthquake Size: - Intensity – RF, MMI, JMA and MSK. Comparison of above. Magnitude – Local magnitude, Calculation (Analytically and graphically), Limitations, Surface wave magnitudes, Moment magnitudes and its Calculation, Saturation of magnitude scales	10	**25**

Module II Earthquake Ground Motion: - Parameters: - Amplitude, Frequency and duration. Calculation of duration from traces and energy. Response Spectra: - Concept, Design Spectra and normalized spectra, Attenuation and Earthquake Occurrence. Guttenberg- Richter Law. Concept of Earthquake Resistant Design: - Objectives, Design Philosophy, Limit states, Inertia forces in Structure. Response of Structures – Effect of deformations in structure, Lateral Strength, Stiffness, Damping and ductility. Floor diaphragms: - Flexible and rigid, Effect of inplane and out of plane loading, Numerical example for lateral load distribution Torsion and Twists in Buildings: - Causes, Effects, Centre of mass and rigidity.Torsionally coupled and uncoupled system, Lateral load distribution, Numerical example based on IS code recommendation. Building Configurations: - Size of Building, Horizontal and Vertical layout, Vertical irregularities, Adjacency of Building, Open-ground	12	**25**
Module III R.C.C for Earthquake Resistant Structures: - How to make buildings ductile, Concept of capacity design, Strong Column weak beam, Soft Storey. Ductile design and detailing of beams and shear walls. Calculation of Base shear and its distribution by using codel provision. Detailing of columns and Beam joints. Performance of R.C.C. Building. Ductile detailing:-Study of IS: 13920-1993. Repair: - Methods, Materials and retrofitting techniques.	10	**25**
Module IV Earthquakes in India: - Past earthquakes in India an overview, Behaviour of buildings and structures during past earthquakes and lessons learnt from that. Seismic Code: - Provisions of IS: 1893-2002. Masonry Buildings:- Performance during earthquakes, Methods of improving performance of masonry walls, box action, influence of openings, role of horizontal and vertical bands, rocking of masonry piers. Reduction of Earthquake Effects: - Base Isolation and dampers; Do's and Don'ts During and after Earthquake.	10	**25**
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6065	**RESEARCH METHODOLOGY*** **	**1-1-0-2**	**2015**

Pre-requisites	**Nil**

Course Objectives

To teach and make the student aware about the methodology and techniques of doing research both in technology as well as in social sciences.

Syllabus

Objectives and types of research, research methods vs methodology, Different types of research, Research design and execution, Execution of the research, data collection and analysis, Reporting and thesis writing.

Course Outcome

On successful completion of the course the students will be equipped to carry out their research and emanate its outcomes to the outside world.

Textbooks

1.Kothari C.R., Research Methodology, New Age International Publishing.
2.Sam Daniel P. and Aroma G. Sam, Research Methodology, Gyan Publishing House.

References

3.Panneerselvam R., Research Methodology, PHI Learning Pvt. Ltd.
4..Bhattacharyya D.K., Research Methodology, Excel Books India.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Objectives and types of research, research methods vs methodology; Different types of research, Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, Literature review - primary and secondary data/information sources, reviews, monographs, patents, discussion series, white papers, research databases like CMIE, BB, UNSD etc., critical literature review, identifying gap areas from literature review.	7	25
Module II Research design and execution: Research design – basic principles, need of research design, features of good design, important concepts relating to research design, observation and facts, laws and theories, prediction and explanation, development of models.	7	25
Module III Execution of the research, data collection and analysis: Aspects of method validation, observation and collection of data, methods of data collection,	7	25

different sampling methods, data analysis techniques of hypothesis testing, ANOVA, randomized block design (RBD) and completely randomized design (CRD).		
Module IV Reporting and thesis writing: Structure and components of scientific reports, types of report, technical reports and thesis. Different steps in thesis writing, layout, structure and language of typical reports, bibliography, referencing and footnotes. Research ethics – ethical issues, ethical committees, Scholarly publishing – design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.	7	25

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6075	**SEMINAR-1**	**0-0-2-2**	**2015**
Pre-requisites	**NIL**		

Course Objectives

- To encourage interest in research
- To motivate the students for self-study
- To develop communication and presentation skills

Syllabus

Students have to register for the seminar and select a topic in consultation with any faculty member offering courses for the programme. The paper should be a detailed study on a recent advancement/trend in the field of geotechnical engineering or structural engineering. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. The seminar shall be of 30 minutes duration and a committee with the Head of the department as the chairman and two faculty members from the department as members shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee.

Course Outcome

Students will be able to:

- Collect and critically review information on new topics.
- Prepare technical reports
- Make technical presentations.

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6085	ADVANCED GEOTECHNICAL LABORATORY	0-0-2-1	2015
Pre-requisites	NIL		

Course Objectives

- To give the students a fundamental understanding of the principles of the common laboratory tests for soils.
- To develop the ability to prepare specimens, conduct tests, take measurements and interpret results.

Syllabus

Specific gravity, Atterberg Limits, Grain size analysis, IS Classification of soil from lab data, Standard and Modified Proctor Compaction Test, Permeability of soil; Relative Density Test, Direct Shear Test, Lab Vane shear test, Triaxial Shear Test (CU, UU), California bearing ratio, Consolidation Test, Physical and Mechanical properties of geosynthetics.

Field visits / Demonstration of Field Tests: Standard Penetration test, Cone penetration test, Field vane shear test.

Course Outcome

On successfully completing this course, students will be able to:

- Prepare specimens for different laboratory tests
- Operate equipment for different laboratory tests
- Conduct tests, take measurements, analyze data, perform calculations and interpret results

References

1. Head, K.H. Manual of Soil Laboratory Testing, Vol 1, 2 and 3. CRC Press, 2006
2. Germaine, J.T. and Germaine, A.V., Geotechnical Laboratory Measurements for Engineers, John Wiley & Sons, 2009
3. Bardet, J.P. Experimental Soil Mechanics, Prentice Hall, New Jersey, 1997
4. Liu, C., Evett, J.B. Soil Properties – Testing, measurement and evaluation, Pearson Education, 2009
5. Relevant IS codes.

SEMESTER II

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6016	**ADVANCED STEEL STRUCTURES**	**4-0-0-4**	**2015**
Pre-requisites	1.Basic Steel Design (or equivalent) (U G Level) 2.Theory of Elastic Stability		

Course Objectives

- Enable the student to incorporate engineering standards of safety and quality in Steel Design.
- Incorporate realistic constraints in design problems.
- Incorporate health and safety, constructability, and sustainability constraints in design problems.

Syllabus

Analysis ,Design Procedures and Requirements as per IS800-2007,Design of Tension & Compression members, Beam column joints, Column bases,Moment connections, Industrial buildings,Multi storeyed buildings,Bridges,Cold formed sections etc.

Course Outcome

- The students should get familiarity with the design provisions of the IS:800-2007.
- Able to design the primary elements of structural steel systems (columns, beams, tension members, and connections).
- The students to become proficient in the design of structural steel building systems.
- The students gain an understanding of the behavior and design requirements of the entire structural system.

Textbooks

1. Subramanian.N, “Design of Steel Structures”, Oxford University Press, 2008.
2. Lynn S. Beedle, “Plastic Design of Steel Frames”, John Wiley and Sons, New York, 1990
3. Rhodes J., ”Design of cold formed steel members” ,Elsevier Science Publishers, 1991.

References

1. Salmon C G,Johnson J E ,”Steel Structures –design and behavior”, Harper and row,1980.
2. Teaching resource for structural steel design ,INSDAG Kolkotta,2001
3. Duggal S K, “Limit state design of steel structure”, TMH publications, 2000

Course Plan

Contents	Contact Hours	Sem. Exam

		Marks
Module I INTRODUCTION: Properties of Structural Steel, Corrosion, Fire Protection.Indian Standard Specifications and Sections. DESIGN APPROACH: Design Requirements & Design Process- Analysis Procedures & Design Philosophy- Introduction to Limit State Design. Other Design Requirements. Review of loads on structures- Dead, Live, wind and Siesmic loads as per IS 800-2007.	11	25
Module II TENSION MEMBERS: Introduction- Plates with Holes-Angles under Tension- Design of Tension Members. COMPRESSION MEMBERS- Buckling Strength of Ideal Columns-Strength of Practical Compression Members- Column Strength Curves- Design of Axially Loaded Columns- Design of Angles Loaded through one-leg- Laced and Battened Columns. BEAMS- Behavior of Steel beams - Limit State Design of Steel Beams - Web Buckling and Crippling - Lateral Torsion Buckling Behavior of Unrestrained Beams - Design approach for Unrestrained Beams - Unsymmetrical sections and Bi-axial bending - Introduction to Plate Girders.	15	25
Module III BEAM-COLUMNS : Short Beam- Columns - Stability Consideration for Long Beam-Columns -Interaction Formula - Design approach to Beam-Columns - Plastic Analysis and Design of Portal Frames. COLUMN BASES : Introduction to Bases and Footings - Design of Solid Slab Base - Design of Gusted Base - Other Types of Footings. MOMENT CONNECTIONS : Simple, Semi-rigid and Rigid Connections - Connection Configurations - Angle Cleat Connections - End-plate Connections - Semi-rigid Connections -Moment-rotation Characteristics.	15	25
Module IV INDUSTRIAL BUILDINGS: Structural Configurations - Functional and Serviceability Requirements - Industrial Floors - Roof Systems - Crane Gantry Girders. MULTI-STOREYED BUILDINGS: Structural Configurations - Steel-Concrete Composite Floor Systems - Lateral Load Resisting Systems. BRIDGES : Classification and Types of bridges - Load and Load Combination for highway Bridges. COLD FORMED STEEL DESIGN : Behaviour of compression elements - Effective width for load and deflection determination - Behaviour of stiffened and unstiffened elements - Design of compression and tension members.	15	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6026	FOUNDATION ANALYSIS AND DESIGN	4-0-0-4	2015
Pre-requisites	NIL		

Course Objectives

- To give the students an understanding of the factors influencing the performance of foundations and choice of type of foundation
- To learn the principles of geotechnical analysis and design of shallow and deep foundations
- To apply basic principles to the practical geotechnical design of shallow and deep foundations

Syllabus

Importance, types and choice of foundations, loads, limit states, settlements and its effects, soil-foundation-structure interaction, contact pressure, subgrade models; Depth of foundation, bearing capacity and settlement of footings and rafts; foundations on rocks and intermediate geomaterials; Classification of piles, effects of installation, shaft and base resistance in soils, IGM's and rocks, lateral capacity of piles, uplift capacity, group effects, settlements of pile groups, defects in bored piles, pile termination criteria, pile load tests; compensated foundations, pile rafts, well foundations, tower foundations.

Course Outcome

On completion of this course, the student will be able to:

- Select appropriate type of foundation based on type of structure and ground conditions
- Determine the allowable bearing pressures and settlements of footings and rafts
- Determine the allowable vertical, lateral and uplift loads on single piles and pile groups and determine vertical settlements of pile groups.
- Have a basic understanding of compensated foundations, piled rafts, wells and tower foundations.

Textbooks

1. Salgado, R., *The Engineering of Foundations*, Tata McGraw-Hill, 2011
2. Bowles, J.E., *Foundation Analysis and Design*, McGraw-Hill, 1996
3. Coduto, D.P., Foundation Design Principles and Practices, Prentice Hall, 2001
4. Tomlinson, M.J., *Foundation Design and Construction*, Pearson Education, 2011

References

5. Tomlinson, M.J. and Woodward, J.C. Pile Design and Construction Practice, CRC Press, Taylor & Francis Group, 2015.
6. Fleming, K., Weltman, A., Randolph, M., and Elson K. Piling Engineering, Taylor & Francis, 2009
7. Nayak, N.V. Foundation Design Manual, Dhanpat Rai Publications, 2012.
8. Relevant IS Codes

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module 1 The need and importance of foundations, factors influencing the choice of foundations, types of shallow and deep foundations, Loads on foundations; design process for foundations, geotechnical limit states for foundations, foundation movements and its effects on structures, differential settlement and angular distortion, allowable settlement; variability and uncertainties of the ground and their influence on foundation design and construction; Introduction to soil-foundation-structure interaction, influence of relative stiffness of structure, foundation and soil, contact pressure distribution below footings and rafts, overview of subgrade models, modulus of subgrade reaction for design of footings and rafts.	12	20
Module 2 Depth of foundation, bearing capacity footings and rafts, drained and undrained analysis, layered soils, eccentric, inclined and lateral loads, footings and rafts on intermediate geomaterials, footings on rocks; Settlement of footings and rafts – distortion settlements using elastic theories, settlement of foundations on sand - schmertmann's method, consolidation settlements of footings and rafts on clay.	14	25
Module 3 Classification of piles based on method of installation, effects of installation, shaft resistance of driven and bored piles in coarse grained and fine-grained soils, shaft resistance of bored piles in residual soils and intermediate geomaterials, end bearing resistance of bored and driven piles in coarse grained and fine-grained soils, residual soils and IGM's, capacity of piles socketted into rock, negative skin friction; lateral capacity of piles – free and fixed head, short and long piles, depth of fixity, Brom's method for short piles, p-y curves for laterally	18	35

loaded piles, uplift capacity of piles; pile groups, settlement of pile groups; Common defects in bored piles, Pile termination criteria, Pile integrity testing, pile load tests – static and dynamic tests.		
Module 4 Compensated foundations – concepts, design principles, uplift, down-drag; Piled rafts – use of piles to control settlements of raft foundations, design principles; Well foundations – types, various components and their design, stability analysis, sinking; Tower foundations – stability against uplift, overturning, sliding.	12	20
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6036	**PRESTRESSED CONCRETE STRUCTURES***	**3-0-0-3**	**2015**
Pre-requisites	**NIL**		

Course Objectives

To impart to students

- Basic concept of Prestressing, Analysis of prestress and bending stress
- Design of Pretensioned and Post-Tensioned Flexural Members
- Prestressing of statically indeterminate structures
- Composite construction of Prestressed and in situ Concrete

Syllabus

Basic concept of Prestressing,Systems of Prestressing: - Pre tensioning and Post tensioning, Analysis of prestress and bending stress: - Stress concept, Strength concept-Losses of Prestress .

Deflection of beams Effect of tendon profile on deflections, Prediction of long term Elastic Design: Shear and Torsional Resistance of PSC members Simplified code procedure for bonded and unbonded symmetrical and unsymmetrical sections.Design of sections for flexure: - Expressions for minimum section modulus, Prestressing force and Eccentricity. Limiting zone for prestressingforce.Design of Pretensioned and Post-Tensioned Flexural Members Prestressing of statically indeterminate structures Concept of Linear

transformation, Guyon's theorem, Concordant cable profile.End blocks: - Anchorage zone Stresses Composite construction -Tension membersDesign of Special Structures: Design and analysis of post and pre tensioned PSC slabs

Course Outcome

On completion of the course the students shall attain knowledge on analysis and design of prestressed concrete beams(determinate and indeterminate),post tensioned slabs, tension members etc andComprehend the design of various prestressed concrete members used in practice**.**

Textbooks

1.N. Krishna Raju, "Prestressed concrete", Tata McGraw Hill Publishing Co.Ltd.

2. N. Rajagopal, "Prestressed Concrete", Narosa Publishing House, New Delhi.

References

1**.** S. Ramamrutham, "Prestressed Concrete", DhanpatRai Publishing Company (P) Ltd., New Delhi.

2. Y. Guyon, "Prestressed Concrete", C. R. Books Ltd., London

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Introduction: Basic concept of Prestressing,Systems of Prestressing: - Pre tensioning and Post tensioning, Thermo elastic and Chemical prestressing. Need of high strength concrete and steel, Advantages of prestressed concrete over reinforced concrete, Analysis of prestress and bending stress: - Stress concept, Strength concept: - Pressure line and internal resisting couple and Load balancing concept for extreme fiber stresses for various tendon profile. Losses of Prestress:- Stages of losses, Types of losses in pre-tensioning and post-tensioning due to Elastic shortening, Shrinkage, Creep, Relaxation, Anchorage Slip, Friction and Sudden changes in temperature. Deflection of beams: Short term, Load deflection curve, Importance of control of deflections, factors influencing deflections, Pre- cracking and Post-cracking, Effect of tendon profile on deflections, Prediction of long term (Concept only)	10	25
Module II Elastic Design: Shear and Torsional Resistance of PSC members: - shear and Principal stresses, Ultimate shear resistance of PSC members: - Section cracked and uncracked, Design for shear using IS code. PSC members in	12	25

torsion:-Pure torsion, Combined bending moment and torsion, Combined bending moment, shear and torsion, modes of failure, Design of reinforcement using IS code provision. Flexural strength: - Simplified code procedure for bonded and unbonded symmetrical and unsymmetrical sections. Behavior under flexure: - Codal provision for Limit state design:-Design stress strain curve for concrete. Design of sections for flexure: - Expressions for minimum section modulus, Prestressing force and Eccentricity. Limiting zone for prestressing force. Design of Pretensioned and Post-Tensioned Flexural Members: Dimensioning of Flexural members, Estimation of Self Weight of Beams, Design of Pre tensioned and Post tensioned members symmetrical about vertical axis.		
Module III Prestressing of statically indeterminate structures: Advantages, Effect, Method of achieving continuity, Primary, Secondary and Resultant moments, Pressure line, Concept of Linear transformation, Guyon's theorem, Concordant cable profile. End blocks: - Anchorage zone Stresses, Stress distribution in end block, Methods of investigation, Anchorage zone reinforcements, Design (IS Code method only)	12	25
Module IV Composite construction of Prestressed and in situ Concrete: Types, Analysis of stresses, Differential shrinkage, Flexural strength, Shear strength, Design of composite section. Tension members: Load factor, Limit state of cracking, Collapse, Design of sections for axial tension. Design of Special Structures: Design and analysis of post and pre tensioned PSC slabs, Pipes, Circular water tanks.(Concepts only)	8	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6146	**BRIDGE ENGINEERING****	**3-0-0-3**	**2015**
Pre-requisites	**Nil**		

Course Objectives

To instruct the students on

- The basic concepts in planning of bridges in terms of geographical location and

functionality

- The design of various types of bridges
- The design aspects of bearings ,substructure and foundation
- Construction methods and rehabilitation of bridges

Syllabus

Planning of bridges:– selection of site, design of right, skew and curved slab bridges. Design of girder bridges, balanced cantilever bridges- pre stressed concrete bridges. Design of elastomeric bearings, Substructure design– piers and abutments, Bridge foundations design. Design of composite bridges (steel & concrete).Major construction methods and maintenance and rehabilitation of bridges.

Course Outcome

On completion of the course the students shall attain knowledge on the basic concepts in proportioning and design of various types of bridges, helps to determine the actions to be considered for the design of bridge according to IRC codes, and the design of substructure and foundations for the bridge.

Textbooks

1.Krishna Raju N (1996), "Design of Bridges", TataMcGrawHill, publishing company, New Delhi.

2.Victor D.J (19991), "Essentials of Bridge Engineering", Oxford & IBH publishing company, New Delhi.

References

1. Ponnuswami S (1993), "Bridge Engineering", Tata Mc–GrawHill, publishing company, New Delhi.
2. Raina V.K (1988), "Concrete Bridge Practice– Construction Maintenance &Rehabilitation", Tata Mc–GrawHill, publishing company, New Delhi

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Planning of bridges:** Investigation for bridges– selection of site. Design of RCC bridges– IRC loading– types of bridges– components of		

bridges– analysis and design of right, skew and curved slab bridges.	12	25
Module II **Design of girder bridges:** T-beam bridges– Analysis and design of deck slab, longitudinal girders and cross girders–Pigeaud's method– Courbon's method– Morice and Little method– Hendry–Jaegar method– grillage analogy method- balanced cantilever bridges- prestressed concrete bridges(simply supported case only).	12	25
Module III **Bearings:** Importance of bearings– bearings for slab bridges– bearings for girder bridges–Design of elastomeric bearings –Joints – Appurtenances.Substructure- different types- materials for piers and abutments- Forces on piers and abutments- substructure design– piers and abutments and approach structures - Bridge foundations - open, pile, well and caisson.	10	25
Module IV **Design of composite bridges (steel & concrete):**Introduction to analysis and design of long span bridges like suspension and cable stayed bridges. Major construction methods and maintenance and rehabilitation of bridges.	8	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6246	**FINITE ELEMENT METHODS**	**3-0-0-3**	**2015**
Pre-requisites	NIL		

Course Objectives

- To equip the students with the Finite Element Analysis fundamentals.
- To enable the students to formulate the design problems into FEA.

- To introduce students to the use of FEM in soil and rock mechanics
- Enable the students to perform engineering simulations using Finite Element Analysis software (ANSYS).

Syllabus

Basics of finite element method (FEM), different steps involved in FEM . Different approaches of FEM, Finite Element modeling of one and two dimensional problems, Analysis of framed Structures, Analysis of plate bending, Basic equations of thin plate theory,Analysis of shells ,Use of FEM in soil and rock mechanics ,Finite element programming and FEA Software

Course Outcome

1. Students shall be able to develop finite element formulations of 1 degree of freedom problems and solve them.

2. Students will familiarize different approaches of FEA.

3. Students will be able to analyse framed structures and plates.

4. Students will understand the use of FEA in soil and rock mechanics.

Textbooks

1. Desai, C.S and Abel J.F, "Introduction to Finite Element Method", CBS Publishers and Distributors, Delhi. 1987

2. Cook R. D. "Concepts and Applications of Finite Element Analysis", John Wiley, New York, 2004.

3. Zienkiewicz O. C. and Taylor R. L., "Finite Element Method, Butterworth Heinemann publication", 2000.

4. Smith I.M , "Programming the FEM with applications to Geomechanics", John Wiley&Sons , 1982

References

1. Reddy J. N., " An introduction to Linear Finite Element Method, Oxford University Press", Oxford, 2004.

2. Chandupatla T. R. & Belegundu A. D, "Introduction to Finite Elements in Engineering", Prentice Hall of India Pvt. Ltd., New Delhi, 5th Reprint, 1999

3. Krishnamoorty C.S. "Finite element methods", Tata-Mc Graw Hill, Second Edition, Delhi, 2002.

4. Gudehus.G, "Finite Elements in Geomechanics", John Wiley & Sons , 1977

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Basic Equations of Solid Mechanics - Review of equilibrium conditions,	12	25

Strain-displacement relations, Stress - Strain relations, Principle of Virtual work & Stationery potential energy and variational formulation. Plane stress and plane Strain problems. Basics of finite element method (FEM), different steps involved in FEM .		
Module II Different approaches of FEM, Direct method, Energy approach, Weighted residual Method; Displacement model - Shape functions - Lagrange and serendipity elements, Element properties. Finite Element modeling of one and two dimensional problems. Isoparametric elements, four node, eight node elements.	12	25
Module III Analysis of framed Structures - 2D and 3D truss and beam elements and applications. Analysis of plane stress/strain and axisymmetric solids triangular, quadrilateral and isoparametric elements.	10	25
Module IV Numerical integration, order of integration Analysis of plate bending Basic equations of thin plate theory. Reissner-Mindlin theory - Plate elements and applications. Analysis of shells - degenerated shell elements. Use of FEM in soil and rock mechanics - Finite element programming and FEA Software	8	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6346	**ANALYSIS OF PLATES AND SHELLS*** **	**3-0-0-3**	**2015**
Pre-requisites	**NIL**		

Course Objectives

To enable the students to learn

- Classical and modern method of analysis of Love – Kirchhoff theory of thin plates under small deflections.
- Pure bending and symmetrical bending of circular plates.
- Bending of laterally loaded circular plates. Differential Equations.
- Navier and Levy's solutions for simply supported plates.
- Shell theories, shell statics, deformation of shells, Membrane theory of shells,
- Pucher stress function

Syllabus

Pure Bending of Thin Plates, Symmetrical Bending of Circular Plates. Small deflection of laterally loaded plates. Kirchhoff's –Love Theory. Navier and Levy's solutions for rectangular plates.Shells – Geometrical relations. CODAZZI and GAUSS equations. Gauss curvature. Synclastic and anticlastic surfaces. General Shell classification. Shell theories. Love – Kirchhoff theory.Statics of a shell. Basic equation of doubly curved shell. Stress resultants and moment resultants. Membrane theory of doubly curved shell other than shell of revolutions. Pseudo stress resultant . Shell equations of equilibrium. Pucher stress function and applications.

Course Outcome

On successful completion of the course the student will be able to analyse and design plate structures as well as shell structures. A student is expected to acquire skill in the application of Membrane theory to analyse and design shells of different types like hyperbolic paraboloid, elliptic paraboloid and conoids.

Textbooks

1 Theory of Plates and Shells, Stephen P. Timoshenko, S. WoinowskyKrieger , Tata McGraw Hills Ltd Publications 2010.

2 Thin Shell Structures- Classical and Modern Analysis, J.N Bandyopadhyay, Hard cover -2007, New Age International Publications

References

1. Design and Construction of Concrete Shell Roofs , G.S Ramaswamy, CBS Publications
2. Thin Plates and Shells, Theory, Analysis and Applications, Edward Ventsel, Theodor Krauthammer.

Course Plan

Contents	Contact Hours	Sem. Exam Marks

Module I **Plate Theory**: Introduction to Pure Bending of Thin Plates with Small Deflections: Slope and curvature of slightly bent plates- Relation between curvature and bending moments in pure bending. Particular cases of pure bending. Symmetrical Bending of Circular Plates:- Differential equation for symmetrical bending of laterally loaded circular plates- Uniformly loaded circular plates- Circular plate with a circular hole at the center- Circular plate concentrically loaded- Circular plate loaded at the center.	10	25
Module II **Small Deflections of Laterally Loaded Plates:** The Differential equation of the deflection surface based on Kirchhoff's -Love hypothesis and assumptions. Boundary conditions – Reduction of the problem of bending of a plate to that of deflection of a membrane. **Simply Supported Rectangular Plates Under Sinusoidal Load:**Navier solution for simply supported rectangular plates. Navier solution for a single load uniformly distributed over the area of a small rectangle (Patch Load). Levy's solution for a simply supported and uniformly loaded rectangular plate. Simply supported rectangular plates under hydrostatic pressure.	8	25
Module III **Shell Theory:** Introduction to the General Shell Theory: Examples of shell structures in engineering and other fields- Advantages of Shell forms- General definitions and fundamentals. Classifications- Thin shells – Linear shell theories- Love- Kirchhoff hypothesis- First order,second order approximation theories – improved theories- subsequent development of general nonlinear theories and specialized shell theories – shallow shells- Membrane or momentless state of stress. The highest efficiency of a shell as a structural member is associated	9	25

with its thinness and curvature. **Statics of a shell:**Hookes law for thin shell – Differential element isolated from a shell by means of four sections normal to its middle surface and tangential to the lines α and α + dα , β and β + dβ. Stress resultants and Couples – Equilibrium of shell element – Six equations of equilibrium (reduced to 5 with 8 unknowns)- Reduced to three equations of equilibrium- Expressions for stress resultants and stress couples in terms of strains and curvatures. **Folded Plates:** Classifications, applications – analysis methods		
Module IV **Deformation of Shells:** Definitions and notations- Stress resultants and moment resultants – Bending strain considering the unit elongation of a thin lamina at a distance from the middle surface – Considering radii of curvature after deformation and stretching of the middle surface – Resultant forces per unit length and moment resultants in terms of the three components of the strains of the middle surface and three quantities representing the changes of curvature and the twist of the middle surface. Discussion on deformation of shells where bending stresses can be neglected and membrane theory can be accepted. Shells in the form of surface of revolution and loaded symmetrically with respect to their axis: Particular cases of shell in the form of surface of revolution – Spherical Dome. Membrane Theory of Cylindrical Shells: Equations of equilibrium and solutions. **Membrane Theory of Shells of Double Curvature other than Shells of Revolution :** Geometrical relations – Radius vector of a point on a surface given in the form z = f(x,y) – Area of element – the first and second quadratic forms- Equations of CODAZZI and GAUSS. Principal curvatures – Gauss curvature. Synclastic , developable or anticlastic surfaces.	15	25

Pseudo stress resultant: Equations of equilibrium – Reduction of three equations of equilibrium to a single differential equation by introducing a stress function as suggested by Pucher . A shell in the form of an Elliptic Paraboloid – A shell in the form of a Hyperbolic Paraboloid.		
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6156	**EARTH RETAINING STRUCTURES**	**3-0-0-3**	**2015**
Pre-requisites	NIL		

Course Objectives

- To give the students an understanding of the factors influencing the performance of earth retaining structures and choice of type of earth retaining structures
- To learn the principles of geotechnical analysis and design of earth retaining structures
- To apply basic principles to the practical geotechnical design of earth retaining structures

Syllabus

Types of earth retaining structures, applications, construction sequence, Active, passive and at-rest earth pressures, effects of wall movements, seepage, drainage; geotechnical design of conventional and reinforced soil walls to retain fill; geotechnical design of embedded retaining walls and braced excavations, basement walls; design of soil nail walls, empirical design of breast walls, water front retaining structures.

Course Outcome

On completion of this course, the student will be able to:

- Determine active, passive and at-rest earth pressures on retaining structures
- Carryout geotechnical stability analysis of gravity, cantilever, counter-fort walls retaining fill
- Carryout preliminary design of simple reinforced soil walls
- Carryout geotechnical stability analysis of embedded retaining walls (sheet piles, diaphragm walls and contiguous pile walls)
- Design support system and check for stability of braced excavations
- Carryout preliminary design of simple soil nail walls
- Proportion breast walls based on empirical rules
- Have a basic understanding of special considerations in the design of water front retaining structures.

Textbooks

1. Clayton, C.R.I., Woods, R.I., Bond, A.J., Milititsky, J. *Earth Pressure and Earth-Retaining Structures*, 2013, CRC Press, Taylor & Francis Group.
2. Coduto, D.P., *Foundation Design Principles and Practices*, Prentice Hall, 2001
3. Bowles, J.E., *Foundation Analysis and Design*, McGraw Hill, 1996

References

1. Puller, M. *Deep Excavations a Practical Manual*, Thomas Telford, 1996
2. Sabatini, P.J., Elias, V. Schmertmann, G.R., Bonaparte, R. *Geotechnical Engineering Circular 3, Earth Retaining Systems*, Federal Highway Administration
3. Huntington, W.C. *Earth Pressures and Retaining Walls*, Wiley, New York, 1957

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module 1 Earth retaining structures - need and applications, retention of fill and cut, different types and their advantages and limitations, construction sequence; Earth pressure – active, passive and at-rest cases, effects of wall movements on earth pressure, earth pressure at rest, Rankine's and Coulomb's theories for active and passive earth pressure, earth pressure due to external loads, compaction pressures, earth pressure in braced excavations; effects of ground water and seepage, pore-pressures, importance of drainage, types of drains and their details.	8	20
Module 2 Design considerations for retaining structures which retain fill, geotechnical design of gravity, cantilever, counterfort, buttressed and gabion walls – preliminary sizing, earth pressure distribution, check for sliding, overturning, eccentricity, bearing capacity, walls with broken-back surcharge slopes; introduction to the design of reinforced soil walls – internal and external stability; backfill materials – selection, testing, compaction, evaluation of angle of shearing resistance.	13	30
Module 3 Design considerations for retaining structures which retain cuts; analysis and design of cantilever and anchored sheet pile walls, contiguous bored pile walls and diaphragm walls; Design of propped and braced excavations – prop forces, base failure, ground movements and overall stability; Design considerations for basement walls; Wall	13	30

and ground movements and their control.		
Module 4 Soil nail walls to retain cuts and to stabilize slopes – basic concepts and mechanics, driven and drilled and grouted nails, suitability for different ground conditions, facings, construction sequence, durability, failure modes and design principles; Breast walls - applications, differences between normal retaining walls and breast walls, types, sizing based on empirical rules; Special considerations in the design of water-front retaining structures – scour and erosion protection, effects of submergence, differential water head.	8	20
End Semester Exam		

Course No.	Course Name	L-T-P- Credits	Year of Introduction
06 CE6256	**GEOTECHNICAL EARTHQUAKE ENGINEERING**	**3-0-0-3**	**2015**
Pre-requisites	NIL		

Course Objectives

1. To give overview of geotechnical aspects of earthquake
2. To understand the concepts and techniques for the analysis of ground response under seismic loading conditions
3. To study the geotechnical earthquake hazards and the best methods to mitigate them.

Syllabus

Introduction to geotechnical earthquake engineering, engineering seismology, ground motion parameters and attenuation relationships, prediction of earthquakes from deterministic and probabilistic studies, wave propagations through unbound media, dynamic soil properties and experimental determination of soil properties under dynamic loads, ground response analysis, local site effects and hazard mitigation.

Expected outcome

At the end of this course the student will be able to

1. Apply fundamentals of geotechnical engineering to analyze the geotechnical earthquake hazards.
2. Evaluate the ground response and local site effects of earthquake
3. Identify the most suitable solutions to avoid geotechnical hazards from the studies on the geotechnical characteristics of soil under seismic loads.

Text Books

1. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall Inc.
2. IkuoTowhata, "Geotechnical Earthquake Engineering", Springer-Verlag Heidelberg.
3. Robert W. Day, "Geotechnical Earthquake Engineering Handbook", McGraw Hill, New York.
4. Shamsher Prakash, "Soil Dynamics", McGraw-Hill Book Company.

References

1. Kenji Ishihara, "Soil Behaviour in Earthquake Geotechnics", Oxford University Press, USA.

Course Plan

Contents	Hours	Sem. Exam Marks
.**Module I** Introduction to geotechnical earthquake engineering-Scope and objective, nature and type of earthquake loading, importance of geotechnical earthquake engineering-earthquake hazards, Engineering seismology and plate tectonics- types of faults and plate boundaries Seismic waves, size of earthquakes-magnitude and intensity of earthquake, ground motion parameters-peak Acceleration, peak Velocity, peak Displacement, frequency Content and duration, spatial Variability of Ground Motion, Attenuation Relationships, Fourier Amplitude Spectra, Arias Intensity, Estimation of ground motion parameters, locating earthquake epicenter	10	25
Module I I Prediction of earthquake- deterministic seismic hazard analysis, probabilistic seismic hazard analysis-earthquake source characertization, Guten berg-Richter recurrence law, predictive relationships, temporal uncertainity, poisson's model, logic tree methods Wave propagation- elastic response of continua, waves in unbound media (one and three dimensional wave equation), waves in semi-infinite media-Rayleigh waves and love waves, waves in a layered body- one dimensional case, attenuation of stress waves-material damping and radiation damping	11	25
Module III Dynamic soil properties- stiffness, damping and plasticity parameters of soil, representation of stresses using mohr circles, Determination dynamic soil parameters- elemental tests and model tests, field tests One dimensional ground response analysis- linear approach, evaluation of transfer functions, equivalent linear approach for non-linear response, Deconvolution, nonlinear approach using explicit formulation	11	25

Module IV Local site effects- influence on amplitude, frequency content and duration, effects of surface topography and basin geometry, introduction to liquefaction- concepts of liquefaction, types evaluation of liquefaction using cyclic stress approach, effects of liquefaction and mitigation techniques, seismic slope stability- static slope stability analysis, seismic slope stability analysis-pseudostatic analysis, Newmark sliding block analysis Soil improvement for mitigation of seismic hazards- densification techniques, vibro techniques, reinforcement techniques, drainage techniques.	10	25

Course No.	Course Name	L-T-P- Credits	Year of Introduction
06 CE6356	**COMPUTATIONAL GEOTECHNICS**	**3-0-0-3**	**2015**
Pre-requisite	**Basics of numerical modeling**		

Course Objectives

1. To give an in-depth understanding of the fundamentals of theory of elasticity and its applications to geomechanics
2. To develop knowledge of principles and techniques numerical modeling and its geotechnical applications.

Syllabus

Elasticity theories, analysis of stresses and strains, relationship between stresses and strains, study on elastic solutions on geotechnical engineering, Numerical methods in geotechnical engineering, Introduction to Finite element and Finite difference methods in geotechnical engineering, Numerical analysis of shallow and deep foundations, load-deformation characteristics, stress paths.

Expected outcome

At the end of this course the student will be able to

1. Analyze the stresses and strains using elastic theories
2. Formulate mathematical models to represent geotechnical problems
3. Analyze the response of shallow and deep foundations using numerical modeling.

Textbooks

1. Sitharam, T.G and GovidaRaju, L., *Applied Elasticity*, Interline publishing, India
2. Desai,C.S. and Christian, J.T. *Numerical Methods in Geotechnical Engineering*, McGraw –Hill book company.
3. Potts, D., Axelsson, K., Grande, L., Schweiger, H., Long, M. Guidelines for the use of Advanced Numerical Analysis, Thomas Telford, 2002.

References

1. Cook, R.D., Malkus, D.S. and Plesha, M.E. *Concepts and Applications of Finite Element Analysis*, John Wiley and Sons.
2. Wood, D.M. *Geotechnical Modelling*, E & FN Spon, 2004

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Theory of elasticity, analysis of stresses- types of stresses, two dimensional state of stress at a point, Cauchy's stress principle, direction cosines, stress transformation, stress invariants, equilibrium of a two dimensional or plane element, Analysis of strain-types of strain, deformation of an infinitesimal line element, strain tensor, strain invariants, Mohr circle for strain, equations of compatibility for strain, measurements of surface strains-strain rosettes	10	25
II	Stress-strain relations- linear elasticity (generalized Hooke's law), transformation of compatibility condition from strain components to stress components, strain energy in an elastic body, St. Venant's principle, principle of superposition, Plane stress problems and plane strain problems, relationship between plane stress and plane strain, stress functions for plane strain and plane stress case	10	25
III	Elastic solutions in geomechanics- Kelvin problem, Boussinessq's problem, Flamant's problem, Cerrutti's problem, Mindlin's problem; Numerical methods in geotechnical engineering - different types of numerical methods, basic principle of numerical modeling; Finite difference method - basic concept, different schemes and sub schemes, categories of boundary conditions; Finite element method - brief description of basic steps involved in FEM	11	25
IV	Numerical analysis of shallow foundation - modeling, selection of soil parameters, SHANSEP approach, design and analysis; Numerical analysis of deep foundations - scope, load-deformation analysis, geotechnical considerations; Numerical analysis using finite element method - piles in sands, piles in stiff clay, pile groups, factors affecting pile behavior-coefficient of lateral earth pressure, stress paths, driving stresses.	11	25

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE 6066	MINI PROJECT	0-0-4-2	2015
Pre-requisites	NIL		

Course Objectives

- To develop practical ability and knowledge about the various tools/techniques related to geotechnical/structural engineering.

Syllabus

During the course of the second semester each student need to undertake mini project .The mini project is designed to develop practical ability and knowledge about practical tools/techniques in order to solve the actual problems related to the industry, academic institutions or similar area. Students can take up any application level/system level project pertaining to a relevant domain. Projects can be chosen either from the list provided by the faculty or in the field of interest of the student. For external projects, students should obtain prior permission after submitting the details to the guide and synopsis of the work. The project guide should have a minimum qualification of ME/M.Tech in relevant field of work. At the end of each phase, presentation and demonstration of the project should be conducted, which will be evaluated by a panel of examiners. A detailed project report duly approved by the guide in the prescribed format should be submitted by the student for final evaluation. Publishing the work in Conference Proceedings/ Journals with National/ International status with the consent of the guide will carry an additional weightage in the review process.

Assessment process

This course is mandatory and a student has to pass the course to become eligible for the award of degree. The student shall make a presentation before a committee constituted by the department which will assess the mini project based on the report submitted and the presentation made. Marks will be awarded out of 100 assigned as per the regulations.

Course Outcome

- At the end of mini project, students will be able to analyse/ solve the actual problems, interpret results and present it in a systematic manner.

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE6076	DESIGN STUDIO	0-0-2-1	2015
Pre-requisites	NIL		

Course Objectives

To equip students to handle software packages like PLAXIS, ANSYS, SAP etc.

Syllabus

Application of software packages like PLAXIS, ANSYS, SAP etc in modeling, simulation, analysis , design and drafting of structural components for raft foundation, retaining wall, pile foundation, beams, columns , slopes and embankments using the concepts given in theory papers. The student has to practice the packages by working out different types of problems. The student has to carry out a mini project work which will be evaluated for internal assessment.

Course Outcome

On completion of the lab, the student will be proficient in

- using ANSYS and SAP for analysing structural components and structures.
- using PLAXIS 3D for generating 3 dimensional models to solve geotechnical problems.

References

Manuals of respective software packages.

SEMESTER III

Course No.	Course Name	L-T-P- Credits	Year of Introduction
06 CE7115	**GEOSYNTHETICS AND REINFORCED SOIL STRUCTURES**	**3-0-0-3**	**2015**
Pre-requisite	NIL		

Course Objectives

- To give an understanding of various geosynthetic products, their manufacture, functions, properties and testing
- To learn the applications of geosynthetics in various areas of civil engineering
- To introduce simple design methods and selection of appropriate products for various applications.

Syllabus

Types of Geosynthetics, materials, manufacture, functions, properties and testing; Use of geosynthetics in separation, filtration, drainage, reinforcement, barrier and erosion control applications; applications in roads, railways, airports, ground improvement, water resources, waste management, erosion and scour protection, embankments on poor ground; reinforced soil walls and slopes, facings, reinforcements, design and construction.

Expected outcome

On completion of this course, the student will be able to:

- Conceptualize alternative solutions to several problems based on the use of geosynthetics
- Compare different products and select appropriate geosynthetic products for different applications
- Specify appropriate products for various applications
- Apply simple design methods to filtration, reinforced soil walls and slopes, reinforced pavements, basal reinforcement of embankments, pre-fabricated vertical drains, reinforced soil walls and slopes.

Textbooks

1. Koerner, R.M. Designing with Geosynthetics, Pearson Education, 2005
2. Holtz, R.D., Christopher, B.R., and Berg, R.R. Geosynthetic Design and Construction Guidelines, FHWA-NHI-07-092, Federal Highway Administration, USA, 2008
3. Ingold, T.S. The Geotextiles and Geomembranes Manual, Elsevier Science Publishers, 1994
4. Jones, C.J.F.P. Earth Reinforcement and Soil Structures, Thomas Telford, 1996

References

1. Berg, R.R., Christopher, B.R., and Samtani, N.C. Design of Mechanically Stabilized Earth Walls

and Reinforced Soil Slopes, FHWA GEC 011 Volume 1 and 2, FHWA-NHI-10-024 and FHWA-NHI-10-025, Federal Highway Administration, USA

2. BS 8006-1:2010 Code of Practice for Strengthened/reinforced Soils and other Fills, British Standards Institution, 2010

Course Plan

Contents	Hours	Sem. Exam Marks
Module 1 Geosynthetics types – geotextiles, geogrids, geo membranes, geonets, geocells, geomats geocomposites, geocomposite clay liners – materials and manufacture; Functions of geosynthetics – separation, filtration, drainage, reinforcement, barrier, protection, containment and surficial erosion control; Properties and testing; overview of applications.	10	25
Module 2 Geosynthetics for separation - products, important properties, applications in roads and railway tracks; Geosynthetics for filtration – products, important properties, filter design criteria, applications in subsurface drainage systems, hard armour erosion control systems; Geosynthetics for drainage – products, important properties, applications in roads, railways, airports, embankments, slopes, landfills, sports fields, tunnels; pre-fabricated vertical drains – types, properties, acceleration of consolidation settlement, design principles; Geosynthetics in barrier applications – geomembranes and geosynthetic clay liners, properties, applications in landfills, pond and canal lining, tunneling, seaming of geomembranes, testing of geomembrane seams	10	25
Module 3 Geosynthetics in subgrade stabilization - products, important properties, applications in roads and railway tracks; Geosynthetics in reinforcement of unbound aggregates and ballast - products, important properties, applications in pavements and railway tracks, design of geosynthetic reinforced unpaved and paved roads; Geosynthetics in asphalt – paving fabrics and asphalt reinforcement; Basal reinforcement of embankments on weak ground; Geosynthetics for erosion control – erosion control blankets, turf reinforcement mats, coir and jute geotextiles, properties, applications in slope erosion control	10	25

Module 4 Classification of reinforced soil structures – walls, steep slopes and shallow slopes, differences in behavior and design methodologies, applications; Products for reinforcement, extensible and inextensible, durability, long-term design strength, interaction properties; Facings – functions, types, importance, considerations in selection; Design of reinforced soil walls using tie-back wedge and coherent gravity methods - external, internal, compound, facing and global stability analysis; Design of reinforced soil slopes – rotational and translational failures, two-part wedge method, chart solutions	12	25
END SEMESTER EXAM		

Course No.	**Course Name**	**L-T-P- Credits**	**Year of Introduction**
06 CE7215	**GROUND MODIFICATION METHODS**	**3-0-0-3**	**2015**
Pre-requisite	NIL		

Course Objectives

- To develop a sound understanding of the different ground improvement methods, their advantages and limitations and suitability to different types of soils
- To acquire knowledge of design methods and construction techniques
- To learn to apply basic principles to practical problems

Syllabus

Ground improvement, objectives, methods, selection, excavation and replacement, surface compaction methods, deep densification of granular soils using vibro-compaction, dynamic compaction, blasting, consolidation of fine-grained soils using preloading and vertical drains; chemical stabilization, grouting techniques; stone columns, sand piles, lime/cement columns, deep mixing; construction dewatering and ground water control, open pumping, well point systems .

Expected outcome

On completion of this course, the student will be able to:

- Select appropriate ground improvement methods based on project requirements and ground conditions
- Carryout preliminary designs and develop specifications for various ground improvement methods
- Design and implement schemes to monitor and assess the efficacy of ground improvement programmes.

Textbooks

1. Kirsch, K. and Bell, A. *Ground Improvement*, CRC Press, 2013
2. Nicolson, P.G., *Soil Improvement and Ground Modification Methods*, Elsevier, 2015.
3. Karol, R.H., *Chemical Grouting and Soil Stabilization*, Marcel Dekker, 2003
4. Hausman, M.R. Engineering Principles of Ground Modification, McGraw-Hill, 1990.

References

1. Xanthakos, P., Abramson, L.W., Bruce, D.A., *Ground Control and Improvement*, John Wiley & Sons, 1994
2. Mitchell, J.M., Jardine, F.M. *A Guide to Ground Treatment*, CIRIA, 2002
3. Townsend, F.C., Anderson, J.B., *A Compendium of Ground Modification Techniques*, Florida Department of Transportation, 2004.

Course Plan

Contents	Hours	Sem. Exam Marks
Module 1 Need for ground improvement, overview of different methods and their advantages and limitations, factors influencing selection of a method; Excavation and replacement – criteria for vertical and lateral extent of replacement, specifications for fill, compaction; Surface compaction methods, use of impact rollers; Deep densification of granular soils – vibro-compaction, dynamic compaction, rapid impact compaction and blasting, equipments and methods, field monitoring and control; Consolidation of fine-grained soils - preloading, sand drains, pre-fabricated vertical drains, design considerations, depth and spacing of vertical drains, increase in shear strength, stage construction, monitoring of settlements and pore-pressures and improvements in properties	12	25
Module 2 Chemical stabilization – admixtures, cement, lime, flyash, bitumen, suitability for different soils, improvements in properties, applications, equipments and methods, monitoring and quality control; Permeation grouting, compaction grouting and jet grouting – principles, types of grouts, applications, equipments and methods, monitoring and quality control	10	25
Module 3 Stone columns – concepts, applications, advantages and limitations, vibro-displacement and vibro-replacement techniques, design	10	25

methods, capacity of columns, testing, group effects, settlement; Sand piles, Lime/cement columns, applications, equipments and methods, deep-mixing, design methods		
Module 4 Construction dewatering and ground water control – overview of different methods, open pumping, well points, deep wells, cut-off and exclusion, their advantages and limitations, suitability for different site conditions; Open pumping – sumps and ditches, pumps, precautions against boiling and heaves; Well point systems – principles, single and multistage systems, design, depth and spacing, installation, pumps, header and piping.	10	25
END SEMESTER EXAM		

Course No.	**Course Name**	**L-T-P- Credits**	**Year of Introduction**
06 CE7315	**MARINE GEOTECHNICAL ENGINEERING**	**3-0-0-3**	**2015**
Pre-requisite	NIL		

Course Objectives

- To develop a sound understanding of the nature and behavior of submarine sediments and techniques for offshore geotechnical investigations and testing
- To give an overview of different types of foundations of offshore platforms
- To introduce techniques for geotechnical design of offshore platforms.

Syllabus

Scope of marine geotechnical engineering, marine sediments, formation, classification, engineering properties, behavior under static and cyclic loading; offshore drilling, sampling and in-situ testing techniques; foundations for gravity structures, types, installation, stability, movements; foundations for jacket type structures, types, installation, design of piles, foundations for jack-up platforms, types, installation, stability, spudcans

Expected outcome

On completion of this course, the student will be able to:

- Identify, classify and characterize submarine sediments and evaluate their engineering properties
- Select appropriate techniques for offshore geotechnical investigations and field testing
- Select appropriate type of foundation and carryout preliminary design of foundations for

offshore gravity structures, jacket type structures and jack-up platforms.

Textbooks

1. Dean E.T.R. *Offshore Geotechnical Engineering Principles and Practice*, Thomas Telford, 2010.
2. Randolph, M. and Gourvenec, S. *Offshore Geotechnical Engineering*, Spon Press, 2011.
3. Poulos, H.G. *Marine Geotechnics*, Allen & Unwin Inc., 1988
4. Chaney, F. *Marine geotechnology and nearshore/offshore structures*, ASTM, STP, 1986.

References

1. Chaney, R. C and Demars, K. R., *Strength Testing of Marine Sediments - Laboratory and In-situ Measurements*, ASTM, STP -883, 1985.
2. George, P. and Wood, D. *Offshore Soil Mechanics*, Cambridge University Press., 1985

Course Plan

Contents	Hours	Sem. Exam Marks
Module 1 Need for ground improvement, overview of different methods and their advantages and limitations, factors influencing selection of a method; Excavation and replacement – criteria for vertical and lateral extent of replacement, specifications for fill, compaction; Surface compaction methods, use of impact rollers; Deep densification of granular soils – vibro-compaction, dynamic compaction, rapid impact compaction and blasting, equipments and methods, field monitoring and control; Consolidation of fine-grained soils - preloading, sand drains, pre-fabricated vertical drains, design considerations, depth and spacing of vertical drains, increase in shear strength, stage construction, monitoring of settlements and pore-pressures and improvements in properties	12	25
Module 2 Chemical stabilization – admixtures, cement, lime, flyash, bitumen, suitability for different soils, improvements in properties, applications, equipments and methods, monitoring and quality control; Permeation grouting, compaction grouting and jet grouting – principles, types of grouts, applications, equipments and methods, monitoring and quality control	10	25
Module 3 Stone columns – concepts, applications, advantages and limitations, vibro-displacement and vibro-replacement techniques, design	10	25

methods, capacity of columns, testing, group effects, settlement; Sand piles, Lime/cement columns, applications, equipments and methods, deep-mixing, design methods		
Module 4 Construction dewatering and ground water control – overview of different methods, open pumping, well points, deep wells, cut-off and exclusion, their advantages and limitations, suitability for different site conditions; Open pumping – sumps and ditches, pumps, precautions against boiling and heaves; Well point systems – principles, single and multistage systems, design, depth and spacing, installation, pumps, header and piping.	10	25
END SEMESTER EXAM		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE7125	**STRUCTURAL DESIGN OF FOUNDATIONS AND EARTH RETAINING STRUCTURES**	3-0-0-3	2015
Pre-requisites	Basic understanding of understanding of soil behaviour, pertaining to different types of foundations.		

Course Objectives

- To introduce students to the detailed design issues related to both deep and shallow foundations.
- To familiarise with the design of pile foundation and pile caps.
- To design various types of special foundations such as foundations for steel towers, water tank and chimneys.
- To design various types of earth retaining structures.

Syllabus

Structural design of spread footings, isolated footings, combined footings, column pedestals, column footings, strap footings, strip footings under several column, mat foundation, combined piled raft foundations, circular and annular rafts , Analysis of flexible beams on elastic foundations, pile, pile cap. Design of special foundations for steel towers, foundation to water tank and chimneys. Design of cantilever and counter fort walls, gravity walls, and Coffer dams, Stability of bottom excavation, Anchorage, Walls and tie rods.

Course Outcome

1. Student will be capable of ensuring design concepts of shallow foundation.

2. The student will be efficient in selecting suitable type of pile for different soil stratum and in evaluation of group capacity by formulation.

3. The student will be able to design different types of special foundations and earth retaining structures.

Textbooks

1. P.C.Varghese, "Design of Reinforced Concrete Foundations", PHI – LTD – New Delhi, 1998

2. Kurien N.P., "Design of foundation systems – Principles and Practices" ,Narora Publishing house – New Delhi (third edition),1992 33

References

1. Bowles J.E., "Foundation Analysis and Design" (4Ed.), Mc.Graw Hill, NY, 1996

2. Shamsher prakash, Gopal Ranjan, & Swami Saran, "Analysis and design of foundations and retaining structures", Sarita Prakashan, New Delhi , 1979

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Introduction to Limit State Design of reinforced concrete in foundations; Soil pressure for structural design; structural design of spread footings, isolated footings, combined footings, column pedestals, column footings, strap footings, strip footings under several column.	12	25
Module II Structural design of mat foundations – beam and slab rafts – combined piled raft foundations (CPRF) – circular and annular rafts – Analysis of flexible beams on elastic foundations.	10	25
Module III Structural design of different types of piles – under reamed pile foundations – Design of pile cap – pile foundation .Structural design of well foundation . Special foundations.Design of foundation for steel towers – foundation to water tank and chimneys.	10	25
Module IV Retaining Structures - Stability of walls – Design of cantilever and counter fort walls – Design of gravity walls – Design of Coffer dams – Braced coffer dams – Stability of bottom excavation – Anchorage – Walls and tie rods.	10	25

End Semester Exam

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE7225	**REPAIR AND REHABILITATION OF CONCRETE STRUCTURES**	**3-0-0-3**	**2015**
Pre-requisites	NIL		

Course Objectives

- To identify the scope of rehabilitation work for obsolete buildings.
- To identify and apply appropriate structural and construction technologies to rectify maintenance problems.
- To prepare short and long term maintenance plans.
- To identify / apply appropriate standards and statutory controls for maintenance and rehabilitation work

Syllabus

Quality assurance for concrete construction, factors influencing on serviceability and durability, Design and construction errors, Corrosion mechanism, methods of corrosion protection, Maintenance and repair strategies, Materials for repair, Techniques for repair

Course Outcome

- Students will be able to recognize the mechanisms of degradation of concrete structures and to design durable concrete structures
- Students will learn how to conduct field monitoring and non-destructive evaluation of concrete structures.
- Students will learn to design repair strategies for deteriorated concrete structures including repairing with composites to understand the methods of strengthening methods for concrete structures

Textbooks

1.Denison Campbell, Allen and Harold Roper, “Concrete Structures , Materials, Maintenance and Repair”,Longman Scientific and Technical UK, 1991.

2. R.T.Allen and S.C.Edwards, “Repair of Concrete Structures” , Blakie and Sons, UK, 1987.

References

1.M.S.Shetty, “Concrete Technology – Theory and Practice” , S.Chand and Company, New Delhi, 1992.

2.Santhakumar, A.R., " Training Course notes on Damage Assessment and repair in Low Cost Housing "," RHDC–NBO " Anna University, July, 1992.

3. Raikar, R.N., “Learning from failures – Deficiencies in Design ", Construction and Service – R & D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I General:– Quality assurance for concrete construction as built concrete properties strength, permeability, thermal properties and cracking. Influence on servicebility and durability:–Effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection.	12	25
Module II Maintenance and repair strategies:– Definitions : Maintenance, repair and rehabilitation, Facets of Maintenance importance of Maintenance, Preventive measures on various aspects Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration , testing techniques.	10	25
Module III Materials for repair:– Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete.	10	25
Module IV Techniques for repair:– Rust eliminators and polymers coating for rebars during repair foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete Epoxy injection, Mortar repair for cracks, shoring and underpinning. Examples of repair to structures:– Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering wear, fire, leakage, marine exposure–case studies.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE7325	DYNAMICS OF STRUCTURES	3-0-0-3	2015
Pre-requisites	NIL		

Course Objectives

- To introduce the concepts of structural dynamics and the response of civil engineering structures to time-varying loads, including those due to wind and earthquakes.

Syllabus

Dynamic load, Formulation of equations of motion, Single Degree of Freedom Systems - Undamped and damped free and forced vibrations, Response spectrum ,Base excited systems, Multiple Degrees of Freedom Systems and Continuous systems.

Course Outcome

At the end of this course, the student should able to:

1.Understand the concept of damping

2. Derive equation of motion for single and multi-degree-of-freedom systems (MDOF)

3. Understand the response spectrum concept

4. Compute the dynamic response by using approximate methods.

Textbooks

1. Clough &Penzien, “Dynamics of Structures”,Computers & Structures Inc.,USA,

2. Meirovitch.L, “Elements of Vibration Analysis”, McGraw-Hill, 1986

3.Anil K Chopra, “Dynamics of structures”, Pearson Education.

References

1.W.T. Thomson , “Vibration Theory and Applications”, Pearson Education Asia Ltd and Tsinghua University Press , 1998

2. M.Mukhopadhyay , “Vibrations, Dynamics & Structural systems”,A.A Balkema Publishers,USA

3.Timoshenko, “Vibration Problems in Engineering”, Benediction Classics, 2011

Course Plan		
Contents	**Contact Hours**	**Sem. Exam Marks**
Module I **Introduction:** Dynamic load - Types of dynamic loading–Significance of structural dynamics in civil engineering practice - Degrees of freedom –Equivalent mechanical systems –Formulation of equations of motion - Natural frequency- Determination of natural frequency-D' Alemberts Principle –Energy principle - Rayleigh's method − Principle of virtual displacements − Hamilton's principle.	12	25
Module II **Single Degree of Freedom Systems:** Undamped and damped free and forced vibrations − Critical damping − Over damping − Under damping − Logarithmic decrement –Energy dissipated in damping-Coulomb damping - Response to harmonic loading − Evaluation of damping − Vibration isolation − Transmissibility Response to periodic forces-Vibration measuring and absorbing equipments -Duhamel integral for undamped system-Response to impulsive loads–Earthquake excitation-Response history and construction of response spectra-Response spectrum characteristics-Base excited systems.	10	25
Module III **Multiple Degrees of Freedom Systems and Continuous systems:** MDF sytems - Natural modes − orthogonality conditions − modal Analysis − free and harmonic vibration −Continuous systems- Free longitudinal vibration of bars − Flexural vibration of beams with different end conditions − Forced vibration - Mode superimposition method- Mode acceleration method.	10	25
Module IV **Approximate methods:** Rayleigh's method − Dunkerley's method − Stodola's method − Rayleigh –Ritz method − Matrix method.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06 CE7035	**SEMINAR-2**	**0-0-2-2**	**2015**
Pre-requisites	NIL		

Course Objectives

- To encourage interest in research
- To motivate the students for self-study
- To develop communication and presentation skills

Syllabus

Students have to register for the seminar and select a topic in consultation with any faculty member offering courses for the programme. The paper should be a detailed study on a recent advancement/trend in the field of geotechnical engineering or structural engineering. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. The seminar shall be of 30 minutes duration and a committee with the Head of the department as the chairman and two faculty members from the department as members shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee.

Course Outcome

Students will be able to:

- Collect and critically review information on new topics.
- Prepare technical reports
- Make technical presentations.

Course No.	Course Name	L-T-P Credits	Year of Introduction
06 CE 7045	**RESEARCH PROJECT (PHASE 1)**	0-0-8-6	2015
Pre-requisites	**Nil**		

Course Objectives

To equip students to conduct research in areas related to geotechnical or structural engineering.

SYLLABUS:

The project work is carried out in two phases – Phase I in III semester and Phase II in IV semester. Project work is to be evaluated both in the third and the fourth semesters. Based on these evaluations the grade is finalised in the fourth semester. Each student is expected to do

an individual project.

Normally, students are expected to do the project within the college. However, they are permitted to do the project in an industry or in a government research institute under a qualified supervisor from that organization. Progress of the project work is to be evaluated at the end of the third semester. For this, a committee headed by the head of the department with two other faculty members in the area of the project, of which one shall be the project supervisor. If the project is done outside the college , (provision is available for them only in the fourth semester), the external supervisor associated with the student will also be a member of the committee. Final evaluation of the project will be taken up only on completion of the project in the fourth semester. This shall be done by a committee constituted for the purpose by the principal of the college. The concerned head of the department shall be the chairman of this committee. It shall have two senior faculty members from the same department, project supervisor and the external supervisor, if any, of the student and an external expert either from an academic/R&D organization or from Industry as members. Final project grading shall take into account the progress evaluation done in the third semester and the project evaluation in the fourth semester. If the quantum of work done by the candidate is found to be unsatisfactory, the committee may extend the duration of the project up to one more semester, giving reasons for this in writing to the student. Normally further extension will not be granted and there shall be no provision to register again for the project. M.Tech projects should be socially relevant and research oriented ones.

Project evaluation weights shall be as follows:-

Marks in III Semester: 50

Progress evaluation by the Project Supervisor : 20 Marks

Presentation and evaluation by the committee : 30 Marks

Course Outcome

On completion of the project (Phase 1) the student is expected to identify a problem, review previous literatures on a relevant and research oriented topic ,and finalise the plan for experimental and / or analytical studies to be continued in the following semester.

SEMESTER IV

Course No.	Course Name	L-T-P Credits	Year of Introduction
06 CE7016	**RESEARCH PROJECT (PHASE 2)**	**0-0-21-12**	**2015**
Pre-requisites	**Nil**		
Course Objectives	To equip students to conduct research in areas related to geotechnical or structural engineering.		

SYLLABUS:

Phase II of the project work shall be in continuation of Phase I ONLY. At the completion of a project, the student shall submit a project report, which will be evaluated (end semester assessment) by duly appointed examiner(s). This evaluation will be based on the project report and a viva voce examination on the project. The method of assessment for Phase II is as given:

Marks in IV semester : 100

Project evaluation by the supervisor/s : 30 Marks

Presentation & evaluation by the Committee : 30 Marks

Evaluation by the External expert : 40 Marks

Course Outcome

At the successful completion of the project, the student will be able to

- Critically review available information.
- Identify gaps in existing knowledge.
- Formulate research problems.
- Conduct experimental and / or analytical investigations.
- Evaluate and interpret findings and draw conclusions.