COURSE STRUCTURE AND SCHEME OF EVALUATION

M. TECH – GEOTECHNICAL ENGINEERING

I – Semester

S. No	Subject Code	Subject Title	L	T	P	C	I	E	TM
1	CEGT 1001	Advanced Soil Mechanics	3	1		4	40	60	100
2	CEGT 1002	Computational methods in Geotechnical Engineering	3		2	4	40	60	100
3	CEGT 1003	Advanced Foundation Engineering	3	1		4	40	60	100
4	CEGT 1004	Ground Improvement Techniques	3	1		4	40	60	100
5	CEGT 1005	Elective - I	3			3	40	60	100
6	CEGT 1006	Elective - II	3			3	40	60	100
7	CEGT 1007	Self Learning Course				2	40	60	100
8	CEGT 1051	Computer Application in Geotechnical Engineering			3	2	40	60	100
9	CEGT 1052	Geotechnical Lab			3	2	40	60	100

L: Lecture T: Tutorial P: Practical C: Credits

I: Internal Assessment E: End Examination TM: Total Marks

CEGT 1005 - Elective – I
- CEGT 1005 / 1 ---- Theory of Elasticity
- CEGT 1005 / 2 ---- Finite Element Analysis
- CEGT 1005 / 3 ---- Shoring, Scaffolding and Formwork

CEGT 1006 - Elective – II
- CEGT 1006 / 1 ---- Pavement Design
- CEGT 1006 / 2 ---- Geo Environmental Engineering
- CEGT 1006 / 3 ---- Clay mineralogy and flow through soils

CEGT 1007 - Self Learning Course
- CEGT 1007 /1 ---- Marine Geo – techniques
- CEGT 1007 /2 ---- Geotechnical Measurements and Exploration

M. TECH – GEOTECHNICAL ENGINEERING

II – Semester

S. No	Subject Code	Subject Title	L	T	P	C	I	E	TM
1	CEGT 2001	Soil Dynamics & Machine foundations	3	1		4	40	60	100
2	CEGT 2002	Rock Mechanics	3	1		4	40	60	100
3	CEGT 2003	Geotechnical Earthquake Engineering	3	1		4	40	60	100
4	CEGT 2004	Geo – Synthetics in Civil Engineering	3	1		4	40	60	100
5	CEGT 2005	Elective - III	3			3	40	60	100
6	CEGT 2006	Elective - IV	3			3	40	60	100
7	CEGT 2051	Geotechnical Field Investigation Lab			3	2	40	60	100
8	CEGT 2052	Geo – Synthetics and Rock Mechanics- lab			3	2	40	60	100
9	CEGT 2053	Industrial seminar				2	40	60	100

L: Lecture T: Tutorial P: Practical C: Credits

I: Internal Assessment E: End Examination TM: Total Marks

CEGT 1005 - Elective – III

- CEGT 2005 / 1 ---- Construction Management
- CEGT 2005 / 2 ---- Earth and Rock Fill Dams
- CEGT 2005 / 3 ---- Design of Earth Retaining Structures

CEGT 1006 - Elective – IV

- CEGT 2006 / 1 ---- Soil Structure Interaction
- CEGT 2006 / 2 ---- Design of R. C. C. Sub Structures
- CEGT 2006 / 3 ---- Maintenance and Rehabilitation of Structures

M. TECH – GEOTECHNICAL ENGINEERING

III – Semester

S. No	Subject Code	Subject Title	Credits	Max Marks (Internal)	Max Marks at the end of semester (Internal)
1	CEGT 3051	Project Work (Part A)	10	40	60

M. TECH – GEOTECHNICAL ENGINEERING

IV – Semester

S. No	Subject Code	Subject Title	Credits	Max Marks (Internal)	Max Marks (External)
1	CEGT 4051	Project Work (Part B)	14	40	60

CEGT 1001 ---- ADVANCED SOIL MECHANICS

Course Category: Programme Core **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: plot stress paths under various drainage conditions
	CO2: evaluate critical state soil parameters under various drainage conditions
	CO3: analyze and evaluate elastic and plastic properties of soils
	CO4: knowledge about three dimensional consolidation, secondary consolidation and basics of rheological models
Course content	**Unit – I** **Geostatic Stresses & Stress Paths**: Stresses within a soil mass: Concept of stress for a particulate system, Effective stress principle, Geostatic stresses, Soil water hydraulics: Principal stresses and Mohr's circle of stress, Stress paths; At Rest earth pressure, Stress paths for different practical situations
	Unit – II **Flow through Soils**: Permeability, seepage, mathematical analysis – Finite difference formulae for steady state and transient flows – flow nets – computation of seepage – uplift pressure, and critical hydraulic gradient
	Unit – III **Compressibility and Consolidation:** One dimensional compression, Oedometer test, parameters – coefficient of volume change, constrained modulus, compression index, swell or unloading, maximum past consolidation stress, Over consolidation ratio, Primary and secondary compression, consolidation -One, two and three dimensional problems, Consolidation of partially saturated soils, Creep/Secondary Compression in soils
	Unit – IV **Stress-Strain-Strength Behaviour of Soils**: Shear strength of soils; Failure criteria, drained and undrained shear strength of soils. Significance of pore pressure parameters; Determination of shear strength; Drained, Consolidated Undrained and Undrained tests; Interpretation of triaxial test results. Behaviour of sands; Critical void ratio; dilation in soils; Critical state parameters; Critical state for normally consolidated and overconsolidated soil; Significance of Roscoe and Hvorslev state boundary surfaces; Yielding, Bounding Surfaces

TEXT BOOKS

1. Das, B. M.- Advanced Soil Mechanics, Taylor and Francis. 3rd edition(2008)

2. Mitchell J.K. - Fundamentals of soil behaviour - John Wiley and Sons, Inc., New York. (third edition) 2005

REFERENCES:

1. Atkinson J. H. - An Introduction to the Mechanics of Soils and Foundation - through critical state soil mechanics, McGraw- Hill Co. (1993)
2. Wood, D.M.- Soil Behavior and Critical State Soil Mechanics.cambridge university press (1991)
3. J A Knappett and R F Craig – Craig's Soil Mechanics, Eighth Edition, Spon Press Taylor & Francis (2012)
4. Lambe, T. W. and Whitman, R. V.- Soil Mechanics SI version , John Wiley & Sons.(2011)
5. Muniram Budhu.- Soil Mechanics and Foundations, John Wiley & Sons, Inc.(2007)

CEGT 1002 ---- COMPUTATIONAL METHODS IN GEOTECHNICAL ENGINEERING

Course Category: Programme Core **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: understand the basic numerical methods used to solve equations, systems of equations, differential equations, Eigen value problems.
	CO2: help them to solve many application problems in engineering, especially those which involve experimental data.
	CO3: apply and the use of statistics in engineering
	CO4: formidable base for analysis and programming using computer applications
Course content	**Unit-I** Approximations and Errors in Numerical Methods; Solutions of Algebraic and Transcendental Equations-Bisection, False Position, Secant & Iterative Methods, Aitken's Δ2, Newton-Raphson, Horner's and Muller's Methods; Simultaneous Linear Algebraic Equations, Iterative methods – Gauss-Siedel method, Relaxation method
	Unit-II Matrix Inversion and Eigenvalue Problems – Power, Jacobi Methods; **Finite Differences** –Factorial Notation; **Interpolation** – Lagrange's, Newton's, Hermite's, Spline, Inverse Interpolation.
	Unit – III **Numerical Differentiation** – Derivatives, Maxima and Minima of a Tabulated Function; **Numerical Integration** – Quadrature, Romberg's, Euler-Maclaurin, Double Integration. **Numerical Solution of Ordinary Differential Equations** - Modified Euler's, Runge-Kutta's, Predictor- Corrector, Milne's Methods; **Partial Differential Equations** - Finite Difference Approximations to Partial Derivatives, Elliptic, Laplace, Parabolic, Hyperbolic Equations
	Unit – IV Linear Programming - Simplex Method; Artificial Variable Techniques M Method, Two Phase Method

Text Books:

1. Grewal, B. S. - Numerical Methods in Engineering & Science, Khanna Publishers, 1999
2. 1. Chapra, S. C. & Canade, R. P. - Numerical Methods for Engineers, McGraw Hill publications, 2011

References:

1. Joe D Hoffman, Hoffman D Hoffman, Steven Frankel, Numerical Methods For Engineers

and Scientists Second Edition, 2001
2. Calculus of finite Difference Method & Numerical Analysis Gupta Malik
3. Analytical & Computer Methods in Finite Difference Methods, Bonles
4. Elastic Analysis of Soil Foundation Interactions, Selva Durai

CEGT 1003 ---- ADVANCED FOUNDATION ENGINEERING

Course Category: Programme Core **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: suggest various bearing capacity determination techniques and
	CO2: design shallow foundation and estimate settlements
	CO3: design Pile foundation for Vertical and lateral load and moment and uplift load.
	CO4: Design and construction of well foundations.
Course content	**Unit – I** **Shallow Foundations**: **Bearing Capacity:-** General Formulae; Effect of Water Table; Footings with Eccentric or Inclined Loads, Footings on Layered Soils, on finite layer with a Rigid Base at Shallow Depth, effect of compressibility of soil, on soils with strength increasing with depth.
	Unit – II **Settlement**: Components – Immediate, Consolidation & Creep, Stresses and Displacements in Homogeneous, Layered and Anisotropic Soils; Consolidation Settlement; One, Two & Three Dimensional Consolidation; Secondary Compression Settlement; Bearing Pressure using SPT & CPT, Settlement of foundations on Sands-Schmertmann and Burland & Busbridge methods; Structure Tolerance to Settlement and Differential Settlements, Rotation of Tall Structures
	Unit – III **Pile Foundations**: Single Pile: Vertically loaded piles, Static capacity- α, β and λ Methods, Dynamic formulae; Wave Equation Analyses; Point Bearing Resistance with SPT and CPT Results; Bearing Resistance of Piles on Rock; Settlement; Pile Load Test; Uplift Resistance; Laterally Loaded Piles -Ultimate Lateral Resistance; Negative Skin Friction; Batter Piles; Under Reamed Piles; Mini and Micro Piles, Buckling of Fully and Partially Embedded Piles; Ultimate Capacity of Pile Groups in Compression, Pullout & Lateral Load; Efficiency; Settlements of Pile Groups;
	Unit – IV **Well Foundations** Method of construction of piers; Open wells and Pneumatic Caissons; Design of pier foundations and well foundations; Lateral stability of well foundations; R.C.C. designs of wells

TEXT BOOKS

1. Das, B. M. - Principles of Foundation Engineering 5th Edition Nelson Engineering (2004)

2. Donald P Coduto – Foundation Design Principles and Practices, 2nd edition, Pearson, Indian edition, 2012. Phi Learning (2008)

REFERENCE BOOKS

1. Bowles, J. E. - Foundation Analysis & Design 5th Edition McGraw-Hill Companies, Inc. (1996)
2. Poulos, H. G. & Davis, E. H. - Pile Foundation Analysis and Design john wiley & sons inc (1980-08)
3. Reese, L. C. & Van Impe, W. F. - Single Piles and Pile Groups under Lateral Loading -Taylor & Francis Group (Jan 2000)
4. Rowe, R. K. - Geotechnical & Geoenvironmental Engineering Hand Book -Springer (2001)
5. Tomlinson, M. J. - Foundation Design and Construction - Prentice Hall (2003)
6. Lymon C. Reese, William M. Isenhower, Shin-Tower Wang- Analysis and Design of Shallow and Deep Foundations (2006)
7. Salgado, R. - The Engineering of Foundations McGraw-Hill, Boston (2008)

CEGT 1004 ---- GROUND IMPROVEMENT TECHNIQUES

Course Category: Programme Core **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: independently design and suggest a suitable ground improvement technique for a given site
	CO2: know different grouting Techniques
	CO3: design the reinforced earth walls
	CO4: select and implement soil stabilization techniques based on field conditions
Course content	**Unit – I** Introduction: Need of Ground Improvement: Different methods of Ground improvement, Mechanical, Hydraulic, Physico-chemical, Electrical, Thermal methods, etc. and their applications. General Principal of Compaction: Mechanics, field procedure, quality control in field
	Unit – II Ground Improvement in Granular Soil: In place densification by (i) Vibrofloatation (ii) Compaction pile (iii) Vibro Compaction Piles (iv) Dynamic Compaction (v) Blasting
	Unit – III Ground Improvement by Grouting and Soil Reinforcement: Grouting in soil, types of grout, desirable characteristics, grouting pressure, grouting methods. Soil Reinforcement: Mechanism, Types of reinforcing elements, reinforcement-soil interaction, Reinforcement of soil beneath the roads, foundation, Geosynthetics and their application
	Unit – IV Soil Stabilization: Lime stabilization-Base exchange mechanism, Pozzolanic reaction, lime-soil interaction, line columns, Design of Foundation on lime columns. Cement stabilization: Mechanism, amount, age and curing. Fly-ash - Lime Stabilization, Soil Bitumen Stabilization

Text Books:

1. R. M. Korner, Design with Geosynthetics, Prentice Hall, New Jersy, 3rd Edn. 2002
2. P. Purushothama Raj, Ground Improvement Techniques, Tata McGrawHill, New Delhi, 1995.

References:

2. Dr. B.C.Chattopadhyay and J.Maity, Ground Control and Improvement Techniques, PEEDOT, Howrah, 2011.
3. G. V. Rao and G. V. S. Rao, Text Book On Engineering with Geotextiles, Tata McGraw Hill 5. T. S. Ingold and K. S. Miller, Geotextile Hand Book, Thomas Telfrod, London
4. N. V. Nayak, Foundation Design Manual, Dhanpat Rai and Sons, Delhi.

CEGT 1005 / 1 ---- THEORY OF ELASTICITY

Course Category: Programme Elective **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: solve problems using elasticity principles
	CO2: obtain solutions by using polynomials
	CO3: obtain solutions for the torsion of a straight bars of different sections
	CO4: : obtain solutions for stresses in plates
Course content	**Unit – I** **Analysis of stress and strain in three dimensions** Stress at a point – components of stress; Principal stresses; Stress ellipsoid and stress director surface; Determination of principal stresses; Stress invariants; Determination of maximum shear stresses; Octahedral shear stress; strain at a point – Components of strain; Differential equations of equilibrium ; Conditions of compatibility; Generalised Hooke's law
	Unit – II **Two-dimensional problems in polar coordinates** General equations in polar coordinates; Stress distribution symmetrical about an axis; Effect of circular holes on stress distribution in plates; Concentrated force at a point of a straight boundary; Concentrated force acting on a beam; Stresses in a circular disc.
	Unit – III **Two-dimensional problems in rectangular coordinates** Plane stress ; Plane strain; Differential equations of equilibrium; Boundary conditions; Compatibility equations; Stress function; Governing differential equation; Solution by polynomials; End effects – Saint-Venant's Principle; Determination of displacements; Bending of a cantilever loaded at the end; Bending of a beam by uniform load.
	Unit – IV **Torsion** Torsion of straight bars – Saint Venant's theory; Elliptic cross section; Membrane analogy; Torsion of a bar of narrow rectangular cross-section; Torsion of rolled profile sections; Torsion of thin tubes

Text Books:

1. Theory of elasticity by S.P.Timoshenko & J.N.Goodier, McGraw-Hill,1970.
2. Mechanics of deformable bodies by I.H.Shames , Prentice-Hall of India, 1965.

Reference Books:

3. Introduction to Solid Mechanics by I.H.Shames & Pitarresi , Prentice-Hall of India, 2003.
4. Engineering mechanics of solids by E.P.Popov, Prentice-Hall of India, 2005.

CEGT 1005 / 2 ---- FINITE ELEMENT ANALYSIS

Course Category: Programme Elective **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: familiar with the use of FEM
	CO2: capable of adopting a suitable constitutive model.
	CO3: apply this technique for the solution of stress-strain which are widely encountered in geotechnical engineering
	CO4: identify the proper technique for solution of the problem in field and then obtain the solution to the same
Course content	**Unit – I** **Basic Principles** Equilibrium equations; Strain-displacement relations; Linear constitutive relations; Principle virtual work; Principle of stationary potential energy. **Element Properties** Different types of elements; Displacement models; Relation between nodal degrees of freedom and generalized coordinates; Convergence requirements; Compatibility requirement; Geometric invariance; Natural coordinate systems; Shape functions; Element strains and stresses; Element stiffness matrix; Element nodal load vector. Isoparametric elements – Definition, Two-dimensional isoparametric elements – Jacobian transformation, Numerical integration
	Unit – II **Direct Stiffness method and Solution Technique** Assemblage of elements–Obtaining Global stiffness matrix and Global load vector; Governing equilibrium equation for static problems; Storage of Global stiffness matrix in banded and skyline form; Incorporation of boundary conditions; Solution to resulting simultaneous equations by Gauss elimination method
	Unit – III **Plane-stress and Plane-strain analysis** Solving plane stress and plane-strain problems using constant strain triangle and four nodded isoparametric element **Analysis of plate bending** Basic theory of plate bending; Shear deformation plates; Plate bending analysis using four noded isoparametric element
	Unit – IV **Analysis of shells** Degenerated shell elements – Evaluation of element stiffness matrix and load vector for eight noded isopametric shell element. .

Text Books:

1. Finite element analysis by C.S.Krishnamurthy, Tata-McGraw-Hill, 1994.
2. Matrix and finite element analyses of structures by M.Mukhopadhay and A.H.Sheikh, Ane Books, 2004.

Reference Book:

3. Concepts and applications of finite element analysis by R.D.Cook et.al., John Wiley and Sons, 1989.

CEGT 1005 / 3 ---- SHORING, SCAFFOLDING AND FORMWORK

Course Category: Programme Elective — **Credits: 4**
Course Type: Theory — **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: Students will be familiar with the Overall planning of formwork and equipment required
	CO2: Students will be capable of knowing different form materials and the pressure that act on the formwork.
	CO3: Students will able to know Shores and form design
	CO4: Students will able to identify the Dome forms, tunnel forms, slipforms and safety practices for scaffolds
Course content	**Unit – I** **Planning, site equipment and plant for form work** Overall Planning – Detailed Planning – Standard units – Corner units – Schedule for column formwork – Formwork elements – Planning at Tender stage – Development of basic system – Planning for maximum reuse – Economical form construction – Planning examples – Crane size, effective scheduling estimate – Recheck plan details – Detailing the forms. Crane arrangement – Site layout plan – Transporting plant – Formwork beams – Formwork ties – Wales – Scaffold frames - Form accessories – Vertical transport table form work
	Unit – II **Form materials and pressures on formwork** Lumber – Types – Finish – Sheathing boards - Working stresses – Repetitive member stress – Plywood – Types and grades – Textured surfaces and strength – Reconstituted wood – Steel – Aluminum Form lining materials – Hardware and fasteners – Nails in Plywood – Bolts lag screw and connectors – Bolt loads. Pressures on Formwork - Concrete density – Height of discharge – Temperature – Rates of Placing – Consistency of concrete – Live loads and wind pressure – Vibration Hydrostatic Adjustment for non standard condition
	Unit – III **Shores and form design** Simple wood stresses – Slenderness ratio – Allowable loads – Tubular steel shores - Patented shores – Site Preparation - Size and spacing – Steel Tower Frames – Safety practices – Horizontal shoring for multi-levels – More concentrated shore loads - T-heads – Two tier wood shores – Ellis shores – Dayton sure grip and Baker Roos shores – Safway Symons shores – Beaver Advance shores - Dead shores – Raking and Flying shores Basic simplification – Beam formulas – Allowable stresses –

	Deflection bending lateral stability – Shear, Bearing – Examples in wall forms – Slab forms – Beam form – Ties, Anchors and Hangers – Column forms – Examples in each.
	Unit – IV **Dome forms, tunnel forms, slipforms and safety practices for scaffolds** Shells of translation and revolution - Hemispherical – Parabolic - Barrel vaults – Hypar Shells – Conoidal Shells - Folded plates – Shell form design – Building the form – Placing concrete – Strength requirements – Tunnel forming components – Curb and Invert forms – Arch and Wall forms - Telescopic forms – Concrete placement methods – Cut and Cover construction – Continuous Advancing slope method - Bulk head method – General design considerations influence of placing equipment – Tolerances – Form construction for Shafts. Slipforms – Principles – Types – Advantage – Functions of various components – Planning of Slipform operations – Desirable characteristics of concrete – Common problems faced – Safety in slip forms - Special structures built with Slipform Technique – Codal provisions – Types of scaffolds – Putlog and Independent scaffold – Single pole scaffolds – Fixing ties – Spacing of ties - Plan Bracing – Knots – Safety nets – General safety requirements – Precautions against particular hazards – Truss, Suspended – Gantry and system scaffolds

TEXT BOOKS:

1. Robert L. Peurifoy and Garold D. Oberlender, “Formwork for Concrete Structures”, Third Edition McGraw-Hill, 1996.
2. Hurd, M.K., “Formwork for Concrete”, Special Publication No. 4 Sixth Edition, American Concrete Institute, Detroit, 1995.

REFERENCES:

3. Michael P. Hurst, “Formwork”, Construction Press, London and New York, 1997.
4. Austin, C.K., “Formwork for Concrete”, Cleaver – Hume Press Ltd., London 1996.
5. Tudor Dinescu and Constantin Radulescu, “Slipform Techniques”, Abacus Press, Turn Bridge Wells, Kent, 1992.
6. “Guide for Concrete Formwork”, American Concrete Institute Detroit, Michigan, 1996.
7. “Safety Requirements for Scaffolding”, American National Standards Institute, New York, 1994.

CEGT 1006 / 1 ---- PAVEMENT DESIGN

Course Category: Programme Elective **Credits: 4**

Course Type: Theory **Lecture Hours: 4Hrs/week**

Internal Assessment: 40

External Assessment: 60

Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: differentiate functions of different layers of both flexible and rigid pavements
	CO2: Estimate stresses and strains due to wheel loads in pavements
	CO3: Design flexible pavements for highways and airports
	CO4: Design Rigid pavement for highways
Course content	**Unit – I** General Consideration: Components of road pavement such as subgrade, Sub base, Base course and wearing course and their functions, Comparison of flexible and rigid pavements, highway and air port pavements
	Unit – II **Stresses and strains in flexible pavements**: Stresses and strains in an infinite elastic half space use of Boussinesq's equations - Burmister's two layer and three layer theories; Wheel load stresses, various factors in traffic wheel loads; Equivalent single wheel load of multiple wheels. Repeated loads and EWL factors.
	Unit – III **Flexible pavement design methods for highways and airports:** Empirical, semi-empirical and theoretical approaches; Development, principle, design steps of the different pavement design methods including AASHTO, Asphalt Institute, Shell Methods. IRC method of pavement design
	Unit – IV **Stresses in rigid pavements:** Types of stresses and causes; Introduction to Westergaard's equations for calculation of stresses in rigid pavement due to the influence of traffic and temperature; Considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses. **Rigid pavement design:** Design of cement concrete pavement for highways and runways; Design of joints, reinforcements, tie bars, dowel bars. IRC method of design; Design of continuously reinforced concrete pavements

TEXT BOOKS:

1. S.K.Khurana, Principles, Practice and Design of Highway Engineering,
2. E.J.Yodar and M.W.Witczac, Principles of Pavement Design, 2nd Edition, John Wiley and Sons, New York.

REFERENCES:

3. C.A. O'Flaherty, Highways, Butterworth Heinemann. 4. Khanna and Justo, Highway Engineering, Nem Chand & Bros. Roorkee.
4. Yang H Huang - Pavement Analysis and Design, 2nd Edition, Pearson Education
5. Khanna & Justo – Highway Engineering, Khanna Publishers.
6. Srinivasa kumar R – Pavement design , University press(India) Pvt.Ltd 2013
7. **MORT&H**- Specifications for Roads and Bridges, 5th Revision, 2013.

CEGT 1006 / 2 ---- GEO ENVIRONMENTAL ENGINEERING

Course Category: Programme Elective **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: Various Sources of Contaminations
	CO2: waste management strategies
	CO3: Contaminant Transport and Remediation Techniques
	CO4: Types of landfills
Course content	**Unit – I** **Sources and Site Characterization:** Scope of Geoenvironmental Engineering, Various Sources of Contaminations, Need for contaminated site characterization; and Characterization methods
	Unit – II **Solid and Hazardous Waste Management**: Classification of waste, Characterization of solid wastes, Environmental Concerns with waste, waste management strategies.
	Unit – III **Contaminant Transport:** Transport process, Mass-transfer process, Modeling, Bio-remediation, Phyto-remediation. **Remediation Techniques:** Objectives of site remediation, various active and passive methods, remediation NAPL sites, Emerging Remediation Technologies.
	Unit – IV **Landfills:** Types of landfills, Site Selection, Waste Containment Liners, Leachate collection system, Cover system, Gas collection system

Text Books:

1. Phillip B. Bedient, Refai, H. S. & Newell C. J. - Ground Water Contamination - Prentice Hall Publications, 4th Edition, 2008
2. Sharma, H. D. and Reddy, K. R. - Geoenvironmental Engineering, John Wiley & Sons (2004)

References:

1. Rowe, R. K. - Geotechnical & Geoenvironmental Engineering Handbook, Kluwer Academic, 2001

CEGT 1006 / 3 ---- CLAY MINERALOGY AND FLOW THROUGH SOILS

Course Category: Programme Elective **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: Study of clay forming minerals
	CO2: Clay mineral identification
	CO3: have the knowledge of Permeability of soils and its determination in lab and field
	CO4: have the knowledge of Flow through earth dam
Course content	**Unit – I** Atomic bonds: Primary and Secondary types; Study of clay forming minerals; Base exchange capacity; Clay water electrolyte system; Gouy-Chapman diffuse double layer theory; Structure of clays; Principle of electro-osmosis
	Unit – II Soil stabilization; Consolidation and strength characteristics of clay in light of clay mineralogy; Clay mineral identification: Differential thermal analysis, X-ray diffraction technique and Scanning electron microscopic studies
	Unit – III Dercy's law, Permeability of soils, Laboratory and field determination, pumping in and pumping out tests. Fundamentals of ground water flow, general hydro-dynamic equations. Velocity potential and stream function, equiprnent function, Flownets - properties and uses.
	Unit – IV Confined and unconfined flow of water. Flow through earth dam, under hydraulic structures and foundation structures. Numerical and similitude methods of solution for confined flow problems. Radial flow of water and seepage from canals and ditches

TEXT BOOKS:

1. D.K.Todd, Groundwater Hydrology, John wiley and Sons
2. H.M. Raghunath, Ground Water, Willy Eastern Ltd.

REFERENCES;

3. M.E. Harr, Ground Water and Seepage, McGraw-Hill, 1962.
4. C.Fitts, Ground Water Science, Elsevier Publications, U. S. A.

CEGT 1007 / 1 ---- MARINE GEO – TECHNIQUES

Course Category: Programme Elective **Credits: 2**
Course Type: Theory **Lecture Hours: ------**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: Study of origin and nature of marine soils
	CO2: understand different types of platforms
	CO3: understand different types of shallow foundations and its construction
	CO4: have the knowledge of Deep Foundations and Anchors
Course content	**Unit – I** **Marine Soils** Origin, nature and distribution of marine soils – their engineering properties – sampling and sample disturbance – in-situ testing. **Offshore Platforms** Introduction of fixed and floating platforms – steel, concrete and hybrid platforms
	Unit – II Environmental loading – wind, wave and current loads after installation.
	Unit – III Site investigation – types of shallow foundation for structures on sea bed – Bearing capacity – effect of eccentric and inclined loads – construction
	Unit – IV **Deep Foundations and Anchors** Pile foundation – Axial capacity – Lateral capacity – deflections – constructions – anchored foundations

REFERENCES

1. Swamisaran, Analysis and Design of Substructures, Oxford & IBH Publishing company Private Ltd., Delhi.
2. H.G.Poulos, Marine Geotechniques, Unwin Hyman, London.
3. Pienne Le Tirrant, Sea bed Recermaissquce and Offshore Soil Mechanic

CEGT 1007 /2 ---- GEOTECHNICAL MEASUREMENTS AND EXPLORATION

Course Category: Programme Elective **Credits: 2**
Course Type: Theory **Lecture Hours: ------**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: make lab tests and interpretation of test results
	CO2: plan the various field tests and sampling techniques
	CO3: make field tests such as SPT, CPT, DCPT etc
	CO4: make data interpretation
Course content	**Unit – I** **Introduction to Soil Mechanics** Index properties, 1-d consolidation theory , direct shear tests: Theory and application **Triaxial tests** Triaxial (static and cyclic) and simple shear testing under stress- and strain-control with pore pressure measurements
	Unit – II **Engineering properties of soil** Relevant theoretical concepts for determination of engineering properties of soils. **Subsurface exploration** Subsurface exploration, planning, drilling and sampling techniques
	Unit – III **In-situ field tests** In-situ field testing and laboratory investigation of soil, including advanced equipments, instrumentation, data acquisition, and measurement techniques: SPT, CPT, DCPT, Pressuremeter, Dilatometer, Permeability, etc
	Unit – IV **Data Interpretation** Data interpretations for determination of engineering properties of soils, and their application to geotechnical design. Preparation of site-investigation reports.

Text Books:

1. Das B. M.: Advanced Soil Mechanics, (2nd Edition), Taylor and Francis, Washington, DC. (1997)
2. Lambe and Whitman: Soil mechanics. John Wiley and Sons. New York. (1969)

Reference:

3. American Society of Civil Engineers: Soil sampling (1999)
4. Bowles, B: Engineering Properties of Soil and Their Measurements, McGraw-Hill Companies, (1992)
5. Clayton et al., Matthews and Simons: Site Investigation, Blackwell Science, (2005)
6. Head, K.H., Manual of Soil Laboratory Testing, Whittles Publishing, (2006)
7. NPTEL: E- Learning Course from IIT Kanpur

CEGT 1051 – COMPUTER APPLICATION IN GEOTECHNICAL ENGINEERING

Course Category: Programme Core **Credits: 2**
Course Type: Lab **Practical class Hours: 3Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: obtain net and safe bearing capacities of shallow foundations
	CO2: analyse the data from Triaxial test
	CO3: analyse the data from one dimensional consolidation
	CO4: analyse the data of different structures by FDM & FEM
Course content	1. Ultimate, Net and Safe Bearing Capacity Using Terzaghi and IS Code Methods. 2. Net Settlement Pressure 3. Hyperbolic Curve Fitting of Tri-axial Compression Data 4. Terzaghi One dimensional consolidation solution by FDM 5. Beam on Elastic Foundation by FDM 6. FDM Solution for Raft Foundation 7. Axial Loaded Piles by Direct FEM 8. Laterally Loaded Piles by FDM & FEM 9. Stability Analysis by Bishop theory 10. Stability Analysis by Method of Slices.

Text Books: 1. M.G.Salvadori and M.L.Baron, Numerical Method in Engineering.
2. Syal and Gupta, Computer Programming and Engg. Analysis

CEGT 1052 – GEOTECHNICAL LAB

Course Category: Programme Core **Credits: 2**
Course Type: Lab **Lecture Hours: 3Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: Study of Index properties of soil, Electrical Resistivity, Cation Exchange Capacity and Wave propagation
	CO2: Study of compaction characteristics- Proctors, SPT, CPT
	CO3: Study of coefficient of permeability
	CO4: Study of shear stress under different drainage conditions in Triaxial test
Course content	1. Grain size analysis –Sieve and Hydrometer Analysis 2. Consistency Limits-Cone Test for Liquid Limit 3. Compaction Tests 4. Permeability of Clay Soils. 5. Free Swell, Swell Potential, Swell Pressure Test 6. Oedometer Test 7. Direct shear test 8. Triaxial Tests 9. Determination of CBR of a soil specimen as per IS code recommendation 10. Soil chemical tests

CEGT 2001 ---- SOIL DYNAMICS & MACHINE FOUNDATIONS

Course Category: Programme Core **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: knowledge of Free and Forced vibrations
	CO2: Dynamic Soil Properties and Stress-strain behavior of soils under cyclic loading
	CO3: Methods of analysis of Machine Foundations
	CO4: have knowledge to Design of Machine Foundations
Course content	**Unit – I** Fundamentals of Vibration: Definitions, Simple harmonic motion, Response of SDOF systems of Free and Forced vibrations with and without viscous damping, Frequency dependent excitation, Systems under transient loads, Rayleigh's method of fundamental frequency, Logarithmic decrement, Determination of viscous damping, Transmissibility, Systems with Two and Multiple degrees of freedom, Vibration measuring instruments
	Unit – II Wave Propagation and Dynamic Soil Properties: Propagation of seismic waves in soil deposits - Attenuation of stress waves, Stress-strain behaviour of cyclically loaded soils, Strength of cyclically loaded soils, Dynamic soil properties - Laboratory and field testing techniques, Elastic constants of soils, Correlations for shear modulus and damping ratio in sand, gravels, clays and lightly cemented sand. Liquefaction of soils: An introduction and evaluation using simple methods.
	Unit – III Vibration Analyses: Types, General Requirements, Permissible amplitude, Allowable soil pressure, Modes of vibration of a rigid foundation block, Methods of analysis, Lumped Mass models, elastic half space method, elasto-dynamics, effect of footing shape on vibratory response, dynamic response of embedded block foundation, Vibration isolation.

	Unit – IV Design of Machine Foundations: Analysis and design of block foundations for reciprocating engines, Dynamic analysis and design procedure for a hammer foundation, IS code of practice design procedure for foundations of reciprocating and impact type machines. Vibration isolation and absorption techniques. Machine Foundations on Piles: Introduction, Analysis of piles under vertical vibrations, Analysis of piles under translation and rocking, Analysis of piles under torsion, Design procedure for a pile supported machine foundation

TEXT BOOKS:

1. Swami Saran - Soil Dynamics and Machine Foundation, Galgotia Publications Pvt. Ltd. (2010)
2. Prakash, S. - Soil Dynamics, McGraw Hill Book Company (1981)

REFERENCES:

1. I.Cshowdhary and S P Dasgupta - Dynamics of Structures and Foundation, 2009.
2. Arya, S. D, O'Neil, M. and Pincus, G.- Design of Structures and Foundations for Vibrating Machines, Gulf Publishing Co., 1979.
3. Prakash, S. and Puri, V. K. - Foundation for Machines: Analysis and Design, John Wiley & Sons, 1998.
4. Kameswara Rao, N. S. V. - Vibration Analysis and Foundation Dynamics, Wheeler Publication Ltd., 1998.
5. Richart, F. E. Hall J. R and Woods R. D. - Vibrations of Soils and Foundations, Prentice Hall Inc., 1970.
6. Das, B. M. - Principles of Soil Dynamics, PWS KENT publishing Company, Boston.2002
7. Bharat Bhushan Prasad – Advanced Soil Dynamics and Earthquake Engineering, PHI Learning Pvt. Limited, New Delhi, 2011.

CEGT 2002 ---- ROCK MECHANICS

Course Category: Programme core **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: understand engineering properties of rock, classification of rocks
	CO2: know Laboratory testing of rocks, failure criteria in rocks
	CO3: know Various techniques to improve the in situ strength of rocks
	CO4: know Stability of Rock Slopes and Foundations on Rocks
Course content	**Unit – I** Engineering Classification of Rocks: Classification of intact rocks, Rock mass classifications, Rock Quality Designation (RQD), Rock Structure Rating (RSR), Rock Mass Rating (RMR), Norwegian Geotechnical Classification (Q-system), Strength and modulus from classifications, Classification based on strength & modulus and strength and fracture strain, Geo – engineering classification
	Unit – II Laboratory and In-Situ Testing of Rocks: Physical properties, Compressive strength, Tensile strength, Direct shear test, Triaxial shear test, Slake durability test, Schmidt rebound hardness test, Sound velocity test, In-Situ Tests: Seismic methods, Electrical resistivity method, In situ stresses, Plate loading test, Goodman jack test, Plate jacking test, In-situ shear test, Field permeability test
	Unit – III Strength, Modulus and Stresses-Strain Responses of Rocks: Factors influencing rock response, Strength criteria for isotropic intact rocks, Modulus of intact rocks, effect of confining pressure, Uniaxial Compressive strength, Strength criteria for intact rocks, Strength due to induced anisotropy in rocks, In- site stress in rock masses: Analysis of stresses, thick wall cylinder formulae, Kreish equation, Green span method, opening in rock mass and stresses around opening

	Unit – IV Stability of Rock Slopes and Foundations on Rocks: Rock slopes, Modes of failure, Rotational failure, Plane failure, Design charts, Wedge method of analysis, Buckling failure, Toppling failure, Improvement of slope stability and protection. Foundations on Rock: Introduction, Estimation of bearing capacity, Stress distribution, Sliding stability of dam foundations, strengthening measures, Settlements in rocks, Bearing capacity of pile/pier in rock, Remedial measures, Foundations located on edge of jointed slope.

Text Books:

1. Goodman – Introduction to Rock mechanics, Willey International (1980).
2. Ramamurthy, T. - Engineering in Rocks for slopes, foundations and tunnels, Prenice Hall of India.(2007)

References:

1. Jaeger, J. C. and Cook, N. G. W. – Fundamentals of Rock Mechanics, Chapman and Hall, London.(1979)
2. Hoek, E. and Brown, E. T. - Underground Excavation in Rock, Institution of Mining and Metallurgy, 1982.
3. Brady, B. H. G. and Brown, E. T. - Rock Mechanics for Underground Mining, Chapman & Hall, 1993.
4. Rock mechanics for engineers: Varma, B.P, Khanna Publishers
5. Rock mechanics in engineering practice: Stag and Zienkiewiz, John wiley & sons

CEGT 2003 ---- GEOTECHNICAL EARTHQUAKE ENGINEERING

Course Category: Programme core **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: Causes of earthquake and Quantification
	CO2: Seismograph and Earthquake Ground Motion
	CO3: Problems of Liquefaction and soil improvement
	CO4: Seismic Slope Stability, Seismic Design of Retaining Walls
Course content	**Unit – I** Earthquake Seismology – Causes of earthquake, Plate tectonics, Earthquake fault sources, Seismic waves, Elastic rebound theory, Quantification of earthquake, Intensity and magnitudes, Earthquake source models
	Unit – II Earthquake Ground Motion – Seismograph, Characteristics of ground motion, Effect of local site conditions on ground motions, Design earthquake, Design spectra, Development of site specification and code-based design.
	Unit – III Liquefaction and Lateral Spreading - Liquefaction related phenomena, Liquefaction susceptibility: Historical, Geological, Compositional and State criteria. Evaluation of liquefaction by cyclic stress and cyclic strain approaches, Lateral deformation and spreading, Criteria for mapping liquefaction hazard zones. Soil improvement for remediation of seismic hazards.
	Unit – IV Seismic design requirements for foundation, Seismic bearing capacity, Seismic settlement, Design loads, Seismic Slope Stability, Seismic Design of Retaining Walls, Dynamic active & passive earth pressures, Soil Improvement for remediation of Seismic hazards.

Text Books:

1. S.L. Kramer, Geotechnical Earthquake Engineering, Pentice Hall, international series, Pearson Education (Singapore) Pvt. Ltd., 2004.
2. S.Saran, Soil Dynamics and Machine Foundation, Galgotia publications Pvt. Ltd., New Delhi 1999.

Reference Books:

1. Ansal, Recent Advances in Earthquake Geotechnical Engineering and Microzonation, Springer, 2006.
2. Towhata, Geotechnical Earthquake Engineering, Springer , 2008.
3. Bharat Bushan Prasad- Advanced Soil Dynamics and Earthquake Engineering, PHI Learning Pvt. Ltd., New Delhi, 2011.
4. R. W. Day - Geotechnical Earthquake Engineering Handbook, McGraw-Hill, 2002.
5. Naeim, F. - The Seismic Design Handbook, Kluwer Academic Publication, 2nd Edition, 2001.
6. Bolt, B. A. - Earthquakes, W. H. Freeman and Company, 4th Edition, 1999.
7. Lourie, W. - Fundamentals of Geophysics, Cambridge University press, 1997.
8. Kamalesh Kumar - Basic Geotechnical Earthquake Engineering – New Age International Publishers,1st Edition, 2008.
9. Dowrick - Earthquake Resistant Design, John Wiley & Sons.(2009)

CEGT 2004 ---- GEOSYNTHETICS IN CIVIL ENGINEERING

Course Category: Programme core **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: Know the Properties and Testing Methods of Geosynthetics
	CO2: Know the Application of Geotextiles
	CO3: Know the Application of Geogrids and Geomembranes
	CO4: Know the Application of Geocomposites
Course content	**Unit – I** Geosynthetics and Properties and Testing Methods: Introduction to Geosynthetics – Basic description – History – Manufacturing methods – Uses and Applications. Properties and Testing methods of Geotextiles – Geogrids – Geomembranes – Geocomposites
	Unit – II **Geotextiles:** Designing for Separation – Reinforcement – Stabilization – Filtration – Drainage and Moisture barriers
	Unit – III **Geogrids:** Designing for Reinforcement – Stabilization – Designing Gabions – Construction methods – Design of retaining walls. **Geomembranes:** Survivability Requirements – Pond Liners – Covers for Reservoirs – Canal Liners – Landfill Liners – Caps and closures – Dams and Embankments.
	Unit – IV **Geocomposites:** Geocomposites – An added advantage – Geocomposites in Separation – Reinforcement – Filtration – Geocomposites as Geowebs and Geocells – Sheet drains – Strip drains and Moisture barriers..

REFERENCE:
1. “Designing with Geosynthetics by Robert M. Koerner Prantice Hall, Eaglewood cliffs, NJ 07632.
2. “Construction and Geotechnical Engineering using Synthetic Fabries” by Robert M. Koerner and Josoph P. Welsh. John Willey and Sons, New York.
3. “Engineering with Geosynthetics”, by G. Venkatappa Rao and GVS Suryanarayana Raju – Tata McGraw Hill Publishing Company Limited – New Delhi.
4. “Foundation Analysis and Design” by J.E. Bowles McGraw Hill Publications.

CEGT 2005 / 1 ---- CONSTRUCTION MANAGEMENT

Course Category: Programme Elective **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: Know the stakeholders of construction project and their responsibilities
	CO2: Know Organization structure of a construction company
	CO3: Know the Types of contracts and barcharts and net work diagrams
	CO4: Know the book keeping procedures of a construction company
Course content	**Unit – I** **Project Planning Management** Introduction: Construction project management and its relevance, Parties / stakeholders of construction project and their responsibilities
	Unit – II **Project Organization**: Forms of Business organization, Organization structure of a construction company, Management levels, Important traits of project manager, Ethical conduct for Engineer
	Unit – III **Contracts**: Definition and salient features of contract, Classification of contracts, Bidding process, Construction Planning: Types of project plan, Work breakdown structure, Bar chart, Network diagram (CPM, PERT), Comparative discussion, Construction equipment
	Unit – IV **Financial Management**: Economic decision making, Cash-flow diagram, Accounting process, Cashbook, working capital, Trading account, Profit and loss account, Balance sheet. Claims, Disputes, and Project closer: Sources of claims, Claim management, Causes of disputes, Arbitration - its resolution, Closer of contract and Financial closer.

Text Books:

1. Bratish Sengupta and Himadri Guha, 'Construction Management and Planning', Tata McGrwHill.

Reference Books:

1. Callahan, M. T., Quackenbush, D. G., and Rowings, J. E., Construction Project Scheduling, McGrawHill, New York, 1992.

2. Cleland, D. I. and Ireland, L. R., Project Management: Strategic Design and Implementation, 4th Edition, McGraw Hill, New York, 2002.

CEGT 2005 / 2 ---- EARTH AND ROCK FILL DAMS

Course Category: Programme Elective **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: Know the basic concepts and Embankment Construction & Causes of Failure and types of instrumentation
	CO2: Know flow nets, seepage control, Filter criteria and use of geo – synthetics
	CO3: Know the stability of slopes of embankment
	CO4: Knowledge of rock-fill dams
Course content	**Unit – I** **BASIC CONCEPTS AND MISCELLANEOUS TOPICS.** Types of Dams – Selection of Type of Dam – Site Topography – Foundation Conditions – Availability of Materials – Spillway Location – River Diversion – Basic Design Requirements – Causes of Failure and Deterioration of Dams – Design Investigations – Fill Material – Foundations – Design Studies – Laboratory Investigations – Embankment Construction – Placement and Compaction – Compaction Requirements – Selection of Moisture Content - Quality Control – Instrumentation – Purpose - Types of Instruments and Brief Description – Installation – Crest Width – Freeboard – Definition – Wind Set-up – Wave Height – Design of Slope Protection – Dumped Riprap – Hand-placed Riprap – Soil-Cement Slope Protection – Downstream Slope Protection.
	Unit – II **SEEPAGE THROUGH DAM SECTION AND ITS CONTROL** Flow Nets – Definitions - Casagrande's Method – Flow Net for Anisotropic Section – Quantity of Seepage through Dam Section – Basic Equations – Stello's Seepage Charts - Quantity of Seepage through Foundation – Seepage Control – Filters – Filter Criteria – Filters for Silts and Clays – Critical and Non Critical Filters – Broadly Graded Soils – Core Material – Core Inclination – Core Thickness – Drainage – Pervious Downstream Shell – Chimney Drains – Rock Toe and Drains – Use of Geotextiles as Filter Material. **CONTROL OF SEEPAGE THROUGH FOUNDATIONS** Trench Cutoff – Partial Cutoff – General Considerations – Design of Upstream Blanket –Horizontal Drainage Blanket – Relief Wells – General Details – Design

	of Relief Wells – Drainage Trenches - Downstream Loading Berm – Cutoff Walls –Slurry Trench Cut-off Walls – Concrete Cut-off Walls or Diaphragms – Grouted Cutoffs – Performance of Seepage Reducing Measures
	Unit – III **Slope Stability Analysis** Introduction – Critical Slip Surface – Shear Strength Under Different Test Conditions – Shear Strength Tests – Test Conditions for Stability Analysis – Pore Pressures under Different Test Conditions – End of Construction – Drawdown Pore pressures – Steady Seepage – Factor of Safety – Stability Analysis – Method of Slices – Equilibrium Requirements – Fellenius Method – Simplified Bishop Method – Taylor – Lowe Force Equilibrium Method– Appraisal of Different Methods of Stability Analysis
	Unit – IV **Rockfill Dams**: Requirements of compacted rockfill, Shear strength of rockfill, Rockfill mixtures, Rockfill embankments, Earth-core Rockfill dams, Stability, Upstream & Downstream slopes.

Text Books:

1 Sherard, Woodward, Gizienski and Clevenger. Earth and Earth-Rock Dams. John Wiley &. Sons. 1963

2. Bharat Singh and Sharma, H. D. – Earth and Rockfill Dams, 1999

References:

1. Sowers, G. F. and Salley, H. I. – Earth and Rockfill Dams, Willams, R.C., and Willace, T.S. 1965.
2. Abramson, L. W., Lee, T. S. and Sharma, S. - Slope Stability and Stabilisation methods – John Wiley & sons. (2002)
3. Bromhead, E. N. (1992).The Stability of Slopes, Blackie academic and professional, London.
4. Christian, Earth & Rockfill Dams – Principles of Design and Construction, Kutzner Published Oxford and IBH.
5. Ortiago, J. A. R. and Sayao, A. S. F. J. - Handbook of Slope Stabilization, 2004.

CEGT 2005 / 3 ---- DESIGN OF EARTH RETAINING STRUCTURES

Course Category: Programme Elective **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: understand Classical Theories of Earth pressure and determinations of earth pressure on different types of retaining walls
	CO2: understand Lateral Pressure in Braced cuts
	CO3: understand method of construction, distribution of earth pressure on Sheet Pile and cofferdams
	CO4: understand functions and Mechanics of reinforced earth
Course content	**Unit – I** 1**. Earth pressures** – Different types and their coefficients- Classical Theories of Earth pressure – Rankine's and Coulomb's Theories for Active and Passive earth pressure- Computation of Lateral Earth Pressure in Homogeneous and Layered soils- Graphical solutions for Coulomb's Theory in active and passive conditions. 2. **Retaining walls** – different types - Type of Failures of Retaining Walls – Stability requirements – Drainage behind Retaining walls – Provision of Joints – Relief Shells
	Unit – II **Braced cuts** – Lateral Pressure in Braced cuts – Design of Various Components of a Braced cut – Stability of Braced cuts – Bottom Heave in cuts
	Unit – III **Sheet pile and cofferdam**. Type, material, method of construction, distribution of earth pressure and related approximation. Distinction between Sheet Pile and Retaining wall, Design of single – wall cofferdams and their stability aspects – TVA method and Cummins' methods.
	Unit – IV **Soil reinforcement** – Reinforced earth - Different components – their functions – Mechanics of reinforced earth – Failure modes-Failure theories – Design of Embakments on problematic soils

Text Books :

1. Principles of Foundation Engineering by Braja M. Das.
2. Foundation analysis and design – Bowles, JE – McGraw Hill

REFERENCES

3. Soil Mechanics in Engineering Practice – Terzaghi, K and Rolph, B. peck 2nd Edn. –

John Wiley & Co.,
4. Analysis and Design of Foundations and Retaining Structures, Prakash, S – Saritha Prakashan, Mearut.

CEGT 2006/1 – Soil Structure Interaction

Course Category: Programme Elective **Credits: 2**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: Identify situations where soil-structure interaction is likely to occur and assess its impact on the behaviour of a structure
	CO2: Analyze finite and infinite length beams on isotropic elastic medium
	CO3: Analyze finite and infinite plates on isotropic and elastic medium
	CO4: Analyze Axially and Laterally Loaded Piles and Pile Groups
Course content	**Unit – I** Introduction to soil-foundation interaction problems, Soil behavior, Foundation behavior, Interface behavior, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic-plastic behavior, Time dependent behavior. **Ground-Foundation-Structure Interaction**: Effect of structure on ground-foundation interaction, Static and dynamic loads
	Unit – II **Beam on Elastic Foundation- Soil Models**: Infinite beam, Two-parameters models, Isotropic elastic half space, Analysis of beams of finite length, classification of finite beams in relation to their stiffness
	Unit – III **Plates on Elastic Continuum**: Infinite Plate, Winkler two Parameters, Isotropic elastic medium, thin and thick rafts(plates), Analysis of finite plates, Numerical analysis of finite plates.
	Unit – IV **Analysis of Axially and Laterally Loaded Piles and Pile Groups**: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap, Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system

Text Books:

1. Selvadurai, A. P. S. - Elastic Analysis of Soil-Foundation Interaction, 1979
2. Rolando P. Orense, Nawawi Chouw & Michael J. Pender - Soil-Foundation-Structure Interaction, CRC Press, 2010 Taylor & Francis Group, London, UK.

References:

1. Soil Structure Interaction – The real behaviour of structures, the institution of structural engineers, London, March 1989.
2. Poulos, H. G., and Davis, E. H. - Pile Foundation Analysis and Design, 1980

CEGT 2006 / 2 ---- DESIGN OF R. C. C. SUB STRUCTURES

Course Category: Programme Elective **Credits: 4**
Course Type: Theory **Lecture Hours: 4Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: understand and design foundations for buildings
	CO2: understand and Design of retaining structures
	CO3: understand and bridge abutments, Design of foundation for transmission towers etc
	CO4: understand and design well foundation
Course content	**Unit – I** **Building foundation design**: Design of footing, isolated footing and steel grillage, combined footings of rectangular, Trapezoid cantilever types. Mat or raft foundation of dry and saturated soil, floating foundations Design of Piles, Pile caps and pile foundations for buildings
	Unit – II Design of retaining structures, Design of retaining walls with surcharge loads. Retaining walls resting on piles
	Unit – III Design of bridge abutments, Design of foundation for transmission towers: - Design of basement walls, Bridge structures Analysis and Design.
	Unit – IV Design of well foundation and caissons of different types, Design of bridge piers resting on piles

Text Books:

1. Swami Saran - Analysis and Design of Sub structures, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Tomlinson, Foundation Design and Construction, Prentice Hall Publication.

References:

3. Soil Mechanics in Engineering Practice – Terzaghi, K and Rolph, B. peck 2nd Edn. – John Wiley & Co.,
4. Analysis and Design of Foundations and Retaining Structures, Prakash, S – Saritha Prakashan, Mearut.

CEGT 2006 / 3 ---- MAINTENANCE AND REHABILITATION OF STRUCTURES

Course Category: Programme Elective **Credits: 4**

Course Type: Theory **Lecture Hours: 4Hrs/week**

Internal Assessment: 40

External Assessment: 60

Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: understand design and construction errors
	CO2: understand Special concretes and mortar, concrete chemicals etc
	CO3: understand Maintenance, repair and rehabilitation
	CO4: understand Various Techniques of repair
Course content	**Unit – I** **Influence on serviceability and durability**: Quality assurance for concrete construction as built concrete properties strength, permeability, thermal properties and cracking, 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
	Unit – II **Special 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. Rust eliminators and polymers coating for Rebars, foamed concrete
	Unit – III **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.
	Unit – IV **Techniques for repair** Mortar and dry pack, vacuum concrete, Gunite and Shotcrete Epoxy injection, Mortar repair for cracks, shoring and underpinning, Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering wear, fire, leakage, marine exposure, Engineered demolition techniques - case studies

Text Books:

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:

. 3. M.S.Shetty, “Concrete Technology - Theory and Practice”, S.Chand and Company, New Delhi, 1992.
4. Santhakumar, A.R., “Training Course notes on Damage Assessment and repair in Low Cost Housing”, “RHDC-NBO” Anna University, July, 1992.
5. Raikar, R.N., “Learning from failures - Deficiencies in Design”, Construction and Service - R & D Centre (SDCPL), Raikar Bhavan, Bombay, 1987

CEGT 2051 – GEOTECHNICAL INVESTIGATION PRACTICE

Course Category: Programme Core **Credits: 2**
Course Type: Lab **Practical class Hours: 3Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: analyse the data from Augur boring
	CO2: analyse the data from Plate load test
	CO3: analyse the data from static and dynamic cone penetration tests
	CO4: analyse the data from sub soil investigation tests
Course content	1. Field Investigation by Auger Boring 2. Bored Pile installation in field 3. Plate load test 4. SPT test 5. Static Cone Penetration test 6. Dynamic cone Penetration test 7. Preparation of Soil test Repots 8. Electrical Resistivity Test 9. Test for Cation Exchange Capacity 10. Wave Propagation Tests.

CEGT 2051 – GEOSYNTHETICS AND ROCK MECHANICS- LAB

Course Category: Programme Core **Credits: 2**
Course Type: Lab **Practical class Hours: 3Hrs/week**
Internal Assessment: 40
External Assessment: 60
Total: 100

Course Outcome	On Successful Completion of the course, the student will be able to**:**
	CO1: Prepare the Rock sample for different Tests
	CO2: Prepare the Geosynthetics for different Tests
	CO3: find the hydraulic and mechanical properties of Geosynthetics
Course content	1. Preparation of Rock Specimen (Drilling, Cutting, Polishing) 2. Slake Durability Test 3. Brazilian Test 4. Point Load Test 5. Unconfined Compression Test 6. Interface Shear Behavior of Soils with Geosynthetics 7. Cone Drop Test on Geotextile 8. Tensile Tests (Wide Width, Narrow Width, etc. on Geotextiles) 9. CBR Push Through on Geotextiles 10. In-Plane and Cross-Plane Permeability of Geotextiles