Master of Technology
In
Geotechnical Engineering

DEPARTMENT OF CIVIL ENGINEERING

VELAGAPUDI RAMAKRISHNA
SIDDHARTHA ENGINEERING COLLEGE
(An Autonomous, ISO 9001:2015 Certified Institution)
(Approved by AICTE, Accredited by NAAC with 'A' Grade, Affiliated to JNTUK, Kakinada)
(Sponsored by Siddhartha Academy of General & Technical Education)
Kanuru, Vijayawada, Andhra Pradesh - 520007, INDIA.
www.vrsiddhartha.ac.in

Institute Vision

To nurture excellence in various fields of engineering by imparting timeless core values to the learners and to mould the institution into a centre of academic excellence and advanced research.

Institute Mission

To impart high quality technical education in order to mould the learners into globally competitive technocrats who are professionally deft, intellectually adept and socially responsible. The institution strives to make the learners inculcate and imbibe pragmatic perception and pro-active nature so as to enable them to acquire a vision for exploration and an insight for advanced enquiry.

Department Vision

To impart teaching, research and develop consultancy that serves the society and to strive continuously for excellence in education.

Department Mission

To provide quality education for successful career and higher studies in Civil Engineering that emphasizes academic and technical excellence in profession and research, effective communication, team work and leadership to meet the challenges of the society.

Program Outcomes

PO 1: Students will learn soil and rock behavior. Students will be able to perform various laboratory and in-situ tests on soil/rock to find out design parameters

PO 2: Students can design shallow/deep foundations, earth retaining structures, embankment and earth dams, tunnel support systems for given site conditions

PO 3: Students can compute factor of safety to assess the stability of slopes and apply preventive measures for stability

PO 4: Student can develop numerical models to estimate the response of various geotechnical structures under different loadings

PO 5: Graduates can adapt to working as an individual or in a team with a sense of social responsibility, integrity and ethics

DEPARTMENT OF CIVIL ENGINEERING

M.TECH IN GEOTECHNICAL ENGINEERING

SCHEME OF INSTRUCTION FOR TWO YEAR PG PROGRAMME [M.TECH 19]

SEMESTER I **Contact Hours: 23**

S.No	Course Type	Course Code	Title of the Course	L	T	P	Credits	CE	SE	Total
1.	Programme Core - I	19CEGT1001	Advanced Soil Mechanics	3	0	0	3	40	60	100
2.	Programme Core - II	19CEGT1002	Advanced Foundation Engineering	3	0	0	3	40	60	100
3.	Programme Core - III	19CEGT1003	Geotechnical Earth Quake Engineering	3	0	0	3	40	60	100
4.	Programme Elective - I	19CEGT1014	A. Earth and Rock fill dams B. Earth Retaining Structures C. Design of Underground Structures D. Industry Oriented Subject	3	0	0	3	40	60	100
5.	Programme Elective - II	19CEGT1015	A. Ground Improvement Techniques B. Pavement Analysis and Design C. Slope Stability Analysis D. Industry Oriented Course	3	0	0	3	40	60	100
6.	Mandatory Learning Course	19MTMC1026	Research Methodology, IPR and patents	2	0	0	0	40	60	100
7.	Laboratory - I	19CEGT1051	Experimental Geotechniques Lab	0	0	3	1.5	40	60	100
8.	Laboratory - II	19CEGT1052	Computer Applications in Geotechnical Engg. Lab.	0	0	3	1.5	40	60	100
			Total	**17**	**0**	**6**	**18**			

SEMESTER II **Contact Hours: 25**

S. No	Course Type	Course Code	Title of the Course	L	T	P	Credits	CE	SE	Total
1.	Programme Core – IV	19CEGT2001	Soil Dynamics and Machine Foundations	3	0	0	3	40	60	100
2.	Programme Core – V	19CEGT2002	Geo-synthetics and Reinforced Soil Structures	3	0	0	3	40	60	100
3.	Programme Core – VI	19CEGT2003	Engineering Rock Mechanics	3	0	0	3	40	60	100
4.	Programme Elective – III	19CEGT2014	A. Foundations on Expansive Soils B. Sub Surface Investigation and Instrumentation C. Geo-Environmental Engineering D. Industry Oriented Course	3	0	0	3	40	60	100
5.	Programme Elective – IV	19CEGT2015	A. Finite Element Methods in Geotechnical Engineering B. Repair and Rehabilitation of Structures C. Construction Management D. Industry Oriented Subject	3	0	0	3	40	60	100
6.	Audit Course	19MTAC2036	Technical Report Writing	2	0	0	-	0	100	100
7.	Laboratory - I	19CEGT2051	Geosynthetics and Rock Mechanics Lab	0	0	3	1.5	40	60	100
8.	Laboratory - II	19CEGT2052	Field Testing of Soil Lab	0	0	3	1.5	40	60	100
9.	Term Paper	19CEGT2063	Term Paper	0	0	2	1	40	60	100
			Total	**17**	**0**	**8**	**19**			

L – Lecture, T – Tutorial, P – Practical, C – Credits

***Students to be encouraged to go industrial training for at least six weeks during semester break**

#Students should conduct the Literature Survey for the proposed research topic and they need to develop a proto type or simulation based (must be outcome oriented) – the same to be presented in any conference (national or international)

Semester III **Contact Hours: 24**

S. No	Course Type	Course Code	Title of the Course	L	T	P	Credits	CE	SE	Total
1.	Programme Elective - V	19CEGT3011	Programme Elective - V	0	0	0	3	0	100	100
2.	Project (Part-A)	19CEGT3061	Project (Part-A)	0	0	20	10	40	60	100
3.	Internship	19CEGT3052	Internship	0	0	4	2	0	100	100
			Total	**0**	**0**	**24**	**15**			

L – Lecture, T – Tutorial, P – Practical, C – Credits

***To be continued in the IV Semester**

Program Elective V may be completed in semester I or II by satisfying the pre-requisites.

 # Evaluation done by MOOCs provider will be considered.

Semester IV **Contact Hours: 32**

S.No	Course Type	Course Code	Title of the Course	L	T	P	Credits	CE	SE	Total
1.	Project (Part-B)	19CEGT4061	Project (Part-B)	0	0	32	16	40	60	100
			Total	**0**	**0**	**32**	**16**			

L – Lecture, T – Tutorial, P – Practical, C – Credits

Total Credits: 68

Semester	Credits
1	**18**
2	**19**
3	**15**
4	**16**

19CEGT1001: ADVANCED SOIL MECHANICS

Course Category: Programme core	**Credits: 3**
Course Type: Theory	**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: calculate and analyze the stresses on soil and be able to draw the stress paths					
	CO2: analyze the effect of flow of fluids through soils					
	CO3: evaluate the compressibility of soils					
	CO4: obtain and analyze the shear strength of soils					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2	**H**				
	CO3	**H**				
	CO4	**H**				

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, 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: Consolidation** One dimensional compression, Oedometer test – coefficient of volume change, compression index, swelling 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 Behavior of Soils Shear strength of soils; Failure criteria, drained and un-drained shear strength of soils. Significance of pore pressure parameters; Determination of shear strength; UU, CU & CD tests; Interpretation of triaxial test results. Behavior of sands; Critical void ratio; dilation in soils; Critical state parameters; Critical state for normally consolidated and over consolidated soil; Significance of Roscoe and Hvorslev state boundary surfaces; Yielding, Bounding Surfaces
TEXT BOOKS	1. K.R. Arora, Soil Mechanics and Foundation Engineering; Standard Publishers & Distributors, Naisarak, New Delhi. 2. Mitchell J.K. - Fundamentals of soil behavior - John Wiley and Sons, Inc., New York. (Third edition) 2005
REFERENCES:	1. Das, B. M - Advanced Soil Mechanics, Taylor and Francis. 3rd edition (2008) 2. Atkinson J. H. - An Introduction to the Mechanics of Soils and Foundation - through critical state soil mechanics, McGraw-Hill Co. (1993)

19CEGT1002: ADVANCED FOUNDATION ENGINEERING

Course Category: Programme core	**Credits: 3**
Course Type: Theory	**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: understand various bearing capacity determination techniques					
	CO2: design shallow foundation and estimate settlements					
	CO3: design Pile foundation for Vertical, lateral, eccentric and uplift loading.					
	CO4: design and construction of well foundations.					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2		**H**			
	CO3		**H**			
	CO4		**H**			

Course content	**Unit – I** **Shallow Foundations**: **Bearing Capacity:-** General Formulae; Effect of Water Table; Footings with Eccentric or Inclined Loads, Footings on Layered Soils, Footings on finite layer with a Rigid Base at Shallow Depth, effect of soil compressibility, Foundations 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 **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. Bowles, J. E. - Foundation Analysis & Design 5th Edition McGraw-Hill Companies, Inc. (1996)
REFERENCES:	1. Donald P Coduto – Foundation Design Principles and Practices, 2nd edition, Pearson, Indian edition, 2012. Phi Learning (2008) 2. Poulos, H. G. & Davis, E. H. - Pile Foundation Analysis and Design john wiley & sons inc (1980-08) 3. K.R. Arora, Soil Mechanics and Foundation Engineering; Standard Publishers & Distributors, Naisarak, New Delhi.

19CEGT 1003: GEO TECHNICAL EARTHQUAKE ENGINEERING

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

Course Outcome	Upon successful completion of the course, the student will be able to:					
	CO1: Understand the process of wave propagation, attenuation and damping					
	CO2: Evaluate seismic response of soil using laboratory tests and model dealing with the cyclic nature of seismicity					
	CO3: Analyze liquefaction susceptibility; liquefaction potential and ground response for the select cases					
	CO4: Analyze Foundation / Slope Stability in Seismic Conditions					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2	**H**				
	CO3	**H**				
	CO4	**H**				

Course content	**UNIT I** **INTRODUCTION:** Introduction, Case studies of past earthquakes. **WAVE PROLIFERATION:** Waves in semi-infinite media – one, two and three dimensional wave propagation; Attenuation of stress waves – material and radiation damping; Dispersion, waves in a layered medium. **UNIT II** **DYNAMIC SOIL PROPERTIES:** Stress & strain conditions, Mohr circle, concept of stress path; Measurement of seismic response of soil at low and high strains - using laboratory tests; Cyclic triaxial, cyclic direct simple shear, resonant column, shaking table, centrifuge, bender element and using field tests - standard penetration test, cone penetration test, seismic

	reflection/refraction tests, SASW/MASW tests, cross bore hole. **EVALUATION** Evaluation of damping and elastic coefficients; Stress-strain behavior of cyclically loaded soils; Effect of strain level on the dynamic soil properties; Equivalent linear, cyclic nonlinear and advanced nonlinear models. **UNIT III** **STUDY OF EARTH RESPONSE:** Introduction, one, two and three dimensional analyses; Transfer functions for soil on rigid rock and elastic rock, effect of damping, Introduction to soil-structure interaction. **LIQUEFACTION:** Introduction, pore pressure, liquefaction related phenomena – flow liquefaction and cyclic mobility: Factors affecting liquefaction, liquefaction of cohesionless soils and sensitive clays, liquefaction susceptibility; State Criteria –CVR line, SSL, FLS; Evaluation of liquefaction potential: characterization of earthquake loading using simplified procedure (Seed and Idriss) and ground response analysis. characterization of liquefaction resistance using field and lab tests, cyclic stress ratio, Effects of liquefaction. **UNIT IV** **GEOTECHNICAL APPLICATIONS:** Earth Pressure & Retaining Walls: Seismic design of retaining walls. Seismic pressures on Yielding retaining walls: Mononobe Okabe method and Steedman-Zeng method. Seismic Slope Stability: Types of earthquake induced landslides; Static and seismic slope stability analyses – limit equilibrium, pseudostatic and Newmark Sliding Block analyses. Stress deformation analysis - Makdisi Seed analysis. Stability analysis with dynamic loading, selection of pseudostatic coefficients, factor of safety, yield acceleration, damage potential, displacement analysis, Finite Element analysis of slope stability. **GROUND IMPROVEMENT TECHNIQUES:** Densification, stone columns and compaction piles, grouting and mixing, drainage. Reinforced earth: application of reinforced earth under static and dynamic loads,

TEXT BOOKS	1. Kramer S.L., "Geotechnical-Earthquake Engineering", Pearson Education – Indian Low Price Edition, Delhi. 2004 2. Kameshwara Rao, N.S.V, "Dynamic Soil Tests & Applications", Wheeler Publications, New Delhi. 2000.
REFERENCES:	1. Day Robert W., "Geotechnical Earthquake Engineering Handbook", McGraw-Hill, New York.2001 2. Saran S. "Soil Dynamics & Machine Foundation", Galgotia Pub. Pvt. Ltd, New Delhi. 2006

19CEGT1014/A---- EARTH AND ROCK FILL DAMS

Course Category: Programme Elective	**Credits: 3**
Course Type: Theory	**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: Outline basic concepts of Dam Construction & Causes of Failure					
	CO2: Understand the equipment and procedures for construction of Earth dams					
	CO3: Understand the material requirements and procedures for construction of Rock fill dams					
	CO4: Design rock fill dams and also demonstrate an understanding of the damages and failures to Rock fill dams					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2	**H**				
	CO3	**H**				
	CO4		**H**			

Course content	**Unit – I** **Earth Dams** Classification of dams, Selection of Site, Basic design requirements, Factors influencing design, Design of components, Preliminary section **Failures and Damages of Earth Dams** Nature of failures –piping, settlement cracks, slides, earthquake and miscellaneous damages –case studies **Unit – II** **Construction of Earth Dams** Construction equipment, Procedures for pervious, Semi-pervious, Impervious and Rock fill sections, Construction supervision. **Unit – III** **Rock Fill Dams** General characteristics, Rock fill materials, Foundation, Construction,

	Deformations, Types of dams, Requirements of compacted rock fill **Unit – IV** **Design of Rock Fill Dams** Design of dam section, concrete face and earth core, Nature of failures and damages, case studies.
TEXT BOOKS	1 Sherard, Woodward, Gizienski and Clevenger. Earth and Earth-Rock Dams. John Wiley and Sons. 1963 2. Bharat Singh and Sharma, H. D. Earth and Rockfill Dams, 1999.
REFERENCES:	1. Sowers, G.F., Earth and Rock fill Dam Engineering, Asia Publishing House, 1962. 2.Christian, Earth and Rock fill Dams – Principles of Design and Construction, Kutzner Published.

19CEGT1014/B-- EARTH RETAINING STRUCTURES

Course Category: Programme Elective	**Credits: 3**
Course Type: Theory	**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: evaluate earth pressure acting on retaining walls					
	CO2: Design rigid retaining walls					
	CO3: recognize functions and Mechanics of Braced cuts					
	CO4: acquire knowledge on distribution of earth pressure acting on Sheet Piles					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2		**H**			
	CO3	**H**				
	CO4	**H**				

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. **Unit – II** **2. Retaining walls** – different types - Type of Failures of Retaining Walls – Design of retaining walls - Stability requirements – Specifications – Drainage behind Retaining walls-Specifications **Unit – III** **3. Braced cuts** – Lateral Pressure in Braced cuts – Design of Various Components of a Braced cut – Stability of Braced cuts – Bottom Heave in cuts.

	Unit – IV **4. Sheet piles** – Type, material, method of construction, distribution of earth pressure and related approximation. Distinction between Sheet Pile and Retaining wall.
TEXT BOOKS	1. Soil Mechanics and Foundation Engineering by K.R. Arora; Standard Publishers & Distributors, Naisarak, New Delhi. 2. J. E. Bowles, Foundation analysis and design, Tata McGraw-Hill International Edition, 5th Edn, 1997
REFERENCES:	1. Basic and Applied Soil Mechanics by Gopal Ranjan and A.S.R.Rao. published by New Age International Ltd., 2. K. Terzaghi, and R. B. Peck, Soil Mechanics in Engineering Practice, John Wiley & Co., 3rd Edn, 1996

19CEGT1014/C – DESIGN OF UNDER GROUND STRUCTURES

Course Category: Programme Elective	**Credits: 3**
Course Type: Theory	**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: Understand the need and types of Underground structures					
	CO2: Design underground structures					
	CO3: design soil nailing system					
	CO4: evaluate pressures on conduits					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2		**H**			
	CO3		**H**			
	CO4	**H**				

Course content	**Unit – I** **Introduction:** Historical: Natural caves, archeological caves and their construction. Introduction to underground openings: Need for Underground Openings: Congestion driven needs for development of infrastructure for transport, water, power supply, vehicle movement in cities, storage of materials. Types: Tunnels, Construction of Erath Tunnels, Conduits, Shafts **Unit – II** **Design of underground openings**: Design based on empirical methods such as RSR, RMR, Q systems, Stability of excavation face and Tunnel portals. **Unit – III** **Soil Nailing**: Components of nailing system, Driven and Grouted Nails, Design of nailing system, anchored Spider Netting **Unit – IV** **Soil pressures on conduits**: Loads on ditch, negative and positive projecting conduits, Bedding conditions for conduits and types of conduits

TEXT BOOKS	1. Introduction to Rock Mechanics by Richard E. Goodman, John Wiley & Sons Inc. 2. Underground excavation in rock by Hoek and Brown, E & FN Spon.
REFERENCES:	1. Engineering Rock Mechanics: An Introduction to the Principles by J. A. Hudson & J.P. Harrison, Elsevier Science & Technology. **2.** Shamsher Prakash, Gopal Ranjan and Swami Saran (1987) "Analysis and Design of Foundations and Retaining Structures", Sarita prakasha

19CEGT1015/A -- GROUND IMPROVEMENT TECHNIQUES

Course Category: Programme Elective	**Credits: 3**
Course Type: Theory	**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: understand need for and methods of ground improvement techniques					
	CO2: suggest suitable ground improvement technique for specific soil					
	CO3: acquire knowledge on different grouting Techniques					
	CO4: select and implement soil stabilization techniques based on field conditions					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2	**H**				
	CO3	**H**				
	CO4	**M**		**H**		

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 and quality control in field **Unit – II** Ground Improvement in Granular Soil: In place densification by (i) Vibroflotation (ii) Compaction pile (iii) Vibro Compaction Piles (iv) Dynamic Compaction (v) Blasting Ground Improvement in fine-grained Soil: Sand drains; Stone columns; Surcharge loading **Unit – III** Ground Improvement by Grouting: Grouting in soil, types of grout, desirable characteristics, grouting pressure, grouting methods.

	Unit – IV Soil Stabilization: Lime stabilization-Base exchange mechanism, Pozzolanic reaction, lime-soil interaction, lime columns. Cement stabilization: Mechanism, amount, age and curing. Fly-ash - Lime Stabilization, Soil Bitumen Stabilization
TEXT BOOKS	1. P. Purushothama Raj, Ground Improvement Techniques, Tata McGrawHill, New Delhi, 1995. 2. Hausmann, M.R., Engineering Principles of Ground Modification, McGraw-Hill International Editions, 1990
REFERENCES:	1.B.C.Chattopadhyay and J.Maity, Ground Control and Improvement Techniques, PEEDOT, Howrah, 2011. 2. R. M. Korner, Design with Geosynthetics, Prentice Hall, New Jersy, 3rd Edn. 2002 3. J. Han, Principles and Practice of Ground Improvement, John Wiley & Sons, 2015

19CEGT1015/B: PAVEMENT ANALYSIS AND DESIGN

Course Category: Programme Elective	**Credits: 3**
Course Type: Theory	**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: understand the basic components of different types of pavements					
	CO2: analyze and design of flexible pavements					
	CO3: evaluate the stresses induced in rigid pavements					
	CO4: analyze and design of rigid pavements					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2	**M**	**H**			
	CO3	**H**				
	CO4	**M**	**H**			

Course content	**Unit – I** **Introduction:** Types of pavement structures, Components of road pavement - subgrade, Sub base, Base course and wearing course, functions of pavement components, Comparison of flexible and rigid pavements, design factors to design a pavement. **Unit – II** **Flexible pavement design methods for highways and airports:** Empirical, semi-empirical and theoretical approaches – CBR method (including determination of CBR), flexible pavement design as per IRC:37-2012, design of rural roads as per IRC SP 20-2002. Burmister method for airport runway. **Unit – III** **Stresses in Rigid pavement:** Types of stresses and causes; calculation of stresses in rigid pavement due to the influence of traffic and temperature; critical combination of stresses. **Construction of rigid pavement**: types of rigid pavement, construction

	of rigid pavement, types of joints and arrangement of joints. **Unit – IV** **Rigid pavement design for highways and airport:** IRC method of rigid pavement design (IRC 58-2011). Design of joints, reinforcements, tie bars, and dowel bars. Design of airport runway pavement using LCN method and PCA method.
TEXT BOOKS	1.Pavement Analysis and Design, Yang H Huang, 2nd Edition, Pearson Education, 2003 2. Sk Khanna, CEG Justo & A Veraragavan – Highway Engineering, Nem Chand & Sons. 2017 3. Sk Khanna, MG Aurora, SS Jain- Airport Planning and Design Nem Chand (1999)
REFERENCES:	1.MORT&H- Specifications for Roads and Bridges, 5th Revision, 2013. 2. IRC:37-2012-GUIDELINES FOR THE DESIGN OF FLEXIBLE PAVEMENTS (should be allowed for external exam) 3.IRC SP 20-2002-Rural Roads Manual (should be allowed for external exam) 4. IRC 58-2011-Plain Jointed Rigid Pavements Design Highways (should be allowed for external exam)

19CEGT1015/C ---- STABILITY ANALYSIS OF SLOPES

Course Category: Programme Elective	**Credits: 3**
Course Type: Theory	**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: Understand the types and causes of slope failures					
	CO2: Analyse the stability of slopes using various methods					
	CO3: Analyse the stability of earth dams under seepage					
	CO4: Understand the strengthening measures to be undertaken for slope stability					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2	**M**		**H**		
	CO3	**M**		**H**		
	CO4	**M**		**H**		

Course content	**Unit – I** **Slopes:** Types and causes of slope failures, mechanics of slope failure, failure modes. **Unit – II** **Stability analysis:** infinite and finite slopes with or without water pressures; concept of factor of safety, pore pressure coefficients, Mass analysis, Wedge methods, friction circle method ; Method of slices, Bishop's method, Janbu's method, Morgenstern and Price, Spencer's method **Unit – III** **Stability analysis in the presence of seepage:** two dimensional flow – Laplace equation and it's solution, graphical method, determination of phreatic line, flow nets in homogeneous and zoned earth dams under steady seepage and draw-down conditions, seepage control in earth dams, influence of seepage on slope stability stability analysis of dam body during steady seepage

	Unit – IV **Strengthening measures:** stabilization of slopes by drainage methods, surface and subsurface drainage, use of synthetic filters, retaining walls, stabilization and strengthening of slopes, shotcreting, rock bolting and rock anchoring, instrumentation and monitoring of slopes, slope movements, warning devices, maintenance of slopes
TEXT BOOKS	1. Chowdhary R and Chowdhary , "Geotechnical Slope Analysis", CRC Press. 2. Duncan M. and Wright, S.G., Soil Strength and Slope stability, John Wiley, 2005.
REFERENCES:	**1.** Das, B. M - Advanced Soil Mechanics, Taylor and Francis. 3rd edition (2008) **2.** Harr M.E., "Ground Water and Seepage", McGraw Hill. 1962. **3.** C. Venkata Ramaiah, "Geotechnical Engoineerig", New Age International Publishjers, New Delhi.

19CEGT1051 - Experimental Geotechniques Lab

Course Category: Programme Core	**Credits: 1.5**
Course Type: Practical	**Lecture – Tutoroial - Practical: 0-0-3**
	Internal Assessment: 40 **External Assessment: 60** **Total: 100**

Course Outcome	On successful completion of the course, the student will be able to**:**					
	CO1: Determine index properties of soils					
	CO2: Determine Engineering properties of soil					
	CO3: Evaluate Compressive behavior of soils					
	CO4: Evaluate Strength behavior of soils					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				**H**
	CO2	**H**				**H**
	CO3	**H**				**H**
	CO4	**H**				**H**
Course content	1. Determination of index properties of soils 2. Determination of Permeability of Coarse and Fine Soils [Constant Head and Variable Head] 3. Determination of Compaction Characteristics of Soils [Standard and Modified Proctor Tests] 4. Determination of Unconfined Compressive Strength of Soils [UCS] 5. Determination of Shear Strength Parameters of Soils using Direct Shear Apparatus 6. Determination of Shear Strength Parameters of Soils using Tri Axial Apparatus 7. Determination of California Bearing Ratio of Soils 8. Consolidation Test					

19GT1052 – COMPUTER APPLICATION IN GEOTECHNICAL ENGINEERING

Course Category: Programme Core	**Credits: 1.5**
Course Type: Practical	**Lecture – Tutoroial - Practical: 0-0-3**
	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: analyze the data from Triaxial test					
	CO3: analyze the data from one dimensional consolidation					
	CO4: analyze the data of different structures by FDM & FEM					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				**H**
	CO2	**H**				**H**
	CO3	**H**				**H**
	CO4	**H**			**H**	**H**

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. Beam on Elastic Foundation by FDM 5. FDM Solution for Raft Foundation 6. Axial Loaded Piles by Direct FEM 7. Laterally Loaded Piles by FDM & FEM 8. Stability Analysis by Bishop theory 9. Stability Analysis by Method of Slices.

19CEGT2001 –SOIL DYNAMICS & MACHINE FOUNDATIONS

Course Category: Programme Core	**Credits: 3**
Course Type: Theory	**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: demonstrate knowledge of Free and Forced vibrations					
	CO2: Understand Dynamic Soil Properties and Stress-strain behavior of soils under cyclic loading					
	CO3: demonstrate knowledge of Vibration analysis					
	CO4: Design of Machine Foundations					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2	**H**				
	CO3	**H**				
	CO4	**M**	**H**			

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 Analysis: 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.Chowdhary 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.

19CEGT2002 -- GEOSYNTHETICS AND REINFORCED SOIL STRUCTURES

Course Category: Programme Core	**Credits: 3**
Course Type: Theory	**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: assess the properties and Testing Methods of Geosynthetics					
	CO2: understand functions and applications of Geosynthetics					
	CO3: Design and Construction of Reinforced Earth Walls					
	CO4: Design of Reinforced Earth Slopes and Foundations					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2	**H**				
	CO3	**M**	**H**			
	CO4	**M**	**H**			

Course content	**Unit – I** Introduction to Geosynthetics-Types of geosynthetics and their applications Manufacture of geosynthetics-Strength of reinforced soils **Unit – II** Testing of Geosynthetics-Properties of Geosynthetics-Functions of Geosynthetics-Applications of Geosynthetics **Unit – III** Different Types of Soil Retaining Structures-Construction Aspects of Geosynthetic Reinforced Soil Retaining Walls-Design Codes for Reinforced Soil Retaining Walls - External Stability Analysis of Reinforced Soil Retaining Walls-Seismic Loads and Internal Stability Analysis of Reinforced Soil Walls- Testing Requirements for Reinforced Soil Retaining Walls-Design of Reinforced Soil Retaining Walls – simple geometry-Design of reinforced soil retaining walls – sloped backfill soil Design of reinforced soil retaining walls supporting a bridge abutment-Design of Gabions

	Unit – IV Stability analysis of soil slopes – infinite and finite slopes-Stability analysis of reinforced soil slopes resting on soft foundation soils-Stability analysis of reinforced soil slopes resting on strong foundation soil-Stability analysis of reinforced soil slopes – bilinear wedge analysis-Design of Embankments supported on Load Transfer Platforms-Reinforced soil for supporting shallow foundations-Natural geosynthetics and their applications-Geosynthetics for construction of municipal and hazardous waste landfills
TEXT BOOKS	1. "Designing with Geosynthetics" by Robert M. Koerner, Prantice Hall, Eaglewood cliffs, NJ 07632. 2. "Fundamentals of Geosynthetics Engineering" by Sanjay Kumar Shukla, Jian-Hua Yin, Taylor & Francis, Milton Park, Abingdon, UK. 3. "Reinforced Soil and Its Engineering Applications" by Swami Saran, I.K. International Pvt Ltd, New Delhi.
REFERENCES:	1."Engineering with Geosynthetics", by G. Venkatappa Rao and GVS Suryanarayana Raju – Tata McGraw Hill Publishing Company Limited – New Delhi. 2. "Construction and Geotechnical Engineering using Synthetic Fabries" by Robert M. Koerner and Joseph P. Welsh. John Willey and Sons, New York.

19CEGT2003: ENGINEERING ROCK MECHANICS

Course Category: Programme Core	**Credits: 3**
Course Type: Theory	**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: understand application of rock mass classification systems					
	CO2: demonstrate the field and laboratory testing of rocks for engineering application					
	CO3: understand the failure criteria of rocks under various stress fields					
	CO4: understand various slope stability methods and estimate the bearing capacity and foundation on rocks					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2	**H**				
	CO3	**H**				
	CO4	**H**				

Course content	**Unit – I** **Introduction to rock mechanics**- Objectives of rock mechanics, Fields of application of rock mechanics, Practical problems in rock mechanics **Classification of Rocks:** Geological Classification – formation of igneous, sedimentary and metamorphic rocks- Textural and structural classification, **Rock mass classifications**- Rock Quality Designation (RQD), Rock Structure Rating (RSR), Rock Mass Rating (RMR), Norwegian Geotechnical Classification (Q-system) **Unit – II** **Introduction**- Physico –mechanical properties of rocks **Laboratory tests** -Compressive strength, Tensile strength, Direct shear test, Triaxial shear test, Slake durability test, Schmidt rebound hardness test **Field tests- In situ direct shear test** - In situ tests for deformability - Plate load test- Uniaxial jacking test- Pressure meter tests **In situ stress and their determination-** Hydraulic fracturing- Flat jack test Stress-relief technique

	Geophysical investigations - Electric resistivity method- Seismic refraction method -Cross hole test **Unit – III** **Failure criteria for rock and rock masses**- Mohr-Coulomb Yield Criterion, Drucker-Prager Criterion, Hoek-Brown Criterion, Tensile Yield Criterion. **Strength and deformability of jointed rock mass**- Fracture strength of jointed rock mass. Shear strength of Rock joints, Deformability of Rock joints, Concept of joint compliance **Unit – IV** **Stability of rock slopes**- Modes of failure, Plane failure, Wedge failure, Circular failure, Toppling failure. **Foundation on rocks**- Estimation of bearing capacity, Stress distribution in rocks, Settlement in rocks, Pile foundation in rocks. **Methods to improve rock mass responses**-Grouting in Rocks, Rock bolting, Rock Anchors.
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) 3. Rock mechanics in engineering practice: Stag and Zienkiewiz, John wiley & sons
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

19CEGT 2014/A: FOUNDATIONS ON EXPANSIVE SOILS

Course Category: Programme Elective	**Credits: 3**
Course Type: Theory	**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: identify expansive soils in-situ					
	CO2: understand clay mineralogy					
	CO3: demonstrate construction techniques for foundations in Expansive soils					
	CO4: suggest suitable ground improvement techniques for expansive soils					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2	**H**				
	CO3	**H**		**M**		
	CO4	**H**		**M**		

Course content	**Unit – I** **Introduction and Identification** Expansive Soils of India, related civil engineering problems, formation of expansive soils in field, identification of expansive soil in laboratory by X-ray diffraction method and differential thermal analysis **Unit – II** Physical and Chemical Properties, Soil structure and clay mineralogy of expansive soil, atomic bond and molecular bonds, honey comb structure, base exchanges capacity, clay water relation, electrolysis processes **Unit – III** Foundation on Black Cotton Soil, Foundations on swelling soils, swelling potential and mechanism of volume change, chemical composition of black cotton soil, construction techniques in black cotton soil, modern method of construction in under reamed piles. **Unit – IV**

	Ground improvement techniques for expansive soils – Stone Columns, Surcharge loading, drains, thermal and electrical methods
TEXT BOOKS	1.Foundations on Expansive Soils –F. H. Chen (Elsevier, Newyork, 1988) 2.B.C.Chattopadhyay and J.Maity, Ground Control and Improvement Techniques, PEEDOT, Howrah, 2011.
REFERENCES:	1.Basic and applied Soil Mechanics (Revised Edition) – Gopal Rajan and Rao A.S.R. (New Age, New Delhi.1998) 2.Foundation Engineering (2^{nd} Edition) – Peck,R.B., Hanson (W.E. and Thornburn. W.H. Johan Wiley, New York, 1976) 3.Soil Engineering in Theory and Practice (Vol. – II) – Alam Singh (Asia Publishing House, New Delhi, 1981)

19CEGT2014/B ---- Sub Surface Investigation and Instrumentation

Course Category: Programme Elective	**Credits: 3**
Course Type: Theory	**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: Recognize various methods of boring and machinery used for boring					
	CO2: Design, plan and execute various field tests and sampling techniques					
	CO3: Interpret data from field tests such as SPT, CPT, DCPT etc.,					
	CO4: Develop instrumentation scheme for monitoring of critical sites					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				
	CO2	**H**				
	CO3	**H**				
	CO4	**H**				

Course content	**Unit – I** **Soil Exploration:** Methods of Boring, Augering and Drilling. Machinery used for drilling, types of augers and their usage for various projects. **Unit – II** **Soil Sampling and Borehole logging:** Sampling methods, types of samples, storage of samples and their transport. Sample preparation, sample sizes, types of sampler specifications for testing. Logging of Boreholes, logging methods, Ground water observations, Water table fluctuations and effects, Preparation of soil profiles, Calculations **Unit – III** **Field testing of soils:** Methods and specifications, Visual identification tests, Vane shear test, Penetration tests, Analysis of test results. Preparation of site-investigation reports. **Unit – IV** **Field Instrumentation:** Rollers, Pressure meters, Piezometer, Pressure cells, Sensors, Inclinometers, Strain gauges etc.,

TEXT BOOKS	1.K.R. Arora, Soil Mechanics and Foundation Engineering; Standard Publishers & Distributors, Naisarak, New Delhi. 2.Lambe and Whitman: Soil mechanics. John Wiley and Sons. New York. (1969)
REFERENCES:	1.Clayton et al., Matthews and Simons: Site Investigation, Blackwell Science, (2005) 2.Bowles, B: Engineering Properties of Soil and Their Measurements, McGraw-Hill Companies, (1992)

19CEGT2014/C ---- GEOENVIRONMENTAL ENGINEERING

Course Category: Programme Elective	**Credits: 3**
Course Type: Theory	**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: Recognize various sources of subsurface contamination and waste management strategies					
	CO2: Distinguish various contaminant transport mechanisms in soils					
	CO3: Design suitable waste containment facilities					
	CO4: Detect contaminated sites and Execute remediation for contaminated sites					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**M**				**L**
	CO2	**M**				**L**
	CO3		**H**			
	CO4	**M**				**H**
Course content	**Unit – I** **Fundamentals of Geoenvironmental Engineering:** Scope of Geoenvironmental Engineering, Sources and Impact of subsurface Contamination, Waste characteristics, Environmental concerns with waste, Waste management strategies **Unit – II** **Soil-Contaminant interaction:** Clay mineralogy; identification of clay minerals by X-ray diffraction method; Soil-water-contaminant interactions and its implications, Transport process, Mass-transfer process, Factors effecting retention and transport of contaminants, Modeling **Unit – III** **Waste Containment System**: Concept and Principles of waste containment, Landfills, Types of landfills, Requirement of barrier materials, Liners for landfills, Landfill Covers, Generation and Control of Leachate and Gas from Landfills					

	Unit – IV **Contaminated Site Remediation:** Need for contaminated site characterization, Characterization methods, Objectives of site remediation, various active and passive methods, remediation NAPL sites, Emerging Remediation Technologies
TEXT BOOKS	1. Sharma, H.D., and Reddy, K.R., Geoenvironmental Engineering, John Wiley & Sons, Inc. 2004. 2. Gulhati, S.K. and Datta M., Geotechnical Engineering, McGraw Hill, 2005.
REFERENCES:	1. Rowe, R. K. - Geotechnical & Geoenvironmental Engineering Handbook, Kluwer Academic, 2001. 2. Daniel, D.E., Geotechnical practice for waste disposal, Chapman and Hall, 1993.

19CEGT 2015 / A ---- FINITE ELEMENT METHODS IN GEOTECHNICAL ENGINEERING

Course Category: Programme Elective	**Credits: 3**
Course Type: Theory	**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: Understand the basic concepts of finite element analysis in general and the transition from structural engineering aspects to geotechnical engineering aspects					
	CO2: Gain experience of finite element analysis applied to classical geotechnical problems (e.g. settlement, seepage, consolidation, slope stability)					
	CO3: Understand the finite element techniques for seepage analysis and joint rock masses					
	CO4: Apply Finite element techniques in design and Analysis of bearing capacity of the soil for shallow foundations					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1				**H**	
	CO2				**H**	
	CO3				**H**	
	CO4				**H**	

Course content	**Unit – I** Concepts of FEM, Steps involved in Finite Element Analysis Procedure, Merits and Demerits. Principles of Elasticity: Stress equations, Strain-Displacement relationships in matrix form, Plane stress, Plane strain and axi-symmetric bodies of revolution with axi-symmetric loading. Element Properties: Concept of an element, various element shapes, Displacement models, Generalized coordinates, Shape functions, Convergent and Compatibility requirements, Geometric invariance, Natural coordinate system - area and volume coordinates Generation of Element Stiffness and Nodal Load Matrices, Isoparametric Formulation: Concept, Different isoparametric elements for 2D analysis, formulation of 4-noded and 8-noded isoparametric quadrilateral elements, Lagrangian elements, Serendipity elements

	Unit – II Discretization of a structure, numbering systems, Aspect ratio its effects, Assemblage, Direct Stiffness method Strain laws: Introduction, Bilinear elastic model, K-G model, hyperbolic model, comparison of models and critical state model (geometric model, hardening law, yield function, flow rule, stress- strain invariant relation, stress-strain component relation, parametric values) with numerical examples **Unit – III** Geotechnical Applications Sequential construction, Excavations and embankments, Bearing capacity and Settlement analysis **Unit – IV** Geotechnical Applications: Seepage analysis: Finite element discretization of seepage equation, computation of velocities and flows, treatment of free surface boundary, Analysis of jointed rock mass: Characters and discontinuity of rock, model behavior of jointed rocks, plane strain analysis
TEXT BOOKS	1. Introduction to the Finite Element Method (1972), Desai, C. S. and J. Abel. Van Nostrand Reinhold Company 2. Finite element analysis in geotechnical engineering Vol 1&2, (1999) M Potts & L Zdravkovic, Thomas Telford publishing, London 3. Finite element analysis in geotechnical engineering, D J Naylor & g Pande (2012)
REFERENCES:	1 Introduction to the Finite Element Method (1993) J. N. Reddy - McGr Hill Publishers, 2. Finite element analysis - Theory and programming (1994) Kris Murthy, C. S. -Tata McGrawHill, 3. Finite element Methods (1971) Zienkiewicz, O. C. -, McGraw- Publishers,

19CEGT 2015 / B ---- REPAIR AND REHABILITATION OF STRUCTURES

Course Category: Programme Elective	**Credits: 3**
Course Type: Theory	**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: 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					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1					**L**
	CO2					**L**
	CO3					**L**
	CO4					**L**

Course content	**Unit – I** **Damage of Structures** 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** **Damage Assessment and Maintenance Strategies** Assessment procedure for evaluating a damaged structure causes of deterioration - testing techniques. Definitions : Maintenance, repair and rehabilitation, Facets of Maintenance importance of Maintenance Preventive measures on various aspects Inspection, **Unit – 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. Rust eliminators and polymers coating for Rebars, foamed concrete **Unit – IV** **Techniques for repair** Mortar and dry pack, vacuum concrete, Gunite and Shotcrete Epoxy injection, Mortar repair for cracks. Repairs to overcome low member strength, Deflection. Chemical disruption, weathering wear, fire, leakage, marine exposure.
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:	1. Peter H Emmons, Concrete Repair and Maintenance Illustrated, R.S Means Company, Inc. 2. Rafat Siddique, Special Structural Concretes, Galgotia Publications, 2000 3. C.P.W.D Handbook for Repair and Rehabilitation

19CEGT 2015/C CONSTRUCTION MANAGEMENT

Course Category: Programme Elective	**Credits: 3**
Course Type: Theory	**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 Understand various construction works and equipments					
	CO2 Attain knowledge on risk management and on appropriate safety measures					
	CO3 Understands concepts of quality, value engineering and human factors in construction					
	CO4 Attain knowledge on role of Information technology relating to the civil engineering.					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1					**L**
	CO2					**L**
	CO3					**L**
	CO4					**L**
Course content	**Unit – I** **Introduction** Classification of construction works; Various stages in the construction of a project. **Construction equipment** Introduction; Classification of construction equipment; Earthmoving equipment; Hauling equipment; Hoisting equipment; Conveying equipment; Aggregate and concrete production equipment; Pile driving equipment; Tunneling and drilling equipment; Pumping and dewatering equipment. **Management of Construction** Introduction; Management requirement; Need for mechanization; Financial aspects of construction plants and equipment; Factors affecting selection of construction equipment; Planning of construction equipment; Factors affecting the cost of owning and operating construction equipment; Planning of infrastructure for mechanization; Role of operations research; Equipment management.					

	Unit – II **Risk Management** Certainty, risk and uncertainty, risk management, identification and nature of construction risks, types of risks, minimizing risks and mitigating losses. **Construction Safety Management** Prevention of fires at construction sites, Fault Tree Analysis. **Unit – III** **Quality control in construction** Importance of quality; Elements of quality- quality characteristics, design quality, quality of conformance; Organization for quality control; Quality assurance techniques-Inspection, Testing, Sampling; Documentation; Quality control circles. **Human Factors in Construction** Qualities of efficient construction managers; Personality; Ethics and integrity; Personal drive; Multi-disciplinary capability; Human relations **Value Engineering** Definition of value engineering; Value engineering job plan; Life cycle costing; Value engineering Applications **Unit – IV** **Management Information Systems** Introduction; Definition of organization; Definition of management; Definition of management information system; Computer as information system; Use of computer in construction industry; Requirements of management information system; A data base approach; Salient features of some software packages used in construction industry. **Information Technology in Construction Industry** Introduction; Information flow and communication; Knowledge data base; Learning organization attributes; Use of information technology in construction industry; Role of artificial intelligence and expert systems.
TEXT BOOKS	1. Construction Engineering and Management by S.Seetharaman, Umesh Publications, 2014.
REFERENCES:	1. Construction planning, Equipment and methods by R.L.Peurifoy, C.J.Schexnayder and Aviad Shaptra, McGraw-Hill, 2005. 2. Construction management by D.W.Halpin, Publisher : Wiley, 2005. 3. Project management in construction by S.M.Levy, McGraw-Hill Professional, 2006.

19GT2051 – GEOSYNTHETICS AND ROCK MECHANICS- LAB

Course Category: Programme Core	**Credits: 1.5**
Course Type: Practical	**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: Prepare the Rock sample for different Tests and find different properties of Rock					
	CO2: Prepare the Geosynthetics for different Tests					
	CO3: Able to determine the physical, mechanical and hydraulic properties of Geosynthetics					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				**H**
	CO2	**H**				**H**
	CO3	**H**				**H**

Course content	1. Preparation of Rock Specimen (Drilling, Cutting, Polishing) 2. Unconfined Compression Test 3. Point Load Test 4. Brazilian Test 5. Slake Durability Test 6. Mass per unit area and Thickness of Geosynthetic 7. Compressibility of Geosynthetics and Tensile strength of Geosynthetics from CBR Test 8. Dynamic Puncture Strength Test and Interface Shear Behavior of Soils with Geosynthetics 9. Apparent Opening Size, Percent Open Area, In-Plane and Cross-Plane Permeability 10. Gradient Ratio of Geotextiles

19CEGT 2052 – FIELD TESTING OF SOIL LAB

Course Category: Programme Core	**Credits: 1.5**
Course Type: Practical	**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: analyze the data from Augur boring					
	CO2: analyze the data from Plate load test					
	CO3: analyze the data from static and dynamic cone penetration tests					
	CO4: analyze the data from sub soil investigation tests					
Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
	CO1	**H**				**H**
	CO2	**H**				**H**
	CO3	**H**				**H**
	CO4	**H**				**H**

Course content	1. Determination of field density of soil 2. Field Investigation by Auger Boring 3. Bored Pile installation in field 4. Plate load test 5. SPT test 6. Static Cone Penetration test 7. Dynamic cone Penetration test 8. Electrical Resistivity Test 9. Test for Cation Exchange Capacity 10. Preparation of Soil test Repots