ACADEMIC CURRICULA

POST GRADUATE DEGREE PROGRAMMES

Master of Technology

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 26
Syllabi for Civil Engineering and Nanotechnology Programmes

Professional Core and Elective Courses

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

ACADEMIC CURRICULA

Civil Engineering

Common Professional Elective Course

Regulations 2021

SRM INSTITUTE OF SCIENCE & TECHNOLOGY
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SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21MAE501T	Course Name	ADVANCED MATHEMATICAL TECHNIQUES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mathematics*	**Data Book / Codes/Standards**		*Statistical table*	

Course Learning Rationale (CLR)	***The purpose of learning this course is to:***
CLR-1:	*learn the concept of one dimensional wave equations and diffusion equation*
CLR-2:	*understand the concepts of Euler's equations*
CLR-3:	*learn concepts of Fredholm and Volterra integral equations*
CLR-4:	*study the sampling techniques to real world applications*
CLR-5:	*learn the concept of design of experiment and control charts*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	**2**	**3**
CO-1:	*solve one dimensional wave equations and diffusion equation by using Laplace and Fourier transform techniques*	*3*	*3*	-
CO-2:	*familiar with solving Euler's equations*	*3*	*3*	-
CO-3:	*solve Fredholm and Volterra integral equations*	*3*	*3*	-
CO-4:	*transfer the knowledge to model the sampling techniques*	*3*	*3*	-
CO-5:	*construct design of experiments and control charts*	*3*	*3*	-

Module 1: Transform Techniques	***9 Hour***
Laplace transform - Fourier transform - One-dimensional wave equation using Laplace transform methods - Displacements in long string - Longitudinal vibration of an elastic bar - One-dimensional diffusion equation using Fourier transform methods – One-dimensional diffusion equation using Fourier sine transform methods – One-dimensional diffusion equation using Fourier cosine transform methods.	
Module 2: Variational and Isoperimetric Problems	***9 Hour***
Euler's Equations - Functional involving x, y, y` - Functional on higher order derivatives - Functional dependent on functions of independent variables - Geodesics – Ritz method.	
Module 3: Integral Equations	***9 Hour***
Fredholm integral equations - Volterra integral equations - Integro- differential equation - Green's function - Fredholm equations with separable kernel - Iterative methods.	
Module 4: Testing of Hypothesis	***9 Hour***
Sampling distribution, Null hypothesis, Alternate hypothesis - One-tailed test, two-tailed test - Level of significance, Critical region - Large samples test - Student - t test - single Proportion - Two Sample proportions - Large sample test, Single Mean - Difference of Means - Paired `t` test - Applications of Difference of Means - small samples - F-test problems - Differences between two population variances - Differences between two Normal population variances - Applications of paired - t-test. - Chi-Square goodness of fit - Chi-square test - Independent Attributes.	
Module 5: Design of Experiments and Statistical Quality Control	***9 Hour***
Design of Experiments – Completely Randomized Design – Randomized Block Design – Latin Square Design - Control theory - Control charts for X and R - Control charts for X and S.	

Learning Resources	1. *Gupta, S.C., & Kapoor, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, Edition 2018* 2. *Dr.B.S.Grewal., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, 2019* 3. *M. B. K. Moorthy, "Advanced Mathematical Methods", Yesdee Publication, 2nd Edition, 2019.*	4. *B .V. Ramana, "Higher Engineering Mathematics", McGraw Hill Publication, 2017.* 5. *Vijay K. Rohatgi., A.K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, 2nd Edition, Wiley, 2008.* 6. *R.A.Johnson and C.B Gupta, " Miller & Freund`s Probability and Statistics for Engineers", Pearson Eduction, Asia, 7th Edition, 2007.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*15%*	-	*15%*	-	*15%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*15%*	-	*15%*	-	*15%*	-
Level 6	*Create*	*15%*	-	*15%*	-	*15%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. *Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in*	1. *Dr. V. Subburayan, SRMIST*
	2. *Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in*	2. *Dr. G. Arul Joseph, SRMIST*

ACADEMIC CURRICULA

Geotechnical Engineering

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE & TECHNOLOGY
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SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21CEC601J	Course Name	SOIL EXPLORATION AND INSTRUMENTATION	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*analyse the various concepts of soil exploration and plan the subsurface investigation program for real time geotechnical problems.*
CLR-2:	*identify types of soil samples and extract samples as per requirement*
CLR-3:	*analyse the various methods of direct and semi direct methods in soil exploration to select the appropriate method.*
CLR-4:	*analyse the field tests and equipments in sub soil investigation.*
CLR-5:	*utilize the principles of indirect methods of soil exploration and interpretation of data for the design of geotechnical structures.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*evaluate the various concepts of soil exploration and plan the subsurface investigation program*	*1*	*3*	*1*
CO-2:	*apply the knowledge of soil samples and sampling techniques to collect and store samples.*	*2*	*3*	*1*
CO-3:	*apply the knowledge of methods of direct and semi direct methods in soil exploration.*	*2*	*3*	*1*
CO-4:	*carryout the field tests to strive at required soil parameters for sub soil investigation.*	*3*	*2*	*1*
CO-5:	*evaluate the principles of indirect methods of soil exploration and interpretation of data for the design of geotechnical structures.*	*3*	*2*	*1*

Module-1 -Soil Exploration Types	***12 Hour***
Introduction to soil exploration, Objectives of soil explorations methods, Introduction to Site investigation, Steps involved in subsurface investigations, preliminary and detailed soil exploration, Depth and spacing of soil exploration, Soil Conditions and foundation types. Soil samples identification tests.	
Module-2 – Soil Samples and Samplers	***12 Hour***
Sampling Techniques, factors influencing sample quality, disturbed and undisturbed soil sampling advanced sampling techniques, offshore sampling, shallow penetration samplers, Split spoon, Thick and Thin walled samplers, Piston Samplers, Denis Samplers, preservation and handling of samples. CBR and Compaction characteristics.	
Module-3 – Open Excavation and Boring Methods	***12 Hour***
Direct methods of soil exploration, Pits, Trenches, Drifts, Shafts, Tunnels, Methods of boring, Auger Borings, Auger and shell boring, Wash Borings, Rotary Drilling, Percussion Drilling, Core Drilling- Types and methods.- Engineering Characteristics of soil	
Module-4 – In situ Tests	***12 Hour***
Field tests – Standard Penetration Tests, Cone Penetration Tests, DCPT – Wet and dry method, SCPT, In-situ Vane Shear Test, Plate Load Test – monotonic and cyclic, Field Permeability Tests, Instrumentation in soil engineering, Strain gauges, piezometers and inclinometers – types and uses. Field sample characteristics evaluation.	
Module-5 – Geophysical Methods of soil exploration	***12 Hour***
Geophysical methods, Electrical Resistivity Method – Electrical Profiling and Electrical Sounding Method, Seismic refraction method, Data interpretation of all methods, Sub-soil Investigation Report, Details regarding the soil exploration report, Case studies. Correlation of field test results	

Learning Resources	3. *Bowles, J.E, Foundation Analysis and Design, McGraw-Hill International, 5th edition, 1997.* 4. *Dunnicliff, J. and Green, G.E, Geotechnical Instrumentation for Monitoring Field Performance, John Wiley & Sons, 1st edition 1982.* 5. *Pardeep Kumar Gupta, R.K. Khitoliya, Foundation Engineering, I K International Publishing House Pvt. Ltd, 1st edition, 2015.*	6. *Arora K.R, "Soil Mechanics and Foundation Engineering", Standard Publication Distributors, 7th edition 2020.* 7. *C. Venkataramaiah, "Geotechnical Engineering", Wiley Eastern Ltd., New Delhi, 5th edition 2017.* 8. *Terzaghi K., Peck R.B., Soil Mechanics in Engineering Practice, John Wiley Ltd., 3rd edition, 1996.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life Long Learning CLA-2- Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	20%	-	-	20%	20%	-
Level 3	Apply	20%	-	-	20%	20%	-
Level 4	Analyze	20%	-	-	20%	20%	-
Level 5	Evaluate	10%	-	-	10%	10%	-
Level 6	Create	10%	-	-	10%	10%	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. P. Manoharan, AEE, Town Panchayat, Kancheepuram, manorasi65@gmail.com*	1. *Dr. V. Murugaiyan, Professor, PCE, Pondicherry, vpmplee@@gmail.com*	1. *Dr. P.T. Ravichandran, SRMIST*
2. *Dr. N. Kamaraj, Chief Engineer, SRM construction, nkamaraj@yahoo.com*	2. *Dr. S. V. Ramasamy, Professor (Retd), Anna University, prof.svramaswamy@gmail.com*	2. *Dr. Divya Krishnan K, SRMIST*

Course Code	21CEC602J	Course Name	SHALLOW FOUNDATIONS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*IS 6403:(1981), IS 8009 Part 1:(1976)*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*comprehend the different type of shallow foundations*
CLR-2:	*apply appropriate bearing capacity theory and factors for different type of loading and ground conditions*
CLR-3:	*evaluation of the design bearing pressure based on settlement, mode of loading and ground conditions*
CLR-4:	*perform interactive analysis for different types of shallow foundation and ground conditions*
CLR-5:	*perform analysis for different types of special foundation and special ground conditions*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*understand the types of shallow foundation for different ground conditions*	3	2	1
CO-2:	*compute the bearing capacity of shallow foundation depending upon the soil condition*	3	2	2
CO-3:	*explore the cause and remedial measures for settlement*	3	2	2
CO-4:	*apply the soil structure interactive analysis*	3	2	2
CO-5:	*understand the concept of special foundations on various soil condition and in real time applications*	3	2	1

Module-1 - Introduction	***12 Hour***
Developments - Need of Foundation Engineering - Responsibility of Foundation Engineer - Classification - General requirements - Additional consideration - Types of Shallow Foundation - Selection of type of foundation - Hostile environment - Structural integrity - Economy.	
Module-2 - Bearing Capacity Estimations	***12 Hour***
Bearing Capacity - Modes of Shear failures - Bearing capacity of shallow foundations - Methods, Terzaghi's method, Meyerhof's method, Skempton's method, Hansen's method - Effect of water table - Homogeneous - Layered soils – Bearing capacity calculation in spread sheet - Evaluation of bearing capacity from insitu tests - Bearing capacity under eccentric loading - Codal provisions.	
Module-3 - Settlement Evaluation	***12 Hour***
Components of settlement – Immediate, Primary, Secondary - Determination of Consolidation Settlement - Settlement analysis - Computations of settlement- layered soil - Construction period correction- Calculation of settlement in spread sheet - Evaluation from insitu tests – Allowable settlement – Allowable bearing pressure - Codal recommendations.	
Module-4 - Interactive Analysis of Foundations	***12 Hour***
Analysis of Shallow foundation with soft skills - Isolated, strip, combined footings, mat foundations - Conventional and elastic approach - Soil structure interaction - Contact pressure distribution - Factors influencing contact pressure distribution beneath rigid and flexible footings - Idealized soil behavior - Foundation behavior, Interface behavior - Foundation interaction analysis	
Module-5 - Foundation for Special Conditions	***12 Hour***
Introduction to special foundations - Foundation design in relation to ground movements - Foundation on compressible fills - Case studies - Foundation for seismic forces - Design of machine foundation - Codal recommendations.	

Learning Resources	1. *Varghese P.C, Foundation Engineering, Prentice-Hall of India, New Delhi, 2009.* 2. *Bowles, J.E, Foundation Analysis and Design, 5th Edition, McGraw Hill, New York, 1995.* 3. *Swami Saran, Soil Dynamics and Machine Foundation, Galgottia Publications Pvt. Ltd., New Delhi-110002, 1999.* 4. *Nainan P. Kurian, Design of Foundation Systems, Principles and Practices, Narosa Publishing House, Third Edition, 2006.* 5. *Ian Smith, Elements of Soil Mechanics, John Wiley & Sons, UK, 9th edition,2014* 6. *Braja M.Das, Principles of Foundation Engineering, 5th Edition, J.Ross Publishing, Cengage Learning India Pvt Ltd, 2011* 7. *Edward Tsudik, Analysis of Structures on Elastic Foundations, J.Ross Publishing, Cengage Learning India Private limited, Delhi, 2013.* 8. *Som.N.N., Das.S.C., Theory and Practice of Foundation Design" PHI learning private Ltd, Delhi, 2013.* 9. *Karuna Moy Ghosh, Foundation Design in Practice" PHI learning private Ltd, Delhi, 2009.*	10. *Varghese P.C, Design of Reinforced Concrete Foundations", Prentice-Hall of India, New Delhi, 2009.* 11. *Reese,L.C., Isenhower,W.M. and Wang,S.T, Analysis and Design of Shallow and Deep Foundations, John Wiley and Sons, New York, 2005.* 12. *John Burland, Tim Chapman, Hilary Skinner, Michael Brown, Geotechnical Design Construction and verification – ICE Manual of Geotechnical Engineering Volume-II, ICE Publishing, UK., 2012.* 13. *Salgado,R, The Engineering of Foundations, Tata McGraw Hill Education Private Limited, New Delhi, 2011.* 14. *Donald P. Coduto, Foundation Design: Principles and Practices, 2nd Edition,* 15. *Braja M. Das, Shallow foundation - Bearing Capacity and Settlement, CRC Press, Third Edition, 2017.* 16. *Varghese P.C, Design of Reinforced Concrete Foundations, Prentice-Hall of India, New Delhi, 2009.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life Long Learning CLA-2- Practice (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	-	*20%*	*20%*	-
Level 2	*Understand*	*20%*	-	-	*20%*	*20%*	-
Level 3	*Apply*	*20%*	-	-	*20%*	*20%*	-
Level 4	*Analyze*	*20%*	-	-	*20%*	*20%*	-
Level 5	*Evaluate*	*10%*	-	-	*10%*	*10%*	-
Level 6	*Create*	*10%*	-	-	*10%*	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Er. K. Sekar, Senior Engineer, Highways, ksekar@gmail.com*	1. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	1. *Dr. V.Janani, SRM IST*
2. *Er. V. T. Ashok Kumar, AEE, Erode Corporation, akr2310@gmail.com*	2. *Dr. K. Premalatha, Professor, Anna University, kvpremalatha@yahoo.com*	2. *Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEC603J	Course Name	GEOTEXTILE CHARACTERIZATION	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**	*IS 14716 (2021), IS 13162 Part 3 (2021), Part 4 & 5(1992), IS 13321Part 1(2022), IS 14293 (2024), IS 14294 (1995), IS 14324 (1995), IS 16078 (2013) I*		

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*explore the concept of development in geosynthetic types and functions and determine the characteristics.*
CLR-2:	*identify the various manufacturing process of different types of geotextiles and its raw materials.*
CLR-3:	*identify the types and stability analysis of structures with geotextiles.*
CLR-4:	*analyse the characteristics of geotextiles and its applications in geotechnical fields.*
CLR-5:	*explore the different applications of geotextiles and its role in environmental factors.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*acquire the knowledge of developments in geosynthetic types, properties and its uses.*	*1*	*1*	*1*
CO-2:	*understand the various manufacturing process and testing of different types of geotextiles from its raw materials and its properties.*	*1*	*1*	*2*
CO-3:	*apply the knowledge of the different types of geotextiles and its stability analysis.*	*3*	*1*	*3*
CO-4:	*apply the concept of characteristics of geotextiles and its applications.*	*1*	*1*	*2*
CO-5:	*analyze the different applications of geotextiles and its role in environmental factors.*	*2*	*2*	*1*

Module-1 – History and Evolution of Geosynthetics	***12 Hour***
Geosynthetics: Introduction, Types of Geosynthetics, History and evolution of Geotextile as ground modification material, Background and overview, types of geotextiles, functions and mechanisms, physical properties of Geotextiles and its determination.	
Module-2 – Manufacturing Process of Geotextile and Properties	***12 Hour***
Raw materials, Natural fibres for geosynthetics, Manufacturing process of various types of Geotextiles, Properties and Testing Methods of Geotextiles, Grab and wide width tensile strengths of geotextiles, - Experimental evaluation - fibres and fabric selection criteria for geotextile applications.	
Module-3 – Application Areas of Geotextiles	***12 Hour***
Application areas of geotextiles, Mechanics and evaluation of reinforcement, filtration and drainage by geotextiles and functions, stability analysis of structures with geotextiles, determination of creep, durability, A.O.S and Puncture Resistance of geotextiles.	
Module-4 – Criteria for Selection of Geotextiles	***12 Hour***
Geosynthetic components and Criteria for selection of geotextiles for the functions, filtration, functions and erosion control techniques for slopes and coastal regions, case studies, permeability of geotextiles and its tests, geotextiles in filters and drains functions.	
Module-5 – Role of Geotextiles	***12 Hour***
Environmental control of Geotextiles, role of geosynthetics in landfill covers and liners, need of landfill, geosynthetic clay liners, landslides, and erosion control. Geotextiles and reinforced soil structures: Textile properties of geotextiles, Retaining walls, embankment, foundation. Geotextiles in roads and railways: separation, draining and filtering.	

Learning Resources	1. *Shukla, S. K, Geosynthetics and their Applications. Thomson Telford., 2002* 2. *T. S. Ingold, Geotextiles and Geomembranes Handbook, Elsevier Science, 2013.* 3. *by G. den Hoedt, Geotextiles, Geomembranes and Related Products Hardcover, CRC Press, 1990*	4. *D. G. Devshikar, J.N.Mandal, A Guide to Geotextiles Testing, New Age International Private Limited, 2002.* 5. *R. Veldhuijzen Van Zanten, Geotextiles and Geomembranes in Civil Engineering, Halsted Pr, 1986.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life Long Learning CLA-2- Practice (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	*-*	*-*	*20%*	*20%*	*-*
Level 2	*Understand*	*20%*	*-*	*-*	*20%*	*20%*	*-*
Level 3	*Apply*	*20%*	*-*	*-*	*20%*	*20%*	*-*
Level 4	*Analyze*	*20%*	*-*	*-*	*20%*	*20%*	*-*
Level 5	*Evaluate*	*10%*	*-*	*-*	*10%*	*10%*	*-*
Level 6	*Create*	*10%*	*-*	*-*	*10%*	*10%*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Er. G. Srinivasa Rao, Saipem India Pvt Ltd, raoguraja@yahoo.com*	1. *Dr. R, Baskar, Professor, Annamalai University, rajaram_baskar@rediffmail.com*	1. *Dr. Divya Krishnan K, SRMIST*
2. *Er. A. Vetriselvan, L&T ECC, Chennai, avsn@Intecc.com*	2. *Dr. P. Vasanthi, Professor and Dean, Cresent Institute of Science and Technology, vasanthi@bsauniv.ac.in*	2. *Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEC604J	Course Name	DEEP FOUNDATIONS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	IS 2911 (Part1, 2, 3 &4): 2010 , IRC 78 (2018)		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	identify the importance of pile foundations and piling equipment
CLR-2:	identify the various load carrying capacity methods
CLR-3:	identify the various lateral and uplift load carrying capacity of piles
CLR-4:	identify the design of pile and pile caps considering wind and seismic loads
CLR-5:	analyze the importance of caissons and stability of caissons based on codal provisions

Course Outcomes (CO):	At the end of this course, learners will be able to:	Programme Outcomes (PO)		
		1	2	3
CO-1:	remember the importance of pile foundation and various functions and responsibilities of geotechnical engineer and contractor, in addition to the piling equipments.	3	2	2
CO-2:	evaluate the vertical load carrying capacity of pile and pile group based on field practices and codal provisions	3	2	2
CO-3:	analyses of piles subjected to lateral and uplift load with reference to codal provision and case studies.	3	3	2
CO-4:	estimate the design of pile and pile caps, considering the wind and seismic loads.	3	3	2
CO-5:	understand the importance of caisson foundation and checking the stability of caissons based on codal provisions.	3	2	2

Module-1 - Pile Classifications	**12 Hour**
Necessity of pile foundation - Function - Classification of piles - Factors governing choice of pile foundation - Load transfer principles - Piling equipments and methods - Effect of pile installation on Cohesionless and Cohesive soil - Requirement of code of practice - Responsibility of engineer and contractor - Case studies on selection of type of foundations.	
Module-2 - Axially Loaded Piles and Pile Groups	**12 Hour**
Allowable load evaluation of piles and pile groups - Static method - Cohesive - Cohesionless soil - Time effects - Dynamic method - Negative skin friction - Pile driving formulae - Wave equation application - Modeling - Interpretation of field test results - Pile load test results - Codal provisions - Settlement of Piles and Pile groups - Codal recommendations - Case studies on settlement of foundations	
Module-3 - Lateral and Uplift Load Evaluation	**12 Hour**
Piles subjected to Lateral loads - Broms method, elastic - P-Y curve analyses - Batter piles - Pile subjected to uplift loads - Load and deformation behaviour - Under reamed pile construction -Drilled shaft- Lateral and uplift load test data interpretation. Foundation on weak compressible – IS codal Provision - Case studies on failure of foundations.	
Module-4 - Structural Design of Pile and Pile Groups	**12 Hour**
Pile foundation - Structural design - pile and pile cap connection - Pile cap design - shape and depth- Assessment and amount of steel - Truss and Bending theory - Reinforcement details of pile and pile caps- IS codal provisions.	
Module-5 – Caissons	**12 Hour**
Caissons - Necessity, types and shape - Stability of caissons - Principles of analysis - Design of well foundation - Case studies - Forces acting on caisson - Construction - Components of well foundation.	

Learning Resources	1. *Das B.M, Principles of Foundation Engineering, Design and Construction, Fourth Edition, PWS Publishing, 1999.* 2. *Poulos H.G, Davis, E.H, Pile Foundation Analysis and Design, John Wiley and Sons, New York, 1980.* 3. *Tomlinson M.J, Foundation Engineering, ELBS, Longman Group, U.K. Ltd., England 1995.* 4. *Michael Tomlinson and John Woodward, Pile Design and Construction Practice, Taylor &Francis Group, London & New York, 2008.* 5. *Cernica, J.N. Geotechnical Engineering Foundation Design, John Wiley and Sons, Inc1995.*	6. *Donald P, Coduto, Foundation Design Principles and Practices, Prentice Hall, Inc. Englewood Cliffs, New Jersey, 1996.* 7. *Varghese P.C, Foundation Engineering, PHI Learning Private Limited, New Delhi, 2005.* 8. *Reese, L.C, Isenhower, W.M. and Wang S.T, Analysis and Design of Shallow and Deep Foundations, John Wiley and Sons, New York, 2005.* 9. *Varghese P.C, Design of Reinforced Concrete Foundations, PHI Learning Private Limited, New Delhi, 2009.* 10. *Reese, L. C. and Van Impe, W. F, Single Piles and Pile Groups Under Lateral Loading, Taylor and Francis, London, 2011.* 11. *Bowles J.E, Foundation Analysis and Design, Fifth Edition, McGraw Hill, New York, 1996.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life Long Learning CLA-2- Practice (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	-	*20%*	*20%*	-
Level 2	*Understand*	*20%*	-	-	*20%*	*20%*	-
Level 3	*Apply*	*20%*	-	-	*20%*	*20%*	-
Level 4	*Analyze*	*20%*	-	-	*20%*	*20%*	-
Level 5	*Evaluate*	*10%*	-	-	*10%*	*10%*	-
Level 6	*Create*	*10%*	-	-	*10%*	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Er. K. Sekar, Senior Engineer, Highways, ksekar@gmail.com*	1. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	1. *Dr. V.Janani, SRM IST*
2. *Er. V. T. Ashok Kumar, AEE, Erode Corporation, akr2310@gmail.com*	2. *Dr. P. Vasanthi, Professor and Dean, Cresent Institute of Science and Technology, vasanthi@bsauniv.ac.in*	2. *Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEC605J	Course Name	ARTIFICIAL INTELLIGENCE APPLICATION IN GEOSYNTHETICS SUSTAINABLE STRUCTURES	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand AI fundamentals and history*
CLR-2:	*apply AI in material characterization*
CLR-3:	*apply AI techniques for optimizing design parameters*
CLR-4:	*acquire practical knowledge in using AI for detecting geotechnical hazards and real-time monitoring of geotextile performance*
CLR-5:	*address ethical and future trends in AI*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*recognize the various applications and potential impacts of AI across different fields*	*3*	*2*	*2*
CO-2:	*apply machine learning and deep learning techniques for predicting geotextile properties and analyzing failure modes, utilizing datasets and hands-on coding exercises*	*3*	*2*	*1*
CO-3:	*optimize geotextile design parameters, simulate interactions with soil and predict long-term behavior under various conditions using AI tools*	*3*	*2*	*3*
CO-4:	*implement AI-driven advanced monitoring and maintenance strategies for geotextile applications*	*3*	*3*	*1*
CO-5:	*understand the ethical and future aspects of AI in geotechnical engineering.*	*3*	*3*	*3*

Module-1 - Introduction to Artificial Intelligence	***12 Hour***
Definition and history of AI - Outlining its evolution and significant milestones - Types of AI (including machine learning, deep learning, natural language processing and their applications in various fields) - Introduction to programming languages for AI - Specifically Python and R with hands-on coding exercises - Discussion on the ethical considerations of AI development and implementation	
Module-2 - AI for Material Characterization	***12 Hour***
Machine learning for predicting geotextile properties such as tensile strength, permeability and filtration capacity using various algorithms and datasets - Deep learning for analyzing geotextile failure modes and damage detection including image recognition and anomaly detection techniques - AI-driven optimization of material selection for specific applications considering various factors and constraints - Case studies and hands-on exercises with real-world data, applying different AI models for material characterization tasks	
Module-3 - AI for Design and Construction	***12 Hour***
AI for optimizing geotextile design parameters, including thickness, pore size, and reinforcement configurations - Deep learning for simulating soil-geotextile interaction and performance evaluation under various loading conditions - AI-based prediction of long-term behavior of geotextile structures, considering environmental factors and degradation mechanisms - Design optimization and simulation exercises using AI tools, exploring the interaction between geotextiles and soil models	
Module-4 - AI for Monitoring and Maintenance	***12 Hour***
AI for detecting and analyzing geotechnical hazards, such as landslides and slope failures, using sensor data and image analysis - Machine learning for monitoring geotextile performance in real-time, including strain and displacement measurements - AI-based prediction of maintenance needs and scheduling, optimizing maintenance costs and resource allocation - Case studies and practical applications of AI for geotextile monitoring, demonstrating its effectiveness in real-time situations.	

Module-5 - Ethical Considerations and Future Trends	***12 Hour***
Discussion on the ethical implications of using AI in geotechnical engineering, including bias, fairness, and transparency concerns - Challenges and limitations of AI in geotextiles, addressing issues of data availability, model accuracy, and computational cost - Future trends and opportunities of AI in the field, exploring emerging technologies and their potential impact on geotextile design and practice - Group discussion and presentation on a chosen topic related to the ethical or future aspects of AI in geotextiles.	

Learning Resources	1. *Melanie Mitchell, Artificial Intelligence: A Guide for Thinking Humans, Farrar, Straus and Giroux, 2019.* 2. *David L. Poole, Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents, 2nd Edition, Cambridge University Press, 2017.* 3. *Robert M. Koerner, Geosynthetics: From Design to Applications, Woodhead Publishing, 2016*	4. *R. Oberoi, H. Sharma, K. Jain, Machine Learning and Artificial Intelligence for Civil Engineering, CRC Press, 2021.* 5. *M. M. Poulton, Deep Learning for Geotechnical Engineering, Wiley, 2023* 6. *Lyesse Laloui, Alessandro F. Rotta Loria, AI and Big Data in Geotechnical Engineering, Springer, 2021*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life Long Learning CLA-2- Practice (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	-	*20%*	*20%*	-
Level 2	*Understand*	*20%*	-	-	*20%*	*20%*	-
Level 3	*Apply*	*20%*	-	-	*20%*	*20%*	-
Level 4	*Analyze*	*20%*	-	-	*20%*	*20%*	-
Level 5	*Evaluate*	*10%*	-	-	*10%*	*10%*	-
Level 6	*Create*	*10%*	-	-	*10%*	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Er. G. Srinivasa Rao, Saipem India Pvt Ltd, raoguraja@yahoo.com*	1. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	1. *Dr. P.T. Ravichandran, SRMIST*
2. *Er. A. Vetriselvan, L&T ECC, Chennai, avsn@lntecc.com*	2. *Dr. G. Janardhanan, NITTTR, gjanardhanan@gmail.com*	2. *Dr.Sasikala E, SRMIST*

ACADEMIC CURRICULA

Geotechnical Engineering

Professional Elective Courses

Regulations 2021

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21CEE601T	Course Name	THEORETICAL SOIL MECHANICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*know the concept of elastic behaviour of soil.*
CLR-2:	*apply theories of elasticity and plasticity to characterize the stress-strain behaviour of soil*
CLR-3:	*understand the effect of anisotropy in stress strain behaviour*
CLR-4:	*understand the mechanism of collapse and solve field problems*
CLR-5:	*analyze the study of flow through porous medium*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	*Programme Outcomes (PO)*		
		1	*2*	*3*
CO-1:	*understand the concept of stress- strain and its functions.*	3	3	2
CO-2:	*analyse stress distribution and displacement in soil medium under the given loading conditions*	3	2	2
CO-3:	*study the analysis of stress displacement and the slip line solution for different drain condition.*	3	2	2
CO-4:	*imparting knowledge required for calculating stress and settlement at any depth in semi-infinite elastic soil medium, anisotropic and layered medium due to external loads*	3	2	2
CO-5:	*analyse the flow of liquid in different soil medium and verify the stability of geotechnical engineering problems*	3	2	2

Module-1 - Theory of Elasticity	***9 Hour***
Introduction - Stability and elasticity properties, concept of stress and strain - Three dimensional and two-dimensional state of stress - Plane stress, plane strain and axisymmetric problems - Equation of equilibrium and compatibility - Stress functions.	
Module-2 - Stresses and Displacements	***9 Hour***
Elastic half-space medium - Stress by external loads - Fundamental solutions - Boussinesq, Flamant, Kelvin and Mindlin solution - Applications of fundamental solutions - Anisotropic and non-homogeneous linear continuum - Influence charts - Elastic displacement.	
Module-3 - Limit Equilibrium Analysis	***9 Hour***
Limit equilibrium analysis - Plasticity - Perfectly plastic models - Stress and strain relationship - Stress and displacement field calculations - Slip lines - Hency's theorem - Slip line solutions for undrained and drained loading.	
Module-4 - Limit Analysis	***9 Hour***
Limit analysis - Principles of virtual work - Theorems of plastic collapse - Mechanism for plane plastic collapse - Simple solutions for drained and undrained loading - Mechanical behaviour of soils - Tresca criterion, Von Mises criterion - Stability of slopes, cuts and retaining structures - Centrifuge model – Principles and scale effects, practical considerations.	
Module-5 – Flow Through Porous Media	***9 Hour***
Flow through porous media - Darcy's law - General equation of flow - Seepage through isotropic anisotropic and non-homogeneous conditions - Steady state condition – Confined and unconfined flow – Solution by flow net – Seepage pressure.	

Learning Resources	1. *Aysen, A, Soil Mechanics: Basic Concepts and Engineering Applications, A.A.Balkema Publishers, 2002.* 2. *Ulrich Smoltc, YK, Geotechnical Engineering Handbook (Vol.1),Ernot&Sohn, 2002.* 3. *Aysen, A, Problem Solving in Soil Mechanics, A.A.Balkema Publishers, 2011.* 4. *Davis, R.O, and Selvadurai, A.P.S, Elasticity and Geomechanics, Cambridge University Press, 1996.* 5. *Taylor, R.N, Geotechnical Centrifuge Technology, Blackie Academic and Professional, 1995.*	6. *Wai-Fah Chen, and Liu, X.L., Limit Analysis in Soil Mechanics, Elsevier Science Ltd., 1991.* 7. *Muni Budhu, Soil Mechanics and Foundations, John Wiley and Sons, Inc., Network, 2000.* 8. *Alkinson, J.H, Foundations and Slopes, McGraw Hill, 1981.* 9. *Harr, M.E, Foundations of Theoretical Soil Mechanics, McGrawHill, 1966.* 10. *Cedergren, H.R, Seepage, Drainage and Flownets, John Wiley, 1997.* 11. *Winterkorn, H.F, and Fang, H.Y, Foundation Engineering Handbook, Galgotia, Book Source, 2000.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. N. Kamaraj, Chief Engineer, SRM construction, nkamaraj@yahoo.com*	1. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	1. *Dr. V.Janani, SRMIST*
2. *Er. G. Srinivasa Rao, Saipem India Pvt Ltd, raoguraja@yahoo.com*	2. *Dr. K. Premalatha, Professor, Anna University, kvpremalatha@yahoo.com*	2. *Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEE602T	Course Name	ANALYSIS AND DESIGN OF PAVEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*identify the importance of types classification and components of pavements*
CLR-2:	*identify the various guidelines for design of flexible pavement*
CLR-3:	*identify the various guidelines for design of flexible pavement*
CLR-4:	*identify the various types of failures in different components of pavements*
CLR-5:	*analyze the importance of stabilizers based on the requirement of construction*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	*Programme Outcomes (PO)*		
		1	*2*	*3*
CO-1:	*remember different types of pavements, wheel load, serviceability and design strategies of pavement.*	*3*	*2*	*2*
CO-2:	*evaluate flexible pavements based on different guidelines*	*3*	*2*	*1*
CO-3:	*evaluate rigid pavements based on different guidelines.*	*3*	*2*	*1*
CO-4:	*understand the various types of failure in different components of pavement and assess the pavement conditions*	*3*	*2*	*2*
CO-5:	*analyze the suitable stabilizers based on mechanism and requirements for construction with quality control in the field.*	*3*	*3*	*3*

Module-1 - Basic Concepts	***9 Hour***
Historical development of pavements - Types, classification, components and principle of load transfer - Approaches to pavement design - Vehicle and traffic considerations - Behaviour of road materials under repeated loading - Stresses and deflections in layered systems.	
Module-2 - Flexible Pavement	***9 Hour***
Factors affecting flexible pavements - Material characterization for analytical pavement design - AASHO, CBR, group index methods - Importance of resilient modulus - Fatigue subsystem - Failure criteria for bituminous pavements - IRC design guidelines.	
Module-3 - Rigid Pavement	***9 Hour***
Factors affecting rigid pavements - Design procedures for rigid pavement - Slab thickness, dowel bar, tie bar, spacing of joints - IRC guidelines - Airfield pavements - Comparison of highway and airfield pavements.	
Module-4 - Pavement Evaluation and Rehabilitation	***9 Hour***
Pavement evaluation - Surface and structural - Causes and types of failures in flexible and rigid pavements - Presents serviceability index of roads - Overlay design - Pavements maintenance, management and construction – Drainage and its importance in pavements.	
Module-5 - Stabilization of Soils for Road Constructions	***9 Hour***
Need for a stabilized soil - Design criteria - Mechanisms - Factors influencing choice of stabilizers - Testing and field control – Applications of Geosynthetics in road construction - Case studies.	

Learning Resources	1. *Wright, P.H, Highway Engineers, John Wiley & Sons, Inc., New York, 1996.* 2. *Khanna S.K, Justo C.E.G, Highway Engineering, Eighth Edition, New Chand and Brothers, Roorkee, 2001.* 3. *Yoder R.J and Witchak M.W, Principles of Pavement Design, John Wiley, 2000.* 4. *Croney, D, Design and Performance of Road Pavements, HMO Stationary Office, 1979.* 5. *Design and Specification of Rural Roads (Manual), Ministry of rural roads, Government of India, New Delhi, 2001.*	6. *Guidelines for the Design of Flexible Pavements, IRC: 37 - 2001, The Indian roads Congress, New Delhi.* 7. *Guideline for the Design of Rigid Pavements for Highways, IRC: 58-1998, The Indian Roads Congress, New Delhi.* 8. *O' Flaherty C.A, Highways – The location, Design, Construction & Maintenance of Pavements, Fourth Edition, Elsevier, 2006.* 9. *Bell, P.S, Developments in Highway Engineering, Applied Sciences publishers, 1978.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*25%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*25%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Er. K. Sekar, SE, Highways, ksekar2024@gmail.com*	1. *Dr. K. Premalatha, Professor, Anna University, kvpremalatha@yahoo.com*	*1. Dr. V.Janani, SRMIST*
2. *Dr. P. Selvanambi, Divisional Engineer (Highways) NABARD & Rural Works, Dharmapuri, sundariselvam@yahoo.com*	2. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	*2. Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEE603T	Course Name	STRUCTURES ON EXPANSIVE SOILS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*identify the occurrence and distribution of expansive soils.*
CLR-2:	*analyse the properties of expansive soils.*
CLR-3:	*identify the various methods of prediction of heave in soil*
CLR-4:	*solve the design procedure for foundation on expansive soils.*
CLR-5:	*identify the various methods of stabilization used in expansive soils.*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	*Programme Outcomes (PO)*		
		1	***2***	***3***
CO-1:	*analyze the occurrence and distribution of expansive soils.*	1	2	1
CO-2:	*evaluate the properties of expansive soils*	2	3	1
CO-3:	*understand the knowledge on various methods of prediction of heave.*	3	2	1
CO-4:	*calculate the design procedure for foundation used in expansive soils.*	2	3	2
CO-5:	*analyze the various methods of stabilization used in expansive soils*	3	3	1

Module-1 – General Properties of Expansive Soil	***9 Hour***
Occurrence and Distribution of expansive soil an overview, Physical properties of expansive soils, Related civil engineering problems and Remedies, Identification of expansive soils, Expansive soil environment interaction, Shrink – swell potential of expansive soil, Field conditions that favour swelling and shrinkage, Influencing factors, Damage on Foundations from Expansive Soils.	
Module-2 – Swelling Characteristics	***9 Hour***
Soil structure, Types of Clay minerals, clay mineralogy, Field exploration, Identification of expansive soils, Cation exchange capacity, Swelling characteristics – Laboratory tests, Methods of prediction of heave - Empirical methods, Double oedometer tests, Expansive index test, Classification using engineering index properties.	
Module-3 – Methods for Controlling Swelling	***9 Hour***
Methods Controlling Swelling characteristics of expansive soil – Concept, Moisture barriers - Horizontal moisture barriers and Vertical moisture barriers, Soil replacement with compaction control, Surface and subsurface drainage – Prewetting, Treatment of expansive soils – Prewetting, Surcharge loading, Chemical additives and CNS layer technique.	
Module-4 – Foundations for Expansive Soils	***9 Hour***
Recommendations for type of foundation in expansive soils, Design consideration - Individual and Continuous footings, Stiffened mats - Codal provisions. Under reamed piles, Design and construction. Advantages and disadvantages, Belled piers – Bearing capacity and skin friction, Advantages and disadvantages of belled piers.	
Module-5 – Alterations of Swelling Characteristics	***9 Hour***
Stabilization-concept, Soil stabilization –Methods, Mechanical and Chemical stabilization – Types and concept, Cement stabilization- Advantages and disadvantages, Lime stabilization – mechanism involved and its limitations, Bituminous stabilization, Thermal stabilization- Thermal Technique and Freezing Technique – concept.	

Learning Resources	1. *John .D.N & Debora .J.M, "Expansive Soils Problems and Practice In Foundation & Pavement Engineering", 1st edition, 1997.* 2. *Chen.F.R, "Foundation on Expansive Soils"- Elsevier, 1st edition, 1975.*	3. *JD Nelson, Foundation Engineering for Expansive Soils, John Wiley & Sons Inc 1st edition, 2015.* 4. *Fu Hua Chen, Foundations on Expansive Soils, Elsevier, 1st edition, 2012.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	10%	-	10%	-	10%	-
Level 6	Create	10%	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. P. Selvanambi, Divisional Engineer (Highways) NABARD & Rural Works, Dharmapuri, sundariselvam@yahoo.com*	1. *Dr. S. V. Ramasamy, Professor (Retd), Anna University, prof.svramaswamy@gmail.com*	1. *Dr. P.T. Ravichandran, SRMIST*
2. *Dr. P. Manoharan, AEE, Town Panchayat, Kancheepuram, manorasi65@gmail.com*	2. *Dr. G. Janardhanan, NITTTR, gjanardhanan@gmail.com*	2. *Dr. Divya Krishnan K, SRMIST*

Course Code	21CEE604J	Course Name	STRENGTH AND SOIL DEFORMATION MECHANISM	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	impart the knowledge to characterize stress-strain behaviour of soils
CLR-2:	understand the shearing strength of the soil under complicated conditions for cohesionless soil.
CLR-3:	gain the thorough knowledge on the shearing behavior of fine grained soil
CLR-4:	analyze and interpret the state of stress in soil and evaluate various failure criteria for soils
CLR-5:	analyze the rheological models for the deformation and strength of soils

Course Outcomes (CO):	At the end of this course, learners will be able to:	Programme Outcomes (PO)		
		1	2	3
CO-1:	understand the principal stresses and strains using theories	1	1	1
CO-2:	apply the shear strength for different conditions of loading, drainage and failure criteria.	2	2	1
CO-3:	analyze the shear strength parameters of soils under varying drainage conditions.	3	2	2
CO-4:	apply various failure criteria for general stress states at points	2	1	1
CO-5:	evaluate the implementation of the fundamental relations and its models	3	2	1

Module-1 – Strength Behavior of Soil	12 Hour
Introduction- stress and strain, Strength behavior of soil, Principal plane and principal stresses, Mohr circle, Mohr coulomb theory, Total stress and effective stress approach, influencing stress – strain characteristics – shear strength Characterisation	
Module-2 – Shear Strength of Cohesionless Soil	**12 Hour**
Shear strength of soil-cohesion-angle of internal friction-Shear strength of granular soils - Different types of test based on Drainage conditions, Dilation, contraction and critical states, Direct shear test, Shearing characteristics of sand, Field applications.	
Module-3 - Shear Strength of Cohesive Soil	**12 Hour**
Shear strength of cohesive soil, Unconfined compression test, Vane shear test, Interpretation of results, Triaxial testing and stress path plotting - pore pressure parameters of Skempton and Henkel - shear strength of partially saturated clay in terms of stress state variables.	
Module-4 – Yield Criterion	**12 Hour**
Elasticity, Plasticity, Yielding behavior of soil, Concepts of failure in soils, Failure theories of Von Mises, Tresca and their extended form, their applicability to soils, Failure envelope of rankine theory, Detailed discussion of Mohr - Coulomb failure theory.	
Module-5 – Stress - Strain Laws for Soils	**12 Hour**
Stress - strain laws for soils, Visco elasticity behavior, Strain and Strain softening, Elastic-plasticity law, Elastic-plastic model for soils, Rheological models of Kelvin applied to soils, Rheological models of Maxwell and Burger applied to soils.	

Learning Resources	1. *Atkinson J.H. and Brandsby P.L. "Introduction to critical state soil mechanics" McGraw Hill, 1st edition,1978.* 2. *Braja, M, Das, "Advanced soil mechanics", McGraw Hill, 5th edition, 2020.* 3. *Ian Smith, "Elements of Soil Mechanics", Wiley-Blackwell, 9th edition, 2014.*	4. *Braja, M. Das, "Principles of Geotechnical Engineering", Brooks/Cole, Thomson Learning Academic Resource, Center, 5th Edition, 2002.* 5. *Graham Barnes, "Soil Mechanics Principles and Practices", Palgrave Macmillan, 3rd edition, 2010.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life Long Learning CLA-2- Practice (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	-	*20%*	*20%*	-
Level 2	*Understand*	*20%*	-	-	*20%*	*20%*	-
Level 3	*Apply*	*20%*	-	-	*20%*	*20%*	-
Level 4	*Analyze*	*20%*	-	-	*20%*	*20%*	-
Level 5	*Evaluate*	*10%*	-	-	*10%*	*10%*	-
Level 6	*Create*	*10%*	-	-	*10%*	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Er. G. Srinivasa Rao, Saipem India Pvt Ltd, raoguraja@yahoo.com*	1. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	1. *Dr. Divya Krishnan K, SRMIST*
2. *Er. A. Vetriselvan, L&T ECC, Chennai, avsn@lntecc.com*	2. *Dr. G. Janardhanan, NITTTR, gjanardhanan@gmail.com*	2. *Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEE605J	Course Name	GROUND IMPROVEMENT TECHNIQUES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*identify the deficiencies in the deposits of the given project area and improve its characteristics by hydraulic modifications.*
CLR-2:	*improve the ground characteristics by mechanical modifications using various method and design the system.*
CLR-3:	*identify and improve the ground characteristics by physical modifications using various method and design the system.*
CLR-4:	*improve the characteristics of soils by various reinforcement techniques and design.*
CLR-5:	*evaluate the various methods of grouting and stabilization in soils.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*analyse the deficiencies in the deposits of the given project area and improve its characteristics by hydraulic modifications.*	3	2	1
CO-2:	*evaluate the ground characteristics by mechanical modifications using various method and design the system.*	3	2	2
CO-3:	*analyse the ground characteristics by physical modifications using various method and design the system.*	2	3	2
CO-4:	*calculate the design procedure for various reinforcement techniques.*	2	2	1
CO-5:	*acquire the knowledge and apply the various methods of grouting and stabilization in soils.*	2	2	1

Module-1 – Dewatering System	***12 Hour***
Ground improvement in Geotechnical engineering, Different methods, Dewatering system- basic concepts, Requirements, and different methods of dewatering system- sumps and ditches, Multistage well point system, well points deep wells, Vacuum dewatering, Electro-osmotic methods. Stabilization by thermal and Freezing techniques – Numerical analysis	
Module-2 – Compaction and Sand Drains	***12 Hour***
Compaction – Introduction, Principle of compaction, Different methods, Deep compaction and Shallow compaction techniques, In-situ compaction of cohesive soils and granular soils, Sand piles, Blasting, Dynamic consolidation preloading methods. Types of Drains, Design of vertical Drains, construction techniques – Field problems	
Module-3 – Stone Column, Soil Nailing and Slope Stability	***12 Hour***
Stone column concept, Function Design principles, load carrying capacity, construction techniques, settlement of stone column foundation, lime piles, slope stability – types of slope failure and Methods to control slope failure, Soil nailing, Sand columns, Root piles- Methods of installation and applications – Case study analysis	
Module-4 – Earth Reinforcement	***12 Hour***
Soil Reinforcement: Mechanism, Types of reinforcing elements, reinforcement-soil interaction, types of reinforcing patterns in soil, Reinforcement of soil beneath the roads, foundation, Geosynthetics, types, functions and their applications – RE Wall Field case study analysis	
Module-5 – Grouting and Soil Stabilisation	***12 Hour***
Ground Improvement by Grouting, types of grout, functions of grouting, desirable characteristics, Principle of injection, grouting methods, Grouting equipment, Application of grouting and grout monitoring. Soil Stabilization, Various methods of soil stabilization- classification and its principles, Lime, Cement and Soil Bitumen Stabilization.: Mechanism, amount, age and curing.	

Learning Resources	1. *R. M. Korner, Design with Geosynthetics, Prentice Hall, New Jersy, 3rd Edition. 2002* 2. *P. Purushothama Raj, Ground Improvement Techniques, Tata McGrawHill, New Delhi, 1st edition, 1999.* 3. *Joyanta Maity, Bikash Chandra Chattopadhyay, Ground Improvement Techniques, PHI Learning, 1st Edition, 2017.* 4. *Robert Koerner, Geotextiles: From Design to Applications, Woodhead Publishing Ltd, 1st edition, 2016.*	5. *Hehn. R.W, "Practical Guide to Grouting of Underground Structures", Amer Society of Civil Engineers, 1st edition, 1996.* 6. *Shroff. A.V, "Grouting Technology in Tunneling and Dam", A A Balkema Publishers, 1st edition, 1993.* 7. *Nihar Ranjan Patra, Ground Improvement Techniques, Vikas Publishing House 1st edition, 2012.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life Long Learning CLA-2- Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	20%	-	-	20%	20%	-
Level 3	Apply	20%	-	-	20%	20%	-
Level 4	Analyze	20%	-	-	20%	20%	-
Level 5	Evaluate	10%	-	-	10%	10%	-
Level 6	Create	10%	-	-	10%	10%	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Er. A. Vetriselvan, L&T ECC, Chennai, avsn@lntecc.com*	1. *Dr. S. V. Ramasamy, Professor (Retd), Anna University, prof.svramaswamy@gmail.com*	1. *Dr. Divya Krishnan K, SRMIST*
2. *Er. G. Srinivasa Rao, Saipem India Pvt Ltd, raoguraja@yahoo.com*	2. *Dr. V. Murugaiyan, Professor, PCE, Pondicherry, vpmplee@@gmail.com*	2. *Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEE606J	Course Name	ENGINEERING GEOLOGY AND GEOTECHNICAL APPLICATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	learn about the types of soil and its structure, physical properties of minerals and geological classification of rocks
CLR-2:	analyze the water bearing qualitites of rocks and geological investigation of ground water.
CLR-3:	study the parts of fold, faults and joints and their causes and engineering significance.
CLR-4:	analyze the geotechnical considerations in mitigation of earthquake hazards, landslides and Tsunamis.
CLR-5:	learn the general methods of geological investigations for major engineering projects.

Course Outcomes (CO):	At the end of this course, learners will be able to:	Programme Outcomes (PO)		
		1	2	3
CO-1:	understand the soil, mineral and rock types and its historical background of formation.	1	3	2
CO-2:	apply the sources, occurrence and geological investigation of ground water.	2	3	1
CO-3:	understand the concept of structural features of folds, faults and joints.	2	3	2
CO-4:	analyze various major geological hazards and mitigation measures.	3	2	3
CO-5:	carryout field investigation for foundations of massive structures	3	2	1

Module-1 -Soil Formation	**12 Hour**
Soil formation, Residual soil and Transported soil, Weathering of rocks, Soil types of India, Introduction to Soil structure, Analyzing formation of clay minerals, Types of Clay Minerals, kaolinite, Illite, Montmorillonite, Physical Properties of Minerals, Rock forming minerals, Rock cycle, Analyzing the classification of rocks, Geological classification of rocks.	
Module-2 – Geological Investigation of Ground water	**12 Hour**
Hydrological cycle, Sources of ground water, classification of ground water based on sodium concentration, Applying ESP and SAR formula, soil moisture constants, water bearing qualities of rocks, concept of aquifer, aquifuge, aquitard and aquiclude, Field Permeability, Numerical problem related to confined aquifer and unconfined aquifer, geological investigation of Ground water, Analyzing geological map.- Interpretation of field data	
Module-3 – Concepts of Folds, Faults and Joints	**12 Hour**
Folds, Classification of folding, Causes of folding, Faults, Classification of faulting, Major causes – stresses, Joints, Origin of joints, Occurrence of joints, Understand igneous, sedimentary and metamorphic rocks in joints, Unconformity, Detection of Unconformity. Rock core Characterisation study	
Module-4 – Geological Hazards and Design Solutions	**12 Hour**
Major geological hazards, such as landslides, earthquakes, Tsunami, classification, types and causes of mass movement, classification of flowage, sliding and subsidence, Types of mass movements Causes of mass movement, Introduction to Earthquakes, Liquefaction phenomenon, Tsunami occurrence, effects of hazards on construction and desirable design solutions. Mitigation analysis	
Module-5 – Field Investigation Methods	**12 Hour**

Field investigation, geological, geotechncial, geophysical methods of field work, Geophysical Investigations -Electrical resistivity method, Seismic method of exploration, Gravitational method of exploration, Magnetic exploration, Case studies: related to dams and reservoirs, tunnels and road cuts, geotechncial considerations for selection of sites.

Learning Resources	1. *Parbin Singh, "Engineering and General Geology", S.K. Kataria & Sons, Reprint 2013.* 2. *Sijing, Wang, Marinos, Engineering Geology, VSP International Science Publishers, 1st edition,199.* 3. *F.G.H. Blyth, Michael de Freitas, A Geology for Engineers, CRC Press, 7th edition, 2006.*	4. *R.F. Legget, Geology and Engineering, McGraw-Hill, 2nd Edition, 1962.* 5. *Dimitri P. Krynine, William R. Judd, Principles of Engineering Geology and Geotechnics, CBS Publishers and Distributors Pvt Ltd, 2018.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life Long Learning CLA-2- Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	20%	-	-	20%	20%	-
Level 3	Apply	20%	-	-	20%	20%	-
Level 4	Analyze	20%	-	-	20%	20%	-
Level 5	Evaluate	10%	-	-	10%	10%	-
Level 6	Create	10%	-	-	10%	10%	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr.P.D.Arumairaj, (Retired professor, GCT-Coimbatore) Managing Director, Alzum Geocivil Integrated Services Pvt.Ltd, Coimbatore, arumairajcbe@gmail.com*	1. *Dr. V. Murugaiyan, Professor, PCE, Pondicherry, vpmplee@@gmail.com*	1. *Dr. P.T. Ravichandran, SRMIST*
2. *Er. V. T. Ashok Kumar, AEE, Erode Corporation, akr2310@gmail.com*	2. *Dr. S. V. Ramasamy, Professor (Retd), Anna University, prof.svramaswamy@gmail.com*	2. *Dr. Divya Krishnan K, SRMIST*

Course Code	21CEE607T	Course Name	SOIL STRUCTURE INTERACTION AND ANALYSIS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*study the appropriate soil response model for interactive analysis.*
CLR-2:	*know the various interactive analyses for different beams.*
CLR-3:	*select the various interactive analyses for different plates.*
CLR-4:	*explore the interactive analysis for piles and pile groups subjected to axial load*
CLR-5:	*establish the interactive analysis for piles and pile groups subjected to lateral load*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	*Programme Outcomes (PO)*		
		1	*2*	*3*
CO-1:	*apply the appropriate soil response model for interactive analysis.*	*3*	*2*	*2*
CO-2:	*compute, differentiate and perform interactive analysis for different beams.*	*3*	*2*	*2*
CO-3:	*identify differentiate and perform interactive analysis for different plates.*	*3*	*2*	*1*
CO-4:	*evaluate and perform interactive analysis for single pile, two pile and multiple groups subjected to axial loading*	*3*	*2*	*1*
CO-5:	*assess and carry out interactive analyses for individual and group piles subjected to lateral loading*	*2*	*3*	*2*

Module-1 - Soil Response Models of Interaction Analysis	***9 Hour***
Introduction to soil - Foundation interaction problems - Soil behavior - Foundation behavior - Interface behavior – Soil foundation interaction analysis - Soil response models - Elastic continuum - Winkler - Two parameter elastic models - Elastic - Plastic behavior - Time dependent behavior	
Module-2 - Infinite and Finite Beams on Elastic Foundations	***9 Hour***
Infinite beam - General solution of the elastic line - Concentrated and distributed loads on beams - Idealization of semi-infinite and finite beams - Classification of finite beams - Different end conditions and loads - Solutions - General method	
Module-3 - Plate on Elastic Medium	***9 Hour***
Infinite plate - Elastic continuum – Winkler - Two parameters - Thin and thick plates - Analysis of finite plates - Rectangular and circular plates - Simple solution - ACI method - Analysis of highway and airfield pavements - Solutions - General method	
Module-4 - Analysis of Pile and Pile Groups	***9 Hour***
Elastic analysis of single pile - Solutions for settlement and load distribution - Simplified method for constructing load settlement curve to failure - Analysis of group settlement - Two pile interaction Analysis, Analysis of general groups - Theoretical solutions for free standing groups - Settlement of groups caused by compressible underlying strata - Use of design charts - Surface settlement around a group - Observed and predicted group behaviour.	
Module-5 - Laterally Loaded Pile	***9 Hour***
Load deflection prediction for laterally loaded piles - Subgrade reaction and elastic analysis - Analysis of pile group - Pile raft system - Solutions through influence charts	

Learning Resources	1. *Salgado, R, The Engineering of Foundations, Tata McGraw Hill Education Private Limited, New Delhi, 2011.* 2. *Saran, S, Analysis and Design of Substructures, Taylor & Francis Publishers, 2006* 3. *Hemsley, J.A, Elastic Analysis of Raft Foundations, Thomas Telford, 1998.* 4. *Poulos, H.G., and Davis, E.H, Pile Foundation Analysis and Design, John Wiley, 1980.* 5. *Selvadurai, A.P.S, Elastic Analysis of Soil Foundation Interaction, Elsevier 1979.* 6. *Kurien, N.P, Design of Foundation Systems: Principles and Practices Narosa Publishing House, New Delhi, 1999.*	9. *Edward Tsudik, Analysis of Structures on Elastic Foundations, J. Ross Publishing, Cengage Learning India Private Limited, Delhi, 2013.* 10. *Choudhury Deepankar, El-Zahaby, Khalid M, Idriss, Izzat, Dynamic soil - structure Interaction for Sustainable Infrastructures, Springer Publication, 2019, ISBN 978 3-030-01920-4.* 11. *Gopal Madabhushi, Jonathan Knappett and Stuart Haigh, Design of Pile Foundations in Liquefiable Soils, Imperial College Press, London WC2H 9HE, 2010.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*15%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*25%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Er. K. Sekar, Senior Engineer, Highways, ksekar2024@gmail.com	*1. Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	*1. Dr. V. Janani, SRMIST*
2.Er. V. T. Ashok Kumar, AEE, Erode Corporation, akr2310@gmail.com	*2. Dr. K. Premalatha, Professor, Anna University, kvpremalatha@yahoo.com*	*2. Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEE608T	Course Name	EARTH PRESSURE AND RETAINING STRUCTURES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the concept of stress states of soil*
CLR-2:	*importance of lateral earth pressure concepts in the design of geotechnical structures*
CLR-3:	*understand the design excavation system using sheet pile walls and supports*
CLR-4:	*apply the knowledge on lateral earth pressure behind and around excavation to analyse and design braced excavations*
CLR-5:	*understand the stability of infinite and finite slopes on lateral earth pressure*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*calculate the lateral earth pressure for any given soil profile and geographic condition using Rankine's and Coulomb's method*	*3*	*2*	*2*
CO-2:	*apply the knowledge of engineering and earth pressure to analyse and design rigid retaining structures*	*3*	*3*	*2*
CO-3:	*apply the knowledge of engineering and earth pressure to analyse and design flexible earth retaining walls*	*3*	*2*	*1*
CO-4:	*evaluate the lateral earth pressure behind and around excavation to analyse and design braced excavations, slurry supported excavations and underground utilities*	*3*	*2*	*2*
CO-5:	*analyse the stability of infinite and finite slopes through total stress and effective stress analysis*	*3*	*2*	*1*

Module-1 - Earth Pressure Theories	***9 Hour***
Introduction - State of stress in retained soil mass – Earth pressure theories – Classical and graphical techniques - Active and passive cases – Earth pressure due to external loads, empirical methods - Wall movement.	
Module-2 - Drainage and Stability	***9 Hour***
Retaining structure – Selection of soil parameters - Lateral pressure due to compaction, strain softening, wall flexibility, Influence of drainage arrangements - Stability analysis of retaining structure.	
Module-3 - Sheet Pile Walls	***9 Hour***
Types of sheet piles - Analysis and design of cantilever and anchored sheet pile walls - Free earth support method - Fixed earth support method - Design of anchor systems - Isolated and continuous.	
Module-4 - Supported Excavations	***9 Hour***
Lateral pressure on sheeting in braced excavation, stability against piping and bottom heaving - Earth pressure around tunnel lining, shaft and silos - Soil anchors - Soil pinning - Basic design concepts - Slurry Supported Trenches - Basic principles - Slurry characteristics - Specifications - Diaphragm walls - Stability analysis	
Module-5 - Stability of Slopes	***9 Hour***
Stability of infinite and finite slopes - Limit Equilibrium method - Wedge analysis - Method of Slices - Bishop's method - Janbu's method etc. - Special aspects of slope analysis - Stability charts - Role of geosynthetics in stabilization of slopes	

Learning Resources	1. *Winterkorn, H.F, Fang, H.Y, Foundation Engineering Handbook, Galgotia Book Source, 2000.* 2. *Rowe, R.K, Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers, 2001.* 3. *Militisky, J. and Woods, R, Earth and Earth retaining structures, Routledge, 1992.* 4. *Koerner, R.M, Design with Geosynthetics (Third Edition), Prentice Hall, 1997.* 5. *Day, R.W, Geotechnical and Foundation Engineering: Design and Construction, McGraw Hill, 1999.*	6. *Das, B.M, Principles of Geotechnical Engineering, The PWS series in Civil Engineering, 1998.* 7. *Clayton, C.R.I., Militisky, J, Woods, R.I, Earth pressure and Earth-Retaining structures (Second Edition), Survey University Press,1993.* 8. *Mandal, J.N, Reinforced Soil and Geotextiles, Oxford &IBH Publishing Co. Pvt. Ltd., New Delhi.1988* 9. *Wayne C.Teng, Foundation Design, Prentice-Hall International, New Delhi, 1992.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*15%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*25%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Kamaraj, Chief Engineer, SRM construction, nkamaraj@yahoo.com*	1. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	*1.Dr. V. Janani, SRMIST*
2. *Dr. P. Manoharan, AEE, Town Panchayat, Kancheepuram, manorasi65@gmail.com*	2. *Dr. S. V. Ramasamy, Professor (Retd), Anna University, prof.svramaswamy@gmail.com*	*2.Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEE609T	Course Name	FORENSIC GEOTECHNICAL ENGINEERING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**	*Nil*		

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the failures and its characterization for geotechnical structures*
CLR-2:	*investigate the data and develop forensic investigation skills*
CLR-3:	*analyze and learn from case histories*
CLR-4:	*understand the guidelines and technical issues related to geotechnical failures and learn about the legal system's role in geotechnical engineering*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*analyze and characterize failures in geotechnical structures, identifying the root causes and understanding the limitations of traditional design methods.*	*3*	*3*	*1*
CO-2:	*develop the ability to conduct comprehensive forensic investigations and to determine the causes of geotechnical failures accurately.*	*3*	*3*	*3*
CO-3:	*gain insights from historical case studies of significant structures, understanding the geotechnical principles that contributed to their stability or failure, and applying this knowledge to contemporary engineering challenges.*	*3*	*2*	*2*
CO-4:	*navigate and address legal conflicts, perform diagnostic tests, and implement recommendations to prevent future failures effectively.*	*3*	*3*	*3*

Module-1 - Introduction	***9 Hour***
Historical failures of geotechnical structures (finite and infinite slopes, high embankments such as earthen dams, tunnels, excavations, foundations-shallow and deep, retaining structures etc.) - Characterization of failures - Inadequateness of Limit state design - Principles and advantages of Mobilizeable strength design -Numerical problems	
Module-2 - Technical Forensic Investigation	***9 Hour***
Collection of data - Problem characterization - Development of failure hypotheses - A realistic back analysis - Field observations and performance monitoring - Modeling of failure hypothesis - Quality control of formal and technical aspects of the work - Numerical Problems.	
Module-3 - Case Histories	***12 Hour***
Construction of historic monuments - Destruction due to environmental changes and survival of monuments among them, such as leaning tower of Pisa, Egyptian pyramids, tall structural foundations in Mexico city, pre historic caves in India etc., - Consideration of geotechnical aspects such as settlement, shear strength, permeability, slope stability, etc., in construction of survived historic monuments as well as for the structures which have collapsed due to the new adjacent constructions or disturbances due to human activities etc.,. - Numerical problems	
Module-4 - Guidelines, Issues & Legal System	***15 Hour***
Guidelines for forensic investigation of geotechnical *Scope of the work - Types of distress - Diagnostic tests: field and laboratory tests, analysis, legal issues such as facts, interpretations, opinions, negligence technical issues related to geotechnical failures Primary Shortcomings Causing Failures - Shortcomings in Design - Inadequate Site Investigations - Unforeseen Occurrences and Phenomena - Shortcomings in Construction - Recommendations to limit future occurrence of failures.*	

Legal System in Geotechnical Engineering *Legal conflict of geotechnical failures - Sanctions in the legal code of construction - Geotechnical work for documentation of forensic cases - Case studies of legal conflict of prominent structures (such as landslides, deep excavations, unexpected settlements of oil tanks, distress in soil walls, failure due to slow creep of hills etc.)*

Learning Resources	1. *Shen En Chen, R Janardhanan, C Natarajan, Ryan Schmidt, Indo-US Forensic Practices: Investigation Techniques and Technology, American Society of Civil Engineers, 2010.* 2. *Robert W Day, Forensic Geotechnical and Foundation Engineering, McGraw Hill; 2nd Edition, 2011.* 3. *V.V.S. Rao, G.L. Sivakumar Babu, Forensic Geotechnical Engineering (Developments in Geotechnical Engineering), Springer, India, Private Ltd, 2016.*	4. *Stephen E. Petty, Forensic Engineering: Damage Assessments for Residential and Commercial Structures 2nd Edition, CRC Press, 2021.* 5. *Colin R. Gagg, Forensic Engineering - The Art and Craft of A Failure Detective 1st Edition, CRC Press, 2020.* 6. *Navid Naster, Rui Liu, Failure Case Studies: Steel Structures (Forensic Engineering Division), American Society of Civil Engineers, 2019.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*15%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*25%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Kamaraj, Chief Engineer, SRM construction, nkamaraj@yahoo.com*	1. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	1. *Dr. P.T. Ravichandran, SRMIST*
2. *Dr. P. Manoharan, AEE, Town Panchayat, Kancheepuram, manorasi65@gmail.com*	2. *Dr. S. V. Ramasamy, Professor (Retd), Anna University, prof.svramaswamy@gmail.com*	2. *Dr. Divya Krishnan K, SRMIST*

Course Code	21CEE610T	Course Name	GEOMECHANICS AND SOIL BEHAVIOUR	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*classify and identify the soil and its deposits*
CLR-2:	*familiarize the student with the physical relationship of soil and water system.*
CLR-3:	*know the swelling and shrinkage characteristics of soil*
CLR-4:	*understand the engineering behaviour of soil with relation to stress state condition*
CLR-5:	*analyze the mechanism of clay with the phenomena of flow on the behavior of soil*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	*Programme Outcomes (PO)*		
		1	*2*	*3*
CO-1:	*understand the classification to identify the soil properties*	2	2	1
CO-2:	*create the knowledge on the role of soil properties with and without water*	3	2	1
CO-3:	*apply the knowledge of volume change behavior of soil*	3	2	1
CO-4:	*evaluate the influence of behaviour its potential on soil*	2	2	1
CO-5:	*analyze the study of flow through porous medium*	3	1	1

Module-1 - Soil Deposits and Clay Minerals	***9 Hour***
Introduction - Importance of soil behaviour - Stability of structure - Origin and formation of soils - Various soil deposits and their engineering suitability - Genesis of clay minerals - Classification and identification - Particle size, textural, unified system, Indian standard - Clay mineralogy - Basic structural units - Symbolic representation of clay mineral - Types - 1:1 clay layer, 2:1 clay layer - Isomorphic substitution - Anion and Cation exchange capacity of clays - Specific surface area.	
Module-2 - Physical and Physio-Chemical Behaviour of Soils	***9 Hour***
Physical, Chemical and physio - chemical behaviour of soils - Factors influencing soil behaviour - Diffused double layer - Gouy chapmann theory, Stern layer theory - Computation of double layer distance -Effect of ionic concentration, ionic valency, dielectric constant, temperature on double layer - Attractive and repulsive forces in clays - Soil structure - Soil water - Mechanism of soil - Water interactions.	
Module-3 - Swelling and Shrinkage Behaviour of Soils	***9 Hour***
Swelling And Shrinkage - Causes and consequences - Measurement of swell , Swell potential and swell pressure - Methods to determine swell potential - Methods for swell pressure determination - Odeometer test , constant volume method , expanding volume method, varying surcharge method -Factors influencing swell and shrink behaviour - Control measures - Soil structure - Soil fabric - definition - Types, Particle associations in clay suspensions - Granular soils - Clay soils - Macrofabric and microfabric features in clay.	
Module-4 - Engineering properties	***9 Hour***
Compaction - Definition - Objectives - Laboratory methods to determine compaction, Light and heavy compaction - Methods of field compaction - Factors influencing lab and field compaction techniques - Compressibility - Stages of compressibility - Factors governing compressibility - Permeability Behavior of Soils - Field applications - Darcy law - Assumptions and limitations - Coefficient of permeability - Methods - Constant and variable head permeability test - Factors influencing permeability - Liquefaction - Case Studies.	

Module-5 – Conduction Phenomena and Prediction of Soil Behaviour	***9 Hour***
Conduction Phenomenon In Soils - Types of flow - Hydraulic, Chemical, Electrical, Thermal - Flow law and its relationship - Coupled flow - Conduction analogy of porous media - Field applications - Electro kinetic process, Stages of electrokinetic phenomenon - Dewatering by electro osmosis - Effect of flows in properties of soils - Prediction of engineering behaviour of soils - Empirical correlations and their applicability.	

Learning Resources	1. *Mitchell, J.K, Fundamentals of Soil Behaviour, John Wiley and Sons, New York, Third edition 2005.* 2. *Lambe, T.W. and Whitman, R.V. "Soil Mechanics", John Wiley and Sons, New York, 1991.* 3. *Van Olphen H, Clay colloid Chemistry, John Wiley, 1996.* 4. *Das, B.M, Principles of Geotechnical Engg, PWS Publishing Comp, Boston, 1998.* 5. *Grim, R.E, Applied Clay Mineralogy, McGraw Hill, New York, 1966.* 6. *Coduto, D.P, Geotechnical Engineering – Principles and Practices ,Prentice Hall of India Pvt. Ltd., New Delhi, 2002*	7. *Yong, R.N. and Warkentin B.P, Introduction to Soil Behaviour, Macmillan, Limited, London, 1979.* 8. *McCarthy D.F, Essentials of Soil Mechanics & Foundations, Prentice-Hall, 2002.* 9. *Robert D. Holtz and William D. Kovacs, An Introduction to Geotechnical Engineering", Prentice Hall (UK) International, London, 1981.* 10. *Gopal Ranjan and A.S.R Rao, Basic and Applied Soil Mechanics, New Age International (P) Limited, New Delhi, 2000.* 11. *Knappett J.A. and R.F. Craig, Craig's Soil Mechanics, Span Press, 711 Third Avenue, New York, NY 10017, 2012.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*15%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*25%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. N. Kamaraj, Chief Engineer, SRM construction, nkamaraj@yahoo.com*	1. *Dr. R, Baskar, Professor, Annamalai University, rajaram_baskar@rediffmail.com*	1. *Dr. V.Janani, SRMIST*
2. *Er. G. Srinivasa Rao, Saipem India Pvt Ltd, raoguraja@yahoo.com*	2. *Dr. V. Murugaiyan, Professor, PCE, Pondicherry, vpmplee@@gmail.com*	2. *Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEE611T	Course Name	EARTHQUAKE GEOTECHNICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**	*Nil*		

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the fundamentals of seismology and earthquake engineering.*
CLR-2:	*analyze and design geotechnical structures under seismic loads.*
CLR-3:	*study the behavior of soils during earthquakes.*
CLR-4:	*learn about advanced techniques in earthquake-resistant geotechnical design.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*identify and analyze seismic hazards and ground motion parameters*	*3*	*2*	*1*
CO-2:	*conduct and interpret laboratory and field tests for evaluating dynamic soil properties.*	*3*	*1*	*1*
CO-3:	*evaluate and ensure the stability of slopes and retaining structures during earthquakes.*	*3*	*2*	*2*
CO-4:	*critically analyze case studies of geotechnical failures in past earthquakes to derive lessons for future designs.*	*3*	*3*	*2*

Module-1 - Fundamentals of Seismology and Earthquake Engineering	***9 Hour***
Introduction to Seismology - Plate Tectonics and Fault Mechanics, Seismic Waves and their Characteristics - Earthquake Magnitude and Intensity Scales - Seismic Hazard Analysis - Deterministic and Probabilistic Seismic Hazard Assessment (DSHA & PSHA) - Ground Motion Parameters - Peak Ground Acceleration (PGA) - Response Spectra	
Module-2 - Soil Behavior during Earthquakes	***13 Hour***
Dynamic Soil Properties - Soil Liquefaction - Cyclic Stress and Strain Behavior - Laboratory and Field Testing for Dynamic Properties - Soil-Structure Interaction - Effect of Soil Conditions on Seismic Response - Soil Amplification	
Module-3 – Analysis and Design of Geotechnical Structures under Seismic Loads	***13 Hour***
Seismic Analysis of Foundations - Shallow and Deep Foundations - Pile Foundations - Seismic Slope Stability - Pseudo-static Analysis - Newmark's Sliding Block Analysis - Design of Retaining Structures under Seismic Loads - Mononobe-Okabe Theory - Seismic Earth Pressures	
Module-4 - Advanced Topics and Case Studies in Earthquake Geotechnics	***10 Hour***
Ground Improvement Techniques for Seismic Mitigation - Vibro-Compaction, Stone Columns, Dynamic Compaction - Earthquake-Resistant Design Codes and Guidelines - Overview of International and National Standards (e.g., IS 1893, ASCE 7) - Forensic Studies of Geotechnical Failures in Earthquakes - Case Histories and Lessons Learned - Recent Advances and Research in Earthquake Geotechnics	

Learning Resources	1. *Braja M. Das, G.V. Ramana, Principles of Soil Dynamics, Cengage Learning, 2010* 2. *T. G. Sitharam, L.G. Sahu, Soil Dynamics and Earthquake Engineering, CRC Press, 2021.* 3. *Robert W. Day, Geotechnical Earthquake Engineering Handbook, McGraw-Hill, 2002* 4. *Amr S. Elnashai, Luigi Di Sarno, Fundamentals of Earthquake Engineering, Wiley-Blackwell, 2008.*	5. *Kyriazis D. Pitilakis, Earthquake Geotechnical Engineering, Springer, 2007* 6. *Anil K. Chopra, Dynamics of Structures: Theory and Applications to Earthquake Engineering, Pearson, 2017.* 7. *Steven L. Kramer, Geotechnical Earthquake Engineering, Pearson, 1996.* 8. *Y. Tsompanakis, N.D. Lagaros, M. Papadrakakis, Seismic Design and Practice into the Next Century, CRC Press, 2021.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*20%*	-	*15%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*25%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. N. Kamaraj, Chief Engineer, SRM construction, nkamaraj@yahoo.com*	1. *Dr. R, Baskar, Professor, Annamalai University, rajaram_baskar@rediffmail.com*	1. *Dr. P.T. Ravichandran, SRMIST*
2. *Er. G. Srinivasa Rao, Saipem India Pvt Ltd, raoguraja@yahoo.com*	2. *Dr. V. Murugaiyan, Professor, PCE, Pondicherry, vpmplee@@gmail.com*	2. *Dr.Divya Krishnan K, SRMIST*

Course Code	21CEE612T	Course Name	SLOPE STABILITY AND LANDSLIDES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*identify the basic concepts of stability, failure processes, type and rate of movements in slopes.*
CLR-2:	*analyse the strength of soil and measurements.*
CLR-3:	*identify the various stresses, distribution of loads and effects on soil.*
CLR-4:	*solve the mode of failures in rocks and design of slopes.*
CLR-5:	*identify the various remediation and evolving practice in landslides.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*check basic concepts of stability, failure processes, type and rate of movements in slopes*	*2*	*1*	*1*
CO-2:	*evaluate the properties and the measurement of soil strength.*	*3*	*3*	*2*
CO-3:	*understand the knowledge on various stresses, distribution of loads and its effects on soil.*	*2*	*1*	*1*
CO-4:	*calculate the design procedure for slope stability.*	*2*	*1*	*3*
CO-5:	*analyze the various methods of remediation and evolving practice in landslides.*	*1*	*2*	*2*

Module-1 – Soil Stability Analysis Interpretation	***9 Hour***
Importance of 4G's of Slope Stability, Geology, Geometry, Geotechnical and Hydro Geology, Slope Failures, Movements, and Processes, Features and Geometry of Instability, Failure Processes, Type and Rate of Movements.	
Module-2 – Fundamentals of Soil Strength	***9 Hour***
Strength of soil, Mohr-Coulomb Failure Criterion, Effective Stress versus Total Stress, State of Stress and Stress Change, Laboratory Measurement of Strength, Simple Shear Tests, Typical Soil Properties, Selection of Design Shear Strengths, In Situ Measurement of Shear Strength.	
Module-3 – Slope Stability Investigation and Reporting	***9 Hour***
Scoping the field investigation, understanding soil and rock bore log, Interpreting soils reports, Earth Pressures and Stresses, Total and effective stresses, Distribution of loads to underlying deposits, Effects of water table fluctuations, Dynamic effects on soil.	
Module-4 – Stability of Rock Slopes	***9 Hour***
Shallow and deep investigation for foundation design and construction aspect, Rock slopes, Modes of failure, Rotational failure, Plane failure, Design charts, slope stability analysis, mode of failures in rock. Design of slopes, excavation in rock and stabilization concepts, Improvement of slope stability and protection.	
Module-5 – Slope Remediation and Evolving Practice	***9 Hour***
Slope Stabilization Methods, Soil Compaction, Buttressing, Drainage, Remediation of Rock Slopes, Rock slope remediation techniques, Rock removal (scaling), Rock reinforcement, Rock Slope Case Studies, Advancing Topics in Slope Stability and Landslides, Stability of landfill systems, Risk assessment, Remote sensing and instrumentation, Rock falls, Debris flows, Emerging climate risks.	

Learning Resources	1. *RE Goodman, Introduction to Rock Mechanics, John Wiley & Sons Inc, 2nd edition, 1988.* 2. *Dimitri P. Krynine, William R. Judd, Principles of Engineering Geology and Geotechnics CBS Publishers and Distributors Pvt Ltd, 2018.* 3. *Dr. B P Verma, Engineering Geology and Rock Mechanics, Khanna Publishers, Standard Edition,1998.*	4. *L. Obert, W.I. Duvall, Rock Mechanics and the Design of Structures in Rock, John Wiley & Sons Inc, 1967.* 5. *Thomas S. Lee, Glenn M. Boyce, Lee W. Abramson, Sunil Sharma, Slope Stability and Stabilization Methods, , John Wiley & sons, 2nd Edition, 2001.* 6. *J. Michael Duncan, Stephen G. Wright, Thomas L. Brandon, Soil Strength and Slope Stability, Wiley, 2nd edition, 2014.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. P. Selvanambi, Divisional Engineer (Highways) NABARD & Rural Works, Dharmapuri, sundariselvam@yahoo.com*	1. *Dr. S. V. Ramasamy, Professor (Retd), Anna University, prof.svramaswamy@gmail.com*	1. *Dr. P.T. Ravichandran, SRMIST*
2. *Dr. P. Manoharan, AEE, Town Panchayat, Kancheepuram, manorasi65@gmail.com*	2. *Dr. G. Janardhanan, NITTTR, gjanardhanan@gmail.com*	2. *Dr. Divya Krishnan K, SRMIST*

Course Code	21CEE613T	Course Name	REINFORCED EARTH STRUCTURES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards		IS 198591 (2024)	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the concepts of soil reinforcement*
CLR-2:	*insight into the materials used for reinforcing soil*
CLR-3:	*apply the design concepts for economical design of reinforced earth walls*
CLR-4:	*understand the mechanism and concept related to the durability of reinforcement materials*
CLR-5:	*understand the performance studies of soil reinforcement for various geotechnical applications*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	*Programme Outcomes (PO)*		
		1	***2***	***3***
CO-1:	*gain a thorough knowledge on the role of soil reinforcement as one of the ground improvement techniques in the infrastructure development*	*3*	*2*	*2*
CO-2:	*selection of proper material for the appropriate function required for the geotechnical application*	*3*	*2*	*1*
CO-3:	*estimate the design and applications of reinforced earth of various reinforcing structures*	*3*	*3*	*3*
CO-4:	*understand the mechanism and concept related to the durability of reinforcement materials*	*3*	*1*	*1*
CO-5:	*conceptual and practical understanding of the mechanism of soil reinforcement for various geotechnical applications*	*3*	*3*	*3*

Module-1 - Principles and Mechanisms	***9 Hour***
Historical Background, Principles, Concepts and Mechanisms of reinforced earth soil - Geosynthetics function and mechanism - Interface resistance - Factors influencing interaction	
Module-2 - Reinforcing Materials	***9 Hour***
Materials used in reinforced soil structures - Fill materials - Reinforcing materials metal strips - Geotextile - Geogrids - Geomembranes - Geocomposites and Geojutes - Geofoam - Natural fibers - Facing elements	
Module-3 - Design Aspects and Application	***9 Hour***
Design aspects of reinforced earth - Design and applications of reinforced earth of various reinforcing structures, like retaining walls, foundations, pavements, embankments and slopes - Drains - Liners for liquid containment - Case studies on reinforced retaining walls – Field monitoring - Application geosynthetics in embankments.	
Module-4 - Durability of Reinforcement Materials	***9 Hour***
Measurement of corrosion factors - Resistivity - Redox potential - Water content - pH - Electrochemical corrosion - Bacterial corrosion	
Module-5 - Case Histories and Applications	***9 Hour***
Performance studies of reinforced dams - Embankments - Pavements - Railroads - Foundations and underground structure - Case studies on natural and synthetic fibre reinforced soils - Soil nailing - Applications.	

Learning Resources	1. *Jewell, R.A, Soil Reinforcement with Geotextile, CIRIA, London, 1996.* 2. *John, N.W.M, Geotextiles, John Blackie and Sons Ltd., London, 1987.* 3. *Jones, C.J.F.P, Earth Reinforcement and Soil Structures, Earthworks, London, 1982.* 4. *Koerner, R.M, Designing with Geosynthetics, (Third Edition), Prentice Hell, 1999.* 5. *Gray, D.H, Sotir, R.B, Biotechnical and Soil Engineering Slope Stabilization: A Practical Guide for Erosion control, John Wiley & Son Inc., New York, 1996.* 6. *Ramanatha Ayyar T.S, Ramachandran Nair C.G, Balakrishna Nair N, Comprehensive Reference Book on Coir Geotextile, Centre for Development for Coir Technology, 2002.*	7. *Sivakumar Babu, G.L, An Introduction to Soil Reinforcement and Geosynthetics, University press 2006* 8. *Swami Saran I. K, Reinforced Soil and its Engineering Applications, International Publishing House Pvt. Ltd,2005* 9. *Cheng.Y.M, Lau.C.K, Slope Stability Analysis and Stabilization, Routledge Taylor & Francis Group, London, 2008.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*20%*	-
Level 2	*Understand*	*15%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*25%*	-	*25%*	-	*20%*	-
Level 4	*Analyze*	*25%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Er. G. Srinivasa Rao, Saipem India Pvt Ltd, raoguraja@yahoo.com*	1. *Dr. K. Premalatha, Professor, Anna University, kvpremalatha@yahoo.com*	1. *Dr. P.T. Ravichandran, SRMIST*
2. *Er. A. Vetriselvan, L&T ECC, Chennai, avsn@Intecc.com*	2. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	2. *Dr. V.Janani, SRMIST*

Course Code	21CEE614T	Course Name	EARTHEN EMBANKMENTS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*explore the fundamentals of earthen embankments.*
CLR-2:	*evaluate the design consideration for the various components of earthen embankments.*
CLR-3:	*evaluate the basic concepts of seepage and drainage characteristics.*
CLR-4:	*identify the suitability of different materials for various components earth embankments and slope protection.*
CLR-5:	*solve the failure mechanism of earthen embankments and quality control.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*understand the fundamentals of earthen embankments.*	*1*	*1*	*1*
CO-2:	*analyze the design consideration for the various components of earthen embankments.*	*2*	*1*	*1*
CO-3:	*evaluate the basic concepts of seepage and drainage characteristics.*	*3*	*2*	*1*
CO-4:	*evaluate the suitability of different materials for various components earth embankments and slope protection.*	*3*	*2*	*3*
CO-5:	*evaluate the failure mechanism of earthen embankments and quality control.*	*3*	*2*	*1*

Module-1 - Investigation of Embankments Sites	***9 Hour***
General and extent of investigation of embankments sites, Preliminary and Final investigation, Geological investigation, Sub - surface investigation, Drilling and Sampling. Various soil test for coarse, Sand and gravels, Clay, Silts & fine sands, Tests of foundation material shear consideration and settlement tests.	
Module-2 – Embankment and Design	***9 Hour***
Earth embankments History, Advantages and disadvantages, General features of earth embankments, Design consideration for the various components. Flow through saturated Porous Media, Darcy' s law - its applications , Laplace equation for isotropic and anisotropic soils , theory of flownets.	
Module-3 – Seepage Analysis	***9 Hour***
Seepage through embankments and its controls, Effect of seepage, critical flow, Flow net, Piping, control of seepage and exit gradients by different structures such as cut off, Sheet pilling upstream blankets, filters, internal drains etc.	
Module-4 – Soil Suitability and Construction	***9 Hour***
Construction materials, Methods and suitability of different materials for various components earth embankments, slope protection. Soil unsuitable for earthen embankments construction its various methods.	
Module-5 – Failures and Quality Control	***9 Hour***
Failure mechanism of earthen embankments, Types, Causes of failures, Remedies of hydraulic seepage and structure failures, Causes of foundation failure and maintenance of earthen embankments, methods of quality control, measuring instruments.	

Learning Resources	1. *Bharat singh, R.S. Varshney, Embankment Dam Engineering, NEM CHAND & BROS, 1st edition, 2004.* 2. *Hari D. Sharma, Embankment Dams, Oxford & IBH Publishing Company, 1991.*	3. *Nemec, J, Engineering Hydrology, McGraw-Hill, 1st edition,1972.* 4. *B. Singh, R. S. Varshney, Engineering for Embankment Dams, A A Balkema Publishers 1st edition, 1995.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	10%	-	10%	-	10%	-
Level 6	Create	10%	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Er. G. Srinivasa Rao, Saipem India Pvt Ltd, raoguraja@yahoo.com*	1. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	1. *Dr. P.T. Ravichandran, SRMIST*
2. *Er. A. Vetriselvan, L&T ECC, Chennai, avsn@lntecc.com*	2. *Dr. G. Janardhanan, NITTTR, gjanardhanan@gmail.com*	2. *Dr. Divya Krishnan K, SRMIST*

Course Code	21CEE615T	Course Name	ROCK MECHANICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*study the rock mass and deal with the rate the quality of rock for tunnelling and foundations works*
CLR-2:	*comprehend the shear strength parameters of rocks to be used for the design of structures resting on rock*
CLR-3:	*explore the knowledge of engineering and assess the influence of insitu stress in the stability of various underground excavations*
CLR-4:	*understand the knowledge on rock mechanics and analyse the stability of rock slopes and arrive at the bearing capacity of shallow and deep foundations resting on rocks considering the presence of joints*
CLR-5:	*select suitable support system considering the interaction betweenrock and support*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*classify the rock mass and rate the quality of rock for tunnelling and foundations works*	*3*	*2*	*2*
CO-2:	*apply the knowledge of engineering and understand the stress – strain characteristics and failure criteria of rock*	*3*	*2*	*1*
CO-3:	*apply the knowledge of engineering and assess the influence of insitu stress in the stability of various underground excavations*	*3*	*2*	*2*
CO-4:	*apply the knowledge on rock mechanics and analyse the stability of rock slopes and arrive at the bearing capacity of shallow and deep foundations resting on rocks considering the presence of joints*	*3*	*2*	*1*
CO-5:	*estimate the insitu strength of rocks by various methods such as rock reinforcement and rock support*	*3*	*2*	*3*

Module-1 - Classification of Rocks	***9 Hour***
Types of Rocks - Rocks of peninsular India and the Himalayas - Index properties and classification of rock masses - Competent and incompetent rock - Value of RMR and ratings in field estimations	
Module-2 - Strength Criteria of Rocks	***9 Hour***
Behaviour of rock under hydrostatic compression and deviatric loading - Modes of rock failure - Planes of weakness and joint characteristics - Joint testing - Mohr - Coulomb failure criterion and tension cut off - Hoek and Brown Strength criteria for rocks with discontinuity sets	
Module-3 - Insitu Stresses in Rocks	***9 Hour***
Insitu stresses and their measurements - Hydraulic fracturing - Flat jack - Over coring and under coring methods - Stress around underground excavations - Design aspects of openings in rocks - Case studies.	
Module-4 - Slope Stability and Bearing Capacity of Rocks	***9 Hour***
Rock slopes - Role of discontinuities in slop failure - Slope analysis and factor of safety - Remedial measures for critical slopes - Bearing capacity of foundations on rocks – Case studies	
Module-5 - Reinforcement of Rocks	***9 Hour***
Reinforcement of fractured and joined rocks –Shotcreting – Bolting - Anchoring - Installation methods - Case studies	

Learning Resources	1. *Goodman, R.E, Introduction to rock mechanics, John Willey and Sons, 1989.* 2. *Hudson, A. and Harrison, P, Engineering Rock mechanics – An introduction to the principles, Pergamon Publications, 1997.* 3. *Hoek, E and Bray, J, Rock slope Engineering, Institute of Mining and Metallurgy, U.K. 1981.* 4. *Hoek, E and Brown, E.T, Underground Excavations in Rock, Institute of Mining and Metallurgy, U.K. 1981.* 5. *Obvert, L. and Duvall, W, Rock Mechanics and the Design of Structures in Rock, John Wiley, 1967.* 6. *Bazant, Z.P, Mechanics of Geomaterials Rocks, Concrete and Soil, John Wiley and Sons, Chichester, 1985.*	7. *Wittke, W, Rock Mechanics. Theory and Applications with case Histories, Springerverlag, Berlin, 1990.* 8. *Bazant, Z.P, Mechanics of Geomaterials Rocks, Concrete and Soil, John Wiley and Sons, Chichester, 1985.* 9. *Wittke, W, Rock Mechanics. Theory and Applications with case Histories, Springerverlag, Berlin, 1990.* 10. *Waltham T, Foundations of Engineering Geology, Second Edition, Spon Press, Taylor & Francis Group, London and New York, 2002.* 11. *Ramamurthy T, Engineering in Rocks for Slopes Foundations and Tunnels, PHI Learning Pvt. Ltd., 2007.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*20%*	-	*15%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*25%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. N. Kamaraj, Chief Engineer, SRM construction, nkamaraj@yahoo.com*	1. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	1. *Dr. V. Janani, SRMIST*
2. *Dr. P. Manoharan, AEE, Town Panchayat, Kancheepuram, manorasi65@gmail.com*	2. *Dr. G. Janardhanan, NITTTR, gjanardhanan@gmail.com*	2. *Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEE616T	Course Name	UNSATURATED SOIL MECHANICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*identify the stress state variables, material variables and constitutive law of unsaturated soil*
CLR-2:	*analyse the physics of soil-water mechanism, relationship of models*
CLR-3:	*identify and determine the soil-water characteristic curve and the shear strength of unsaturated soil*
CLR-4:	*analyse the principles of vapour flow, air diffusion, pore liquid flow and rate of infiltration in unsaturated soil*
CLR-5:	*identify the material variables and select the suitable soil models.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*analyse stress state variables, material variables and constitutive law of unsaturated soil*	*3*	*2*	*2*
CO-2:	*evaluate the physics of soil-water mechanism, relationship of models*	*3*	*3*	*2*
CO-3:	*evaluate the soil-water characteristic curve and the shear strength of unsaturated soil*	*3*	*2*	*3*
CO-4:	*determine the principles of vapour flow, air diffusion, pore liquid flow and rate of infiltration in unsaturated soil*	*3*	*2*	*2*
CO-5:	*analyse the material variables and select the suitable soil models.*	*2*	*3*	*3*

Module-1 - State of Unsaturated Soil	***9 Hour***
Definition - Interdisciplinary nature of unsaturated soil - Soil classification - Nature and practice - Stress profiles - Stress state variables - Material variables - Constitutive law - Suction potential of soil water	
Module-2 - Physics of Soil Water System	***9 Hour***
Physical properties of Air and water - Partial pressure and relative Humidity Density of moist air - Surface Tension - Cavitations of water - Solubility of Air in water - Air water solid interface - Vapor pressure lowering - Soil water characteristic-curve - Capillary tube model - Contacting sphere model - Young Laplace equation - Height of capillary rise - Rate of capillary rise - Capillary pore size distribution - Theoretical basis - Determination - Laboratory method.	
Module-3 - Stress State Variables and Shear Strength	***9 Hour***
Effective-stress - Stress between two spherical particles - Hysteresis in SWCC - Stress parameter - Stress tensor - Stress control by Axis Translation - Analytical representation of stress - Volume change characteristics - Extended Mohr - Coulomb criterion - Shear strength parameters - Interpretation of direct shear test results and Tri axial test results - Unified representation of failure envelope - Influence of suction in earth pressure distribution.	
Module-4 - Steady and Transient Flows	***9 Hour***
Driving mechanism - Permeability and Hydraulic conductivity - Capillary barriers - Steady infiltration and evaporation - Vapor flow - Air diffusion in water - Principles for pore liquid flow - Rate of infiltration - Transient suction and moisture profiles - Principles for Pore Gas flow - Barometric pumping Analysis.	
Module-5 - Material Variable Measurement and Modelling	***9 Hour***

Measurement of total suction - Psychrometers - Filter paper measurement of matric suction - High air entry disks - Direct measurements - Tensiometers - Air-translation technique - Indirect measurements - Thermal conductivity sensors - Measurement of osmotic suction - Squeezing technique - Soil water characteristic curves and Hydraulic conductivity models

Learning Resources	1. *Fredlund, D.G, Rahardjo, H, Fredlund, M.D, Unsaturated Soil Mechanics in Engineering Practice, John Wiley & Sons, INC, New Jersey, 2012.* 2. *Ning Lu, William, J. Likes, Unsaturated Soil Mechanics, John Wiley & Sons, INC. New Jersey, 2004.* 3. *Ng Charles, W.W, Menzies Bruce, Advanced Unsaturated Soil Mechanism and Engineering, Taylor & Francis Group, 2007.*	4. *Ning Lu, Laureano R. Hoyes, Lakshmi Reddi, Advances in Unsaturated Soil, Seepage and Environmental Geotechnics, ASCE, Geotechnical Special Publication No.148.* 5. *Jean- Louis Briaud, Geotechnical Engineering: Unsaturated and Saturated Soils, John Wiley & Sons, INC, New Jersey, 2013.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*20%*	-	*15%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*25%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. N. Kamaraj, Chief Engineer, SRM construction, nkamaraj@yahoo.com*	1. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	*1. Dr. V.Janani, SRMIST*
2. *Dr. P. Manoharan, AEE, Town Panchayat, Kancheepuram, manorasi65@gmail.com*	2. *Dr. K. Premalatha, Professor, Anna University, kvpremalatha@yahoo.com*	*2. Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEE617T	Course Name	MACHINE FOUNDATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*learn the basic knowledge in machine vibrations and frequency of foundation soil system.*
CLR-2:	*learn the general concepts of wave propagation and dynamic soil properties*
CLR-3:	*analyse the modelling of soil medium and design machine foundations*
CLR-4:	*explore the methods of static and dynamic analysis and foundation design for reciprocating and impact machines.*
CLR-5:	*create the knowledge to the design of concrete foundation and different vibration isolation methods.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*understand the basic knowledge in machine vibrations.*	*1*	*2*	*1*
CO-2:	*analyze the concepts of wave propagation with dynamic properties of soil.*	*2*	*3*	*2*
CO-3:	*apply the principles of design of machine foundations.*	*2*	*3*	*2*
CO-4:	*apply the ability to design foundations for reciprocating and impact machines.*	*2*	*2*	*2*
CO-5:	*analyze the design of concrete foundation different and apply the vibration isolation methods.*	*2*	*2*	*3*

Module-1 - Theory of Vibrations	***9 Hour***
Basic definitions, Free and Forced vibrations with and without damping for Single degree freedom system, Resonance and its effect, Magnification, Logarithmic decrement, Transmissibility, Natural frequency of foundation soil system and IS methods	
Module-2 – Wave Propagation and Dynamic Soil Properties	***9 Hour***
Elastic waves in Rods, Waves in elastic Half space, Field and Laboratory methods of determination, Uphole, Down hole and Cross hole methods, Cyclic plate load test, Block vibration test, Interpretation and analysis of field and laboratory tests.	
Module-3 – Design of Machine Foundations	***9 Hour***
Modelling of soil medium by frequency dependent and frequency independent elements, Effect of soil material damping and shape, Basic principles of design of machine foundations, types of foundations, Degree of freedom of machine foundation.	
Module-4 – Design of Foundations for Reciprocating and Impact Machines	***9 Hour***
Foundation analysis: static and dynamic analysis, Effect of foundation embedment, Analysis of Two Degree freedom systems under free and forced vibrations -Principles of Design of Foundations for reciprocating and impact machines as per IS code.	
Module-5 – Concrete Foundation and Vibration Analysis	***9 Hour***
Analysis and design of concrete foundation, block foundations for reciprocating engines, Low speed rotary machines, Forge hammers and frame foundations for high speed rotary machineries, Types and methods – Isolating materials and their properties	

Learning Resources	1. Barkan, D., "Dynamics of Bases and Foundations", McGraw Hill Publishing, 1970. 2. Shamsher Prakash, "Soil Dynamics", John Wiley, 2000. 3. Richart, Hall and Woods, "Vibration of Soils and Foundations", Prentice Hall, 1981.	4. Prasad.B.B., "Advance Soil Dynamics and Earthquake Engineering", PHI, 2011. 5. Srinivasulu.P and Vaidyanathan..G.V, "Handbook of Machine Foundations", Tata McGraw Hill, 1999.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	10%	-	10%	-	10%	-
Level 6	Create	10%	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.P.D.Arumairaj, (Retired professor, GCT- Coimbatore) Managing Director, Alzum Geocivil Integrated Services Pvt.Ltd, Coimbatore. Email; arumairajcbe@gmail.com	1. Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com	1. Dr. Divya Krishnan K, SRMIST
2. Er. A. Vetriselvan, L&T ECC, Chennai, avsn@lntecc.com	2. Dr. S. V. Ramasamy, Professor (Retd), Anna University, prof.svramaswamy@gmail.com	2. Dr. P.T. Ravichandran, SRMIST

Course Code	21CEE618T	Course Name	GEOPHYSICAL EXPLORATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the basic concepts and principles of geophysical explorations.*
CLR-2:	*analyse the principles of gravity anomaly and gravity surveys.*
CLR-3:	*explore the identification and interpretation of magnetic anomalies of sheets and dykes.*
CLR-4:	*identify the importance of electrical and electromagnetic methods and applications.*
CLR-5:	*acquire the knowledge of seismic data acquisition on land and sea and seismic data processing.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*evaluate the basic concepts and principles of geophysical explorations.*	1	2	1
CO-2:	*explore the principles of gravity anomaly and gravity surveys.*	2	3	2
CO-3:	*analyze the importance and interpretation of magnetic anomalies of sheets and dykes.*	3	2	3
CO-4:	*understand the importance of electrical and electromagnetic methods and applications.*	1	1	1
CO-5:	*acquire the knowledge of seismic data acquisition on land and sea and technological advances in seismic data processing.*	2	2	3

Module-1 - Overview of Geophysical Methods	***9 Hour***
Overview of geophysical methods of exploration; classification – major and minor; artificial and natural, applications and limitations, need for integrated surveys. Physical properties of rocks and factors controlling the properties. Role of geophysics in understanding the internal structure of the earth and plate tectonics.	
Module-2 – Gravity Exploration	***9 Hour***
Gravity Methods, Principle of gravity exploration, concept of gravity anomaly, gravity surveys. Reduction of data, free air, Bougrer and topographic correlations; concepts of regional and residuals; contamination and derivative maps.	
Module-3 – Magnetic Methods and Anomaly Maps	***9 Hour***
Magnetic Methods, Earth's magnetic field, origin; magnetic elements, interrelationships, transient and temporal variations, principle of magnetic method, anomaly maps, identification and interpretation of magnetic anomalies of sheets and dykes.	
Module-4 – Resistivity Methods and Electromagnetic Methods	***9 Hour***
Electrical and Electromagnetic Methods, resistivity method, concept of apparent resistivity, Werner, Schlumberger and Dipole-dipole configurations; electrical sounding and electrical profiling, elements of electromagnetic methods, application in oil exploration.	
Module-5 – Seismic Methods and Data Processing	***9 Hour***
Seismic Methods, Elastic propagation soil, principles of seismic refraction method, travel time curves and interpretation of results; seismic data acquisition on land and sea. Technological advances in seismic data processing and its geotechnical applications.	

Learning Resources	1. *Dobrin, M.B. and Savit, C.H, Introduction to geophysical prospecting, McGraw Hill, 1988.* 2. *John Wayne, Geophysical Exploration of Petroleum Products, Oxford Book Company, 2024.* 3. *Coffeen, J.A, Seismic exploration fundamentals and seismic techniques for finding oil, PennWell Books, 1978.*	4. *Luc T. Ikelle, Coding and Decoding: Seismic Data: The Concept of Multishooting, Elsevier; 2017.* 5. *Michael Dentith, Stephen T. Mudge, Geophysics for the Mineral Exploration Geoscientist, Cambridge University Press, 2014.* 6. *Jhon, Milsom, Field Geophysics, John Wiley, 2003.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	10%	-	10%	-	10%	-
Level 6	Create	10%	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. N. Kamaraj, Chief Engineer, SRM construction, nkamaraj@yahoo.com*	1. *Dr. P. Vasanthi, Professor and Dean, Cresent Institute of Science and Technology, vasanthi@bsauniv.ac.in*	1. *Dr. Divya Krishnan K, SRMIST*
2. *Dr. P. Selvanambi, Divisional Engineer (Highways) NABARD & Rural Works, Dharmapuri, sundariselvam@yahoo.com*	2. *Dr. S. V. Ramasamy, Professor (Retd), Anna University, prof.svramaswamy@gmail.com*	2. *Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEE619T	Course Name	DYNAMICS OF SOILS AND FOUNDATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*identify the different type of dynamic loads and theory of vibration of different systems*
CLR-2:	*analyse the different dynamic properties from different testing principles and applications*
CLR-3:	*identify the analysis and design of reciprocating machines based on different methods.*
CLR-4:	*solve the analysis and design of impact and rotary machines*
CLR-5:	*identify the influence of vibration from different dynamic source and design suitable remediation*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*analyse the different type of dynamic loads and theory of vibration of different systems*	*3*	*2*	*2*
CO-2:	*identify the different dynamic properties from different testing principles and applications*	*3*	*3*	*2*
CO-3:	*identify the knowledge on design of reciprocating machines based on different methods.*	*3*	*2*	*2*
CO-4:	*calculate the design of impact and rotary machines*	*3*	*2*	*2*
CO-5:	*analyse the influence of vibration from different dynamic source and design suitable remediation*	*3*	*2*	*1*

Module-1 - Theory of Vibration	***9 Hour***
Nature of dynamic loads - Vibrations of single degree freedom system - Free vibrations of spring - Mass systems - Forced vibrations - Viscous damping, Transmissibility - Principles of vibration measuring instruments - Vibrations of multi degree freedom system	
Module-2 - Dynamic Behaviour	***9 Hour***
Dynamic stress and strain characteristics - Deformation and strength of soils - Principles of measuring dynamic properties - Laboratory Techniques - Field tests - Factors affecting dynamic properties - Dynamic bearing capacity – Dynamic earth pressure.	
Module-3 - Foundations for Reciprocating Machines	***9 Hour***
Types of machines and foundations - General requirements - Modes of vibration of a rigid foundation, block method of analysis - Linear Elastic weightless spring method - Elastic half space method - Analog models; Design of Block foundation - Codal Provisions	
Module-4 - Foundation for Impact and Rotary Machines	***9 Hour***
Dynamic analysis of impact type machines - Design of Hammer foundations - Use of vibrator absorbers - Design - Codal recommendation - Special consideration for rotary machines - Design criteria - Loads on turbo generator foundation - Method of analysis – Design - Dynamic soil structure interaction - Codal Provisions.	
Module-5 - Vibration Isolation	***9 Hour***
Mechanism of Liquefaction - Influencing factors - Evaluation of Liquefaction potential based on SPT - Force isolation - Motion isolation - Use of spring and damping materials - Salient construction aspects of machine Foundations.	

Learning Resources	1. *Kameswara Rao, N.S.V, Dynamics soil tests and applications, Wheeler Publishing, New Delhi, 2000.* 2. *Moore, P.J, Analysis & Design of Foundations for Vibrations, Oxford & IBH, 2006.* 3. *Krammer S.L, Geotechnical Earthquake Engineering, Prentice Hall, International Series, Pearson Education (Singapore) Pvt. Ltd., 2004.* 4. *Prakash, S and Puri, V.K, Foundations for machines, McGraw Hill, 1987.*	5. *Swami Saran, Soil Dynamics and Machine Foundation, Galgotia publications Pvt. Ltd., New Delhi 1999.* 6. *Kameswara Rao, Vibration Analysis and Foundation Dynamics, Wheeler Publishing, New Delhi, 1998.* 7. *A. K. Chopra, Dynamics of Structures, Theory and Applications to Earthquake Engineering, 5th edition, Pearson Education, 2017..*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*15%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*25%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Er. V. T. Ashok Kumar, AEE, Erode Corporation, akr2310@gmail.com*	1. *Dr. K. Premalatha, Professor, Anna University, kvpremalatha@yahoo.com*	1. *Dr. P.T. Ravichandran, SRMIST*
2. *Er. A. Vetriselvan, L&T ECC, Chennai, avsn@Intecc.com*	2. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	2. *Dr. V. Janani, SRMIST*

Course Code	21CEE620T	Course Name	OFFSHORE GEOTECHNIQUES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*explore the type of soil strata available in offshore and geotechnical investigations.*
CLR-2:	*evaluate the foundations and study the foundation stability of offshore structures.*
CLR-3:	*evaluate the types and design loads and prediction of individual footing performance.*
CLR-4:	*utilize the concepts for analysis of pile driving, deformation and dynamic response in pile foundation.*
CLR-5:	*identify the causes of seafloor instability, piles for offshore structures and submarine pipelines.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*understand the type of soil strata available in offshore and geotechnical investigations.*	2	2	1
CO-2:	*analyze the foundation stability of offshore structures and the design considerations.*	2	2	2
CO-3:	*analyse the types and design loads and prediction of individual footing performance.*	2	1	3
CO-4:	*apply the analysis in pile driving, deformation and dynamic response in pile foundation.*	3	2	3
CO-5:	*estimate the causes of seafloor instability, piles for offshore structures and submarine pipe lines*	3	2	2

Module-1 - Nature of Submarine Soils	***9 Hour***
Origin, classification and distribution of marine sediments; in-situ stress state in submarine deposits; inorganic clay deposits; calcareous sediments; siliceous sediments. Offshore Geotechnical Investigations: phases of the investigation, geophysical survey, drilling and sampling procedures, in-situ testing techniques, laboratory testing.	
Module-2 – Foundations for Offshore Gravity Structures	***9 Hour***
Construction and installation of gravity structures, instrumentation of gravity platforms, stability analysis, deformation analysis based on elastic theory, piping and erosion. Design considerations and design of suction piles for offshore structure.	
Module-3 – Foundations for Jack-up Rigs	***9 Hour***
Foundations, types and design loads, Prediction of individual footing performance, prediction of mat footing performance, seabed anchors, load capacity of anchors, breakout forces, anchor systems for floating structures.	
Module-4 – Offshore Pile Foundations	***9 Hour***
Types of offshore piles, temporary support of piled structures, dynamic analysis of pile driving, axial load capacity of offshore pile foundations, axial deformation analysis, Lateral loading analysis, and dynamic response in pile foundation.	
Module-5 – Seafloor Stability	***9 Hour***
Causes of seafloor instability, geological features of submarine slides, mechanisms of instability, slope stability under gravity forces and wave forces, Effects of soil instability on piles, installation and stability of submarine pipelines.	

Learning Resources	1. *Ben C Gerwick, jr, Construction of Marine and offshore Structures, CRC Press Inc, 3rd Edition, 2018.* 2. *Pierre Le Tirant, Seabed Reconnaissance and Offshore Soil Mechanics for the Installation of Petroleum Structures, Technip Editions, 1979.* 3. *Harry G. Poulos, Marine Geotechnics, Routledge, 1988.*	4. *Michael Tomlinson, John Woodward, Pile Design and Construction Practice, CRC Press, 6th Edition, 2014.* 5. *Gregory P. Tsinker, Port Engineering: Planning, Construction, Maintenance, and Security, Wiley, 1st Edition, 2004.* 6. *Shamsher Prakash, Hari D. Sharma, Pile Foundations in Engineering Practice, Wiley India Pvt Ltd, 2012.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 2	*Understand*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 3	*Apply*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 4	*Analyze*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 5	*Evaluate*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 6	*Create*	*15%*	*-*	*15%*	*-*	*15%*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Er. G. Srinivasa Rao, Saipem India Pvt Ltd, raoguraja@yahoo.com*	1. *Dr. M. Muttharam, Professor, Anna University, muttharam@gmail.com*	1. *Dr. Divya Krishnan K, SRMIST*
2. *Er. A. Vetriselvan, L&T ECC, Chennai, avsn@lntecc.com*	2. *Dr. G. Janardhanan, NITTTR, gjanardhanan@gmail.com*	2. *Dr. P.T. Ravichandran, SRMIST*

Course Code	21CEE621T	Course Name	DESIGN OF SUBSTRUCTURES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*identify the concepts in the analysis of foundations and basic requirements.*
CLR-2:	*evaluate the load carrying capacity of pile foundation in the field condition.*
CLR-3:	*explore the essential steps involved in different well foundations and its design.*
CLR-4:	*identify the basic principles of design of machine foundation, dynamic properties of soil and vibration analysis.*
CLR-5:	*identify the various types of foundations used in expansive soils and its principles.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*understand the concepts in the analysis of foundations and basic requirements.*	2	2	1
CO-2:	*apply the load carrying capacity of pile foundation in the field condition.*	3	3	1
CO-3:	*analyse the essential steps involved in different well foundations and its design.*	2	2	3
CO-4:	*understand the basic knowledge in machine vibrations.*	3	2	2
CO-5:	*explore the various types of foundations used in expansive soils.*	2	2	2

Module-1 – Site Investigation and Selection of Foundations	***9 Hour***
Soil investigation– Basic requirements of foundation– Types and selection of foundations. Bearing capacity of soil- plate load test, Design of reinforced concrete isolated, strip, combined and strap footings– mat foundation.	
Module-2 – Pile Foundations and its Load Carrying Capacity	***9 Hour***
Pile Foundations, Introduction, Types of pile foundations– load carrying capacity- Static and dynamic analysis, pile load test, types of pile load tests, design of straight piles, configuration of piles, different shapes of piles cap.	
Module-3 – Well Foundations and Design	***9 Hour***
Well Foundations, Types of well foundation, Elements of well foundation, Grip length Forces acting on a Well Foundation, load carrying capacity, construction stages of wells, Failures and Remedies, Design of well foundation, Lateral stability.	
Module-4 – Machine Foundations for Reciprocating Machines	***9 Hour***
Machine Foundations, Introduction, Types of machine foundation, Basic principles of design of machine foundation, Dynamic properties of soil, vibration analysis of machine foundation, Design of foundation for Reciprocating machines and Impact machines.	
Module-5 – Foundation on Expansive Soil and Considerations	***9 Hour***
Foundation on expansive soil, choice of foundation, under-reamed pile foundation, design considerations, types, Foundation for concrete Towers, chimneys, Anchors, types and design of anchors- Reinforced earth retailing walls.	

Learning Resources	1. *Swamy Saran, Analysis and Design of substructures, Oxford & IBH Publishing Co Pvt.Ltd, 2018.* 2. *Varghese. P.C, Design of Reinforced Concrete Foundation Prentice Hall India Learning Private Limited, 2009.* 3. *Braja M. Das, Principles of Geotechnical Engineering, Cengage Learning, 2002.*	4. *Bowles .J.E., Foundation Analysis and Design, McGraw-Hill Education, 2001* 5. *Swami Saran, Design of Sub-structures, Oxford & IBH Publishing Co Pvt.Ltd, 2018.* 6. *Tomlinson.M.J, Foundation Design and Construction, Pearson, 2003.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*15%*	-	*15%*	-	*15%*	-
Level 6	*Create*	*15%*	-	*15%*	-	*15%*	-
	Total	*100 %*		*100 %*		*100 %*	

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. P. Manoharan, AEE, Town Panchayat, Kancheepuram, manorasi65@gmail.com*	1. *Dr. V. Murugaiyan, Professor, PCE, Pondicherry, vpmplee@@gmail.com*	1. *Dr. Divya Krishnan K, SRMIST*
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SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

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