ACADEMIC CURRICULA

Professional Elective Courses

CIVIL ENGINEERING

Regulations - 2018

Volume – 4 (5)

(Detailed Syllabus for Third & Fourth Year Courses)

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18CEE301T	Course Name	FOUNDATION ENGINEERING AND DESIGN	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 :	*Understanding the essential steps involved in a Geotechnical Investigation*
CLR-2 :	*Analyze the principle types of foundation and the factors governing the choice of the most suitable type of foundation.*
CLR-3 :	*Get exposed to determination of bearing capacity of shallow foundation*
CLR-4 :	*Analyze the cause and remedial measures for settlement and slope failure*
CLR-5 :	*Get an insight into the load carrying capacity of pile foundation in the field condition*
CLR-6 :	*Understand and analyse the concept of earth pressure*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Identify the soil characteristics through geotechnical investigation*	*2*	*85*	*80*	*H*	*H*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*H*	*-*	*-*
CLO-2 :	*Proper type of foundation is chosen depending upon the soil condition*	*2*	*85*	*75*	*H*	*H*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*H*	*-*	*-*
CLO-3 :	*Compute g the bearing capacity of shallow foundation*	*2*	*80*	*75*	*H*	*H*	*-*	*H-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*H*	*-*	*-*
CLO-4 :	*Utilize the proper measures for reducing the settlement and slope failure*	*2*	*85*	*80*	*H*	*H*	*-*		*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*H*	*-*	*-*
CLO-5 :	*Utilize the proper type of pile in the field*	*2*	*85*	*75*	*H*	*H*	*-*	*H*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*H*	*-*	*-*
CLO-6 :	*Estimate of earth pressure for different soil condition*	*2*	*80*	*75*	*H*	*H*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*H*	*-*	*-*

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Site investigation, soil Exploration*	*Definition: Foundation, purpose of foundation.*	*Combined footing - types*	*Deep foundation – Necessity. Pile Foundations classification*	*Lateral Earth Pressures Theories-Introduction:*
	SLO-2	*Planning and stages in site investigation*	*Definition: Shallow Foundation – classification. Ultimate, gross, net, safe bearing capacity. safe and allowable bearing pressure*	*Combined footing - types*	*Pile Foundations – classification*	*applications of earth pressure theories*
S-2	SLO-1	*Soil exploration – Methods – direct, semi-direct and indirect method*	*Bearing capacity failure - modes of shear failures – general, local and punching shear failure*	*Method of proportioning – Rectangular footing*	*Load carrying capacity of pile – Methods*	*Different types of earth pressure at rest, active and passive pressure*
	SLO-2	*Direct method – test pit, trenches*	*Factors affecting bearing capacity*	*Method of proportioning – Rectangular footing*	*Dynamic method – ENR, and Hiley's - Problems*	*Different types of earth pressure at rest, active and passive pressure*
S-3	SLO-1	*Indirect methods. Geophysical methods- Seismic Refraction Method*	*Bearing capacity determinations – Methods.*	*Method of proportioning – Trapezoidal footing*	*Static method – all type of soils - problems*	*Rankine's Earth Pressure Theory, active earth pressure and passive earth pressure for horizontal backfill for cohesion-less soil*
	SLO-2	*Geophysical methods- Electrical Resistivity Method*	*Terzaghi theory – Assumption.*	*Method of proportioning – Trapezoidal footing*	*Static method – all type of soils - problems*	*Rankine's Earth Pressure Theory, active earth pressure and passive earth pressure for horizontal backfill for cohesion-less soil*
S-4	SLO-1	*Indirect method – SPT*	*Bearing capacity – Strip and Square foundation*	*Combined footing - problems*	*Static method – all type of soils - problems*	*Rankine's Earth Pressure Theory, active earth pressure and passive earth pressure for horizontal backfill for cohesion-less soil-Problems*

	SLO-2	*Indirect method – SPT*	*Bearing capacity – Circular and Rectangular foundation*	*Combined footing - problems*	*Static method – all type of soils - problems*	*Rankine's Earth Pressure Theory, active earth pressure and passive earth pressure for horizontal backfill for cohesion-less soil-Problems*
S-5	SLO-1	*Indirect method – DCPT*	*Bearing capacity – effect of water table*	*Settlement – total and differential settlement.*	*Pile load capacity – penetration test results*	*Rankine's Earth Pressure Theory, active earth pressure and passive earth pressure for horizontal backfill for cohesive soils.*
	SLO-2	*Indirect method –SCPT*	*Bearing capacity – effect of water table*	*Settlement – total and differential settlement.*	*Pile load capacity – penetration test results*	*Rankine's Earth Pressure Theory, active earth pressure and passive earth pressure for horizontal backfill for cohesive soils*
S6	SLO-1	*Semi direct method Borings – auger*	*Bearing capacity - problems*	*Causes and methods to minimize the total settlement*	*Pile group – efficiency - problems*	*Rankine's Earth Pressure Theory, active earth pressure and passive earth pressure for horizontal backfill for cohesive soils-Problems*
	SLO-2	*Semi direct method Borings –shell and auger*	*Bearing capacity - problems*	*Causes and methods to minimize the total settlement*	*Pile group – efficiency - problems*	*Rankine's Earth Pressure Theory, active earth pressure and passive earth pressure for horizontal backfill for cohesive soils-Problems*
S-7	SLO-1	*Semi direct method Borings – wash boring and rotary drilling*	*Bearing capacity - problems*	*Causes and methods to minimize the differential settlement*	*Pile group – efficiency - problems*	*Earth pressure theories – Graphical method*
	SLO-2	*Semi direct method Borings – percussion method*	*Bearing capacity - problems*	*Causes and methods to minimize the differential settlement*	*Pile group – efficiency - problems*	*Earth pressure theories – Graphical method*
S-8	SLO-1	*Number and deposition of trail pits and borings*	*Hansen and IS code method*	*Slopes – types – Causes of slope failure*	*Pile load test : Types - Load carrying capacity of pile, under-reamed pile and pile group*	*Rebhann's Construction for Active Pressure*
	SLO-2	*Bore log details*	*Bearing capacity from Penetration test results*	*Methods to minimize the slope failure*	*load test as per BIS – estimation of load carrying capacity*	*Rebhann's Construction for Active Pressure*
S-9	SLO-1	*Soil Sample ; UDS*	*Bearing capacity : Plate load test as per BIS ,*	*Slope stability – methods - Swedish Method of Slice for a Cohesive-frictional Soil*	*Problems in pile load test.*	*Culmann'sgraphical solutions for active and passive case*
	SLO-2	*Soil Sample ; DS*	*limitations and estimation of settlements - Performance of foundation*	*Slope stability – methods - Swedish Method of Slice for a Cohesive-frictional Soil*	*Negative skin friction*	*Culmann'sgraphical solutions for active and passive case*

Learning Resources	1. *Joseph.E Bowles, "Foundation Analysis and Design", Mc Graw Hill Publishing co., 2001.* 2. *Murthy .V.N.S, "Textbook of Soil Mechanics and Foundation Engineering", CBS Publishersand Distributors, New Delhi, 2009.* 3. *Arora .K.R. "Soil Mechanics and Foundation Engineering", Standard Publishers and Distributors, New Delhi, 2011.* 4. *Varghese, P.C., "Foundation Engineering", PHI Learning New Delhi. 2011*	5. *Punmia.B.C., "Soil Mechanics and Foundations", Laxmi publications Pvt Ltd., 2000.* 6. *Das .B.M, "Principles of Foundation Engineering", (Fifth Edition), Thomson Books, 2010.* 7. *NPTEL Course – Advanced Foundation Engineering : https://nptel.ac.in/courses/105105039/* 8. *NPTEL Course – Foundation Engineering : https://nptel.ac.in/courses/105101083/*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*50%*	-	*40%*	-	*40%*	-	*45%*	-	*70%*	-
	Understand										
Level 2	Apply	*50%*	-	*60%*	-	*60%*	-	*55%*	-	*30%*	-
	Analyze										
Level 3	Evaluate	-	-	-	-	-	-	-	-	-	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4: Assignments and / or Field visits

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. P.Selvanambi, Divisional Engineer (Highways), sundariselvam@yahoo.com	*Dr.M.Muttharam, Anna University, muttharam@annauniv.edu*	*Dr. P.T. Ravichandran, SRMIST*
Mr.Lenin K.R., Head –GEOTECH, SECON Private Limited, Bangalore, lenin.kr@secon.in	*Dr.V.Murugaiyan, Pondichery Engineering College, vmurugaiyan@pec.edu*	*Ms. S. Mary Rebekah Sharmila, SRMIST.*

Course Code	18CEE302T	Course Name	GEOTECHNICAL DESIGN	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 essential steps involved in a Geotechnical Investigation*
CLR-2 :	*Understand the concept of consolidation and the estimation of preconsolidation pressure*
CLR-3 :	*Analyze the stress strain behavior of different types of soil*
CLR-4 :	*Compute of the ultimate load carrying capacity of shallow foundation under different field condition*
CLR-5 :	*Estimate of pile load capacity and settlement of single and group of piles*
CLR-6 :	*Utilize the ultimate loads of shallow and pile foundation in the civil engineering field*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Analyze the soil properties based on geotechnical investigation*	2	85	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	*Utilize the preconsolidation pressure for determining the rate of consolidation*	2	85	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	*Utilize the stress strain behavior of soil in the field*	2	80	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-4 :	*Identify the application of ultimate loads of shallow foundation in the field*	2	85	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-5 :	*Identify the application of ultimate loads of pile foundation in the field*	2	85	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-6 :	*Apply of shallow and deep foundation in the field*	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Planning of subsurface investigation*	*Terzaghi's theory of one dimensional consolidation*	*Stress and strain behavior of soil*	*Bearing capacity and settlement analysis of shallow foundations: Modes of failure*	*Pile foundation: Functions*
	SLO-2	*Purpose and scope*	*Terzaghi's theory of one dimensional consolidation*	*Stress and strain behavior of soil*	*Bearing capacity and settlement analysis of shallow foundations: Modes of failure*	*Pile foundation: Functions*
S-2	SLO-1	*Influence of soil conditions on exploratory program*	*Derivation of Terzaghi's equation (solution in detail need not be covered)*	*Triaxial test -drained and un-drained behavior of sand*	*Failure criteria, Prandtl Reissner Method, Assumptions - Estimation of ultimate loads,*	*Types of pile foundations*
	SLO-2	*Type of foundation on exploratory program*	*Derivation of Terzaghi's equation (solution in detail need not be covered)*	*Triaxial test -drained and un-drained behavior of sand*	*Failure criteria, Prandtl Reissner Method, Assumptions - Estimation of ultimate loads,*	*Types of pile foundations*
S-3	SLO-1	*Subsurface soundings –Static methods*	*Estimation of Cc and Cv from laboratory tests*	*Triaxial test -drained and un-drained behavior of clays*	*Terzaghi solution, Assumptions - Estimation of ultimate loads*	*Pile load tests, Use of load tests*
	SLO-2	*Subsurface soundings –Static methods*	*Estimation of Cc and Cv from laboratory tests*	*Triaxial test -drained and un-drained behavior of clays*	*Terzaghi solution, Assumptions - Estimation of ultimate loads*	*Pile load tests, Use of load tests*
S-4	SLO-1	*Subsurface soundings – Dynamic methods*	*Estimation of Cc and Cv from laboratory tests*	*Failure criteria in soils –only Mohr – Coulomb's criteria*	*Estimation of ultimate loads- Effect of shape,*	*Methods of estimation of pile load capacity- Static and dynamic*
	SLO-2	*Subsurface soundings – Dynamic methods*	*Estimation of Cc and Cv from laboratory tests*	*Failure criteria in soils –only Mohr – Coulomb's criteria*	*Estimation of ultimate loads- Effect of shape,*	*Methods of estimation of pile load capacity- Static and dynamic*
S-5	SLO-1	*Planning of subsurface investigations*	*Estimation of Pc by various methods*	*Ideal, plastic and real soil behavior*	*Estimation of ultimate loads- embedment of footing*	*Estimation of single pile capacity by static*
	SLO-2	*Planning of subsurface investigations*	*Estimation of Pc by various methods*	*Ideal, plastic and real soil behavior*	*Estimation of ultimate loads- embedment of footing*	*Estimation of single pile capacity by static*
S6	SLO-1	*Planning of subsurface investigations*	*Field consolidation curves*	*Shear strength of sand and clays*	*Estimation of ultimate loads- eccentricity in loading*	*Estimation of single pile by dynamic methods*

	SLO-2	*Planning of subsurface investigations*	*Field consolidation curves*	*Shear strength of sand and clays*	*Estimation of ultimate loads- eccentricity in loading*	*Estimation of single pile by dynamic methods*
S-7	SLO-1	*Type and sequence of operations*	*Quasi pre-consolidation*	*Estimation of stresses: Boussinesq's theory*	*Compressibility (including critical rigidity index), Choice of factor of safety, Settlement of foundations on sand –Schmertmann method*	*Group capacity of piles*
	SLO-2	*Type and sequence of operations*	*Quasi pre-consolidation*	*Estimation of stresses: Boussinesq's theory*	*Compressibility (including critical rigidity index), Choice of factor of safety, Settlement of foundations on sand –Schmertmann method*	*Group capacity of piles*
S-8	SLO-1	*Lateral extent and depth of exploration*	*Quasi Secondary consolidation*	*Estimation of stresses: Westergard's theory*	*Foundations on collapsing and swelling soils, non-uniform soils, compressible soils and on rock*	*Separation of skin friction and end bearing capacity*
	SLO-2	*Lateral extent and depth of exploration*	*Quasi Secondary consolidation*	*Estimation of stresses: Westergard's theory*	*Foundations on collapsing and swelling soils, non-uniform soils, compressible soils and on rock*	*Separation of skin friction and end bearing capacity*
S-9	SLO-1	*Interpretation of field and laboratory data*	*Practical applications*	*Estimation of stresses: Newmark's charts*	*Design of isolated and combined footings*	*Settlement of single and group of piles.*
	SLO-2	*Interpretation of field and laboratory data*	*Practical applications*	*Estimation of stresses: Newmark's charts*	*Design of isolated and combined footings*	*Settlement of single and group of piles.*

Learning Resources	1. *Joseph.E Bowles, "Foundation Analysis and Design", Mc Graw Hill Publishing co., 2001.* 2. *Murthy .V.N.S, "Textbook of Soil Mechanics and Foundation Engineering", CBS Publishersand Distributors, New Delhi, 2009.* 3. *Arora .K.R. "Soil Mechanics and Foundation Engineering", Standard Publishers and Distributors, New Delhi, 2011.*	4. *Varghese, P.C., "Foundation Engineering", PHI Learning New Delhi. 2011* 5. *Punmia.B.C., "Soil Mechanics and Foundations", Laxmi publications Pvt Ltd., 2000.* 6. *Das .B.M, "Principles of Foundation Engineering", (Fifth Edition), Thomson Books, 2010.* 7. *NPTEL Course – Foundation Design : https://nptel.ac.in/courses/105104162/*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*50%*	-	*40%*	-	*40%*	-	*45%*	-	*70%*	-
	Understand										
Level 2	Apply	*50%*	-	*60%*	-	*60%*	-	*55%*	-	*30%*	-
	Analyze										
Level 3	Evaluate	-	-	-	-	-	-	-	-	-	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 : Assignments and / or Field visits

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. P.Selvanambi, Divisional Engineer (Highways), sundariselvam@yahoo.com	*Dr.M.Muttharam, Anna University, muttharam@annauniv.edu*	*Dr. P.T. Ravichandran, SRMIST*
Mr.Lenin K.R., Head –GEOTECH, SECON Private Limited, Bangalore, lenin.kr@secon.in	*Dr.V.Murugaiyan, Pondichery Engineering College, vmurugaiyan@pec.edu*	*Ms.S. Mary Rebekah Sharmila, SRMIST.*

Course	18CEE303T	Course	GROUND IMPROVEMENT TECHNIQUES	Course	E	*Professional Elective*	L	T	P	C

Code		Name		Category			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:*	Learning		
		1	2	3
CLR-1 :	*Understand the need for ground improvement*			
CLR-2 :	*Understand the techniques adopted for ground improvement with respect to hydraulic modification*			
CLR-3 :	*Identify conceptual and practical understanding of in-situ soil densification techniques*			
CLR-4 :	*Familiarize with soil chemical modification techniques and acquaintance with emerging technologies*			
CLR-5 :	*Understand the mechanism and concept related to soil modification by reinforcements*			
CLR-6 :	*Recommend and design cost effective ground improvement techniques for difficult practical soil conditions*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Gain a thorough knowledge on the role of ground improvement techniques in the infrastructure development*	*2*	*85*	*80*	*H*	*L*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-2 :	*Recommend hydraulic modification techniques for related problems*	*2*	*85*	*75*	*H*	*M*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-3 :	*Apply densification techniques for loose sand deposits and alternative techniques for soft clay deposits*	*2*	*80*	*75*	*H*	*M*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-4 :	*Recommend additives and frame soil chemical modification schemes for stabilizing problematic soil*	*2*	*85*	*80*	*H*	*M*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-5 :	*Design geotechnical structures using reinforcements like reinforced earth retaining walls, slopes, foundations etc.,.*	*3*	*85*	*75*	*H*	*H*	-	*M*	-	-	-	-	-	-	-	-	*H*	-	-
CLO-6 :	*Recommend design efficient and economic alternatives using ground improvement techniques for problematic and difficult sites*	*3*	*80*	*75*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction-Ground improvement techniques*	*Hydraulic modification-concept and principle*	*In-situ densification of cohesionless soil*	*Grouting -introduction*	*Soil reinforcement concepts*
	SLO-2	*Role of ground improvement techniques in foundation engineering*	*Dewatering -objectives -types*	*Various Methods and mechanism involved*	*Necessity types of grout-suspension-solution grouts*	*Principle and mechanism*
S-2	SLO-1	*Objectives and scope of ground improvement techniques*	*Dewatering Techniques -well points system*	*Consolidation of cohesive soil-types*	*Functions of grouting-permeation*	*Reinforced earth retaining structures-various applicability in geotechnical engineering*
	SLO-2	*Classification of techniques adopted*	*Installation -mechanism and suitability of soil*	*Properties and behaviour*	*Functions-Compaction-hydro fracture*	*Embankments -slopes etc..*
S-3	SLO-1	*Hydraulic-Mechanical-Chemical-Reinforcement*	*Dewatering methods-Ditches*	*Vibrofloatation techniques*	*Grouting equipment and methods*	*Types of reinforcing materials*
	SLO-2	*Choice of method of ground improvement techniques*	*Dewatering methods-Sumps*	*Dry feed method-wet feed method*	*Grouting with soil, bentonite*	*Natural and manmade materials*
S-4	SLO-1	*Geotechnical problems in Lateritic soil*	*Dewatering methods -Vacuum method.*	*Sand compaction piles*	*Grouting with cement mixes*	*Geosynthetics-types*
	SLO-2	*Properties and behavior and techniques adopted*	*Dewatering methods-Electroosmotic method*	*Installation techniques*	*Mechanism and concept*	*Geotextile-geogrids-geonets*
S-5	SLO-1	*Geotechnical problems in Alluvial soil*	*Seepage analysis of 2-dimensional flow-concepts*	*Deep compaction -dynamic compaction -blasting technique*	*Grout injection methods*	*Functions of geosynthetics*
	SLO-2	*Properties and behavior and techniques*	*Theory and problems*	*Concepts and factors influencing*	*grout monitoring schemes*	*Filtration, drainage*

		adopted				
S6	SLO-1	*Geotechnical problems in Black Cotton soil*	*Seepage analysis-fully penetrated slot*	*Stone columns -installation*	*Civil engineering application of grouting techniques*	*Geosynthetics-Reinforcement*
	SLO-2	*Properties and behavior and techniques adopted*	*Theory and problems*	*Mechanism*	*Some of the field studies*	*Separation function -Geotechnical field application*
S-7	SLO-1	Selection of suitable ground improvement techniques based on soil condition	Preloading-concept	Design criteria	Stabilization -concept	Geomembranes-containments
	SLO-2	Some field conditions for practical applicability	Field applicability	Stone column- soil criteria-field application	Stabilization of expansive soil	Barriers- field application
S-8	SLO-1	Use of Piezometers	Vertical drains-sand drains	Lime columns-applicability	Lime stabilization-concept-suitability criteria	Current practices-geosynthetics
	SLO-2	Field applications	Installation and mechanism	Soil criteria-mechanism involved	Mechanism involved	Field application reinforcement
S-9	SLO-1	Use of inclinometers	Prefabricated vertical drains	Field application	Cement stabilization -concept-suitability criteria	Geosynthetics in field applications
	SLO-2	Field applications	Installation and mechanism	Installation -mechanism	Mechanism involved	Introduction of ground anchors

Learning Resources	1. *Purushothama Raj. P, "Ground Improvement Techniques", Lakshmi Publications, 2ndEdition, 2016.* 2. *Manfired R. Hausmann, Engineering Principles of Ground Modification, McGraw-Hill Pub, Co., 1990.* 3. *Koerner, R.M. "Construction and Geotechnical Methods in Foundation Engineering", McGraw Hill, 1994.*	4. *Nihar Ranjan Patra, "Ground Improvement Techniques", Vikas Publishing House, FirstEdition, 2012.* 5. *Mittal.S, "An Introduction to Ground Improvement Engineering", Medtech Publisher, First Edition, 2013.* 6. *NPTEL Course - Advanced Techniques in Geotechnical and Foundation Engineering : https://nptel.ac.in/courses/105106144/* 7. *NPTEL Course - Ground Improvement Techniques : https://nptel.ac.in/courses/105108075/*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
Level 2	Apply Analyze	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
Level 3	Evaluate Create	20%	-	30%	-	30%	-	30%	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. P.Selvanambi, Divisional Engineer (Highways), sundariselvam@yahoo.com	*Dr.M. Muttharam, Anna University, muttharam@annauniv.edu*	*Dr. P.T. Ravichandran, SRMIST*
Mr. K.R. Lenin Head –GEOTECH, SECON Private Limited, Bangalore, lenin.kr@secon.in	*Dr.V. Murugaiyan, Pondichery Engineering College, vmurugaiyan@pec.edu*	*Dr. S. Bhuvaneshwari, SRMIST*

Course Code	18CEE304T	Course Name	FOUNDATION ON EXPANSIVE SOIL	Course Category	E	*Professional Elective Course*	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:*	Learning	Program Learning Outcomes (PLO)

		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand the occurrence and distribution of expansive soils			
CLR-2 :	Deals the properties of expansive soils			
CLR-3 :	Identify the various methods of prediction of heave			
CLR-4 :	Analyse the design procedure for foundation on expansive soils			
CLR-5 :	Identify the various methods of stabilization used in expansive soils			
CLR-6 :	Create overall knowledge on properties and performance of expansive soil and design of foundation on expansive soil			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Gaining the knowledge of the occurrence and distribution of expansive soils	*2*	*85*	*80*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-2 :	Identify the properties of expansive soils	*2*	*85*	*75*	*H*	*H*	-	*M*	-	-	-	-	-	-	-	-	*H*	-	-
CLO-3 :	Identify the knowledge on various methods of prediction of heave	*2*	*80*	*75*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-4 :	Apply the design procedure for foundation on expansive soils	*3*	*85*	*80*	*H*	*H*	-	*M*	-	-	-	-	-	-	-	-	*H*	-	-
CLO-5 :	Analyse the various methods of stabilization used in expansive soils	*2*	*85*	*80*	*H*	*H*	-	*M*	-	-	-	-	-	-	-	-	*H*	-	-
CLO-6 :	Acquire knowledge on design of suitable foundations on expansive soil	*2*	*80*	*75*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-

Duration (hour)		09	09	09	09	09
S-1	SLO-1	*Introduction- Expansive soils an overview*	*Soil structure – coarse grained soil*	*Clay mineralogy - Types of Clay minerals*	*Design alternatives*	*Methods Controlling Swelling characteristics of expansive soil – Prewetting*
	SLO-2	*Occurrence of expansive soil*	*Soil structure – Fine grained soil*	*Basic structural unit*	*Structural Alternatives – Soil Alternatives*	*Surface and subsurface drainage*
S-2	SLO-1	*Distribution of expansive soil*	*Composite structure*	*Synthesisation of clay mineral*	*Isolation of structre from soil*	*Treatment of expansive soils -Surcharge loading,*
	SLO-2	*Nature of expansive soil with moisture content*	*Specific surface - adsorbed and absorbed water*	*Properties and characterisation of clay minerals*	*Recommendations for type of foundation in expansive soils*	*Concept Moisture barriers - Horizontal moisture barriers*
S-3	SLO-1	*Environmental interaction*	*Field exploration methods soils - Sounding test*	*Minerological methods - X – Ray diffraction*	*Design consideration - Individual*	*Moisture barriers - Vertical moisture barriers*
	SLO-2	*Physical properties of expansive soils*	*Identification of expansive – laboratory methods*	*Differential Thermal Analysis*	*Design consideration - Continuous footings*	*Soil replacement with compaction control*
S-4	SLO-1	*Effect of expansive soils on structures*	*Atterberg limit*	*Electron microscopy*	*Stiffened mats - Codal provisions.*	*Soil Stabilization-concept*
	SLO-2	*Problems and Remedies of expansive soils*	*CEC*	*Potential Volume Change*	*Under reamed piles - Design*	*Mechanical stabilization – Types and concept*
S-5	SLO-1	*Identification of expansive soils*	*Swelling characteristics – Laboratory tests*	*Expansion Index Test*	*Under reamed piles construction*	*Chemical stabilisation*
	SLO-2	*Assessment of Expansion Potential*	*Swell potential identification from Atterberg limit*	*Coefficient Of Linear Extensibility (Cole)*	*Advantages and disadvantages of Under reamed piles*	*Cement stabilization- Advantages and disadvantages*

S6	SLO-1	*Moisture equilibrium – concept*	*Casagrande's PI-LL Chart*	*Methods of prediction of heave - Empirical methods*	*Double under reamed pile*	*Lime stabilization – mechanism involved and its limitations*
	SLO-2	*Stable and unstable zone*	*Swell potential identification from Activity index and particle size*	*Soil suction – Osmotic and matric*	*Load test on Under reamed pile*	*Bituminous stabilization*
S-7	SLO-1	*Shrink – swell potential of expansive soil*	*Diffferential free swell – classification using engineering properties*	*Measurement of soil suction - methods*	*Estimation of load carrying capacity from under reamed pile*	*Thermal stabilization- Thermal Technique- concept*
	SLO-2	*Field conditions that favour swelling*	*Swell Pressure mesaruement*	*Tensio meter*	*Belled piers – Bearing capacity and skin friction*	*Thermal stabilization – Freezing Technique- concept*
S-8	SLO-1	*Consequences of swelling*	*Analysis on swell pressure*	*Axis translation*	*Advantages and disadvantages of belled piers*	*Industrial waste in soil stabilisation*
	SLO-2	*Distress symptoms*	*Isomporphous substitution*	*Psychrometers*	*Stiffened slab on grade*	*Use of fly ash in soil stabilsation*
S-9	SLO-1	*Damage on Foundations from Expansive Soils*	*Diffused double layer of water*	*Filter paper method*	*Drilled pier and beam*	*Types of fly ash - characteristics*
	SLO-2	*Factors influencing swelling and shrinkage of soils*	*Specific surface area*	*Thermal Matric Potential Sensors*	*Underpinning method*	*Sustainable materials in stabilisation*

Learning Resources	1. *John .D.N & Debora .J.M, "Expansive Soils Problems and Practice In Foundation & Pavement Engineering", 1992.* 2. *Chenn.F.R, "Foundation on Expansive Soils"- Elsevier, 1973.*	3. *Parcher.J.V & Means .R.E, "Soil Mechanics and Foundations", Columbus, 1968.* 4. *Boominathan. S,"Lecture Notes on Structures on Expansive Soil", College of Engineering,Guindy, Anna University, Chennai. 1990.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Understand										
Level 2	Apply	*30%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	30%	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 : Assignments and / or Multiple choice Quizzes

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. P.Selvanambi, Divisional Engineer (Highways) , sundariselvam@yahoo.com	*Dr.M.Muttharam, Anna University, muttharam@annauniv.edu*	*Dr. P.T. Ravichandran, SRMIST*
Mr. K.R. Lenin., Head –GEOTECH, SECON Private Limited, Bangalore, lenin.kr@secon.in	*Dr.V.Murugaiyan, Pondichery Engineering College, vmurugaiyan@pec.edu*	*Ms. Divya Krishnan K, SRMIST*

Course Code	18CEE305J	Course Name	CONCRETE TECHNOLOGY	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	*IS 10262: 2019 and IS 456: 2000*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand and test the properties of materials constitutes concrete*
CLR-2 :	*Understand about chemical and mineral admixtures used in concrete. Also understand and test fresh concrete properties*
CLR-3 :	*Know and understand the properties of concrete in hardened state*
CLR-4 :	*Know and understand the durability properties of concrete and special concrete*
CLR-5 :	*Understand the importance of concrete mix design*
CLR-6 :	*Understand the process involved in manufacture of concrete*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Test and study the properties of cement, aggregates and water*	*3*	*80*	*75*	*H*	*M*	-	-	-	-	-	-	-	-	-	-	*L*	*H*	*M*
CLO-2 :	*Know the effects of admixtures in concrete and test the fresh concrete properties*	*3*	*85*	*75*	*H*	*M*	-	-	-	-	-	-	-	-	-	-	*L*	*H*	*M*
CLO-3 :	*Test the hardened concrete properties*	*3*	*75*	*75*	*H*	*M*	-	-	-	-	-	-	-	-	-	-	*L*	*H*	*M*
CLO-4 :	*Understand the importance of durability of concrete and properties of special concrete*	*3*	*90*	*80*	*H*	*L*	-	-	-	-	-	-	-	-	-	-	*L*	*H*	*M*
CLO-5 :	*Design the concrete mix without and with admixtures*	*3*	*85*	*75*	*H*	*H*	*H*	-	-	-	-	-	-	-	-	-	*M*	*H*	*M*
CLO-6 :	*Know the various stages of manufacture of concrete*	*3*	*80*	*75*	*H*	*L*	-	-	-	-	-	-	-	-	-	-	*L*	*H*	*M*

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*CONCRETE CONSTITUENTS MATERIALS Overview. Cement, brought up, invention, chemical composition, oxide composition, limits and role.*	*ADMIXTURES Overview –Chemical and mineral admixtures – additive – plasticizers – definition – situation need high workability – effects of plasticizer in concrete.*	*HARDENED CONCRETE Test – purpose – density - compressive strength test.*	*DURABILITY OF CONCRETE Definition - significance – permeability – reasons for permeability in actual structures.*	*CONCRETE MIX DESIGN Definition – Principle of mix design – Factors choice of mix proportion – Properties of concrete related to mix design.*
	SLO-2	*Hydration - Bogue's compound – types of cement.*	*Super plasticizers – effects in – fresh and hardened concrete.*	*Factors affects strength of concrete. Failure of compression specimen.*	*Joints in concrete – classifications.*	*Physical properties of materials required for mix design.*
S-2	SLO-1	*Properties of cement - Tests on cement – field.*	*Accelerators – accelerating plasticizer.*	*Flexural strength – central point load.*	*Concrete subjected to high temperature.*	*Nominal and design mix – variables in mix design.*
	SLO-2	*Laboratory tests – fineness – specific gravity – procedures.*	*Retarders – use – materials. Water proofers.*	*Flexural strength –third point load.*	*Freezing and thawing.*	*Objective of mix design – List of methods of mix design. Basic steps — Information required for mix design.*
S-3	SLO-1	*Determination of fineness of cement and normal consistency of cement practically in lab.*	*Determination of soundness of cement (Demo only) practically in lab.*	*Determination of crushing strength of coarse aggregate practically in lab.*	*Determination of flakiness and elongation index of coarse aggregate practically in lab.*	*Determination of flexural strength of concrete practically in lab.*
	SLO-2					
S-4	SLO-1	*Consistency - setting time of cement – initial and final setting time.*	*Fly ash – characteristics – use – classification –effects in fresh and hardened concrete.*	*Indirect tension test.*	*Sulphate attack – methods to control.*	*Indian standard method of mix design - Step by step mix design procedure.*
	SLO-2	*Soundness and strength of cement.*	*Silica fume – characteristics – effects in*	*Stress – strain curve.*	*Acid attack – concrete in sea water.*	*Mix design example : Without admixture*

			fresh and hardened concrete.			
S-5	SLO-1	*Aggregates – classification – source - size – shape – texture.*	*GGBS - effects in fresh and hardened concrete – uses.*	*Modulus of elasticity –determination.*	*Carbonation - factors.*	*Mix design examples: With chemical admixture and mineral admixture*
	SLO-2	*Properties of aggregates and tests: Crushing – 10% fines – impact.*	*Metakaolin – application – advantages – uses.*	*Different elastic moduli.*	*Chloride attack – limits of chloride.*	
S-6	SLO-1	*Determination of initial setting time of cement and final setting time (Demo only) - practically in lab.*	*Determination of fineness modulus of coarse aggregate practically in lab.*	*Determination of impact resistance of coarse aggregate practically in lab.*	*Compressive strength of bricks and concrete cubes practically in lab.*	*Determination of split tensile strength of concrete practically in lab.*
	SLO-2					
S-7	SLO-1	*Abrasion – bulk density – specific gravity Absorption and moisture content – bulking.*	*FRESH CONCRETE Workability –factors – tests.*	*Impact resistance test – Impact energy.*	*Effects of some materials on durability.*	*MANUFACUTRE OF CONCRETE Process – various stages of manufacture of concrete.*
	SLO-2	*Soundness – flakiness index – elongation index.*	*Slump and compaction factor tests.*	*Impact energy calculation*	*Surface treatments of concrete – materials used.*	*Batching – mixing*
S-8	SLO-1	*Grading – sieve analysis – fineness modulus.*	*Segregation – types – conditions – remedies.*	*Shrinkage – classifications – factors affect.*	*Concrete permeability test - Rapid chloride penetration test.*	*Transporting – Methods adopted for transportation of concrete.*
	SLO-2	*Water – quality – quantity.*	*Bleeding – effects – test.*	*Creep – definition – measurement of creep – factors affect.*	*Introduction to special concretes.*	*Placing – compacting - curing – finishing.*
S-9	SLO-1	*Determination of specific gravity of cement, fine and coarse aggregate practically in lab*	*Determination of bulking of sand practically in lab.*	*Determination of abrasion resistance of coarse aggregate practically in lab.*	*Workability of concrete – slump – compaction factor test practically in lab.*	*Determination of impact strength of concrete practically in lab.*
	SLO-2					

Learning Resources	1. *Neville, A.M. Properties of Concrete, Fifth Edition, Pearson, 2011.* 2. *Shetty, M.S. Concrete Technology, Theory and Practice, S. Chand & Company, New Delhi, 2013.* 3. *A.R. Santhakumar, Concrete Technology, 2009 Edition, Oxford University Press*	4. *Kumar Mehta Paulo,P and Monteiro, J.M. Concrete Microstructure, Properties and Materials, Fourth Edition, McGraw Hill Education, 2006, copy right ©2014.* 5. *NPTEL Course: Concrete Technology: https://nptel.ac.in/courses/105102012/* 6. *Laboratory Manual - SRMIST*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20 %*	*20 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*
	Understand										
Level 2	Apply	*20 %*	*20 %*	*20 %*	*20 %*	*20 %*	*20 %*	*20 %*	*20 %*	*20 %*	*20 %*
	Analyze										
Level 3	Evaluate	*10 %*	*10 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er. G.Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	*1. Dr. R. Santhakumar, Professor, Centre for Rulal Department, NITTTR*	*1. Dr. K. Gunasekaran, SRMIST*
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	*2. Dr. P. Jayabalan, NIT, Trichy, pjeya@nitt.edu*	*2. Dr. P. R. KannanRajkumar, SRMIST*

Course Code	18CEE306T	Course Name	PRESTRESSED CONCRETE 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 1343: 2012*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Know and utilize the concepts of prestress concrete to analyseprestress concrete sections*
CLR-2 :	*Know and understand the different losses of prestress and anchorage zone stress to design*
CLR-3 :	*Understand flexural failure types and to analyze and also to design flexural and tension members*
CLR-4 :	*Understand shear strength analyze and also to design for shear. Also to analyze due to torsion*
CLR-5 :	*Know the design concept of prestressed concrete one way and two way slab*
CLR-6 :	*Know the design concept of prestressed concrete flat slab*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Analyze the prestress concrete sections using different concepts*	*3*	*80*	*75*	*H*	*H*	-	*H*	-	-	-	-	-	-	-	-	*H*	-	*M*
CLO-2 :	*Analyze the different losses of prestress and anchorage zone stress to design*	*3*	*85*	*75*	*H*	*H*	-	*H*	-	-	-	-	-	-	-	-	*H*	-	*M*
CLO-3 :	*Analyze and design of prestressed concrete flexural and tension members*	*3*	*75*	*75*	*H*	*H*	-	*H*	-	-	-	-	-	-	-	-	*H*	-	*M*
CLO-4 :	*Analyze and design of prestressed concrete for shear and also analyze due to torsion*	*3*	*90*	*80*	*H*	*H*	-	*H*	-	-	-	-	-	-	-	-	*H*	-	*M*
CLO-5 :	*Design the prestressed concrete one way and two way slab*	*3*	*85*	*75*	*H*	*H*	-	*H*	-	-	-	-	-	-	-	-	*H*	-	*M*
CLO-6 :	*Design the prestressed concrete flat slab*	*3*	*80*	*75*	*H*	*H*	-	*H*	-	-	-	-	-	-	-	-	*H*	-	*M*

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*PRESTRESSED CONCRETE* *Introduction - Basic concept – Principle of prestressing – Materials.*	*LOSSES OF PRESTRESS* *Nature of losses of prestress – types of losses of prestress in – pre and post tensioning.*	*FLEXURAL STRENGTH ANALYSIS* *Flexural failure - control parameters.*	*SHEAR STRENGTH ANALYSIS* *Shear and principal stresses – maximum and minimum principal stresses.*	*PRESTRESSED CONCRETE SLAB* *Slabs types –cross section of floor panels.*
	SLO-2	*Forms of steel – systems of prestressing*		*Types of flexural failure.*	*Eliminate diagonal tension cracks - improvement of shear resistance.*	
S-2	SLO-1	*Types of prestressing – uses of prestressed concrete.*	*Loss due to elastic deformation*	*Indian code provisions – moment of resistance – bonded tendons only.*	*Example without and with axial prestress*	*Design of one-way slab*
	SLO-2	*Materials – concrete strength limitation – requirements of steel for prestressed concrete.*	*Example*	*Rectangular section*		
S-3	SLO-1	*Analysis – basic assumptions.*	*Loss due to shrinkage and creep of concrete*	*Examples*	*Example with curved cable and vertical cable.*	*Example*
	SLO-2	*Concentric and eccentric tendons – resultant stresses – at transfer – at service. Concepts of prestressing – rectangle – symmetrical I-section only.*	*Example*			
S-4	SLO-1	*Stress concept*	*Loss due to relaxation of steel – friction – anchorage slip.*	*T – Sections. Neutral axis – within the flange – outside the flange.*	*DESIGN FOR SHEAR* *Types of shear cracks – sections uncracked in flexure – sections cracked in*	*Example*

					flexure.	
	SLO-2		*Example*	*Examples*	*Design of shear reinforcement*	
S-5	SLO-1	*Stress concept – examples*	*ANCHORAGE ZONE STRESSES* *Anchorage zone – nature of stresses – objective.*	*DESIGN FOR FLEXURE* *Stress conditions - minimum section modulus – critical combinations – four fundamental conditions – at transfer – at service loads.*	*Examples*	*Design of two-way slab*
	SLO-2		*Stress distribution in end block – single and double anchor plates – ideal stress distribution.*	*Minimum prestressing force – maximum eccentricity.*		
S-6	SLO-1	*Stress concept - examples*	*Effect of transverse tensile stress*	*Examples*	*Examples*	*Example*
	SLO-2		*Analysis of anchorage zone stress – methods (names only)*			
S-7	SLO-1	*Strength concept - examples*	*Indian standard method of analysis of anchorage zone stresses*	*Examples*	*TORSION ANALYSIS* *Shear stress due to torsion - circular – rectangle – T –section and box section.*	*Design of simple flat slab*
	SLO-2					
S-8	SLO-1	*Load balancing concept – cable profile – reaction – equivalent loads.*	*Examples*	*DESIGN OF TENSION MEMBER* *Determination of area of concrete*	*Examples*	*Example*
	SLO-2			*Load factor – cracking and collapse*		
S-9	SLO-1	*Load balancing concept – examples.*	*Design of anchorage zone.*	*Example*	*Examples*	*Example*
	SLO-2		*Example*			

Learning Resources	1. *Krishnaraju .R, "Prestressed Concrete", Tata McGraw-Hill Education, Edition: 2018, NewDelhi.* 2. *Pandit .G.S, Gupta .S.P, "Prestressed Concrete", CBS Publishers & Distributors, 2008* 3. *S. Ramamrutham, "Prestressed Concrete", DhanpatRai Publishing Company, Fifth Edition, Reprint 2016*	4. *Lin T.Y, Design of, "Prestressed Concrete Structures", Asia Publishing House, Bombay 1995.* 5. *IS: 1343-2012 "IS Code of Practice for Prestressed Concrete", BIS, New Delhi, 2012.* 6. *NPTEL Course: Prestressed Concrete Structures: https://nptel.ac.in/courses/105106117/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er. G.Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	*1. Dr. R. Santhakumar, Professor, Centre for Rulal Department, NITTTR*	*1. Dr. K. Gunasekaran, SRMIST*
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	*2. Dr. P. Jayabalan, NIT, Trichy, pjeya@nitt.edu*	*2. Dr. P. R. Kannan Rajkumar, SRMIST*

Course Code	18CEE307T	Course Name	DESIGN OF EARTHQUAKE RESISTANT 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 1893 (Part 1):2016, IS 13920 : 2016*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning			Program Learning Outcomes (PLO)														
CLR-1 :	*Understand the principles of structural dynamics with regard to Single Degree Of Freedom (SDOF) system.*	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	*Extension of understanding of SDOF system to Multi Degree Of Freedom System (MDOF) with emphasis on two degree of freedom system.*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLR-3 :	*Understand the fundamentals of earthquake forces.*																		
CLR-4 :	*Apply structural dynamics principles to the analysis of structures subjected to earthquake forces.*																		
CLR-5 :	*Design earthquake resistant moment resistant frames / shear walls with emphasis on ductile detailing.*																		
CLR-6 :	*Understand the modern concepts in the design of earthquake resistant structures using isolation techniques.*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1 :	*Analyze single degree moment resistant frame for free and forced vibrations*	*3*	*80*	*80*	*H*	*H*	*-*	*H*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*H*	*-*	*-*
CLO-2 :	*Analyze two degree moment resistant frame for free vibrations using modal superposition method*	*3*	*75*	*75*	*H*	*H*	*-*	*H*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*H*	*-*	*-*
CLO-3 :	*Calculate base shear using equivalent static method as per IS 1893*	*3*	*90*	*85*	*H*	*H*	*H*	*H*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*L*	*H*	*-*	*-*
CLO-4 :	*Calculate base shear using response spectrum method as per IS 1893*	*3*	*85*	*80*	*H*	*H*	*H*	*H*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*L*	*H*	*-*	*-*
CLO-5 :	*Apply the provisions of IS13920 to structures*	*3*	*90*	*80*	*H*	*M*	*M*	*M*	*-*	*-*	*L*	*-*	*-*	*-*	*-*	*L*	*H*	*-*	*-*
CLO-6 :	*Suggest isolation systems for earthquake resistance*	*3*	*75*	*75*	*H*	*L*	*L*	*L*	*-*	*-*	*L*	*-*	*-*	*-*	*-*	*-*	*M*	*-*	*-*

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*SINGLE DEGREE OF FREEDOM SYSTEM (SDOF) Introduction to Systems with single degree of freedom*	*MULTI-DEGREE OF FREEDOM SYSTEM (MDOF) Introduction to Systems with two degrees of freedom*	*DESIGN SEISMIC FORCES AS PER IS 1893-2016 Basis of earthquakes – epicenter*	*DUCTILE DESIGN FOR EARTHQUAKE RESISTANCE USING IS 13920-2016 Definition of ductility – member and structural*	*BASE ISOLATION Introduction to base isolation*
	SLO-2	*Definition of free vibration – mass, stiffness,*	*Introduction to Systems with multi degrees of freedom (MDOF)*	*Magnitude of earthquake – measurement – Richter's scale*	*Response reduction factor and ductility*	*Passive base isolation – introduction*
S-2	SLO-1	*Damped and undamped vibration*	*Moment resistant frames as MDOF– two degree freedom system*	*Intensity of earthquake – different scales*	*General specification for ductility*	*Base isolation for a building*
	SLO-2	*Fundamental / Natural frequency and time period – problem solving*	*Shear building and lumped mass*	*Configurations of buildings to resist earthquake*	*Ductile requirements of beams – general*	*Purpose of base isolation*
S-3	SLO-1	*Forced vibration –Harmonic loading*	*Calculation of column stiffness – effect of orientation of column on stiffness*	*Vertical and in-plan mass irregularities*	*Ductile requirements of beams – Longitudinal reinforcement*	*Principles of base isolation*
	SLO-2	*Derivation of equation of motion for free and forced vibration*	*Computation of diagonal mass matrix*	*Vertical and in-plan stiffness irregularities – calculation of eccentricities in plan*	*Ductile requirements of beams – Transverse reinforcement*	*Basic requirements of base isolation system*
S-4	SLO-1	*Solution of equation of motion for free vibration*	*Computation of stiffness matrix*	*Storey drift and storey shear*	*Ductile requirements of columns – geometry*	*Type of Base Isolation Systems – Elastomeric rubber bearings – Roller and ball bearings,*
	SLO-2	*Solution of equation of motion for forced vibration – harmonic loading*	*Forming acceleration and velocity vectors*	*Response spectrum*	*Relative strength of columns and beams at a joint*	
S-5	SLO-1	*Problem solving for finding the response for undamped free vibration*	*Equation of motion of undamped two degree lumped mass free vibration of moment resistant frame*	*Seismic zone factor, Importance factor,*	*Transverse reinforcement in column*	*Type of Base Isolation Systems – springs – sliding bearing*
	SLO-2	*Problem solving for finding the response*	*Solution of equation of motion of*	*Response reduction factor*	*Ductile detailing for shear walls –*	*Modeliing base isolation in SAP –*

		for damped free vibration	*undamped two degree freedom system for free vibration*		*introduction*	*introduction*
S-6	SLO-1	*Problem solving for finding the response for undamped forced vibration*	*Eigen value problem and modal superposition method*	*Percentage of imposed loads , seismic weight of floors- Load combinations*	*General requirements*	*Input requirements for SAP*
	SLO-2	*Problem solving for finding the response for damped forced vibration*	*Determining modal frequencies and time periods*	*Introduction to Equivalent Static Method (ESM) and its limitations*	*Design for shear force*	*Input requirements for ETABS*
S-7	SLO-1	*Magnification factor*	*Uncoupled equations in SDOF and finding modal response*	*Computation of base shear for single & double storey moment resistant plane frame using ESM*	*Design for axial force*	*Modeling for base isolation in STAAD.Pro*
	SLO-2	*Application to determine the forces transferred to base from machine foundation*	*Undamped equation of motion for two degree moment resistant frame with lateral harmonic loading at the DOF*	*Introduction to Response Spectrum Method(RSM) and applicability*	*Design for bending moment*	*Input requirements for STAAD.Pro*
S-8	SLO-1	*Machine isolation*	*Modal superposition method to form uncoupled SDOF equations including modal load vector.*	*Computation of base shear for single storey and double storey moment resistant plane frame using RSM*	*Opening in walls – introduction*	*Introduction to active base isolation*
	SLO-2	*Determination of damping required to minimize forces transferred to foundation*	*Determination of response of the structure at discrete time intervals.*	*Introduction to DBE (Design Based Earthquake) and MCE(Maximum Considered Earthquake)*	*Detailing around the openings*	*Underlying principles of active base isolation*
S-9	SLO-1	*Definition of ground motion due to earthquake*	*Superposition of modal responses*	*Performance based design – Capacity and demand spectra as per ATC40*	*Ductile construction joints*	*Schematic diagram of a typical active base isolation system*
	SLO-2	*Equivalent model for considering ground motion in moment resistant fame*	*Square Root of Sum of Squares (SRSS) method.*	*Principles of pushover analysis and pushover curve*	*Ductile design of gravity columns in buildings*	*Comparison between passive and active base isolation*

Learning Resources	1. *Anil K.Chopra, "Dynamics of structures" (Theory and Applications to Earthquake Engineering), 5th Edition, Pearson, 2016* 2. *Short course on "Seismic design of reinforced concrete buildings", CEP, IIT, Kanpur, 2005.*	3. *IS 1893: 2016, (Part I) "Criteria for Earthquake Resistant Design of Structures - Part 1: General Provisions and Buildings", BIS, 2016.* 4. *IS 13920: 2016,"Ductile design and detailing of reinforced concrete structures subjected to seismic forces - Code of practice", BIS, 2016.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*40 %*	-	*40 %*	-	*10 %*	-	*40%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*70 %*	-	*55%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*20 %*	-	*20 %*	-	*20 %*	-	*5%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er. S. Dhanabal, General Manager, NLY, Neyveli, dhans1960@yahoo.co.in	*1. Dr. R. Santhakumar, Professor, Centre for Rulal Department, NITTTR*	*Prof. G. Augustine Maniraj Pandian, SRMIST*
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	*2. Dr. P. Jayabalan, NIT, Trichy, pjeya@nitt.edu*	*Dr. K.S. Satyanarayanan, SRMIST*

Course Code	18CEE308T	Course Name	DESIGN OF STEEL-CONCRETE COMPOSITE 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 456 :2000, IS 800: 2007, IS 11384, Steel Tables*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the concept of steel-concrete composite member design and to get introduced to the relevant IS codes*
CLR-2 :	*Create insights to the concepts of Limit state method of design*
CLR-3 :	*Utilize the concepts in performing design of steel-concrete composite beams and columns*
CLR-4 :	*Utilize the concepts in performing design of steel-concrete composite connections*
CLR-5 :	*Understand the behaviour of composite girder bridges*
CLR-6 :	*Create insights to the seismic behaviour of composite structures*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Identify the effect of external loads on steel-concrete composite members and the factors influencing their behaviour and to get familiarity with the relevant IS codes*	*2*	*85*	*80*	*H*	-	-	*M*	-	-	-	-	-	-	-	*H*	*H*	*M*	-
CLO-2 :	*Analyze the behavior of steel-concrete composite sections under flexure, shear and compression*	*2*	*85*	*80*	*H*	*H*	-	*M*	-	-	-	-	-	-	-	*H*	*H*	*M*	-
CLO-3 :	*Apply Limit state method of design to steel-concrete composite beams and columns*	*2*	*80*	*75*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	-	*H*	*H*	*M*	-
CLO-4 :	*Apply Limit state method of design to steel-concrete composite connections*	*2*	*80*	*75*	*H*	*H*	-	*M*	-	-	-	-	-	-	-	*H*	*H*	*M*	-
CLO-5 :	*Analyze the behavior of steel-concrete composite girder bridges*	*2*	*80*	*75*	*H*	-	-	*M*	-	-	-	-	-	-	-	*H*	*H*	*M*	-
CLO-6 :	*Analyze the seismic behaviour of composite structures*	*2*	*85*	*80*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	-	*H*	*H*	*M*	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*INTRODUCTION Introduction to Steel - Concrete Composite Construction-Advantages-Limitations*	*Design Example 1*	*Design Example 3*	*Design Example 1*	*SEISMIC BEHAVIOUR OF STEEL-CONCRETE COMPOSITE STRUCTURES Introduction*
	SLO-2	*Materials to be used-Structural advantages-Factors deciding selection of materials*	*Design Example 1*	*DESIGN OF CONNECTIONS Introduction*	*Design Example 1*	*Basic concepts*
S-2	SLO-1	*Introduction to steel - concrete composite codes/standards*	*Design Example 2*	*Types of Connections*	*Design Example 2*	*General design criteria*
	SLO-2	*Limitations of using BIS codes-Introduction to Eurocode 4*	*Design Example 2*	*Choice of Connections in Composite structures*	*Design Example 2*	*General design criteria*
S-3	SLO-1	*Theory of composite structures*	*Design Example 2*	*Behaviour of Connections in Composite structures*	*DESIGN OF STEEL-CONCRETE COMPOSITE GIRDER BRIDGES Introduction*	*Code provisions*
	SLO-2	*Behaviour of composite beams*	*Design Example 2*	*Basic concepts*	*Behaviour of girder bridges*	*Seismic behaviour of composite beams*
S-4	SLO-1	*Behaviour of composite beams*	*Design of Composite Columns*	*Code provisions*	*Behaviour of girder bridges*	*Seismic behaviour of composite beams*
	SLO-2	*Behaviour of composite columns*	*Design Procedure*	*Design procedure*	*Design concepts*	*Seismic behaviour of composite slabs*
S-5	SLO-1	*Behaviour of composite columns*	*Relevant BIS code provisions*	*Design Example 1*	*Design concepts*	*Seismic behaviour of composite slabs*
	SLO-2	*Limit state method of design of steel-concrete composite sections under flexure-code provisions*	*Choice of cross-sections*	*Design Example 1*	*Materials to be used-Types of cross-sections*	*Seismic behaviour of composite columns*

S-6	SLO-1	*Limit state method of design of steel-concrete composite sections under shear- code provisions*	*Design Example 1*	*Design Example 2*	*Basic design considerations*	*Seismic behaviour of composite columns*
	SLO-2	*Limit state method of design of steel-concrete composite sections under compression- code provisions*	*Design Example 1*	*Design Example 2*	*Basic design considerations*	*Seismic behaviour of composite connections*
S-7	SLO-1	*DESIGN OF STEEL-CONCRETE COMPOSITE MEMBERS Design of Composite beams*	*Design Example 1*	*Design Example 3*	*Failure types*	*Seismic behaviour of composite connections*
	SLO-2	*Design Procedure*	*Design Example 2*	*Design Example 3*	*Failure types*	*Seismic behaviour of composite frames*
S-8	SLO-1	*Relevant BIS code provisions*	*Design Example 2*	*Design of Shear Connections*	*Relevant code provisions*	*Seismic behaviour of composite frames*
	SLO-2	*Choice of cross-sections*	*Design Example 2*	*Basic concepts*	*Mandatory checks*	*Seismic behaviour of composite frames*
S-9	SLO-1	*Design Example 1*	*Design Example 3*	*Code provisions*	*Comparison with conventional bridge types*	*Design methods*
	SLO-2	*Design Example 1*	*Design Example 3*	*Design procedure*	*Comparison with conventional bridge types*	*Design methods*

Learning Resources	1. *"Teaching Resource Material for Structural Steel Design", Volume 2/3 jointly prepared by 1. I.I.T., MS 2. Anna University 3. SERC, MS 4. "Institute for Steel Development and growth", Calcutta.* 2. *Owens .G.W, & Knowels.P. "Steel Designs Manual", (sixth Edition) Steel Concrete Institute (UK) Oxford Black; well Scientific Publications, 2003.*	3. *Johnson.R.P, "Composite Structures of Steel and Concrete". Vol-I, # Oxford Black; well Scientific Publications (Third Edition) U.K. 2004.* 4. *Subramanian.N, Design of Reinforced Concrete Structures, Oxford University Press New Delhi, 2013* 5. *Subramanian.N, Design of Steel structures-Limit state method, Oxford University Press New Delhi, 2016*

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3(15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Understand										
Level 2	Apply	*50%*	-	*50%*	-	*50%*	-	*50%*	-	*60%*	-
	Analyze										
Level 3	Evaluate	*20%*	-	*20%*	-	*20%*	-	*20%*	-	*10%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Mini-Projects

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er. G.Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	*1. Dr. R. Santhakumar, Professor, Centre for Rulal Department, NITTTR*	*Prof.G.Augustine Maniraj Pandian, SRMIST*
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	*2. Dr. P. Jayabalan, NIT, Trichy, pjeya@nitt.edu*	*Prof. N.Umamaheswari, SRMIST*

Course Code	18CEE309T	Course Name	GEOGRAPHIC INFORMATION SYSTEM	Course Category	E	Professional Elective Course	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 :	Introduce to mapping techniques
CLR-2 :	Identification of the data and DBMS
CLR-3 :	Interpretation and analysis of GIS Data
CLR-4 :	perform various GIS analysis
CLR-5 :	Understand the Digital elevation Model
CLR-6 :	Apply the knowledge of GIS

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	understand the GIS, background, Development of and Components of GIS	2	85	80	H	-	-	-	-	-	-	-	L	-	-	H	H	-	-
CLO-2 :	study the data capturing techniques in GIS & Database management	2	85	75	H	-	-	-	-	-	-	-	M	-	-	H	H	-	-
CLO-3 :	analyze various spatial and Non-spatial Data	2	80	75	H	-	M	M	H	-	H	-	M	-	-	H	H	-	-
CLO-4 :	Generation of various thematic	2	85	80	H	H	M	M	H	-	H	-	M	-	-	H	H	-	-
CLO-5 :	study the Generation and Application of DEM	2	85	75	H	H	H	M	H	H	H	-	M	-	-	H	H	-	-
CLO-6 :	appreciate the applications of GISI	2	80	75	H	H	H	H	H	H	H	-	M	-	-	H	H	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction & Définition	Data and Information	Data Analysis	Digital elevation model	Applications of GIS
	SLO-2	GIS in civil engineering	Data and data types	Spatial data analysis	DTM,DSM,	GIS in resource mapping
S-2	SLO-1	Historical background	Spatial data	Buffering-point, Line and polygon buffering	DEM -Data requirement	Land use and Land cover Analysis
	SLO-2	Concept of Development	Nonspatial data	Over lay –Point on polygon	Sources of DEM	Ground water Studies
S-3	SLO-1	Qualifications of GIS	Spatial data-raster data	Over lay –Line on polygon	Generation of DTM	Groundwater potential mapping and Artificial recharge suitability mapping
	SLO-2	Requirement of GIS	Spatial data-vector data	Over lay –Polygon on polygon	Generation of TIN	Runoff modeling
S-4	SLO-1	Elements of GIS	Merits and demerits of Raster data	Raster Over lay analysis	Generation of DEM	Forest mapping, Agricultural Studies-Crop yiel estimation, acreage production etc
	SLO-2	Cartography	Merits and demerits of Vector data	Vector Over lay analysis	Parameters of DEM analysis	Disaster management studies-natural and artificial disasters
S-5	SLO-1	Digital cartography	Data input methods	Network analysis-Alternate route analysis	Applications of DEM	Flood and earthquake studies,
	SLO-2	Symbolization & Generalization	Data input methods- Digitization	Shortest path and proximity analysis	Slope and aspect	Drought management
S6	SLO-1	Map and definition of Map	Data input methods -Scanning	Reclassification	Use of EDM for Hydrological studies	Other disaster related studies
	SLO-2	Types of Map	Data input methods-Keyboard entry	Non-Spatial data Analysis - Query -object based and field based analysis	Groundwater studies	Wetland management,
S-7	SLO-1	Classification of Map Based on Scale	Data Output methods	Data Manipulation, Data Generalization	Site suitability for construction of Dam ar Reservoir	Urban and Regional planning
	SLO-2	Classification of Map Based on purpose ar	Data Output methods-Soft copy output	Data Abundance and Data Redundancy	Consideration for Construction of	Smart city mapping

		Theme			*Irrigation structure*	
S-8	SLO-1	*Map Analysis*	*Data Output methods-Hard copy output*	*Data Retrieval-RDBMS*	*DEMs in site suitability for solar and wind energy generation*	*Smart Transportation systems*
	SLO-2	*Coordinate systems*	*Software modules ArcGIS, -Arcinfo, Arc Toolbox*	*Record modeling In GIS*	*DEMs in disaster studies-Flood Hazard Mapping,,*	*Solid Waste management using GIS*
S-9	SLO-1	*Projection systems*	*ArcEdit, ArcMap, Arc catalog*	*Expert System-Artificial Intelligence*	*Landslide studies, Avalanches studies*	*Water qualitystudies*
	SLO-2	*Coordinate systems used in India*	*QGIS, and other open source softwares*	*Artificial Neural Networking*	*limitations of DEM*	*Soilmoisturestudies*

Learning Resources	1. Anji Reddy .M, "Remote sensing and Geographical information system",B.S Publications, 2011. 2. Chestern, "Geo Informational Systems - Application of GIS and Related Spatial Information Technologies », ASTER Publication Co., 1992. 3. Jeffrey Star and John Estes, "Geographical Information System - An Introduction", Prentice Hall, 1990.	4. Burrough .P.A, "Principles of GIS for Land Resources Assessment", Oxford Publication,1980 5. SatheeshGopi, "Global Positioning System - Principles and Applications," Tata McGrawHill Publishing Company Limited, New Delhi (India), 2005 6. *NPTEL: Course – GIS in Civil Engineering :* https://nptel.ac.in/courses/105102015/8

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*50%*	-	*40%*	-	*40%*	-	*45%*	-	*70%*	-
	Understand										
Level 2	Apply	*50%*	-	*60%*	-	*60%*	-	*55%*	-	*30%*	-
	Analyze										
Level 3	Evaluate	-	-	-	-	-	-	-	-	-	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. Sarunjith K J, Scientist, NCSCM	*Dr. S.G.D. Sridhar, University of Madras*	*Dr. Sachikanta Nanda, SRMIST*
Dr. Nagasundaram M, Geological Survey of India, nagasundaram.m@gsi.gov.in	*Dr. Nisha Radha Krishnan, NIT TRichy*	*Dr. R Annadurai, SRMIST*

Course Code	18CEE310T	Course Name	SOLID AND HAZARDOUS WASTE MANAGEMENT	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 :	*Create insights to the various sources and classification of solid and hazardous waste*
CLR-2 :	*Address concepts related to waste characteristics and source reduction*
CLR-3 :	*Create insights to the storage, collection and transport of waste*
CLR-4 :	*Address concepts related to waste processing technologies*
CLR-5 :	*Address concepts related to waste disposal*
CLR-6 :	*Role of Government and NGO's in sustaining the waste management*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Understand the various sources of solid and hazardous waste*	*2*	*85*	*80*	*H*	*H*	*M*	*L*	-	*L*	*H*	-	-	-	-	*L*	*M*	-	-
CLO-2 :	*Able to identify the options for Reduction, reuse and recycling of waste*	*2*	*85*	*75*	*H*	*H*	*H*	*H*	-	-	*H*	-	-	-	-	-	*M*	-	-
CLO-3 :	*Knowledge of collection and transport of solid and hazardous waste*	*2*	*80*	*75*	*H*	*H*	*M*	*M*	-	*L*	*H*	-	-	-	-	*L*	*M*	-	-
CLO-4 :	*Able to know about various waste processing techniques*	*2*	*85*	*75*	*H*	*H*	*H*	*H*	-	-	*H*	-	-	-	-	-	*M*	-	-
CLO-5 :	*Understand the waste disposal methods and management*	*2*	*85*	*80*	*H*	*H*	*M*	*M*	*L*	*L*	*M*	-	-	-	-	*L*	*M*	-	-
CLO-6 :	*Knowledge of basic solid and hazardous waste legislations*	*2*	*80*	*75*	*H*	*H*	*M*	-	-	*L*	*M*	-	-	-	-	-	*M*	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Sources, classification and regulatory framework: Sources of solid waste*	*Waste characterization and source reduction: Waste generation rates*	*Storage, collection and transport of waste: Handling of waste at source*	*Waste processing technologies: Objectives of waste processing*	*Waste disposal : Waste disposal options for solid and hazardous waste*
	SLO-2	*Types of solid waste*	*Waste generation variation*	*Segregation of waste at source*	*material separation technologies in solid waste*	*Disposal in landfills*
S-2	SLO-1	*Hazardous Waste - Identification*	*sampling and characterization*	*Storage of municipal solid waste*	*Physical Processing Equipment*	*Landfill Classification*
	SLO-2	*Hazardous Waste -Classification*	*factors affecting waste generation rate and Composition*	*On-site storage methods*	*material processing technologies*	*Landfill types*
S-3	SLO-1	*Need for solid waste management*	*Physical properties of solid waste*	*Effect of storage*	*chemical conversion technologies*	*Landfill methods*
	SLO-2	*Need for hazardous waste management*	*Chemical properties of solid waste*	*Materials used for containers*	*biological conversion technologies methods of Composting*	*Site selection*
S-4	SLO-1	*Elements of integrated waste management*	*Biological properties of solid waste*	*Collection of municipal solid waste-Methods*	*biological conversion technologies methods of Composting*	*Design and operation of sanitary landfills*
	SLO-2	*roles of stakeholder's*	*Hazardous Characteristics*	*Collection vehicles – Manpower – Collection routes*	*Factors of Composting*	*Landfill liners*
S-5	SLO-1	*Role of public and NGO's*	*TCLP tests*	*Analysis of Collection systems*	*Thermal conversion technologies-energy recovery*	*Secure landfills*
	SLO-2	*Tutorial 1: Case Study: Status of Waste Generation in Bangalore*	*Tutorial 3 : Practices in household waste management*	*Solving problems using Tutorial Sheet 7*	*Thermal conversion technologies- energy recovery*	*Landfill bioreactors*

S-6	SLO-1	*Public health and environmental impacts*	*Tutorial 4: Source Reduction and Recycling.*	*Need for transfer and transport*	*Incineration*	*Leachate management*
	SLO-2	*Salient features of Indian legislations on management and handling of municipal solid waste*	*Source reduction of waste*	*Transfer stations*	*Hazardous Waste Treatment*	*Landfill gas management*
S-7	SLO-1	*Hazardous waste*	*Waste exchange*	*Hazardous Waste-Storage and collection*	*Physical and chemical treatment*	*Landfill closure*
	SLO-2	*Biomedical waste*	*Extended producer responsibility*	*Hazardous Waste-Storage and collection*	*Thermal treatment*	*Environmental monitoring*
S-8	SLO-1	*Lead acid batteries*	*Recycling*	*Hazardous Waste -Transfer and transport*	*Biological treatment*	*Rehabilitation of open dumps*
	SLO-2	*Electronic waste*	*Reuse*	*Hazardous Waste -Transfer and transport*	*Pollution Prevention and Waste Minimization*	*Landfill remediation*
S-9	SLO-1	*Plastics and fly ash*	*Solving problems using Tutorial Sheet 5*	*Hazardous waste manifests*	*Hazardous Wastes Management in India*	*Solving problems using Tutorial Sheet 9*
	SLO-2	*Tutorial 2: Mention the public awareness program*	*Solving problems using Tutorial Sheet 6*	*Hazardous waste transport*	*Solving problems using Tutorial Sheet 8*	*Solving problems using Tutorial Sheet 10*

Learning Resources	1. *George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, Mc-Graw Hill International edition, New York, 1993.* 2. *Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and Environmental Resources Management, Hazardous waste Management, Mc-Graw Hill International edition, New York, 2001.*	3. *CPHEEO, "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000.* 4. *NPTEL Course-Municipal solid waste management : https://nptel.ac.in/courses/120108005/* 5. *NPTEL Course-Solid and Hazardous waste management : https://nptel.ac.in/courses/105106056/*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*60%*	-	*60%*	-	*60%*	-	*60%*	-	*60%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	-	-	-	-	-	-	-	-	-	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, and Conference Paper etc.

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	*1. Dr. E. S. M Suresh, NITTTR Taramani Chennai, esmsuresh@gmail.com*	*Mr. D. Justus Reymond, Asst.Prof, SRMIST*
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Course Code	18CEE311T	Course Name	AIR AND NOISE POLLUTION AND CONTROL	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 :	*Create insights to the various sources ofair quality*
CLR-2 :	*Address concepts related to modeling of atmospheric pollutants*
CLR-3 :	*Create insights to the air and noise pollution monitoring techniques*
CLR-4 :	*Address concepts related to reduce air pollution*
CLR-5 :	*Address concepts related to reduce noise pollution*
CLR-6 :	*Role of Government and NGO's in sustaining the air pollution at the source*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Understand the various sources of air and noise pollution*	*2*	*85*	*80*	*H*	*H*	*M*	*L*	-	*L*	*H*	-	-	-	-	*L*	*M*	-	-
CLO-2 :	*Able to analyze air quality parameters*	*2*	*85*	*75*	*H*	*H*	*H*	*H*	-	-	*H*	-	-	-	-	-	*M*	-	-
CLO-3 :	*Knowledge of atmospheric transport models for air pollutants*	*2*	*80*	*75*	*H*	*H*	*M*	*M*	-	*L*	*H*	-	-	-	-	*L*	*M*	-	-
CLO-4 :	*Able to identify techniques to reduce noise pollution*	*2*	*85*	*75*	*H*	*H*	*H*	*H*	-	-	*H*	-	-	-	-	-	*M*	-	-
CLO-5 :	*Apply the concept of reducing air and noise pollution*	*2*	*85*	*80*	*H*	*H*	*M*	*M*	*L*	*L*	*M*	-	-	-	-	*L*	*M*	-	-
CLO-6 :	*Knowledge of basic environmental legislations related to air and noise pollution*	*2*	*80*	*75*	*H*	*H*	*M*	-	-	*L*	*M*	-	-	-	-	-	*M*	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction*	*Sources, classification and effects*	*Sampling and Meteorology*	*Air Pollution Control Measures*	*Noise pollutionand its control*
	SLO-2	*Air pollutants, Sources, classification,*	*Ambient air quality and emission standards*	*Ambient air sampling*	*Basics of pollution control*	*Basics of acoustics and specification of sound;*
S-2	SLO-1	*Monitoring techniques for air and noise pollution*	*Air pollution indices.*	*pollution measurement methods,*	*Control equipments –*	*sound power, sound intensity and sound pressure levels;*
	SLO-2	*Combustion Processes and pollutant emission,*	*Natural sources*	*principles and instruments*	*Particulate control methods*	*plane, point and line sources, multiple sources;*
S-3	SLO-1	*Air Act, legislation and regulations*	*Type of air pollutants*	*Monitoring stations in India*	*settling chambers,*	*outdoor and indoor noise propagation;*
	SLO-2	*Air quality management in India.*	*Effects on Health, vegetation-*	*temperature lapse rate and stability*	*cyclone separation,*	*psychoacoustics and noise criteria,*
S-4	SLO-1	*Greenhouse effect.*	*-materials and atmosphere*	*Adiabatic lapse rate*	*Wet collectors*	*effects of noise on health, annoyance rating schemes;*
	SLO-2	*Urban heat island*	*Reactions of pollutants in the atmosphere and their effects*	*Wind Rose, Inversion*	*fabric filters*	*special noise environments*
S-5	SLO-1	*Major contributions of air pollutant*	*-Smoke, smog and ozone*	*Wind velocity and turbulence*	*electrostatic precipitators*	*Infrasound, ultrasound, impulsive sound and sonic boom;*
	SLO-2	*Noise -What is Noise?*	*Layerdisturbance,*	*Plume behavior*	*Removal of gaseous pollutants by adsorption, absorption,*	
S-6	SLO-1	*Noise pollution,*	*Ambient noise quality and emission standards*	*Carbon emission*	*Biological air pollution control technologies,*	*noise standards and limit values;*
	SLO-2	*Sources, classification,*	*Noise pollution indices.*	*Noise sampling and Noise level meter*	*Indoor air quality*	*Occupational noise standard*
S-7	SLO-1	*Monitoring techniques for noise pollution*	*Manmade sources*	*Pollution measurement methods,*	*control principles*	*Noise instrumentation and monitoring*

						procedure.
	SLO-2	*Noise Act, legislation and regulations*	*Types of noise pollutant*	*Principles and instruments*	*Alternative*	*Noise indices.*
S-8	SLO-1	*Noise quality management in India.*	*Effects on Human Health and*	*Occupational noise monitoring*	*Case studies on Air pollution -1*	*Noise control methods*
	SLO-2	*Noise management in other countries*	*O0occupational exposure*	*Monitoring-case studies*	*Case studies on Air pollution -1*	*Case studies on Air pollution– 2*
S-9	SLO-1	*Solving problems using Tutorial Sheet 1*	*Solving problems using Tutorial Sheet 3*	*Tutorial hour-1*	*Tutorial hour-3*	*Case studies on noise pollution*
	SLO-2	*Solving problems using Tutorial Sheet 2*	*Solving problems using Tutorial Sheet 4*	*Tutorial hour-2*	*Tutorial hour-4*	*Case studies on noise pollution*

Learning Resources	1. *C. S. Rao, "Environmental Pollution Control Engineering", Wiley Eastern Limited, 2000.* 2. *M. N. Rao, H. V. N. Rao, Air pollution, Tata McGraw Hill Pvt Ltd, New Delhi, 1993* 3. *Dr. Y. Anjaneyulu, "Air Pollution and Control Technologies", Allied publishers Pvt. Ltd., 2002.* 4. *Noel De Nevers, "Air pollution control Engineering", McGraw Hill International Edition* 5. *Peterson and E.Gross Jr., "Hand Book of Noise Measurement", 5 th Edition, 1963*	6. *Mukherjee, "Environmental Pollution and Health Hazards", causes and effects, 1986* 7. *Antony Milne, "Noise Pollution: Impact and Counter Measures", David & Charles PLC, 1979.* 8. *Kenneth wark, Cecil F.Warner, "Air Pollution its Origin and Control", Harper and Row Publishers* 9. *NPTEL Online Course - Noise Management and Control : https://swayam.gov.in/nd1_noc19_me72/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*60%*	-	*60%*	-	*60%*	-	*60%*	-	*60%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	-	-	-	-	-	-	-	-	-	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, and Conf. Paper etc.

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Elvis Dsouza, EDPC Polymer Industries, Maharashtraelvisdsouza11@gmail.com	*Dr. Rehana Shaik, Assiatant Professor, Dept of Civil Engineering, IIIT Hyderbad rehanaiisc@gmail.com*	*Dr. Paromita Chakraborty, Research Assoc.Professor, SRMIST*
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Course Code	18CEE312T	Course Name	ENVIRONMENTAL IMPACT ASSESSMENT AND LIFE CYCLE 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 :	*Know the interrelationship between various activities and their impact on environment*
CLR-2 :	*Understand how to conduct an environmental impact assessment*
CLR-3 :	*Learn principles and methods of environmental analysis*
CLR-4 :	*review and comment on an environmental impact statement, environmental assessment and environmental regulations*
CLR-5 :	*Understand role of standards and how government, NGOs, and the private sector can affect their evolution*
CLR-6 :	*Explain the concept of life cycle assessment (LCA) as an environmental management tool and its potential for identifying all the environmental impacts throughout the entire life cycle of a product*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Explainkey concepts in environmental impact assessment & Management*	*3*	*85*	*80*	*H*	-	-	-	-	-	*H*	*H*	-	-	-	-	*M*	-	-
CLO-2 :	*Understand the importance of various rules & regulation in EIA*	*2*	*85*	*75*	-	*M*	-	-	-	*M*	*H*	-	-	-	-	-	*M*	-	-
CLO-3 :	*Evaluate the Impact on various environments and role of stake holders in EIA*	*2*	*80*	*75*	*H*	*M*	-	*M*	-	*M*	*M*	-	-	-	-	-	*M*	-	-
CLO-4 :	*Explain the application of Life cycle analysis*	*2*	*85*	*75*	*H*	*M*	-	-	-	*H*	*H*	*M*	-	-	-	-	*M*	-	-
CLO-5 :	*Identify most suitable tool for assessment process and make suggestions for solutions*	*2*	*85*	*80*	*H*	*H*	-	*M*	*M*	-	*M*	*M*	-	-	-	-	*M*	-	-
CLO-6 :	*Participate in a group to evaluate a project using EIA & LCA using one or more management tools*	*2*	*80*	*75*	*H*	*H*	-	*M*	-	-	*H*	-	*H*	-	-	-	*H*	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction Introduction, definitions and concepts of EIA, Ethics and environment, EIA for civil engineers*	*Evolution of EIA Evolution of EIA worldwide; Evolution of EIA in India; Forecasting Environmental Changes*	*Assessment Technique Components of the Environment: Water- Standards pertaining to water quality*	*Life Cycle Analysis Life cycle assessment and its purpose; Evolution of Life Cycle Assessment; Stages in LCA of a Product; A Code of Good Conduct for LCA*	*EIA Methodologies Initial Environmental Examination; Screening*
	SLO-2	*Discussion: Identify the Ethics that you breach in daily activities which affects the environment*	*Discussion: Introduction to importance of Rio Convention*	*Activity & Discussion using a Case Study*	*Discussion: Necessary for LCA*	*Case Study involving screening*
S-2	SLO-1	*Ecology and the environment ; Ecosystem and its characteristics*	*Types of EIA: Rapid; Comprehensive; Strategic; Sectoral; Regional Rationale and scope of each type*	*Components of the Environment: Air & Noise- Standards pertaining to Air & Noise quality*	*Procedures for LCA; Defining the goal and scope; Analyzing the inventory; Assessing environmental impact*	*Scoping Analysis of alternatives*
	SLO-2	*In continuation with previous class discussion in how the ecosystem in which you live gets affected your activities*	*Case Study*	*Activity & Discussion using a Case Study*	*Case Study using LCA*	*Case Study in EIA*
S-3	SLO-1	*Structure of Ecosystem; Biotic Components Abiotic components*	*EIA Regulations in India Overview of Indian laws – Constitutional Provisions (Water, Air, Forest, Hazardous etc)*	*Components of the Environment: Soil- Soil quality, Landuse Criteria*	*Carbon trading: Energy foot printing, Food foot printing and Carbon foot printing.*	*Mitigation- Definition, options for mitigation of impact on water, air and land, water, energy, flora and fauna*
	SLO-2	*Identify the impact of your activities on Biotic and abiotic components of your ecosystem& How their services gets affected*	*Discussion: Evolution of law with time*	*Activity & Discussion using a Case Study*	*Case Study On carbon footprint*	*Case study Employing mitigation measures*

S-4	SLO-1	*Food chains, Food webs and Tropic levels*	*EPA 1986*	*Components of the Environment: Biosphere (Macro, Micro)- Introduction to Hazard Exposure levels for biota*	*Environmental management: Principles, problems and strategies; Review of political, ecological and remedial actions.*	*Environmental Impact Statement- Document planning - collection and organization of relevant information*
	SLO-2	*Identify the impact of your activities on various trophic levels of your ecosystem*	*Discussion: Amendment of E(P) Rules, 1986 on time of 545 days for finalisation of Draft Notification (MOEFCC Website)*	*Activity & Discussion using a Case Study*	*Discussion With Activity: Why Environmental Management is important – using case study*	*Example: Case study with Documentation*
S-5	SLO-1	*Energy and energy flows; Elemental cycles,*	*EIA Notification 2006*	*Components of the Environment: Socio-economic*	*Environmental audit: Definitions,concepts, partial audit, compliance audit, methods & regulations.*	*ToR& Sectoral ToR*
	SLO-2	*Choose a element cycle and how it affects the ecosystem*	*Case Study*	*Activity & Discussion using a Case Study*	*Discussion: Introduction to ISO 19011 (EMS Auditing)*	*Example of ToR for various environments*
S-6	SLO-1	*Concept of Succession;Role of succession in restoration and recovery of ecosystem*	*CPCB and State PCBs – roles and responsibilities*	*Components of the Environment: Cultural and Aesthetics*	*Local infrastructure development and environmental management: A system approach, Regional environmental management system Landuse Conversion plan development and implementation strategies*	*Environmental Assessment- Base line, Construction Phase, Post Construction/ Operational phase scenario*
	SLO-2	*Example: Restoration of an ecosystem (Mining area)*	*Discussion: Sethusamudram Project- Role of CPCB& SPCB and Central & State Governments*	*Activity & Discussion using a Case Study*	*Discussion: Problems faced in developmental projects- using case study*	*Case study on a project*
S-7	SLO-1	*Ecosystem disturbances and their causes; natural causes and anthropogenic causes*	*Structured Environmental Management Systems ISO 14001 - EMS*	*Role of Public Participation in EIA*	*Environmental management systems in local government. Certification body assessments of EMS Documentation for EMS*	*Impact Assessment Methodologies: Checklists- Simple, Descriptive, Scaling Checklist*
	SLO-2	*Discussion: How Do Species Replace One Another in Ecological Succession?*	*Case Study: (Whitelaw and Butterworth, ISO 14001: Environmental System Handbook, 1997)*	*Reference EIA Notification 2006*	*Discussion: Expert systems (Software/ Model) used for EMS*	*Case study involving Checklist methods*
S-8	SLO-1	*Ecosystem and Ecological Footprints*	*ISO 18001- OHSAS*	*Role of stakeholders*	*Sustainable development – Definitions, Charter and Global Conventions; Future scenarios.*	*Matrix- Simple, Interaction- Leopold Matrix, Stepped matrix*
	SLO-2	*Discussion: How Cultural Changes Have Increased Our Ecological Footprints?*	*Discussion: Accreditation Procedure for ISO 14001*	*Activity & Discussion using a Case Study, Role Play*	*Discussion on various important conventions*	*Case study involving Matrix methods Discussion: Aldo Leopold's Environmental Ethics*
S-9	SLO-1	*Discussion of basic concepts*	*Environmental Risk Assessment*	*Setting the baseline*	*Case Studies on EIA*	*Network Methods Decision Tree, Expert Systems*
	SLO-2	*Example: Case study (An Affected Area)*	*Discussion: risk screening/prioritization*	*Discussion-Describe the various aspects of the environmental components of your neighborhood*	*Case Studies on EIA*	*Case study involving Network methods Introduction to various Expert system (Software/ models widely used)*

Learning Resources	*1 .L. W. Canter, Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 1997.* *2. G. Burke, B. R. Singh and L. Theodore, Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons, 2000* *3. R. Therivel, John Glasson, Andrew Chadwick, Introduction to Environmental Impact Assessment (Natural and Built Environment), Routledge, 2005.* *4. K. Whitelaw and Butterworth, ISO 14001: Environmental System Handbook, 1997*	*5. H. Scott Matthews, Chris T. Hendrickson, and Deanna Matthews, Life Cycle Assessment: Quantitative Approaches for Decisions that Matter, 2014. Open access textbook, retrieved from https://www.lcatextbook.com/* *6. NPTEL Course - Environmental Management: https://nptel.ac.in/courses/120108004/16#* *7. NPTEL Course - Environmental Impact Assessment : https://nptel.ac.in/syllabus/105103024/*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*60%*	-	*60%*	-	*60%*	-	*60%*	-	*60%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	-	-	-	-	-	-	-	-	-	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, and Conf. Paper etc.

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Course Code	18CEE313T	Course Name	DESIGN OF HYDRAULIC STRUCTURES AND IRRIGATION 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 :	*Provide knowledge on irrigation and its types, and on water movement through soil*
CLR-2 :	*Expound on the design principles of gravity and earthen dams and associated structures*
CLR-3 :	*Introduce diversion structures and their design by applying failure concepts*
CLR-4 :	*Provide an understanding of canal structures*
CLR-5 :	*Address concepts on sediment movement*
CLR-6 :	*Introduce design concepts for various types of canals*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Acquire knowledge on soil–plant–water relationship*	2	85	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	*Complete a design for dams and spillways*	2	85	75	H	H	-	H	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	*Understand the types of diversion structures and design them by applying failure concepts*	2	85	75	H	H	-	H	-	-	-	-	-	-	-	-	H	-	-
CLO-4 :	*Identify the various canal structures and design them*	2	85	80	H	H	-	H	-	-	-	-	-	-	-	-	H	-	-
CLO-5 :	*Understand basic concepts of sediment movement*	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-6 :	*Design various types of canals considering efficiency and economy*	2	85	75	H	H	-	H	-	-	-	-	-	-	-	-	H	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Irrigation: Necessity and importance of irrigation*	*Lane's weighted creep theory*	*Earthen dams – types*	*Canal falls – necessity and location of falls*	*Computing the design capacity of an irrigation canal*
	SLO-2	*Methods of irrigation*	*Design of a vertical drop weir on Bligh's creep theory*	*Design of earthen dams*	*Types of canal falls*	*Shield's entrainment method*
S-2	SLO-1	*Methods of improving soil fertility*	*Design of a vertical drop weir on Bligh's creep theory*	*Design of earthen dams*	*Design of a trapezoidal notch fall*	*Design of non-scouring stable channels with protected side slopes in alluvium soil (Shield's entrainment method)*
	SLO-2	*Standards of quality for irrigation water*	*Khosla's method – flow nets*	*Seepage analysis in earthen dams*	*Design of a trapezoidal notch fall*	*Design of non-scouring stable channels with protected side slopes in alluvium soil (Shield's entrainment method)*
S-3	SLO-1	*Duty and delta – factors affecting duty*	*Khosla's method of independent variables for determination of pressures and exit gradient for seepage below a weir or a barrage*	*Seepage analysis in earthen dams*	*Design of simple vertical drop fall*	*Design of non-scouring channels with unprotected side slopes in alluvium soil*
	SLO-2	*Methods of improving duty*	*Design problem on Khosla's method of independent variables*	*Design for stability of earthen dams*	*Design of simple vertical drop fall*	*Design of non-scouring channels with unprotected side slopes in alluvium soil*
S-4	SLO-1	*Irrigation efficiencies*	*Design problem on Khosla's method of independent variables*	*Design for stability of earthen dams*	*Design of a Sarda fall*	*Design of most efficient channel section*

	SLO-2	*Problems in irrigation efficiencies*	*Complete design of weir/barrage using Khosla's theory*	*Spillways – types and design considerations*	*Design of a Sarda fall*	*Design of most efficient channel section*
S-5	SLO-1	*Estimation of consumptive use –Blaney Criddle method*	*Complete design of weir/barrage using Khosla's theory*	*Design of chute spillway*	*Cross drainage works – types*	*Design of stable channels – Kennedy's theory*
	SLO-2	*Pan evaporation method – Penman's method*	*Storage structures: Gravity dam – cross section of gravity dam*	*Design of chute spillway*	*Cross drainage works – selection of suitable type*	*Design of stable channels – Kennedy's theory*
S-6	SLO-1	*Classes and availability of soil water – soil moisture deficiency*	*Modes of failure of gravity dam*	*Design of ogee spillway*	*Design considerations for cross drainage works*	*Design of stable channels – Lacey's theory*
	SLO-2	*Depth of water stored in root zone*	*Criteria for structural stability of gravity dam*	*Design of ogee spillway*	*Design considerations for cross drainage works*	*Design of stable channels – Lacey's theory*
S-7	SLO-1	*Limiting soil moisture conditions*	*Design considerations for gravity dam*	*Energy dissipators*	*Design of cross drainage works*	*Balancing depth of canals*
	SLO-2	*Depth and frequency of irrigation*	*Design considerations for gravity dam*	*Design of stilling basin*	*Design of cross drainage works*	*Balancing depth of canals*
S-8	SLO-1	*Diversion structures: Weirs and barrages*	*Design of gravity dam*	*Canal structures: Canal regulators – head and cross regulator*	*Design of cross drainage works*	*Economic justification of canal lining for unlined canals*
	SLO-2	*Diversion head works and its components*	*Design of gravity dam*	*Functions – Alignment of the off-taking channel*	*Design of cross drainage works*	*Economic justification of canal lining for unlined canals*
S-9	SLO-1	*Failure of hydraulic structures – failure by piping and failure by direct uplift*	*Design of gravity dam*	*Design of cross regulator*	*Conveyance: Mechanics of sediment transport*	*Design of lined canals*
	SLO-2	*Bligh's creep theory*	*Design of gravity dam*	*Design of distributary head regulator*	*Computing the design capacity of an irrigation canal*	*Design of lined canals*

Learning Resources	1. *Santhosh Kumar Garg, "Irrigation Engineering and Hydraulic Structures",Khanna Publishers, 2000.* 2. *Punmia B.C. et al., "Irrigation and Water Power Engineering", Laxmi Publications Pvt. Ltd., New Delhi, 2009* 3. *AsawaG. L., "Irrigation and Water Resources Engineering", New Age International Publishers, New Delhi, 2005.*	4. *SharmaR.K., "Irrigation Engineering and Hydraulic Structures", Oxford and IBH Publishing Company, New Delhi, 2002* 5. *NPTEL – Irrigation and Drainage:https://nptel.ac.in/courses/126105010/* 6. *NPTEL – Water Resources Engineering: https://nptel.ac.in/downloads/105105110/*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, MOOCs, Certifications, and Conf. Paper etc.

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Abdul Hakeem, National Remote Sensing Center, Hyderabad, abdulhakeem_k@nrsc.gov.in	*1. Dr. Rehana Shaik, IIIT, Hyderabad, rehana.s@iiit.ac.in*	*1. Dr. DeepthaThattai, SRMIST*
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Course Code	18CEE314T	Course Name	GROUND WATER 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:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Create insights into the occurrence and properties of groundwater*			
CLR-2 :	*Address concepts related to movement of groundwater*			
CLR-3 :	*Create insights on well hydraulics*			
CLR-4 :	*Address concepts related to exploration and investigation of groundwater*			
CLR-5 :	*Create insights into groundwater management and seawater intrusion*			
CLR-6 :	*Understand the software applications in groundwater modeling*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Understand the various properties of groundwater*	*2*	*85*	*80*	*H*	*M*	*L*	*L*	-	*L*	*H*	-	-	-	-	*L*	*M*	-	-
CLO-2 :	*Understand the governing equations of groundwater movement*	*2*	*85*	*75*	*H*	*H*	*H*	*H*	-	-	*H*	-	-	-	-	-	*M*	-	-
CLO-3 :	*Acquire the knowledge on yield of the well and its hydraulics*	*2*	*80*	*75*	*H*	*H*	*M*	*M*	-	*L*	*H*	-	-	-	-	*L*	*M*	-	-
CLO-4 :	*Understand the concept of various methods of exploration*	*2*	*85*	*75*	*H*	*L*	*M*	*M*	-	-	*H*	-	-	-	-	-	*M*	-	-
CLO-5 :	*Understand the concept of seawater intrusion and conjunctive use*	*2*	*85*	*80*	*H*	*M*	*H*	*H*	-	*M*	*M*	-	-	-	-	*L*	*M*	-	-
CLO-6 :	*Acquire knowledge on groundwater modeling and models in use*	*2*	*80*	*75*	*H*	*H*	*H*	*H*	*H*	*M*	*H*	-	-	-	-	*H*	*M*	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to Groundwater: Global distribution of water, role of groundwater in hydrological cycle*	*Groundwater Movement Groundwater Movement- Governing Equation*	*Well Hydraulics Flow into a well*	*Subsurface Exploration Objective and Need for exploration Various methods*	*Groundwater Management and Modeling Groundwater quality and Contamination*
	SLO-2	*Various water bearing formations, subsurface water distribution*	*Darcy's Law*	*Steady radial flow into a well: Dupuit equation, Thiem's equation*	*Geophysical investigations*	*Groundwater quality standards*
S-2	SLO-1	*Aquifers and types of aquifers*	*Heterogeneity and anisotropy*	*Unsteady radial flow into a well: Theis equation*	*Surface geophysical techniques*	*Types and sources of groundwater contamination*
	SLO-2	*Aquifer properties: porosity, permeability, specific yield, storage coefficient and transmissivity, factors affecting permeability*	*Estimation of aquifer parameters*	*Jacob's correction for very thin aquifers with water table condition*	*Electrical resistivity method*	*Various quality parameters and its significance*
S-3	SLO-1	*Problems on aquifer properties*	*Problems on Darcy's law*	*Problems on Theis equation*	*Seismic refraction method*	*Attenuation of groundwater quality*
	SLO-2	*Problems on aquifer properties*	*Problems on aquifer parameter estimation*	*Problems on Jacob equation*	*Remote sensing in groundwater exploration*	*Potential evaluation of groundwater quality*
S-4	SLO-1	*Groundwater fluctuation*	*1D governing equation of flow through porous medium*	*Theis recovery, well hydraulics*	*Other surveying methods*	*Physical, chemical and biological method of analysis*
	SLO-2	*Groundwater balance and budgeting*	*2D governing equation of flow through porous medium*	*Wells in leaky aquifer*	*Borehole geophysical techniques*	*Problems on quality evaluation*

S-5	SLO-1	*Problems on water balance equation*	*Equation for flow into leaky aquifer*	*Partially penetrating wells*	*Electric logging, radioactive logging*	*Conjunctive use of groundwater and basin management*
	SLO-2	*Problems on groundwater fluctuation*	*Flow through unconfined aquifer*	*Image well theory, multiple wells*	*Induction, fluid and sonic logging*	*Groundwater development under various scales*
S-6	SLO-1	*Groundwater in different rocks*	*Boundary conditions*	*Well capacity and well development*	*Geochemical method of exploration*	*Groundwater modeling, problems in groundwater*
	SLO-2	*Groundwater potential in India*	*Groundwater flow rates and direction*	*Construction and types of open well*	*Application of GIS in groundwater exploration*	*Types of models*
S-7	SLO-1	*Case Study 1*	*Groundwater flow problems*	*Construction and types of tube well*	*Seawater intrusion theory*	*Conceptual model, physical model*
	SLO-2	*Case Study 2*	*Steady one dimensional flow, flow into galleries*	*Problems on well hydraulics*	*Shape of interface*	*Mathematical model and analog model*
S-8	SLO-1	*GEC Norms*	*Aquifer with recharge*	*Problems on Theis recovery*	*Slope of interface*	*Data, input, boundary conditions and output, prediction*
	SLO-2	*Methodology of estimation*	*flow into confined aquifer with constant*	*Pumping test and recuperation test*	*Causes of seawater intrusion*	*Calibration and validation of a model*
S-9	SLO-1	*Status of groundwater in various parts of India- a case study*	*flow into confined aquifer with variable thickness*	*Problems on yield test*	*Effects of seawater intrusion*	*Groundwater models*
	SLO-2	*Threats to groundwater*	*Groundwater Theory, Solution for differential Equations*	*Well losses and determination*	*Various methods of reducing seawater intrusion*	*MODFLOW, MT3D, FEFLOW, SEAWAT*

Learning Resources	*1. Raghunath, H. M., "Ground Water", New Age International (P) Ltd, 2014.* *2. D.K. Todd and L. F. Mays, "Groundwater Hydrology", John Wiley and Sons.* *3. K. R. Karanth, "Hydrogeology", Tata McGraw Hill Publishing Company.*	*4. NPTEL course - Ground Water Hydrology: http://nptel.ac.in/courses/105105042/* *5. NPTEL course - Ground Water Hydrology: http://nptel.ac.in/courses/105103026/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	*2. Dr. S. Saravanan, NIT Trichy, saravanans@nitt.edu*	*2. Ms. T. Saranya, SRMIST*

Course Code	18CEE315T	Course Name	SURFACE HYDROLOGY	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:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Create insights into various hydrometeorological variables and components of hydrological cycle*			
CLR-2 :	*Address concepts related to precipitation and water losses*			
CLR-3 :	*Analyze concepts of runoff and hydrograph analysis*			
CLR-4 :	*Address concepts related to floods and their estimation*			
CLR-5 :	*Create insights into reservoir routing and stream flow routing*			
CLR-6 :	*Address various types of models and their processes*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Identify various hydrometeorological variables and components of hydrological cycle*	*2*	*85*	*80*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-2 :	*Analyze precipitation and water losses*	*3*	*85*	*75*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-3 :	*Understand runoff and hydrograph analysis*	*3*	*85*	*75*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-4 :	*Analyze floods and their estimation*	*2*	*85*	*80*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-5 :	*Understand reservoir routing and channel routing*	*2*	*80*	*75*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-6 :	*Analyze various models and their processes*	*3*	*85*	*75*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Weather and climate*	*Precipitation: forms and types*	*Runoff, components of stream flow*	*Floods: Standard project flood, maximum probable flood, PMP, design flood*	*Systems and models – system concept in hydrology*
	SLO-2	*Scope of hydrometeorology*	*Test for consistency of the record, causes of inconsistency in the record*	*Catchment characteristics, watershed concepts*	*Estimation of peak flood: Empirical flood formulae- Dickens, Ryves, Inglis, Myers*	*Types of models – physical, conceptual, empirical, mathematical models*
S-2	SLO-1	*Meteorological variables*	*Double mass curve techniques*	*Classification of streams, isochrones*	*Rational method and concentration time method*	*Life cycle of a model*
	SLO-2	*Temperature, atmospheric pressure*	*Depth-Area relationship, Intensity-Duration-Frequency (IDF) curves*	*Factors affecting runoff*	*Problems on peak discharge*	*Types of mathematical models*
S-3	SLO-1	*Atmospheric humidity*	*Analysis of rainfall data*	*Runoff estimation: rational method, assumptions and drawbacks*	*Flood frequency studies: California method and Weibull method*	*Formulation of a mathematical model – modeling concepts*
	SLO-2	*Simple problems on saturation vapour pressure and relative humidity*	*Problems on mean, median and mode, mass curve, hyetograph, moving average, IDF and frequency curve*	*Components of streamflow hydrograph*	*Problems on flood frequency*	*Watershed–System concept*
S-4	SLO-1	*Clouds: categories and its classification*	*Design storm*	*Baseflow separation methods*	*Encounter probability: probability of exceedance and Probability of non-exceedance*	*Types of watershed models*
	SLO-2	*Atmosphere: different strata of atmosphere*	*Water losses*	*Problems on rainfall excess estimation by baseflow separation methods*	*Problems on encounter probability*	*Models in practice for various hydrologic processes*

S-5	SLO-1	*Wind and wind belts*	*Evaporation from water surfaces, Dalton's law of evaporation*	*Derivation of a unit hydrograph*	*Flood routing: Reservoir routing and channel routing*	*Stochastic model: space independent and space co-related*
	SLO-2	*Evaporation, vertical air motions*	*Evaporation pans: floating pans, land pan and Colorado sunken pan*	*Elements and propositions of unit hydrograph*	*Reservoir routing: ISD method*	*Artificial Neural Network (ANN)*
S-6	SLO-1	*Global distribution of water*	*Pan coefficient, problems on loss of water due to evaporation*	*Problems on unit hydrograph*	*Modified Pul's method*	*ANN activation function*
	SLO-2	*Water resources of India*	*Measures to reduce lake evaporation*	*Problems on unit hydrograph*	*Problem on reservoir routing*	*Network training algorithm – back propagation*
S-7	SLO-1	*Seasons in India*	*Transpiration, transpiration ratio and evapotranspiration*	*S-curve method*	*Problem on reservoir routing*	*Advantages and limitations of ANN*
	SLO-2	*Hydrology and hydrologic cycle*	*Consumptive use determination by Blaney-Criddle method, problems.*	*Problems on S-curve hydrograph*	*Stream flow routing: prism storage and wedge storage*	*Fuzzy sets and fuzzy logic*
S-8	SLO-1	*Distribution of rainfall in India*	*Infiltration, Horton's equation*	*Problems on S-curve hydrograph*	*Muskingum method*	*Fuzzification, evaluation of rules, defuzzification*
	SLO-2	*Scope of hydrology*	*Measurement of infiltration: infiltrometer and rainfall simulator*	*Synthetic unit hydrograph*	*Problem on Muskingum method*	*Fuzzy rule based reservoir operation model*
S-9	SLO-1	*Hydrological data*	*Infiltration indices: phi index and W-index*	*Snyder's method*	*Problem on Muskingum method*	*Changes in climate as related to water*
	SLO-2	*Hydrologic equation, simple problems on water budget.*	*Problems on Horton's equation and infiltration indices*	*Problems on Snyder's method*	*Flood forecasting and warning*	*Impacts and responses – climate change and water resources*

Learning Resources	1. *Raghunath, H.M., Hydrology, New Age International Publishers, New Delhi, 2007.* 2. *Subramanya, K., Engineering Hydrology, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2014* 3. *Pukh Raj Rakhecha and Vijay P. Singh, Applied Hydrometeorology, Capital Publishing Company, 2009.* 4. *Chow, V.T., and Maidment, Hydrology for Engineers, McGraw Hill Inc., Ltd., 2000* 5. *Vedula, S., and Mujamdar, P.P., Water Resources Systems, McGraw Hill Inc., 2005*	6. *NPTEL Course – Advanced Hydrology: https://nptel.ac.in/courses/105101002/#* 7. *Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., 2008: Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 210 pp.* 8. *NPTEL course – Watershed Management: https://nptel.ac.in/courses/105101010/16*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	*2. Dr. S. Saravanan, NIT Trichy, saravanans@nitt.edu*	*2. Dr. Deeptha Thattai, SRMIST*

Course Code	18CEE401T	Course Name	PAVEMENT ANALYSIS AND DESIGN	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 layered structure stress-strain analysis*
CLR-2 :	*Understand the viscoelastic characterization of the material*
CLR-3 :	*To impart basic knowledge on various bituminous technology and its characterization*
CLR-4 :	*Familiarize with the design of flexible pavement*
CLR-5 :	*Study about the distress of pavements*
CLR-6 :	*Knowabout the pavement condition survey*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*analyze the critical conditions of the layered structure*	*2*	*85*	*80*	*H*	*H*	*M*	*L*	*H*	*-*	*H*	*-*	*-*	*-*	*-*	*-*	*M*	*-*	*-*
CLO-2 :	*Predict the real time behavior of the material*	*2*	*85*	*75*	*H*	*H*	*H*	*H*	*-*	*-*	*H*	*-*	*-*	*-*	*-*	*-*	*M*	*-*	*-*
CLO-3 :	*Select appropriate material for the bituminous pavement construction*	*2*	*80*	*75*	*H*	*H*	*M*	*M*	*-*	*-*	*H*	*-*	*-*	*-*	*-*	*-*	*M*	*-*	*-*
CLO-4 :	*Design the flexible pavement for different conditions of traffic and with different material combination*	*2*	*85*	*75*	*H*	*H*	*H*	*H*	*-*	*-*	*H*	*-*	*-*	*-*	*-*	*-*	*M*	*-*	*-*
CLO-5 :	*Evaluate the existing condition of the pavement*	*2*	*85*	*80*	*H*	*H*	*M*	*M*	*L*	*-*	*M*	*-*	*-*	*-*	*-*	*-*	*M*	*-*	*-*
CLO-6 :	*Suggest the suitable measures to improve the condition of the pavement*	*2*	*80*	*75*	*H*	*H*	*M*	*-*	*-*	*-*	*M*	*-*	*-*	*-*	*-*	*-*	*M*	*-*	*-*

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Stress Analysis of Layered Structure: Importance of pavement design*	*Viscoelasticity: Introduction to viscoelasticity*	*Pavement Materials: Bitumen.*	*Design of Flexible pavement: Different layers of flexible pavement*	*Evaluation of pavement: Distress in flexible pavement*
	SLO-2	*Overview of layered system*	*Creep and recovery*	*Modified bitumen*	*Design factors*	*Distress in flexible pavement*
S-2	SLO-1	*Single layer system- stress analysis*	*Stress relaxation*	*Bitumen emulsion-Types*	*Traffic factors*	*Distress of rigid pavement*
	SLO-2	*Single layer system- stress analysis*	*Viscoelastic models*	*Grading of bitumen*	*Traffic factors*	*Distress of rigid pavement*
S-3	SLO-1	*Solving problems*	*Viscoelastic solid model*	*Performance grading*	*Material characteristics*	*Evaluation of distress*
	SLO-2	*Solving problems*	*Derivation of Voigt-Kelvin model*	*Aging of binder*	*Temperature*	*Distress measurement-Surface roughness*
S-4	SLO-1	*Two-layer pavement- stress analysis*	*Creep and recovery response of Voigt-Kelvin model*	*Bituminous mixture*	*Critical locations in pavement*	*Skid resistance*
	SLO-2	*Two-layer pavement- stress analysis*	*Stress relaxation response of Voigt-Kelvin model*	*Hot mix asphalt mixture*	*Pavement design as per IRC*	*Deflection measurements*
S-5	SLO-1	*Solving problems*	*Viscoelastic fluid model*	*Warm mix asphalt mixture*	*Solving problems-VDF*	*Benkelman beam test - concept*
	SLO-2	*Solving problems*	*Derivation of Maxwell model*	*Half warm mix asphalt mixture*	*Solving problems-VDF*	*Benkelman beam test – Method of measuring deflection*
S-6	SLO-1	*Multilayered stress analysis*	*Creep and recovery response of Maxwell model*	*Cold mix asphalt mixture*	*Solving problems-Pavement Design*	*Falling weight deflectometer-Working principle*
	SLO-2	*Multilayered stress analysis*	*Stress relaxation response of Maxwell model*	*Cold mix asphalt mixture*	*Solving problems-Pavement Design*	*Fallingweightdeflectometer-Calculation of moduli*
S-7	SLO-1	*Multilayered stress analysis*	*Burger's model*	*Mixture characterization - Resilient modulus*	*Solving problems-Pavement Design*	*Design of overlay by Benkelman beam method*

	SLO-2	*Multilayered stress analysis*	*Derivation of Burger's model*	*Mixture characterization - Determination of resilient modulus*	*Solving problems-Pavement Design*	*Design procedure*
S-8	SLO-1	*Software demo for multilayered structure*	*Oscillatory shearing*	*Mixture characterization - Dynamic modulus*	*Airfield pavement*	*Design procedure*
	SLO-2	*Software demo for multilayered structure*	*Response of elastic material to Oscillatory shearing*	*Mixture characterization - Determination of dynamic modulus*	*Specifications of airfield pavement*	*Solving problems*
S-9	SLO-1	*Software demo for multilayered structure*	*Response of viscous material to Oscillatory shearing*	*Mixture characterization - Time-temperature superposition*	*Design procedure of airfield pavement*	*Solving problems*
	SLO-2	*Software demo for multilayered structure*	*Response of viscoelastic material to Oscillatory shearing*	*Mixture characterization – Rutting and fatigue characterization*	*Design procedure of airfield pavement*	*Solving problems*

Learning Resources	1. *Yang Huang, Pavement Analysis and Design, Pearson, 2004* 2. *Chakroborthy and A. Das, Priciples of Transportation Engineering, Prentice-Hall of India,2003* 3. *S. K. Khanna, C.E.G. Justo and A. Veeraragavan, Highway Engineering, Revised 10th edition, Nem Chand &Bros., Roorkee, 2014.* 4. *Yoder,E.J., and Witczak, Principles of Pavement Design, 2nd ed.John Wiley and Sons, 1975.*	5. *Wineman, A.S. and Rajagopal, K. R, Mechanical Response Of Polymers: An Introduction, Cambridge University Press, 2000.* 6. *6.Guidelines for the Design of Flexible Pavements, IRC :37, The Indian Road Congress, New Delhi* 7. *Subash C, Saxena, Textbook of Highway and Traffic Engineering, CBS Publishers, 1st Edition,2014* 8. *NEPTEL link - https://nptel.ac.in/courses/105105107/1 and https://nptel.ac.in/courses/112104040/12 (as on 05.07.2019)*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
Level 2	Apply Analyze	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
Level 3	Evaluate Create	*30%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

#CLA – 4 can be from any combination of Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conference Paper

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. Asif Ahmed, Business manager, Ingevity, ahmed.asif@ingevity.com	*Dr. VenkaiahChowdary, Associate Professor, NITW, vc@nitw.ac.in*	*Dr. A. Padma Rekha, SRM IST*
Mr.AnkitPachouri, Transport Planner, IUT, New Delhi, ankit.pachouri@iutundia.org	*Dr. V Sunitha, Assistant Professor, NITT, sunitha@nitt.edu*	*Ms R Dhanya, SRM IST*

Course Code	18CEE402T	Course Name	RAILWAY, AIRPORT AND HARBOUR 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:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Get exposed to Railway track planning and design*			
CLR-2 :	*Understand the process of operation and maintenance of Railway track*			
CLR-3 :	*Attain knowledge on the concepts of planning and design of airport components*			
CLR-4 :	*Learn the structural design of the airfield pavement*			
CLR-5 :	*Understand the process in the Evaluation of the airfield pavement*			
CLR-6 :	*Acquire knowledge on the site characteristics and component planning for harbour*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Apply the planning and design concepts of railway alignment and geometric design of railway track*	*2*	*85*	*80*	*H*	*H*	*M*	*L*	-	*L*	*H*	-	-	-	-	*L*	*M*	-	-
CLO-2 :	*Plan and design the operational facilities for effective rail transportation*	*2*	*85*	*75*	*H*	*H*	*H*	*H*	-	-	*H*	-	-	-	-	-	*M*	-	-
CLO-3 :	*Apply the planning and design concepts of airport components*	*2*	*80*	*75*	*H*	*H*	*M*	*M*	-	*L*	*H*	-	-	-	-	*L*	*M*	-	-
CLO-4 :	*Design the airfield pavement*	*2*	*85*	*75*	*H*	*H*	*H*	*H*	-	-	*H*	-	-	-	-	-	*M*	-	-
CLO-5 :	*Evaluate the airfield pavement*	*2*	*85*	*80*	*H*	*H*	*M*	*M*	*L*	*L*	*M*	-	-	-	-	*L*	*M*	-	-
CLO-6 :	*Understand the basic need for handling the cargos in the harbour*	*2*	*80*	*75*	*H*	*H*	*M*	-	-	*L*	*M*	-	-	-	-	-	*M*	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*RAILWAY PLANNING AND DESIGN Introduction to railway engineering*	*Numericals in length of transition curve*	*AIRPORT PLANNING AND GEOMETRIC DESIGN Importance and limitations Advantages and Limitations of Air Transport.*	*PAVEMENT DESIGN AND EVALUATION Importance of pavement design and evaluation*	*HARBOUR ENGINEERING Importance of Harbour Engineering*
	SLO-2	*Role of Indian Railways in National Development*	*Numericals in length of transition curve*	*Characteristics of Air travel.*	*Components of airfield pavement*	*History and modern trends of waterway transportation,*
S-2	SLO-1	*Track Alignment -Importance*	*Widening of Gauges in Curves , Gradients Grade Compensation*	*Airport Master Plan, Evaluation and Institutional arrangements*	*Wheel and Axle Configurations*	*Definition of Terms - Harbours, Ports, Docks, , Sounding,*
	SLO-2	*Obligatory points in railway track alignment*	*Vertical Curves*	*Site Selection and survey,*	*Traffic considerations*	*Tides and Waves, Sounding, Littoral Drift*
S-3	SLO-1	*Engineering Surveys for Track Alignment*	*RAILWAY TRACK OPERATION AND MAINTENANCE Points and Crossings -*	*Components of airport- Runway Orientation,*	*Stress and strain analysis in airfield pavement*	*Classification of Harbours*
	SLO-2	*Remote Sensing, GIS &GPS, EDM and other equipment*	*Turnouts – Types - Working Principle*	*Cross wind Component, Wind rose Diagram*	*Stress and strain analysis in airfield pavement*	*Site Selection and harbour planning*
S-4	SLO-1	*Permanent Way and its components*	*Signaling*	*Numericals in Type I and II Wind Rose Diagram*	*Numericals in stress and strain*	*Types of Layouts of ports and components*
	SLO-2	*Functions of each component -Concept of Gauges*	*Interlocking*	*Basic Runway length and Corrections*	*Numericals in stress and strain*	*Approach facilities- With head gates, Without head gates*

S-5	SLO-1	*Gauges and the type of gauges*	*Track Circuiting*	*Numericals in Corrections of BRL*	*Cummulative Damage Factor*	*Protection facilities*
	SLO-2	*Coning of Wheels, Creeps and kinks*	*Construction & Maintenance Materials,*	*Numericals in Corrections of BRL*	*Environmental factors*	*Breakwater and its types*
S-6	SLO-1	*Geometric Design of Railway Tracks - basic terms and representations*	*Track Drainage*	*Airport classification, Geometric design and specifications of runway*	*FAARFIELD input*	*Docking facilities*
	SLO-2	*Super-Elevation, Negative superelevation*	*Track Modernization*	*Geometric Design elements and specifications of taxiway*	*Design of airfield pavement using FAARFIELD*	*Wet docks and Dry docks*
S-7	SLO-1	*Numericals in design of superelevation*	*Automated maintenance and upgrading, Technologies,*	*Runway patterns - Minimum Separation Distances*	*Pavement Evaluation - importance*	*Navigational Aids - Buoys and Beacons*
	SLO-2	Numericals in design of superelevation	Re-laying of Track	Clearance over Highways and Railways	Method of evaluation and overview	Light ships, Light house
S-8	SLO-1	Numericals in design of superelevation	Lay outs of Railway Stations and Yards,	Drainage - Airport Zoning	Structural Evaluation - test procedure	Storage Facilities
	SLO-2	Numericals in design of superelevation	Rolling Stock	Aircraft parking systems	Structural Evaluation - evaluation techniques	Dolphins
S-9	SLO-1	Horizontal Curves, Transition Curves,	Tractive Power, Track Resistance	Visual Aids , Wind Direction Indicators	Functional Evaluation - test procedure	Mooring Accessories
	SLO-2	Numericals in length of transition curve	Numericals in Tractive resistance	Runway and Taxiway Markings and Lightings	Functional Evaluation - evaluation techniques	Dredging facilities

Learning Resources	1. *SaxenaSubhash C and Satyapal Arora, "A Course in Railway Engineering", DhanpatRai and Sons, Delhi, 1998.* 2. *Khanna S K, Arora M G and Jain S S, "Airport Planning and Design", Nemchand and Brothers, Roorkee, 1994.* 3. *R Horonjeff and F X Mckelvy, Planning and design of Airport, Mc-Graw Hill International Editions, 1993*	4. *R. Srinivasan, "Harbour, Docks and Tunnel Engineering", Charotar Publishing home, 27th Edition, 2015* 5. *S P Bindra, "A Course in Docks and Harbour Engineering", DhanpatRai and Sons, NewDelhi, 1993.* 6. *NPTEL link - https://nptel.ac.in/courses/105107123/ (as on 05.07.2019)*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
Level 2	Apply Analyze	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
Level 3	Evaluate Create	*30%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of Assignments, Seminars, Tech Talks, Mini Projects, Case Studies, Self Study, MOOCs, Certifications, Conference Paper

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. Asif Ahmed, Business manager, Ingevity, ahmed.asif@ingevity.com	*Dr. VenkaiahChowdary, Associate Professor, NITW, vc@nitw.ac.in*	*Dr. A. Padma Rekha, SRM IST*
Mr.AnkitPachouri, Transport Planner, IUT, New Delhi, ankit.pachouri@iutundia.org	*Dr. V Sunitha, Assistant Professor, NITT, sunitha@nitt.edu*	*MsArunimaJayakumar, SRM IST*

Course Code	18CEE403T	Course Name	TRAFFIC ENGINEERING AND MANAGEMENT	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 basics of traffic flow modelling.*
CLR-2 :	*Familiarize the microscopic modelling*
CLR-3 :	*Learn and understand the level of service of traffic flow*
CLR-4 :	*Address the issues related to flow interruptions*
CLR-5 :	*Learn and design the facilities required for the traffic control measures*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Develop model for the traffic stream parameters*	*2*	*85*	*80*	*H*	*H*	*M*	*L*	-	*L*	*H*	-	-	-	-	*L*	*M*	-	-
CLO-2 :	*Create the microscopic models of the traffic flow*	*2*	*85*	*75*	*H*	*H*	*H*	*H*	-	-	*H*	-	-	-	-	-	*M*	-	-
CLO-3 :	*Apply the qualitative rankings on uninterrupted flow*	*2*	*80*	*75*	*H*	*H*	*M*	*M*	-	*L*	*H*	-	-	-	-	*L*	*M*	-	-
CLO-4 :	*Provide the facilities for interrupted flow*	*2*	*85*	*75*	*H*	*H*	*H*	*H*	-	-	*H*	-	-	-	-	-	*M*	-	-
CLO-5 :	*Apply the concept of traffic control measures*	*2*	*85*	*80*	*H*	*H*	*M*	*M*	*L*	*L*	*M*	-	-	-	-	*L*	*M*	-	-
		2	80	75	H	H	M	-	-	L	M	-	-	-	-	-	M	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*TRAFFIC STREAM MODELLING Importance of traffic Engineering and need for flow modelling*	*MICROSCOPIC TRAFFIC FLOW MODELLING Concepts of microscopic modeling*	*UNINTERRUPTED FLOW Concept of uninterrupted flow*	*INTERRUPTED FLOW Concept of interrupted flow - intersections*	*TRAFFIC CONTROL Various traffic control measures*
	SLO-2	*Importance of traffic Engineering and need for flow modelling*	*Car-following model, Basic terms and notations*	*Definitions - Capacity, Level of Service(LoS)*	*Various traffic measures for interrupted flow*	*Applications of control measures*
S-2	SLO-1	*Fundamental parameters - speed, density, volume,travel time,headway, spacing*	*Concept of stimulus - response*	*Highway capacity*	*Traffic signs*	*Traffic signal - elements*
	SLO-2	*Time-Space diagram*	*Application of stimulus response theory in traffic flow modelling*	*Factors affecting LoS*	*Types and specifications*	*Definition and analysis of saturation headway, saturation flow, lost time*
S-3	SLO-1	*Fundamental relations - time mean speed, space mean speed and their relation,*	*General motor's models*	*HCM methods*	*Road markings - longitudinal marking*	*Phase design - two, three, four phases*
	SLO-2	*Numerical problems and solutions*	*Derivation - general motor model*	*Urban Street - Classification*	*Road markings - transverse and object marking*	*Cycle time determination - Green split time*
S-4	SLO-1	*Relation between speeds, flow, density,*	*Simulation Problem in general motor model*	*Operational Performance measures*	*Channelization*	*Definitions and measurement of stopped and control delay*
	SLO-2	*Fundamental diagrams*	*Simulation Problem in general motor model*	*Congestion Management*	*Case studies*	*Webster's delay model*
S-5	SLO-1	*Greenshield's model – Assumptions and model form*	*Simulation Problem in general motor model*	*Case studies for congestion management*	*Traffic rotary*	*Problems in traffic signal design*
	SLO-2	*Derivation -greenshield model*	*Simulation Problem in general motor model*	*Case studies for congestion management*	*Conflict resolution in a rotary*	*Capacity and LoS analysis*

S-6	SLO-1	*Numerical solution - Greenshield model*	*Vehicle arrival model,Poisson distribution*	*Multilane highways - Characteristics, Capacity*	*Geometric layout*	*HCM 2000 method - analysis of a signalized intersections*
	SLO-2	*Numerical solution - Greenshield model*	*Problems in Poisson distribution*	*Multilane highways - Level of service*	*Design elements of rotary*	*Determination of level of service as per HCM 2000*
S-7	SLO-1	*Greenberg's logarithmicmodel*	*Headway modeling*	*Freeway operations*	*Capacity of rotary*	*Signal coordination- concepts*
	SLO-2	*Underwood's exponential model*	*Random vehicle generation*	*Freeway operations- operational considerations*	*Problem in rotary capacity*	*Application of coordinated traffic signal*
S-8	SLO-1	*pipe'sgeneralized model*	*Microscopic traffic simulation*	*Capacity and Level of service of freeway segment*	*Grade separated intersection - road over bridges*	*Concept of offset*
	SLO-2	*multi-regime models*	*Microscopic traffic simulation*	*Capacity and Level of service of freeway segment*	*Underpass, Overpass concepts*	*Common cycle length andbandwidth*
S-9	SLO-1	*Movingobserver method.*	*Design, calibration, validation, applications,*	*Weaving operation*	*Types of interchanges based on the traffic flow*	*Offset for one-way and two-way streets*
	SLO-2	*Numerical solution - moving observer method*	*Operational models.*	*Weaving operation*	*Case studies on interchanges*	*Vehicle actuated signals*

Learning Resources	1. *Roess, R. P. McShane, W. R. &Prassas, E. S. (1998), Traffic Engineering, Prentice – Hall.* 2. *May, A. D. (1990), "Fundamentals of Traffic Flow", second edn, Prentice Hall.* 3. *Papacostas, C. S. (1987), "Fundamentals of Transportation Engineering", Prentice-Hall, India* 4. *Kadiyali, L. R. (1987), "Traffic Engineering and Transportation Planning", KhannaPublishers, India.* 5. *Papacostas, C. S. and Prevedouros, P.D. (2001) "Transportation Engineering and Planning", Prentice Hall of India Pvt. Ltd.* 6. *Highway Capacity Manual (2010), Transportation Research Board, USA* 7. *NPTEL link - https://nptel.ac.in/downloads/105101008/# (as on 05.07.2019)*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
Level 2	Apply Analyze	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
Level 3	Evaluate Create	*30%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of Assignments, Seminars, Tech Talks, Mini Projects, Case Studies, Self Study, MOOCs, Certifications, Conference Paper

Course Designers

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Mr.AnkitPachouri, Transport Planner, IUT, New Delhi, ankit.pachouri@iutundia.org	*Dr. V Sunitha, Assistant Professor, NITT, sunitha@nitt.edu*	*Mr. G. Sivaprakash, SRM IST*

Course Code	18CEE404T	Course Name	CONSTRUCTION EQUIPMENT AND AUTOMATION	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 management concepts of construction equipment*
CLR-2 :	*Identify the various earthwork equipments and its applications in real projects*
CLR-3 :	*Identify the various off shore equipments and techniques for dewatering*
CLR-4 :	*Identify the various equipments used on aggregate and concrete production*
CLR-5 :	*Analyze the basic concepts of methods and techniques on demolishing and dismantling structures*
CLR-6 :	*Explore the advanced level of automated equipments for various construction activities*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Accrue the knowledge of equipment management and cost controlling methods*	*2*	*85*	*75*	*H*	*M*	-	*L*	-	-	-	*H*	*M*	*M*	*H*	*H*	*M*	-	*H*
CLO-2 :	*Apply the knowledge of calculating productivity of earthwork equipments*	*3*	*85*	*75*	*H*	*H*	-	*L*	*L*	-	-	-	*H*	*H*	*H*	*M*	*M*	-	*H*
CLO-3 :	*Accrue the knowledge of equipments used in off shore construction practice*	*2*	*85*	*75*	*H*	*H*	-	*M*	*M*	-	-	-	*H*	*H*	*H*	*M*	*M*	-	*H*
CLO-4 :	*Accrue the knowledge of equipments used for aggregate and concrete production, techniques for demolition*	*3*	*85*	*75*	*H*	*H*	-	*M*	*M*	-	-	-	*H*	*H*	*H*	*M*	*M*	-	*H*
CLO-5 :	*Apply the knowledge in demolition and dismantling the distressed structures*	*2*	*85*	*75*	*H*	*H*	-	*H*	*M*	-	-	-	*H*	*H*	*H*	*M*	*M*	-	*H*
CLO-6 :	*Accrue comprehensive knowledge of automation in construction practices*	*2*	*85*	*75*	*H*	*H*	-	*M*	*H*	-	-	-	*H*	*H*	*H*	*H*	*M*	-	*H*

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction on Construction Equipment*	*Earth Moving operations*	*Dredging equipment*	*Drilling equipments*	*Lifting equipments*
	SLO-2		*Types of Earthwork Equipment*	*Types of Dredging equipment*	*Types of Drilling equipments*	*Material handling equipments*
S-2	SLO-1	*Equipment Management in Construction Projects*	*Earthwork Equipment - Tractors*	*Types of trenching equipment*	*Principles of Blasting*	*Hoisting Equipments*
	SLO-2	*Management Programme*	*capacity calculations*		*Types of Blasting equipment*	*Types and safety precautions*
S-3	SLO-1	*Maintenance and Safety management*	*Earthwork Equipment - Motor Graders*	*Concept of Pipe jacking techniques*	*Aggregate production equipment*	*Slip form techniques*
	SLO-2	*Equipment requirement for construction project*	*Capacity calculations*	*Equipment used for Pipe jacking*	*Crushers*	
S-4	SLO-1	*Planning of Equipment*	*Earthwork Equipment - Scrapers,*	*Compaction equipments*	*Various types of crushers, feeders and screening equipments*	*Equipments for Conveyors*
	SLO-2	*Selection of Equipment*	*capacity calculations*	*Types of Compaction equipments*		*Types of Conveyors*
S-5	SLO-1	*Cost Control of Equipment*	*Earthwork Equipment - Front end Loaders*	*Pumping and Dewatering equipments*	*Concrete mixers*	*Prestressing techniques*
	SLO-2	*Depreciation on Equipment*	*capacity calculations*	*Types of pumps*	*Types of concrete mixers*	*Insitu prestressing in high rise structures*
S-6	SLO-1	*Conventional construction methods*	*Earthwork Equipment – Bull dozer*	*Well point Dewatering system*	*Pouring and pumping of concrete*	*Aerial transportations*
	SLO-2		*Capacity calculations*	*Vacuum dewatering of concrete flooring*	*Precautions*	*Applications and applications*
S-7	SLO-1	*Mechanized methods*	*Earthwork Equipment – Excavators*	*Pile Driving Equipments*	*Ready mix concrete - concept and procedure*	*Robots in construction*
	SLO-2	*Advanced Mechanized methods*	*Capacity calculations*	*Types and methods*		*Different automated equipments*
S-8	SLO-1	*Types of construction project*	*Equipments Used for Box Jacking Techniques*	*Concept of Coffer dam*	*Demolition equipment*	*Conventional plastering machines*
	SLO-2	*Types of construction equipment*		*Sheet piling*	*Controlled demolition techniques*	*Use of robots for repetitive activities*

S-9	SLO-1	*Safety Management*	*General safety in excavations*	*Tunneling equipments*	*Sequence of demolition*	*Drones in construction*
	SLO-2	*Safety measures*		*Methods of tunneling*	*Procedure for Dismantling*	*Advantages of drones*

Learning Resources	1. *Peurifoy, R.L., Ledbetter, W.B. and Schexnayder.C, "Construction Planning Equipment and Methods", McGraw Hill. Singapore 2005.* 2. *Sharma S.C. "Construction Equipment and Management", Khanna Publishers, Delhi, 2008.* 3. *Deodhar, S.V. "Construction Equipment and Job Planning", Khanna Publishers Delhi, 2008.*	4. *Mahesh Varma .Dr., "Construction Equipment and its planning and application", Metropolitan Book Company, New Delhi,2003.* 5. *https://nptel.ac.in/courses/105104161/12* 6. *https://nptel.ac.in/courses/105103023/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100%	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, and Conf. Paper etc.

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Course Code	18CEE405T	Course Name	CONTRACTS MANAGEMENT	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:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*To understand Indian Contract Act and to know the various types of construction contracts and their legal aspects*			
CLR-2 :	*Learn about contracts and agreements*			
CLR-3 :	*Acquire the knowledge of FIDIC concepts*			
CLR-4 :	*Apply the concept of various types of taxes*			
CLR-5 :	*Learn about the different types of labour laws*			
CLR-6 :	*Utilize the knowledge of labour laws and legal requirements in broader perspective*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	*Understanding the method of quoting the rates for bidding and tender process*	*3*	*85*	*75*
CLO-2 :	*Knowing the types of contracts*	*2*	*85*	*75*
CLO-3 :	*Steps involved in making contracts and records to be maintained in execution of contract*	*2*	*85*	*75*
CLO-4 :	*Knowledge in legal requirements in construction*	*2*	*85*	*75*
CLO-5 :	*Awareness of labour laws and Indian Contract Act*	*2*	*85*	*75*
CLO-6 :	*Acquiring knowledge to execute a contract*	*2*	*85*	*75*

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
H	*M*	-	-	-	*M*	-	*H*	*H*	*M*	*L*	*M*	*H*	-	*L*
H	*H*	-	-	-	*M*	-	*H*	*H*	*M*	*L*	*M*	*H*	-	*L*
H	*H*	-	-	-	*M*	-	*H*	*M*	*M*	*L*	*M*	*H*	-	*L*
H	*M*	-	-	-	*L*	-	*H*	*M*	*M*	*L*	*M*	*H*	-	*L*
H	*L*	-	-	-	*L*	-	*H*	*M*	*M*	*L*	*M*	*H*	-	*L*
H	*H*	-	-	-	*M*	-	*H*	*H*	*M*	*L*	*M*	*H*	-	*L*

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Indian contract act*	*Tender- Definitions and Methods*	*Construction claims: Extra items and causes of claims*	*Legal Requirements- Insurance and Bonding*	*Labour Regulations-social security*
	SLO-2	*Definitions and important terms. Clause 1-75*	*Need for tendering, agreements and bonds in tendering process*	*Types of construction claims, documentation*	*Types of insurance*	*Welfare legislation*
S-2	SLO-1	*Elements of contract*	*Notice inviting tender*	*Settlement of claims*	*Laws governing sale*	*Laws relating to wages, Bonus and industrial disputes*
	SLO-2	*Types of contract – Legal parlance, Engineering contracts*	*Tender- Prequalification process*	*Arbitration- comparison and action of laws*	*Purchase and sale of urban and rural land*	*Labour administration*
S-3	SLO-1	*Features and suitability*	*Bidding, Accepting*	*Agreements, subject matter*	*Land revenue codes*	*Insurance and safety regulations*
	SLO-2	*Design of contract documents*	*Evaluation of technical, contractual and commercial point of view*	*Causes of disputes and importance of role of various stakeholders in prevention of disputes*	*Tax laws- income tax, sales tax ,VAT*	*Workmen compensation act*
S4	SLO-1	*International contract document*	*One cover and two cover system*	*Alternate dispute resolution methods*	*Excise on custom duties and their influence on construction cost*	*Indian factory act*
	SLO-2	*Standard contract document*	*Contract formation and interpretation*	*Violations, Appointment of arbitrator*	*Legal requirements for planning*	*Child labour act*

S-5	SLO-1	*Importance of breach of contract*	*Potential contractual problems*	*Conditions of arbitrator Powers and duties of arbitrator*	*Property law, Agency law*	*Maternity act*
	SLO-2	*Law of torts*	*World bank procedures and guidelines*	*Rules of evidences*	*Local government laws for approval*	*Minimum wages act*
S-6	SLO-1	*Special and general conditions of contract*	*Tamilnadu transparency in tenders Act.*	*Dispute review boards*	*Statutory regulations*	*Payment of wages act,1936*
	SLO-2	*Introduction to FIDIC contracts and types*	*EMD, SD*	*Indian arbitration and conciliation act1996*	*The companies act 1956: nature and definition of a company*	*Industrial dispute act*
S-7	SLO-1	*ICE conditions- introduction*	*Environmental provisions for construction contracts*	*Difference between 1940 act and 1996 act*	*Registration and incorporation*	*Domestic engaging of misconduct*
	SLO-2	*Evaluation of FIDIC document, types*	*Duties and responsibilities- engineers and contractors, Project manager, owner*	*Extent application of 1996 act. objectives and general provisions*	*Memorandum of association*	*The Tamilnadu and country planning act*
S-8	SLO-1	*Design and build contract, EPC contract*	*Important site documents*	*Conciliation and its provisions in the act*	*Articles of association,, prospectus, kinds of company*	*Building and other construction works act,1996*
	SLO-2	*Short forms contract-colour code*	*Process of building permissions*	*Conduct of conciliation and arbitral proceedings, ground for challenge*	*Directors: powers, duties, meetings and winding up*	*Employees state insurance act,1948*
S -9	SLO-1	*Various conditions of red book*	*Provisions for scheduling delays and accelerations*	*Procedure of appeal against the awards.*	*Managing performance- introduction, monitoring and performance*	*Contract labour act,1970*
	SLO-2	*Case study*	*Case study*	*Case study*	*Case study*	*Case study*

Learning Resources	1. *John G. Betty., "Engineering Contracts", McGraw Hill,2003* 2. *Gajaria G.T., "Laws Relating to Building and Engineering Contracts in India", M. M. Tripathi Private Ltd., Bombay, 1982 Tamilnadu PWD Code, 2006.* 3. *Jimmie Hinze, "Construction Contracts", McGraw Hill, 2001*	4. *Joseph T. Bockrath, "Contracts, the Legal Environment for Engineers and Architects", McGraw Hill, 2000.* 5. *Lecture Notes, "Legal Aspects for Civil Engineers, Short Term Course organized by SRMEC", 29th May to 4th June, 2002.* 6. *https://nptel.ac.in/courses/105103093/11* 7. *https://nptel.ac.in/syllabus/105102013/*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40*	-	*30*	-	*40*	-	*30*	-	*40*	-
	Understand										
Level 2	Apply	*40*	-	*40*	-	*40*	-	*30*	-	*40*	-
	Analyze										
Level 3	Evaluate	*20*	-	*30*	-	*20*	-	*40*	-	*20*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100%	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, and Conf. Paper etc.

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Department coordinators
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Course Code	18CEE406T	Course Name	REPAIR AND REHABILITATION OF 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:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*To assess the diagnosis of distress*			
CLR-2 :	*To provide an overview of performance of concrete structures*			
CLR-3 :	*To identify the sources of dampness and its prevention remedies*			
CLR-4 :	*To choose the appropriate material and its application*			
CLR-5 :	*To assess the extent of distress*			
CLR-6 :	*To study strengthening and demolition of structural component*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*				Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Diagnosis the distresses*	*3*	*85*	*75*	*H*	*H*	-	*M*	-	*H*	-	-	-	-	-	-	*H*	-	-
CLO-2 :	*Understand the performance of the concrete*	*3*	*85*	*75*	*H*	*H*	-	*M*	-	*H*	-	-	-	-	-	-	*H*	-	-
CLO-3 :	*Sources of dampness and its remedies can be able to identify*	*3*	*85*	*75*	*H*	*H*	-	*M*	-	*H*	-	-	-	-	-	-	*H*	-	-
CLO-4 :	*Know about types of materials and its selection*	*3*	*85*	*75*	*H*	*H*	-	*M*	-	*H*	*M*	-	-	-	-	-	*H*	-	-
CLO-5 :	*Rectify the Distress in various structures*	*3*	*85*	*75*	*H*	*H*	-	*M*	-	*H*	-	-	*H*	-	-	-	*H*	-	-
CLO-6 :	*Strengthen and demolish the structural components*	*3*	*85*	*75*	*H*	*H*	-	*M*	-	*H*	*M*	*M*	*H*	-	-	-	*H*	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*General Consideration – Distresses monitoring, Causes of distresses*	*Sources of dampness*	*Materials: Types*	*Distresses : Concrete Structures: Introduction, Causes of deterioration*	*General principle for Strengthening*
	SLO-2	*Defects due to climate, wear and erosion*	*Moisture movement from ground*	*Essential parameters for Materials*	*Diagnosis of causes, Flow charts for diagnosis*	*Relieving loads*
S-2	SLO-1	*Quality assurance & Inspection*	*DPC*	*Special Mortar And Concretes, Concrete Chemicals*	*Methods of repair – repairing, spalling and disintegration*	*Strengthening super structures*
	SLO-2	*Structural & Economic appraisal*	*Reasons for ineffective DPC*	*Special Cements*	*Repairing of concrete floors and pavements*	*Plating*
S-3	SLO-1	*Life Expectancy of Different Types of Buildings*	*Roof leakage - Pitched roofs*	*High Grade Concrete*	*Steel Structures : Types and causes for deterioration*	*Conversation to composite construction*
	SLO-2	*Influence of Environmental Elements on Buildings*	*Madras Terrace roofs*	*Expansive Cement*	*Types and causes for deterioration – preventive measures*	*Post stressing*
S-4	SLO-1	*Design and Construction Errors*	*Leakage of Concrete slabs*	*Polymer Concrete*	*Repair procedure - Brittle fracture*	*Jacketing*
	SLO-2	*Corrosion Mechanism*	*Protective Seal coatings*	*Epoxies, Resins*	*Lamellar tearing*	*Bonded overlays*
S-5	SLO-1	*Effect of Biological Agents*	*Ferro cement overlay*	*Surface Coatings*	*Defects in welded joints*	*Reinforcement addition*
	SLO-2	*Termite Control and Prevention*	*Resin or polymer slurry injection*	*Parameters & types of coatings*	*Mechanism of corrosion*	*Fiber wrap techniques*
S-6	SLO-1	*Chemical Attack on Building*	*Thin polymer overlay*	*Sulphur Infiltrated Concrete*	*Design of protect against corrosion*	*Pre placed aggregate concrete*
	SLO-2	*Aspects of Fire on Buildings*	*Thin epoxy overlay*	*Properties and application of SIFCON*	*Design and fabrication errors*	*Shortcrete*

S-7	SLO-1	*Building Cracks Causes – diagnosis*	*Dampness in solid walls*	*Ferro cement*	*Distress during erection.*	*Strengthening concrete by surface impregnations*
	SLO-2	*Remedial measures*	*Condensation – hygroscopic salts*	*Application of Ferro cement*	*Masonry Structures: Discoloration and weakening of stones*	*Vacuum methods*
S-8	SLO-1	*Thermal cracks*	*Remedial treatments*	*Fiber Reinforced Concrete*	*Biotical treatments*	*Strengthening the substructures: Shoring*
	SLO-2	*Shrinkage cracks*	*Dry pack & epoxy bonded dry pack*	*Types and applications*	*Preservation – Chemical preservatives*	*Under pinning*
S-9	SLO-1	*Vegetation and trees*	*Chemical coating*	*Admixtures*	*Brick masonry structures*	*Increasing the load capacity of footing*
	SLO-2	*Foundation movements*	*Flexible and rigid coatings*	*Chemical and Mineral admixtures*	*Distresses and remedial measures.*	*Design for rehabilitation.*

Learning Resources	1. *"Handbook on repair and rehabilitation of RCC buildings", CPWD, Government of India, Government of India Press, India, 2011* 2. *Allen R.T and Edwards S.C, "Repair of Concrete Structures", Blakie and Sons, UK, 1987* 3. *Dayaratnam.P and Rao.R, "Maintenance and Durability of Concrete Structures", University Press, India, 1997.* 4. *Denison Campbell, Allen and Harold Roper, "Concrete Structures, Materials, Maintenance and Repair", Longman Scientific and Technical, UK, 1991.*	5. *Dodge Woodson.R,"Concrete Structures – protection, repair and rehabilitation", Elsevier Butterworth – Heinmann, UK, 2009.* 6. *Peter H.Emmons, "Concrete Repair and Maintenance Illustrated", Galgotia Publications Pvt. Ltd., 2001.* 7. *Raikar, R.N., "Learning from failures - Deficiencies in Design, Construction and Service" – Rand D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.* 8. *https://onlinecourses-archive.nptel.ac.in/noc19_mm06/preview*

Learning Assessment												
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
Level 2	Apply Analyze	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
Level 3	Evaluate Create	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, and Conf. Paper etc.

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Course Code	18CEE407T	Course Name	SUSTAINABLE CONSTRUCTION METHODS	Course Category	E	Professional Elective Course	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:*	**Learning**		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Identify the various formwork system for construction*			
CLR-2 :	*Analyze the basic concepts of functional requirement of building*			
CLR-3 :	*Explore the advanced concepts of green building construction*			
CLR-4 :	*Understand various concepts and applications of BIM*			
CLR-5 :	*Identify the various lean tools for sustainable construction*			
CLR-6 :	*Explore the knowledge in the field of energy efficiency of buildings*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	1	2	3	**Program Learning Outcomes (PLO)**														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Accrue the knowledge of various sustainable formwork system and formwork management*	*2*	*85*	*80*	*H*	*M*	*M*	*L*	*M*	*-*	*M*	*-*	*M*	*L*	*M*	*H*	*M*	*-*	*-*
CLO-2 :	*Apply the knowledge of planning, orientation, and selection of modern material for green building concepts*	*3*	*80*	*75*	*H*	*L*	*L*	*L*	*M*	*-*	*H*	*-*	*H*	*H*	*H*	*M*	*M*	*-*	*--*
CLO-3 :	*Accrue the knowledge of rating system for certification of green building*	*2*	*85*	*75*	*H*	*H*	*-*	*M*	*M*	*-*	*H*	*-*	*L*	*H*	*H*	*M*	*M*	*-*	*-*
CLO-4 :	*Utilize various concepts and applications of BIM*	*2*	*80*	*75*	*H*	*H*	*-*	*M*	*M*	*-*	*H*	*-*	*L*	*L*	*H*	*M*	*M*	*-*	*-*
CLO-5 :	*Apply the lean tools for sustainable construction*	*2*	*85*	*75*	*H*	*H*	*-*	*H*	*M*	*M*	*H*	*-*	*L*	*-*	*H*	*M*	*M*	*-*	*-*
CLO-6 :	*Accrue comprehensive knowledge in the field of energy efficiency of buildings*	*3*	*90*	*85*	*H*	*H*	*-*	*M*	*H*	*-*	*H*	*-*	*L*	*-*	*H*	*H*	*M*	*-*	*-*

Duration (hour)		***9***	***9***	***9***	***9***	***9***
S-1	*SLO-1*	*Basics of Formwork and Staging*	*Principles of Planning*	*Green Building - Introduction*	*BIM –Introduction*	*Energy and Environment*
	SLO-2	*Form work materials*	*Planning Regulations and Byelaws*	*Benefits of Green Buildings,*	*Software's used for Building Information modeling*	*Energy efficiency and conservation*
S-2	*SLO-1*	*Types of form work*	*Orientation of Building*	*Green Building Materials and Equipment in India*	*Categories of BIM*	*Introduction to clean energy technologies*
	SLO-2	*Quantity calculation*	*Functional Requirements of a Building*	*Key Requisites for Constructing a Green Building*	*BIM in Project Development stage*	*Importance in sustainable development*
S-3	*SLO-1*	*Advancement of form work*	*Life-cycle assessment of construction building*	*Important Sustainable features for Green Building*	*BIM in Design stage*	*Energy consumption and sustainability*
	SLO-2	*System Formwork*		*Indian Green Building Council*	*BIM in Implementation stage*	*Future energy use - influenced by economic and environmental factors*
S-4	*SLO-1*	*Mivan form work system - basics*	*Traditional construction method*	*Green Building Moment in India*	*BIM in maintenance of buildings*	*Identification of energy related enterprises that represent the breath of the industry*
	SLO-2					
S-5	*SLO-1*	*Procedures of Mivan form work system*	*Advanced construction methods*	*Benefits Experienced in Green Buildings*	*Lean concepts*	*Energy Modeling*
	SLO-2	*Formwork for Structural system*	*Construction projects*	*Launch of Green Building Rating Systems*	*Application of lean tools in construction*	*Use as a tool for measuring sustainability*
S-6	*SLO-1*	*Foundation and wall formwork*	*Engineering Materials*	*Residential Sector*	*General Principles of passive Solar*	*Energy Audit of Facilities*

					Heating	
	SLO-2	Column, Beam, and slab formwork	Sustainable building materials	Opportunities of Green Building	General Principles of Passive Cooling	Optimization of energy consumption
S-7	SLO-1	Formwork for special structures	Environmental impact of materials	Green Building Features	Thermal Design of buildings Influence of Design Parameters – Mechanical controls	Energy efficiency ,an overview of design concepts, and architectural interventions
	SLO-2	Formwork for precast structures	Advantage and disadvantage	LEED India Rating System	Direct gain – Trombe Walls, Water Walls Radiant Barriers, Glazing material	Energy efficient buildings for various zones - cold, and cloudy
S-8	SLO-1	Formwork failure	Material selection to optimize performance Process for selection	Parameters for Rating system	Ventilation –Requirements – Minimum standards for ventilation	Cold and sunny; composite – hot and dry; moderate.
	SLO-2	Case studies			Ventilation Design ,Energy Conservation	
S-9	SLO-1	Pre award formwork management system	Green construction materials	HVAC System for Green Building	Ventilating systems – Design for Natural Ventilation	Warm and humidcase studies of residences
	SLO-2	Post award formwork management system	Production process	Design philosophy	Ventilation –Requirements – Minimum standards for ventilation	Applications of Operational Research in construction management

Learning Resources	1. Robert L. Peurifoy and Garold D. Oberlender, "Formwork for Concrete Structures", McGraw- Hill, 2006. 2. Hurd. M.K., "Formwork for Concrete", Special Publication No.4 Fifth Edition American Concrete Institute, Detroit, 2003. 3. A Text book of Building Construction, S.P. Arora and S.P. Bindra, DhanpatRai& Sons. 4. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.	5. Green Building Hand Book by Tomwoolley and Samkimings, 2009. 6. Moore, F., "Environmental Control System", McGraw Hill Inc. 2002 7. Brown, G.Z. and DeKay, M., "Sun, Wind and Light – Architectural Design Strategies", John Wiley and Sons Inc, 2001 8. "Energy Conservation Building Code, Bureau of Energy Efficiency", New Delhi, 2007. 9. https://nptel.ac.in/courses/105102088/ 10 .https://nptel.ac.in/noc/individual_course.php?id=noc19-ce40

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	30%	-	30%	-	30%	-	30%	-	30%	-
Level 2	Apply / Analyze	40%	-	40%	-	40%	-	40%	-	40%	-
Level 3	Evaluate / Create	30%	-	30%	-	30%	-	30%	-	30%	-
	Total	100 %		100 %		100 %		100 %		-100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, and Conf. Paper etc.

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