DEPARTMENT OF CIVIL ENGINEERING

ANNA UNIVERSITY, CHENNAI

OUR VISION:

Department of Civil Engineering, Anna University, shall strive hard to develop and impart technical knowledge and professional skills required for Civil Engineering practice through excellence in teaching, research and consultancy to address sustainable infrastructure development needs at local, national and International levels.

OUR MISSION:

Department of Civil Engineering, Anna University shall contribute to technological and social development by

1. Providing a firm scientific and technological base in Civil Engineering to achieve self-reliance.
2. Providing quality education through innovation in teaching practices at par with global standards.
3. Nurturing leadership and entrepreneurship qualities with ethical values.
4. Developing and disseminating latest knowledge and technologies in emerging areas of Civil Engineering.
5. Sharing intellectual resources and infrastructure facilities through collaborative partnership.
6. Ensuring supporting conditions for enhancing the employability skills.

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

M. E. SOIL MECHANICS AND FOUNDATION ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

Graduates of the programme M E Soil Mechanics and Foundation Engineering will

PEO1	Gain knowledge and skills in geotechnical engineering which will enable them to have a career and professional accomplishment in the public or private sector organizations
PEO2	Become consultants on complex real life geotechnical engineering problems related to foundation, strengthening of ground, stability of sloping ground, ground contamination, assessment of seepage and liquefaction
PEO3	Become entrepreneurs and develop processes and technologies to meet desired safety via ensuring the stability of ground and foundation of structure needs of society and formulate solutions that are technically sound, economically feasible, and socially acceptable.
PEO4	Perform investigation for solving geotechnical engineering problems by conducting research using modern equipment and software tools.
PEO5	Function in multi-disciplinary teams and advocate policies, systems, processes and equipment for control and remediation of ground and foundation of structure.

Programme Outcomes (Pos):

Graduates of the programme M E Soil Mechanics Foundation Engineering will be able to

PO1	Knowledge of Engineering Sciences	Apply the knowledge of mathematics, science and engineering fundamentals to the conceptualization of Geotechnical Engineering models
PO2	Problem analysis	Identify, formulate and solve Geotechnical Engineering problems
PO3	Design / development of solutions	Design solutions for complex Geotechnical Engineering problems and design systems, components or processes that meet specified needs with appropriate consideration of safety and economy
PO4	Investigation	Extract information pertinent to geotechnical engineering problems through literature survey, apply appropriate research methodologies, analysis and interpretation of data, and synthesis of information to provide valid conclusions
PO5	Modern Tool Usage	Create, select and apply appropriate techniques and modern engineering tools including prediction and modelling software, with due understanding of the limitations.
PO6	Individual and Team work	Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings and demonstrating a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis.
PO7	Communication	Communicate effectively on Geotechnical Engineering issues with the engineering community and with society at large, and write reports and make effective presentations.

PO8	Engineer and Society	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to Geotechnical Engineering practice.
PO9	Ethics	Understand and commit to professional ethics and responsibilities of Geotechnical Engineers and to contribute to the society for sustainable development.
PO10	Environment and Sustainability	Understand the socio economic impact of Geotechnical Engineering solutions and demonstrate knowledge of sustainable development
PO11	Project Management and Finance	Demonstrate a knowledge and understanding of management, business practices and understand their limitations
PO12	Life Long Learning	Develop ability to engage in independent and life-long learning to improve competence by critical examination of the outcomes of one's actions in addressing geotechnical engineering issues and learning from corrective and preventive measures.

PROGRAM SPECIFIC OUTCOMES (PSOs) – Graduates of the programme M.E. Soil Mechanics and Foundation Engineering will be able to		
PSO1	Knowledge of Geotechnical Engineering discipline	Demonstrate in-depth knowledge of Geotechnical Engineering discipline, with an ability to evaluate, analyze and synthesize existing and new knowledge.
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	Critically analyze complex Geotechnical Engineering problems, apply independent judgment for synthesizing information and make innovative advances in a theoretical, practical and policy context.
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	Conceptualize and solve Geotechnical Engineering problems, evaluate potential solutions and arrive at technically feasible, economically viable and environmentally sound solutions with due consideration of safety.

PEO / PO Mapping:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
I	✓	✓	✓					✓				
II								✓		✓	✓	
III			✓	✓	✓		✓	✓				
IV				✓	✓					✓	✓	✓
V			✓						✓	✓	✓	✓

Mapping of Course Outcome and Programme Outcome

		Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
YEAR I	SEMESTER I	Advanced Mathematical Methods	M	H	M	L	L	L	L	L	L	L	L	H
		Properties and Behaviour of Soils	M	M	M	M	M	L	L	L	L	L	L	H
		Constitutive Behaviour of Soils	M	M	H	H	M	M	L	M	L	L	L	H
		Subsurface Investigation and Instrumentation	H	M	H	H	L	M	M	M	M	M	H	H
		Computational Geomechanics	H	H	M	L	L	L	M	M	L	L	M	H
		Research Methodology and IPR	M	H	M	L	L	M	H	L	L	L	L	H
		Audit course - I												
		Advanced Soil Mechanics Laboratory – I	H	H	L	M	M	H	M	L	L	L	L	H
	SEMESTER II	Deep Foundations	M	H	H	M	M	M	M	L	L	L	L	H
		Earth and Earth Retaining Structures	H	M	H	H	H	M	M	M	M	M	H	H
		Finite Element Method in Geotechnical Engineering	M	H	M	L	M	M	L	L	L	L	L	H
		Shallow Foundations	H	M	H	M	H	M	L	M	H	M	M	H
		Program Elective I	M	M	M	M	M	M	L	M	M	H	L	H
		Program Elective II	M	H	H	M	M	M	L	M	L	M	L	H
		Audit course - II												
		Advanced Soil Mechanics Laboratory – II	H	H	L	M	H	H	M	L	L	L	L	H
YEAR II	SEMESTER III	Program Elective III	M	M	M	M	M	M	L	M	M	M	M	H
		Program Elective IV	H	M	M	M	M	M	L	M	M	M	M	H
		Open Elective												
		Design Studio	M	H	H	L	H	M	H	M	M	L	L	H
		Practical Training (2 weeks)	M	H	H	M	M	H	H	M	M	L	M	H
		Project Phase I	H	M	L	H	L	H	M	M	M	L	L	H
	SEMESTER IV	Project Phase II	H	M	M	M	M	H	M	M	M	M	M	H

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UNIVERSITY DEPARTMENTS

M.E. SOIL MECHANICS AND FOUNDATION ENGINEERING

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI FOR I TO IV SEMESTERS

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA5152	Advanced Mathematical Methods	FC	3	1	0	4	4
2.	SF5101	Properties and Behaviour of Soils	PCC	3	0	0	3	3
3.	SF5102	Constitutive Behaviour of Soils	PCC	3	0	0	3	3
4.	SF5103	Subsurface Investigation and Instrumentation	PCC	3	0	0	3	3
5.	SF5104	Computational Geomechanics	PCC	4	0	0	4	4
6.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
7.		Audit course I*	AC	2	0	0	2	0
PRACTICALS								
8.	SF5111	Advanced Soil Mechanics Laboratory – I	PCC	0	0	4	4	2
			TOTAL	**20**	**1**	**4**	**25**	**21**

***** Audit Course is Optional

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	SF5201	Deep Foundations	PCC	3	0	0	3	3
2.	SF5202	Earth and Earth Retaining Structures	PCC	3	0	0	3	3
3.	SF5203	Finite Element Method in Geotechnical Engineering	PCC	3	0	0	3	3
4.	SF5204	Shallow Foundations	PCC	3	0	0	3	3
5.		Program Elective I	PEC	3	0	0	3	3
6.		Program Elective II	PEC	3	0	0	3	3
7.		Audit course II*	AC	2	0	0	2	0
PRACTICALS								
8.	SF5211	Advanced Soil Mechanics Laboratory – II	PCC	0	0	4	4	2
			TOTAL	**20**	**0**	**4**	**24**	**20**

*****Audit Course is Optional

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective III	PEC	3	0	0	3	3
2.		Program Elective IV	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
4.	SF5311	Design Studio	PCC	0	0	4	4	2
5.	SF5312	Practical Training (2 weeks)	EEC	0	0	0	0	1
6.	SF5313	Project Phase I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**16**	**25**	**18**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	SF5411	Project Phase II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR AWARD OF THE DEGREE: 71

FOUNDATION COURSES (FC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA5152	Advanced Mathematical Methods	3	1	0	4	**1**

PROGRAM CORE COURSES (PCC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	SF5101	Properties and Behaviour of Soils	3	0	0	3	I
2.	SF5102	Constitutive Behaviour of Soils	3	0	0	3	I
3.	SF5103	Subsurface Investigation and Instrumentation	3	0	0	3	I
4.	SF5104	Computational Geomechanics	4	0	0	4	I
5.	SF5111	Advanced Soil Mechanics Laboratory -I	0	0	4	2	I
6.	SF5201	Deep Foundations	3	0	0	3	II
7.	SF5202	Earth and Earth Retaining Structures	3	0	0	3	II
8.	SF5203	Finite Element Method in Geotechnical Engineering	3	0	0	3	II
9.	SF5204	Shallow Foundations	3	0	0	3	II
10.	SF5211	Advanced Soil Mechanics Laboratory -II	0	0	4	2	III
11.	SF5311	Design Studio	0	0	4	2	III
					TOTAL CREDITS	**31**	

PROGRAM ELECTIVE COURSES [PEC]

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			C	Group
			L	T	P		
1.	SF5001	Environmental Geotechnology	3	0	0	3	1
2.	SF5002	Geology for Geotechnical Applications	3	0	0	3	1
3.	SF5003	Pavement Analysis and Design	3	0	0	3	1
4.	SF5004	Earthquake Resistant Design of Foundations	3	0	0	3	2
5.	SF5005	Ground Improvement Techniques	3	0	0	3	2
6.	SF5006	Soil Structure Interaction	3	0	0	3	2
7.	SF5007	Dynamics of Soils and Foundations	3	0	0	3	3
8.	SF5008	Geotechnical Earthquake Engineering	3	0	0	3	3
9.	SF5009	Mechanics Of Unsaturated Soils	3	0	0	3	3
10.	SF5010	Geosynthetics and Reinforced Soil Structures	3	0	0	3	3
11.	SF5011	Rock Mechanics and Applications	3	0	0	3	4
12.	SF5012	Earth and Rock Fill Dams	3	0	0	3	4
13.	SF5013	Geotechnics for Underground Structures	3	0	0	3	4
14.	SF5014	Marine Geotechniques	3	0	0	3	4

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM5151	Research Methodology and IPR	2	0	0	2	1
					TOTAL CREDITS	**2**	

OPEN ELECTIVE COURSES [OEC]

***(Out of 6 Courses one Course must be selected)**

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	OE5091	Business Data Analytics	3	0	0	3	3
2.	OE5092	Industrial Safety	3	0	0	3	3
3.	OE5093	Operations Research	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	3	0	0	3	3
5.	OE5095	Composite Materials	3	0	0	3	3
6.	OE5096	Waste to Energy	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AX5091	English for Research Paper Writing	2	0	0	0	1/2
2.	AX5092	Disaster Management	2	0	0	0	
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0	
4.	AX5094	Value Education	2	0	0	0	
5.	AX5095	Constitution of India	2	0	0	0	
6.	AX5096	Pedagogy Studies	2	0	0	0	
7.	AX5097	Stress Management by Yoga	2	0	0	0	
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0	
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0	
TOTAL CREDITS						**0**	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1	SF5312	Practical Training (2 weeks)	0	0	0	1	3
2	SF5313	Project Phase I	0	0	12	6	3
3	SF5411	Project Phase II	0	0	24	12	4
TOTAL CREDITS						**19**	

SUMMARY

	Name of the Programme: M.E SOIL MECHANICS AND FOUNDATION ENGINEERING					
S. NO.	**SUBJECT AREA**	**CREDITS PER SEMESTER**				**CREDITS TOTAL**
		I	**II**	**III**	**IV**	
1.	FC	04	00	00	00	04
2.	PCC	15	14	02	00	31
3.	PEC	0	06	06	00	12
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	00	07	12	19
7.	Non Credit/Audit Course	✓	✓	00	00	
8.	**TOTAL CREDIT**	**21**	**20**	**18**	**12**	**71**

MA5152 ADVANCED MATHEMATICAL METHODS L T P C
3 1 0 4

OBJECTIVE:

- To familiarize the students in the field of differential equations.
- To enable them to solve boundary value problems associated with engineering applications using transform methods.
- To expose the students to the concepts of calculus of variations.
- To introduce conformal mappings and their applications to fluid flows and heat flows.
- To give the students a complete picture of tensor analysis.

UNIT I LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Laplace transform: Definitions, properties -Transform of error function, Bessel's function, Dirac Delta function, Unit Step functions – Convolution theorem – Inverse Laplace Transform: Complex inversion formula – Solutions to partial differential equations: Heat equation, Wave equation

UNIT II FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Fourier transform: Definitions, properties – Transform of elementary functions, Dirac Delta function– Convolution theorem – Parseval's identity – Solutions to partial differential equations: Heat equation, Wave equation, Laplace and Poison's equations.

UNIT III CALCULUS OF VARIATIONS 12

Concept of variation and its properties – Euler's equation – Functionals dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries -Direct methods – Ritz and Kantorovich methods.

UNIT IV CONFORMAL MAPPING AND APPLICATIONS 12

Introduction to conformal mappings and bilinear transformations – Schwarz Christoffel transformation – Transformation of boundaries in parametric form – Physical applications : Fluid flow and heat flow problems.

UNIT V TENSOR ANALYSIS 12

Summation convention – Contravariant and covariant vectors – Contraction of tensors – Inner product – Quotient law – Metric tensor – Christoffel symbols – Covariant differentiation – Gradient, divergence and curl.

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of the course, the students will be able to

- develop the mathematical methods of applied mathematics and mathematical physics
- solve boundary value problems using integral transform methods
- apply the concepts of calculus of variations in solving various boundary value problems
- apply conformal mappings in fluid flows and heat flow problems
- familiarize with the concepts of tensor analysis.

REFERENCES:

1. Andrew L.C. and Shivamoggi B.K., "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. Elsgolts L., "Differential Equations and the Calculus of Variations", MIR Publishers, Moscow, 2003.
3. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.
4. Gupta A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 2004.

5. James G., “Advanced Modern Engineering Mathematics”, Pearson Education, 4th Edition, Horlow, 2016.
6. Mathews J.H. and Howell R.W., “Complex Analysis for Mathematics and Engineering”, Narosa Publishing House, 6th Edition, New Delhi, 2012.
7. O’Neil P.V., “Advanced Engineering Mathematics”, Thomson Asia Pvt. Ltd., 8th Edition, Singapore, 2017.
8. Ramanaiah, G.T., “Tensor Analysis”, S. Viswanathan Pvt. Ltd., Chennai, 1990.
9. Sankara Rao K., “Introduction to Partial Differential Equations”, Prentice Hall of India Pvt. Ltd., 3rd Edition, New Delhi, 2010.
10. Spiegel M.R., “Theory and Problems of Complex Variables and its Application” (Schaum’s Outline Series), McGraw Hill Book Co., Singapore, 2000.

SF5101 PROPERTIES AND BEHAVIOUR OF SOILS L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on the various factors governing the Engineering behaviour of soils and the suitability of soils for various Geotechnical Engineering applications.

UNIT I SOIL DEPOSITS AND CLAY MINERALS 8

Formation of soils – different soil deposits and their engineering properties – Genesis of clay minerals – classification and identification – Anion and Cation exchange capacity of clays – specific surface area – index properties – bonding in clays.

UNIT II PHYSICAL AND PHYSIO CHEMICAL BEHAVIOUR OF SOILS 9

Physical and physio chemical behaviour of soils – diffused double layer theory – computation of double layer distance – effect of ion concentration, ionic valency, pH, dielectric constant, temperature on double layer – stern layer – attractive and repulsive forces in clays – types of soil water – mechanism of soil – water interactions - soil fabric and structure.

UNIT III SWELLING, SHRINKAGE AND COMPACTION BEHAVIOUR OF SOILS 10

Swelling and shrinkage behaviour of soils – Causes, consequences and mechanisms – factors influencing swell – shrink characteristics – swell potential – case studies – osmotic swell pressure – soil fabric and measurement – sensitivity, thixotrophy of soils – soil suction – soil compaction – factors affecting soil compaction.

UNIT IV COMPRESSIBILITY, SHEAR STRENGTH AND PERMEABILITY BEHAVIOUR OF SOILS 10

Compressibility, shear strength and permeability behaviour of fine and coarse grained soils – mechanisms and factors influencing engineering properties – soil liquefaction – causes and consequences – case studies.

UNIT V CONDUCTION PHENOMENA AND PREDICTION OF SOIL BEHAVIOUR 8

Conduction in soils – hydraulic, electrical, chemical and thermal flows in soils – applications - coupled flows – Electro-kinetic process – thermo osmosis - electro osmosis – prediction of engineering behaviour of soils using index properties – empirical equations and their applicability.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

CO1	classify the suitable and unsuitable soil based on index properties and classification
CO2	understand the micro level understanding of the clay mineralogy and its intricacies and consequences apart from conventional procedures of handling fine and coarse grained soil

CO3	explain the peculiar behaviour of clays which exhibits extreme volume changes (Swelling and shrinkage) owing to the presence of swelling mineral, in addition to field reclamation geotechnical projects through compaction techniques
CO4	interpret the engineering behaviour of soils such as compressibility, permeability and shear strength with index properties so as to design the safe foundation system.
CO5	understand the various geotechnical applications of conduction phenomenon which are of great significance in the case of ground contamination and decontamination, ground improvement methods and land reclamation projects

CO – PO Mapping – PROPERTIES AND BEHAVIOUR OF SOILS

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	M			L	M	M
PO2	Problem analysis		M	H	M		M
PO3	Design / development of solutions	M	M	H	M		M
PO4	Investigation		M	H	M	M	M
PO5	Modern Tool Usage	M	M	M	L	L	M
PO6	Individual and Team work	L					L
PO7	Communication			L			L
PO8	Engineer and Society		L				L
PO9	Ethics					L	L
PO10	Environment and Sustainability	L				M	L
PO11	Project Management and Finance	L					L
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	H	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	M	H	H		H
PSO3	Conceptualization and evaluation of Engineering solutions to geotechnical engineering issues	M	H	H	H	M	H

REFERENCES:

1. Mitchell, J.K., Fundamentals of Soil Behaviour, John Wiley, New York, 1993.
2. Yong, R.N. and Warkentin, B.P., Introduction to Soil Behaviour, Macmillan, Limited, London, 1979.
3. Coduto, D.P., Geotechnical Engineering – Principles and practices, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
4. Perloff, W.H. and Baron, W, Soil Mechanics, The Ronal Press Company, 1976.
5. Van Olphen, H., Clay colloid Chemistry, John Wiley, 1996
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7. Lambe, T.W. and Whitman, R.V. Soil Mechanics, John Wiley & Sons, New York, 1979.
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12. Knappett J.A. and R.F. Craig, ‘Craig’s Soil Mechanics’, Span Press, 711 Third Avenue, New York, NY 10017, 2012

SF5102 **CONSTITUTIVE BEHAVIOUR OF SOILS** **L T P C**
3 0 0 3

OBJECTIVES:

- To impart knowledge to characterize stress-strain behaviour of soils, the failure criteria and to evaluate the shear strength and compressibility parameters of soils.

UNIT I SHEAR STRENGTH OF COHESIONLESS SOILS 9

Introduction-Shear strength of soil-cohesion-angle of internal friction-Shear strength of granular soils - Direct shear - Triaxial Testing- Drained and undrained Stress-strain behaviour - Dilation, contraction and critical states - Liquefaction and cyclic mobility of saturated sands. Factors influencing stress – strain characteristics – shear strength.

UNIT II SHEAR STRENGTH OF COHESIVE SOILS 9

Shear strength of normally consolidated and over consolidated clays - Stress-strain behaviour - Total stress and effective stress approach - Triaxial testing and stress path plotting - pore pressure parameters of Skempton and Henkel - shear strength of partially saturated clay in terms of stress state variables. Factors influencing stress – strain characteristics – shear strength.

UNIT III FAILURE THEORIES 9

Concepts of yield and failure in soils- Failure theories of Von Mises, Tresca and their extended form, their applicability to soils - Detailed discussion of Mohr - Coulomb failure theory.

UNIT IV CONSTITUTIVE MODEL AND DEFORMATION MODULUS OF SOILS 9

Constitutive law for soil – linear, non linear model- hyperbolic idealisation – Mohr-Columb model- Hardening law-Hardening soil model- Hardening soil model with small strain stiffness- Soft soil - Soft soil model - limitation of all models- Deformation modulus for different type of loadings – Poisson's ratio.

UNIT V CRITICAL STATE SOIL MECHANICS 9

The critical state line- Roscoe's surface- Hvorslev's surface- Behavior of sand- Effects of dilation- Limitations of Taylor model- Elastic and plastic deformation-Camclay critical state model- Modified Camclay model- Parameters for design

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

CO1	Select the shear strength parameters of cohesionless soil based on mode of shear, drainage conditions and differentiate the cyclic stress – strain behaviour of cohesionless soil due to earthquake loading.
CO2	Select the shear strength parameters of cohesive soil based on mode of shear, drainage conditions, degree of saturation and degree of consolidation
CO3	Apply different failure criteria and its applicability based on drainage conditions and type of soil.
CO4	Apply constitutive models for soils and their applicability for different type of drainage conditions.
CO5	Explain critical state behaviour, modelling of soils and to select the respective design parameters.

CO – PO Mapping - CONSTITUTIVE BEHAVIOUR OF SOILS

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences				M		M
PO2	Design / development of solutions	H	H	M	M	M	M
PO3	Investigation			H	H	H	H
PO4	Modern Tool Usage	H	H				H

PO5	Individual and Team work				M	M	M
PO6		M	M				M
PO7	Communication	L	L	L	L	L	L
PO8	Engineer and Society	M					M
PO9	Ethics	L					L
PO10	Environment and Sustainability	L					L
PO11	Project Management and Finance	L					L
PO12	Life Long Learning	H	H	M	H	H	H
PSO1	Knowledge of Geotechnical Engineering	H	H	H	H	H	H
PSO2	Critical Analysis of Geotechnical Engineering Problems and Innovation	M	M	H	H	H	H
PSO3	Conceptualization of Evaluation of Engineering Solutions to Geotechnical Engineering Issues	M	M	H	H	M	M

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SF5103 SUBSURFACE INVESTIGATION AND INSTRUMENTATION L T P C
3 0 0 3

OBJECTIVES:

- Students are expected to understand the importance of site investigation, planning of sub soil investigation, interpretation of investigated data to design suitable foundation system.

UNIT I PLANNING OF EXPLORATION AND GEOPHYSICAL METHODS 8

Scope and objectives, planning an exploration program, methods of exploration, exploration for preliminary and detailed design, spacing and depth of bores, data presentation. Geophysical exploration and interpretation, seismic method, Multichannel Analysis of Surface Waves *(*MASW*),* spectral analysis of surface waves (SASW) methods and electrical methods, cross hole – up hole - down hole methods.

UNIT II EXPLORATION TECHNIQUES 7

Methods of boring and drilling, non-displacement and displacement methods, drilling in difficult subsoil conditions, offshore drilling, limitations of various drilling techniques, stabilization of boreholes, bore logs.

UNIT III SOIL SAMPLING 8

Sampling Techniques – quality of samples – factors influencing sample quality - disturbed and undisturbed soil sampling advanced sampling techniques, offshore sampling, shallow penetration samplers, preservation and handling of samples.

UNIT IV FIELD TESTING IN SOIL EXPLORATION 12

Field tests, penetration tests, Field vane shear, Insitu shear and bore hole shear test, pressuremeter test, dilatometer test - plate load test–monotonic and cyclic; field permeability tests – block vibration test. Procedure, limitations, correction and data interpretation of all methods.

UNIT V INSTRUMENTATION 10

Instrumentation in soil engineering, functional components of data acquisition system - strain gauges, resistance and inductance type, load cells, earth pressure cells, settlement and heave gauges, pore pressure measurements - slope indicators, sensing units, case studies.

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Plan the subsurface investigation program for a given project also capable of extending consultancy service for real time Soil Mechanics and Foundation Engineering problems
CO2	Apply the knowledge of different methods of exploration to select appropriate method of boring for investigating real field condition.
CO3	Apply the knowledge of different sampling techniques to collect, store and transport soil samples from onshore and offshore to meet specified needs and also to characterise the soil.
CO4	Carryout appropriate field test to arrive at required soil parameters for the design of geotechnical structures considering all the influential parameters
CO5	Plan the instrumentation programme, execute the same in the field and monitor the performance of geotechnical structures to ensure its stability during its life time. Also conduct research pertinent to soil mechanics and foundation engineering as well as engage in independent life-long learning

CO – PO Mapping – Subsurface Investigation and Instrumentation

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	H	M	M	H	H	H
PO2	Problem analysis	H	M	M	H	L	M
PO3	Design / development of solutions	H	H	H	H	M	H
PO4	Investigation	H	H	H	L	M	H
PO5	Modern Tool Usage				L	M	L
PO6	Individual and Team work	H	M	M	L	L	M
PO7	Communication	H	L	M	M		M
PO8	Engineer and Society	H	M	M	H	M	M
PO9	Ethics	H	L	L	L	H	M
PO10	Environment and Sustainability	H	L	L	M	M	M
PO11	Project Management and	H	H	H	H	H	H

	Finance						
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	M	M	H	M	M
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	H	M	M	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	H	M	M	H	H	H

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SF5104 COMPUTATIONAL GEOMECHANICS L T P C
4 0 0 4

OBJECTIVES:

- To impart knowledge required for computing stress and settlement at any point in the semi-infinite elastic soil medium, anisotropic medium and layered deposits due to foundation loads and evaluation of stability of foundations, slopes, cuts and retaining structures both for the conditions of undrained and drained loading through theorems of plastic collapses. Also, to impart knowledge on reliability based design in geotechnical engineering.

UNIT I THEORY OF ELASTICITY 12

Basic Concepts – Mechanics of continua: Stress and strain - concept of stress and strain – Three dimensional and Two dimensional state of stress – Plane stress, plane strain and axisymmetric problems – equilibrium and compatibility conditions, constitutive relations, stress functions – Two dimensional problems in Cartesian and polar co-ordinates.

UNIT II STRESS AND DISPLACEMENT 12

Elastic half-space medium – Stress by external loads – Isotropic, anisotropic and non-homogeneous elastic continuum – Boussinesq, Frochlich, Westergaard solutions for force on the surface of semi-infinite medium – Cerruti and Mindlin's method for force in interior of semi-infinite medium, solutions by influence charts – Elastic displacement – Layered soil – Burmister method.

UNIT III THEORY OF PLASTICITY 14

Perfect plastic material- theory of plasticity – Hardening law, flow rule. Theorem of plastic collapse – bound theorems – Mechanism for plane plastic collapse – slip fans, stress fans – discontinuities – Simple solutions for undrained and drained loading – Stability of foundations, retaining walls, slopes and cuts. Slip line solutions for undrained and drained conditions.

UNIT IV FLOW THROUGH POROUS MEDIA 10

Flow through porous media – Darcy's law – General equation of flow, seepage through isotropic anisotropic and non-homogeneous conditions – Steady state condition, confined and unconfined flow – solution by flow net – seepage pressure – piping.

UNIT V RISK ANALYSIS IN GEOMECHANICS 12

Spatial variability and random field theory - soil variability and uncertainty quantification - Simple probabilistic methods for reliability analysis in geotechnical engineering - Reliability based design in geotechnical engineering.

TOTAL : 60 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to

CO1	Explain the basic concept of elasticity, understand the mechanics of continuum and solve field problems
CO2	Analyse stress distribution and displacement in homogeneous, non homogeneous and anisotropic soil medium under the given loading conditions
CO3	Explain the basic concept of plasticity, understand the mechanism of collapse and solve field problems
CO4	Understand the liquid flow theory, analyse the flow of liquid in different soil medium and verify the stability of geotechnical engineering problems
CO5	Analyse various parameters using probabilistic methods and perform reliability based design in geotechnical engineering related problems

CO – PO Mapping – Computational Geomechanics

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	H	H	H	M	L	H
PO2	Problem analysis	H	H	H	H	M	H
PO3	Design / development of solutions	M	M	H	H	M	M
PO4	Investigation		L		L		L
PO5	Modern Tool Usage				L	M	L
PO6	Individual and Team work			L	L		LL
PO7	Communication		L	M	M		M
PO8	Engineer and Society		L	H	M	M	M
PO9	Ethics			L	L		L
PO10	Environment and Sustainability			L	L		L
PO11	Project Management and Finance					M	M
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	M	M	H	H	M	M
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	M	H	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	M	M	H	H	H	H

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RM5151 RESEARCH METHODOLOGY AND IPR LT P C
2 0 0 2

OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases.Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.
Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

COURCE OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓											
CO3	✓							✓				
CO4	✓				✓							
CO5	✓					✓						✓

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SF5111 ADVANCED SOIL MECHANICS LABORATORY - I L T P C
0 0 4 2

OBJECTIVES:

- At the end of the course student attains adequate knowledge in assessing index properties, compaction, CBR, Compressibility, Swell characteristics and permeability of soils by conducting laboratory tests.

LIST OF EXPERIMENTS

UNIT I INDEX TESTS 12

Specific gravity of soil solids-Grain size distribution (Sieve analysis and Hydrometer analysis) - Liquid limit and Plastic limit tests - Shrinkage limit and Differential free swell tests

UNIT II CHEMICAL TESTS 12

Chemical analysis – pH – Conductivity – quantification of CEC through flame Photometer – Determination of organic, sulphate and chlorite content.

UNIT III COMPACTION AND CBR TESTS 12

Field density Test - Compaction tests - Determination of moisture – density relationship – Influence of compaction energy – CBR Test.

UNIT IV CONSOLIDATION AND PERMEABILITY TESTS 12

One dimensional consolidation test, determination of consolidation parameters, permeability of soil – constant and falling head methods.

UNIT V SWELLTESTS 12

Determination of percent swell – swell pressure, constant volume method; expanded - loaded method – double odometer test.

TOTAL: 60 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to

CO1	Classify soils based on assessing the index properties of soils
CO2	Evaluate the chemical properties of soils
CO3	Evaluate the compaction characteristics and CBR of soils
CO4	Evaluate the engineering properties of soils by conducting appropriate tests
CO5	Determine the swelling characteristics of soils by conducting appropriate tests.

CO – PO Mapping – Advanced Soil Mechanics Laboratory - I

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	H	H	H	H	H	H
PO2	Problem analysis	H	H	H	H	H	H
PO3	Design / development of solutions			L		L	L
PO4	Investigation	M	M	M	M	M	M
PO5	Modern Tool Usage	H	M	H	M	M	M
PO6	Individual and Team work	H	H	H	H	H	H
PO7	Communication	M	M	M	M	M	M
PO8	Engineer and Society			L	L		L
PO9	Ethics	L		L			L
PO10	Environment and Sustainability	L				L	L
PO11	Project Management and Finance	L					L
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	H	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	H	H	H	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	L	L	L	L	L	L

REFERENCES:

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11. I.S. Code of Practice (2720): Relevant Parts, as amended from time to time.

SF5201 **DEEP FOUNDATIONS** **L T P C**
3 0 0 3

OBJECTIVES:

- The student will be exposed to the design of piles, pile groups and caissons with respect to vertical and lateral loads for various field conditions.

UNIT I PILE CLASSIFICATIONS AND LOAD TRANSFER PRINCIPLE 10

Necessity of pile foundation – classification of piles – Factors governing choice of type of pile – Load transfer mechanism – piling equipments and methods – effect of pile installation on soil condition – pile raft system – basic interactive analysis - criteria for pile socketing - responsibility of engineer and contractor.

UNIT II AXIAL LOAD CAPACITY OF PILES AND PILE GROUPS 10

Allowable load of piles and pile groups – Static and dynamic methods – for cohesive and cohesionless soil – negative skin friction – group efficiency – pile driving formulae - limitation – Wave equation application – evaluation of axial load capacity from field test results – pile integrity test - Settlement of piles and pile group – IS codal provisions and IRC guide lines.

UNIT III LATERAL AND UPLIFT LOAD CAPACITIES OF PILES 10

Piles under Lateral loads – Broms method, elastic, p-y curve analyses – Batter piles – response to moment – piles under uplift loads – under reamed piles – Drilled shaft – Lateral and pull out load tests – piled-raft design philosophy - IS codal provision – IRC and API guide lines – case studies.

UNIT IV STRUCTURAL DESIGN OF PILE AND PILE GROUPS 9

Structural design of pile – structural capacity – pile and pile cap connection – pile cap design – shape, depth, assessment and amount of steel – truss and bending theory- Reinforcement details of pile and pile caps –— pile subjected to vibration – IS codal provision – IRC guide line.

UNIT V CAISSONS 6

Necessity of caisson – type and shape - Stability of caissons – principles of analysis and design – tilting of caisson – construction - seismic influences - IS codal provision.

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Explain the importance of pile foundation and various functions and responsibilities of geotechnical engineer and contractor, in addition to the piling equipments.
CO2	Determine the vertical load carrying capacity of pile and pile group- keeping the settlement of pile as an important criteria based on field practices and codal provisions
CO3	Apart from vertically loaded piles, the structures are exposed to the peculiar pile subjected to lateral and uplift load with reference to codal provision and case studies.
CO4	Understand the design of pile and pile caps, considering the wind and seismic loads.
CO5	Explain the importance of caisson foundation and checking the stability of caissons based on codal provisions.

CO – PO Mapping – Deep Foundations

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	L	M	M	L	M	M
PO2	Problem analysis	L	H	M	M	M	H
PO3	Design / development of solutions	L	H	H	H	M	H
PO4	Investigation	H		M	M	M	M
PO5	Modern Tool Usage	M	L	M	M		M
PO6	Individual and Team work	M					M
PO7	Communication	M					M
PO8	Engineer and Society	L		L		L	L
PO9	Ethics	L					L
PO10	Environment and Sustainability	L		L			L
PO11	Project Management and Finance	L			L		L
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	M	H	M	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	L	M	L	M	M
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	M	H	H	M	H	H

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SF5202 EARTH AND EARTH RETAINING STRUCTURES L T P C
3 0 0 3

OBJECTIVES:

- At the end of this course, students are expected to analyse and design rigid, flexible earth retaining structures, slurry supported trenches and deep cuts.

UNIT I EARTH PRESSURE THEORIES 10

State of stress in retained soil mass – Earth pressure theories – Classical and graphical techniques (Culmann's method) – Active and passive cases – Earth pressure due to external loads.

UNIT II STABILITY OF RETAINING STRUCTURES 8

Retaining structure – Selection of soil parameters - Lateral pressure due to compaction, strain softening, wall flexibility, drainage arrangements and its influence. – Stability analysis of retaining structure both for regular and earthquake forces.

UNIT III SHEET PILE WALLS 8

Types of sheet piles - Analysis and design of cantilever and anchored sheet pile walls – free earth support method – fixed earth support method. Design of anchor systems - isolated and continuous.

UNIT IV SUPPORTED EXCAVATIONS 9

Lateral pressure on sheeting in braced excavation, stability against piping and bottom heaving. Earth pressure around tunnel lining, shaft and silos – Soil anchors – Soil pinning –Basic design concepts - Slurry Supported Trenches- Basic principles – Slurry characteristics – Specifications – Diaphragm walls – stability Analysis.

UNIT V STABILITY OF SLOPES 9

Stability of infinite and finite slopes, Limit Equilibrium method, Wedge analysis, Method of Slices, Bishop's method, Janbu's method etc. Special aspects of slope analysis, stability charts. Role of geosynthetics in stabilization of slopes.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to

CO1	Analyse the earth pressure acting on retaining structures by applying classical theories considering all influencing parameters and suggest the earth pressure to be considered for the design of retaining structures.
CO2	Apply the knowledge of engineering and earth pressure to analyse and design rigid retaining structures considering effect of compaction, wall flexibility, pore water pressure and earth quake forces.
CO3	Apply the knowledge of engineering and earth pressure to analyse and design flexible earth retaining walls and also acquire the knowledge of design of anchors
CO4	Apply the knowledge on lateral earth pressure behind and around excavation to analyse and design braced excavations, slurry supported excavations and underground utilities.
CO5	Analyse the stability of infinite and finite slopes through total stress and effective stress analysis by considering the actual shape of failure surface expected in the field.

CO – PO Mapping – Earth Pressure and Earth Retaining structure

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	H	M	M	H	H	H
PO2	Problem analysis	H	M	M	H	L	M
PO3	Design / development of solutions	H	H	H	H	M	H
PO4	Investigation	H	H	H	L	M	H
PO5	Modern Tool Usage	M	H	H	H	H	H
PO6	Individual and Team work	H	M	M	L	L	M
PO7	Communication	H	L	M	M		M
PO8	Engineer and Society	H	M	M	H	M	M

PO9	Ethics	H	L	L	L	H	M
PO10	Environment and Sustainability	H	L	L	M	M	M
PO11	Project Management and Finance	H	H	H	H	H	H
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	M	M	H	M	M
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	H	M	M	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	H	M	M	H	H	H

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SF5203 FINITE ELEMENT METHOD IN GEOTECHNICAL ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- Students are focused on acquiring the basic knowledge and computational skills in terms of finite element formulation with respect to various kinds of Geotechnical Engineering problems.

UNIT I BASIC CONCEPTS 9

Basic concepts - discretization of continuum, typical elements, the element characteristic matrix, element assembly and solution for unknowns – applications. Variational principles, variational formulation of boundary value problems, variational methods of approximation such as Ritz and weighted residual (Galerkin) methods.

UNIT II DISPLACEMENT MODELS 9

Displacement based elements - element equations, convergence requirements, shape functions – element stresses and strains – element stiffness matrix - global equations – boundary conditions – solution of global equations – finite elements for axi-symmetric problem – one dimensional problem of stresses and strains – finite element analysis for two – dimensional problems.

UNIT III ISOPARAMETRIC FORMULATION 8

Isoparametric element - Local and Natural Co-ordinates systems, Line, Triangular, Quadrilateral and Tetrahedral Element-Interpolation - Displacement Models Formulation of Isoparametric - Finite element matrices in Local and Global Coordinate system – refined elements – numerical integration techniques.

UNIT IV GEOTECHNICAL CONSIDERATION 9

Total stress analysis – pore pressure calculation – FEM to model structural components, strain definitions, constitutive equation, finite element formulation, membrane elements – Finite elements to model interfaces – basic theory – finite element formulation – boundary conditions – finite element theory for nonlinear behavior of soils.

UNIT V APPLICATION IN GEOTECHNICAL ENGINEERING 10

Use of FEM to problems in soils – description and application to consolidation – seepage - FEM to simulate soil – structure interaction problems – finite element theory for simulating and analyzing the real foundation problem such as footing, pile foundation and deep excavations.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to

CO1	understand the basic concept involved in finite element method using variational principles
CO2	differentiate various types of displacement models, select suitable finite element model and able to solve geotechnical problems
CO3	understand the basic concept of isoparametric finite element formulation and its use in solving geotechnical related problems
CO4	consider the various geotechnical concept in the finite element formulations including interfacial behaviour
CO5	develop finite element formulation for different geotechnical engineering related problems

CO – PO Mapping – FINITE ELEMENT METHOD IN GEOTECHNICAL ENGINEERING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	H	M	M	H	M	M
PO2	Problem analysis	H	H	H	M	M	H
PO3	Design / development of solutions	L	M	M	M	M	M
PO4	Investigation					L	L
PO5	Modern Tool Usage		M	M		M	M
PO6	Individual and Team work					M	M
PO7	Communication	L				L	L
PO8	Engineer and Society					L	L
PO9	Ethics		L			L	L
PO10	Environment and Sustainability					L	L
PO11	Project Management and Finance			L		L	L

PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	L	M	M	H	H	M
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	M	M	M	H	M
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	M	M	M	M	H	M

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SF5204 SHALLOW FOUNDATIONS L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge to select, analyse, geotechnical and structural design of shallow foundation depending on ground conditions.

UNIT I FOUNDATION DESIGN DECISIONS 6

Geotechnical triangle – Geotechnical design triangle – Types of foundation – Types of Shallow foundation, their applicability – Selection of type of foundation – conceptual design principles – General and additional considerations – Depth of foundations – Hostile Environment – holistic approach – circumstances.

UNIT II BEARING CAPACITY 9

Theories of bearing capacity – Ultimate Bearing capacity - Homogeneous - Layered soils – Rocks - Evaluation of bearing capacity from in-situ tests – Safe bearing capacity – Bearing capacity of foundations in slope – Bearing capacity under eccentric loading –partial safety factor approach - Codal provisions.

UNIT III SETTLEMENT AND ALLOWABLE BEARING PRESSURE 9

Component of settlement – Influence of foundation stiffness approach to settlement computations - immediate, primary and secondary consolidation settlement - stress path method of settlement evaluation - layered soil - construction period correction. Evaluation from in-situ tests – Allowable settlement – Allowable bearing pressure - codal provisions.

UNIT IV INTERACTIVE ANALYSIS AND DESIGN OF FOUNDATIONS 12

Analysis of foundation - isolated - strip - combined footings - Flat raft – Stiffened raft foundations. Conventional - elastic approach - Soil Structure Interaction Principles – Winkler foundation – Elastic half space approach – Structural design of Shallow foundation – Codal provisions.

UNIT V FOUNDATION FOR SPECIAL CONDITIONS 9

Shell foundations - Foundation design in relation to ground movements - Foundation on compressible fills – Foundation for tower – Foundation for earthquake effects – bucket foundation – Machine foundation - Codal Provisions.

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Differentiate different type of shallow foundations, their selection, design principles for different ground conditions
CO2	Apply appropriate bearing capacity theory and factors for different type of loading and ground conditions
CO3	Decide the design bearing pressure based on settlement, mode of loading and ground conditions
CO4	Perform interactive analysis for different types of shallow foundation and ground conditions
CO5	Perform analysis for different types of special foundation and special ground conditions

CO – PO Mapping - SHALLOW FOUNDATIONS

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	H	H	H	M	M	H
PO2	Problem analysis	M	M	M	H	H	M
PO3	Design / development of solutions				H	H	H
PO4	Investigation	M	M	M	H	H	M
PO5	Modern Tool Usage				H		H
PO6	Individual and Team work			M	M	M	M
PO7	Communication					L	L
PO8	Engineer and Society	M			M	H	M
PO9	Ethics	H				H	H
PO10	Environment and Sustainability				M	M	M
PO11	Project Management and Finance					M	M
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	H	H	H	H	H

PSO2	Critical analysis of Geotechnical Engineering problems and innovation	H	M	M	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	H			H	H	H

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SF5211 ADVANCED SOIL MECHANICS LABORATORY - II L T P C
0 0 4 2

OBJECTIVES:

- At the end of the course student attains adequate knowledge in assessing Shear Strength, dynamic properties of soil and shear strength, indirect tensile strength and compressive strength of Rocks. Student learns to assess the different properties of geosynthetics. Student is trained to gain knowledge in assessing the properties of soils through field tests and also by conducting model tests.

UNIT I SHEAR STRENGTH TESTS 12

Direct shear – Triaxial compression (UU and CU) test – Unconfined compression test –Vane shear test.

UNIT II SUCTION TESTS 8

Soil water characteristic curves of soil by Pressure Plate apparatus – Filter paper technique.

UNIT III TEST ON GEOSYNTHETICS 12

Opening size of Geotextiles – Tensile strength of Geosynthetic materials – Interfacial friction – Permeability

UNIT IV TEST ON ROCKS 12

Point load index – Brazilian test – Direct shear test – Uniaxial compressive strength test

UNIT V MODEL AND FIELD TESTS (demonstration only) **16**

Model test on foundation elements - strain gauges - load cells. Field tests - Plate load test – static cone penetration test – standard penetration test – pressure meter test - Block vibration test – Cyclic triaxial test.

TOTAL: 60 PERIODS

OUTCOME:

On completion of the course, the student is expected to be able to;

CO1	assess the shear strength of soils by conducting appropriate tests
CO2	analyse the soil water characteristic curves of different soils
CO3	analyse and assess the characteristics of soils using the geosynthetics
CO4	evaluate the strength characteristics of rocks
CO5	Understand the concept of conducting model tests and use data acquisition system for conducting model test in laboratory

CO – PO Mapping – Advanced Soil Mechanics Laboratory - II

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	H	H	H	H	M	H
PO2	Problem analysis	H	H	H	H	M	H
PO3	Design / development of solutions	L					L
PO4	Investigation	M	L	M	M	M	M
PO5	Modern Tool Usage	H	M	H	M	H	H
PO6	Individual and Team work	H	H	H	H	H	H
PO7	Communication	M	M	M	M	M	M
PO8	Engineer and Society		L				L
PO9	Ethics			L			L
PO10	Environment and Sustainability		L				L
PO11	Project Management and Finance	L				L	L
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	H	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	H	H	H	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	L	L	L	L	L	L

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SF5311 **DESIGN STUDIO** **L T P C**
0 0 4 2

OBJECTIVES:

- Train the students to use various software packages for simulating and analyzing the real field problems in Geotechnical Engineering.

SYLLABUS:

Students have to work individually with software packages for simulating and analyzing the various geotechnical engineering problems;

- Soil – structure interaction such as Foundations and Retaining walls
- Ground improvement related problems.
- Analyze and design real challenging problems - deep excavation – impact on adjacent structures
- Stability analysis of slope and embankment - surcharge adjacent to an existing structure
- A detailed report on the work done should be submitted by individual students at least 10 days before the last working day of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

TOTAL: 60 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to

CO1	use software programs for arriving solutions to various practical design problems in Geotechnical Engineering
CO2	develop numerical model tool with the use of software to arrive solutions for geotechnical problems
CO3	Communicate the numerical model concept and interact with geotechnical engineering community

REFERENCES:

1. Web link for open source and shareware software using the link http://www.ggsd.com.

CO – PO Mapping – DESIGN STUDIO

PO/PSO		Course Outcome			Overall Correlation of COs to POs
		CO1	CO2	CO3	
PO1	Knowledge of Engineering Sciences	M	H	M	M
PO2	Problem analysis	H	H	M	H
PO3	Design / development of solutions	H	H	M	H
PO4	Investigation			L	L
PO5	Modern Tool Usage	H	H	M	H
PO6	Individual and Team work			M	M
PO7	Communication			H	H

PO8	Engineer and Society			M	M
PO9	Ethics			M	M
PO10	Environment and Sustainability			L	L
PO11	Project Management and Finance			L	L
PO12	Life Long Learning	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	H	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	H	H	H	H

SF5312 **PRACTICAL TRAINING (2 WEEKS)** **L T P C**
0 0 0 1

OBJECTIVES:

- To train the students in field work so as to have a firsthand knowledge of practical problems in carrying out Soil Mechanics and Foundation engineering tasks. To develop skills in facing and solving the geotechnical engineering field problems.

Syllabus Content:

- Students individually undertake training in reputed Soil Mechanics and Foundation Engineering Companies during the summer vacation for a specified period of two weeks.
- Students allowed to get field exposure and effectively interact with geotechnical engineers
- At the end of training, a detailed report on the work done should be submitted to the course coordinator
- Students will be evaluated through a viva-voce examination by a team of internal staff.

OUTCOME:

- On completion of the course, the student is expected to be able to

CO1	Understand the real field problem and compare the theoretical knowledge with field
CO2	Solve Soil Mechanics and Foundation engineering problems in the field either individually or in team.
CO3	Understand the professional ethics
CO4	Work in a team to obtain the solution for various field problems

CO – PO Mapping – Practical Training

PO/PSO		Course Outcome				Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	
PO1	Knowledge of Engineering Sciences	M	M	L	H	M
PO2	Problem analysis	H	H	M	H	H
PO3	Design / development of solutions	H	H	M	H	H
PO4	Investigation	H	M	L	M	M
PO5	Modern Tool Usage	M	M	L	H	M
PO6	Individual and Team work	H	H	M	H	H
PO7	Communication	H	H	M	M	H
PO8	Engineer and Society	M	M	M	M	M
PO9	Ethics	M	M	H	M	M
PO10	Environment and Sustainability	L	L	L	L	L

PO11	Project Management and Finance	L	L	M	M	M
PO12	Life Long Learning	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	H	H	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	M	H	H	H	H

SF5313 **PROJECT PHASE I** **L T P C**
0 0 12 6

OBJECTIVES:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS:

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 180 PERIODS

OUTCOME:

- At the end of the course the students will have a clear idea of his/her area of work and they are in a position to carry out the remaining phase II work in a systematic way.

PO/PSO		**Overall Correlation of COs to POs**
PO1	Knowledge of Engineering Sciences	H
PO2	Problem analysis	H
PO3	Design / development of solutions	H
PO4	Investigation	H
PO5	Modern Tool Usage	H
PO6	Individual and Team work	H
PO7	Communication	H
PO8	Engineer and Society	H
PO9	Ethics	L
PO10	Environment and Sustainability	H
PO11	Project Management and Finance	M
PO12	Life Long Learning	H
PSO1	Knowledge of Geotechnical Engineering discipline	M
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	H

SF5411 **PROJECT PHASE II** **L T P C**
0 0 24 12

OBJECTIVES:

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS:

The student should continue the phase I work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated through based on the report and the viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 360 PERIODS

OUTCOME:

- On completion of the project work students will be in a position to take up any challenging practical problem and find better solutions.

PO/PSO		Overall Correlation of Cos to POs
PO1	Knowledge of Engineering Sciences	H
PO2	Problem analysis	H
PO3	Design / development of solutions	H
PO4	Investigation	M
PO5	Modern Tool Usage	H
PO6	Individual and Team work	M
PO7	Communication	L
PO8	Engineer and Society	H
PO9	Ethics	L
PO10	Environment and Sustainability	H
PO11	Project Management and Finance	H
PO12	Life Long Learning	H
PSO1	Knowledge of Geotechnical Engineering discipline	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	H

SF5001 **ENVIRONMENTAL GEOTECHNOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- The student acquires the knowledge on the Geotechnical engineering problems associated with soil contamination, safe disposal of waste and remediate the contaminated soils by different techniques thereby protecting environment.

UNIT I SOIL – WASTE INTERACTION **9**

Role of Geoenvironmental Engineering – sources, generation and classification of wastes – causes and consequences of soil pollution – case studies in soil failure -factors influencing soil-pollutant interaction – modification of index, chemical and engineering properties – physical and physio-chemical mechanisms.

UNIT II CONTAMINANT TRANSPORT AND SITE CHARACTERISATION 9

Transport of contaminant in subsurface – advection, diffusion, dispersion – chemical process – biological process, sorption, desorption, precipitation, dissolution, oxidation, complexation, ion exchange, volatization, biodegradation – characterization of contaminated sites – soil and rock data – hydrological and chemical data – analysis and evaluation – risk assessment – case studies.

UNIT III WASTE CONTAINMENT AND REMEDIATION OF CONTAMINATED SITES 9

Insitu containment – vertical and horizontal barrier – surface cover – ground water pumping system on subsurface drain – soil remediation – soil vapour extraction, soil waste stabilization, solidification of soils, electrokinetic remediation, soil heating, vitrification, bio remediation, phyto remediation – ground water remediation – pump and treat , Insitu flushing, permeable reacting barrier, Insitu air sparging - case studies.

UNIT IV LANDFILLS AND SURFACE IMPOUNDMENTS 9

Source and characteristics of waste - site selection for landfills – components of landfills – liner system – soil, geomembrane, geosynthetic clay, geocomposite liner system – leachate collection – final cover design – monitoring landfill - Environmental laws and regulations.

UNIT V STABILISATION OF WASTE 9

Evaluation of waste materials – flyash, municipal sludge, plastics, scrap tire, blast furnace slag, construction waste, wood waste and their physical, chemical and biological characteristics – potential reuse – utilization of waste and soil stabilization – case studies.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to;

CO1	Understand the various causes and consequences of waste interaction with soil and their modification.
CO2	Understand the various mechanism of transport of contaminants into the subsurface and characterization of contaminated sites and their risk analysis.
CO3	Understand on how to decontaminate the site so as to reuse the site for human settlement
CO4	Understand how to safely dispose the waste through different containment process.
CO5	Expose on how to convert the waste into a resource material through soil waste stabilization techniques with or without chemical stabilization.

CO – PO Mapping – ENVIRONMENTAL GEOTECHNOLOGY

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	L			L	M	L
PO2	Problem analysis	L	L	L	H	M	L
PO3	Design / development of solutions	M			H	M	M
PO4	Investigation	L		M	M	H	M
PO5	Modern Tool Usage	L		L			L
PO6	Individual and Team work				M	H	H
PO7	Communication				M	M	M
PO8	Engineer and Society	M	M	H	M	M	M
PO9	Ethics			M	M	M	M
PO10	Environment and Sustainability	H	H	H	H	H	H
PO11	Project Management and Finance	L		L		L	L
PO12	Life Long Learning	H	H	H	H	H	H

PSO1	Knowledge of Geotechnical Engineering discipline	M	M	M	H	L	M
PSO2	Critical analysis of Geotechnical Engineering problems and innovation			M		M	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues		M	H	H	M	H

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SF5002 GEOLOGY FOR GEOTECHNICAL APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge and skills in assessing the quality of foundation rocks, their aggregates and building materials derived from rocks and assess the geological suitability of sites for engineering projects.

UNIT I ENGINEERING PROPERTIES OF ROCKS AND MINERALS 9

Geology for foundation engineering – Types of rocks, rock description-texture, structure, composition and its relation to quality and strength of rocks, engineering classification of rocks – weathering grade and its significance in engineering site-Engineering properties of rocks - Physical and chemical properties of minerals and their relation to strength and durability of rock.

UNIT II SURFACE AND SUBSURFACE GEOLOGICAL INVESTIGATIONS 9

Surface investigations: Bed rock attitudes - Strike and dip of rocks-Field mapping- thickness, calculation of True thickness and vertical thickness of bed rock-pitting and trenching-Subsurface investigations: electrical and seismic geophysical methods in subsurface geological investigations for foundation engineering, applications of GPR in subsurface strata studies.

UNIT III LOGGING AND CORE SAMPLING TECHNIQUES 9

Core logging techniques – Resistivity log, Neutron log, Sonic log, Gamma log etc. Bore logging methods, interpretation. Drilled core sections – rocks and soil sampling methods. Description of discontinuities-Fence diagrams, RQD and RMR.

UNIT IV CLAY MINERALS IN GEOTECHNICAL INVESTIGATIONS 9

Physical, chemical and thermal properties of clays-identification-effects of clay minerals-classification and types of clays- plasticity, clay behaviour under natural and hydrated conditions.

UNIT V GEOLOGICAL INVESTIGATIONS FOR FOUNDATION SITES 9

Ground stability studies - Scour and erosion studies-stability of slopes: Geological information for slope stabilization and geological solution for slope stability in landslides areas-Overview of rocks of TamilNadu.

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course, the student is expected to be able to;

CO1	Identify various rock types and understand the strength and durability of different rock types.
CO2	Map the surface and subsurface geological formations using geological and geophysical exploration techniques.
CO3	Explore and analyse the subsurface rocks and their discontinuities for design and construction of major Civil engineering structures.
CO4	Understand the geological characteristics of clay minerals and their effect in choosing
CO5	Analyse the slopes and decide the suitable methods for improving slope stability and manage unstable slopes efficiently.

CO – PO Mapping – GEOLOGY FOR GEOTECHNICAL APPLICATIONS

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	M	M	M	H	M	M
PO2	Problem analysis	M	H	M	M	H	M
PO3	Design / development of solutions	L	L	M	L	H	M
PO4	Investigation		H	L	L	M	M
PO5	Modern Tool Usage		M	M			M
PO6	Individual and Team work	L					L
PO7	Communication			L			L
PO8	Engineer and Society						L
PO9	Ethics						L
PO10	Environment and Sustainability	L			L		L
PO11	Project Management and Finance	L				L	L
PO12	Life Long Learning	H	H	M	H	M	H
PSO1	Knowledge of Geotechnical Engineering discipline	M	M	H	M	M	M
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	M	H	M	H	M
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	M	M	H	M	H	M

REFERENCES:

1. Roy E. Hunt, Geotechnical Engineering Investigation Handbook, CRC Press, 2005.
2. Varghese P.C. Engineering Geology for civil engineers, PHI learning Pvt.Ltd. New Delhi, 2012
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SF5003 PAVEMENT ANALYSIS AND DESIGN L T P C
3 0 0 3

OBJECTIVES:

- Student gains knowledge on designing rigid and flexible pavements for different serviceability conditions of roads.

UNIT I BASIC CONCEPTS 9

Historical development of pavements – types, classification, components and principle of load transfer – Approaches to pavement design – vehicle and traffic considerations – behaviour of road materials under repeated loading – Stresses and deflections in layered systems**.**

UNIT II FLEXIBLE PAVEMENT 9

Factors affecting flexible pavements – material characterization for analytical pavement design – AASHO, CBR, group index methods – Importance of Resilient modulus – Fatigue subsystem – failure criteria for bituminous pavements – IRC design guidelines.

UNIT III RIGID PAVEMENT 9

Factors affecting rigid pavements - Design procedures for rigid pavement – Slab thickness, dowel bar, tie bar, spacing of joints – IRC guidelines – Airfield pavements – Comparison of highway and airfield pavements.

UNIT IV PAVEMENT EVALUATION AND REHABILITATION 9

Pavement evaluation – surface and structural - causes and types of failures in flexible and rigid pavements – Presents serviceability index of roads – Overlay design - pavements maintenance, management and construction – Drainage and its importance in pavements.

UNIT V STABILIZATION OF SOILS FOR ROAD CONSTRUCTIONS 9

Need for a stabilized soil – Design criteria – Mechanisms - factors influencing choice of stabilizers - Testing and field control – Applications of Geosynthetics in road construction - Case studies.

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course, the student is expected to be able to

CO1	Explain different types of pavements, wheel load, serviceability and design strategies of pavement.
CO2	Design flexible pavements based on different guidelines.
CO3	Design rigid pavements based on different guidelines.
CO4	Explain the various types of failure in different components of pavement and assess
CO5	Select suitable stabilizers based on mechanism and requirements for construction with quality control in the field.

CO – PO Mapping - PAVEMENT ANALYSIS AND DESIGN

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences		M	M	M		M
PO2	Problem analysis		M	M	M	M	M
PO3	Design / development of solutions		H	H	M		H
PO4	Investigation	M	M	M	H	H	M
PO5	Modern Tool Usage		M	M	M		M
PO6	Individual and Team work		M	M	M	M	M
PO7	Communication					L	L
PO8	Engineer and Society		M	M	M	M	M
PO9	Ethics				H	H	H
PO10	Environment and Sustainability				H	H	H
PO11	Project Management and Finance				M	M	M

PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	H	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	M	M	H	H	M
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues				H	H	H

REFERENCES:

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

SF5004 EARTHQUAKE RESISTANT DESIGN OF FOUNDATIONS L T P C

3 0 0 3

OBJECTIVES:

- Focus is mainly on identifying the different kinds of loading induced on the foundation due to earthquake and soil - foundation interaction analysis with reference to various design parameters that including liquefaction of soil due to earthquake.

UNIT I BASIC DESIGN PARAMETERS 9

Dynamic properties of soils and its evaluation, strength and deformation characteristics of soils under earthquake loading, liquefaction hazard evaluations and remedial measures, geotechnical failure of foundations during earthquake, provision of IS 1893 and IS 13920

UNIT II SHALLOW FOUNDATION 9

Design requirements – bearing capacity theory under earthquake loading – bearing capacity analysis for liquefied soil – bearing capacity analysis for cohesive and cohesionless soils - seismic settlement of foundation.

UNIT III DEEP FOUNDATION 10

Earthquake loading – inertial and kinematic loading - performance of piles during earthquake loading – theories of pile failure in liquefiable soils – failure based on bending mechanism/buckling instability – methods of analysis – force based or limit equilibrium method – p-y method – pile settlement - guidelines for designing of piles under kinematic loading due to liquefaction – seismic design of well/cassion foundations.

UNIT IV SEISMIC DESIGN OF RETAINING WALL 9

Seismic passive lateral earth pressure, behaviour of retaining wall during earthquakes, modification of Coulomb's Theory, Modified Culmann's Theory, displacement analysis, Indian standard code of practice.

UNIT V STRUCTURAL DESIGN OF FOUNDATION 8

Loads acting on foundations during earthquake – fundamental failure mechanisms of foundations – essential criteria for design of foundations in liquefiable soils – structural design of foundations subjected to earthquake loading.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to;

CO1	Evaluate the dynamic properties of soils and relevant design parameters
CO2	Design the shallow foundation subjected to earthquake loading by including the effect of soil liquefaction
CO3	Analyse and design the deep foundation by considering various earthquake forces
CO4	Analyse and design the retaining wall by incorporating earthquake forces
CO5	Perform structural design of foundations subjected to both static and dynamic loading

CO – PO Mapping – EARTHQUAKE RESISTANT DESIGN OF FOUNDATIONS

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	H	M	M	M	M	M
PO2	Problem analysis	H	H	H	H	H	H
PO3	Design / development of solutions	M	H	H	H	M	H
PO4	Investigation	M		L		L	L
PO5	Modern Tool Usage	M		L		L	L
PO6	Individual and Team work					L	L
PO7	Communication		L				L
PO8	Engineer and Society		L				L
PO9	Ethics	L					L
PO10	Environment and Sustainability	L					L
PO11	Project Management and Finance					L	L
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	H	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	H	H	H	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	H	H	H	H	H	H

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1. Design of foundation in seismic areas: Principles and some applications by Bhattacharya S. (eds), Published by NICEE [National Centre for Earthquake Engineering (India)]. ISBN: 81-904190-1-3, 2007.
2. Day R. W., Geotechnical Earthquake Engineering handbook, McGraw – Hill, New York, 2002.
3. Gopal Madabhushi, Jonathan Knappett and Stuart Haigh, Design of Pile Foundations in Liquefiable Soils, Imperial College Press, London WC2H 9HE, 2010.
4. Kamalesh Kumar, Basic geotechnical earthquake engineering, New Age International Publishers, New Delhi, 2008.

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6. Poulos H.G. and Davis E.H., Pile foundation analysis and design, John Wiley and Sons, 1980.
7. Prakash, S., Soil dynamics, McGraw Hill, New York, 1981.
8. Srbulov, M., Geotechnical Earthquake Engineering Simplified Analyses with Case Studies and Examples, Springer, Dordrecht. 2008.
9. Steven L. Kramer, Geotechnical Earthquake Engineering, Prentice Hall, New Delhi, 1996.
10. Tomilinson M.J., Foundation design and construction, Longman Scientific & Technical, England, 1986.

SF5005 GROUND IMPROVEMENT TECHNIQUES L T P C
3 0 0 3

OBJECTIVES:

- Students will be exposed to various problems associated with soil deposits and methods to evaluate them. The different techniques will be taught to them to improve the characteristics of difficult soils as well as design techniques required to implement various ground improvement methods.

UNIT I HYDRAULIC MODIFICATIONS 9

Scope and necessity of ground improvement in Geotechnical engineering basic concepts. Drainage – Ground Water lowering by well points, deep wells, vacuum and electro-osmotic methods. Stabilization by thermal and freezing techniques - Applications.

UNIT II MECHANICAL MODIFICATIONS 9

Insitu compaction of granular and cohesive soils, Shallow and Deep compaction methods – Sand piles – Concept, design, factors influencing compaction. Blasting and dynamic consolidation - design and relative merits of various methods – Soil liquefaction mitigation methods - Case studies.

UNIT III PHYSICAL MODIFICATION 9

Preloading with sand drains, fabric drains, wick drains – theories of sand drain - Stone column with and without encased, lime stone – functions – methods of installation – design, estimation of load carrying capacity and settlement. Root piles and soil nailing – methods of installation – Design and Applications - - case studies.

UNIT IV MODIFICATION BY INCLUSIONS 9

Reinforcement – Principles and basic mechanism of reinforced earth, simple design: Synthetic and natural fiber based Geotextiles and their applications. Filtration, drainage, separation, erosion control – case studies.

UNIT V CHEMICAL MODIFICATION 9

Grouting – Types of grout – Suspension and solution grouts – Basic requirements of grout. Grouting equipment – injection methods – jet grouting – grout monitoring – Electro – Chemical stabilization – Stabilization with cement, lime - Stabilization of expansive clays – case studies.

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course, the student is expected to be able to

CO1	identify and evaluate the deficiencies in the deposits of the given project area and improve its characteristics by hydraulic modifications
CO2	improve the ground characteristics by mechanical modifications using various method and design the system
CO3	improve the ground characteristics by physical modifications using various method and design the system

CO4	improve the characteristics of soils by various reinforcement techniques and design
CO5	Analyse the ground and decide the suitable chemical method for improving its characteristics

CO – PO Mapping – GROUND IMPROVEMENT TECHNIQUES

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	H	M	M	M	M	M
PO2	Problem analysis	H	H	H	H	H	H
PO3	Design / development of solutions	M	H	H	H	M	H
PO4	Investigation	M	M	L	L	M	M
PO5	Modern Tool Usage	L	H	H	H	L	H
PO6	Individual and Team work	M					M
PO7	Communication	M					M
PO8	Engineer and Society	M		M			M
PO9	Ethics	L					L
PO10	Environment and Sustainability	M					M
PO11	Project Management and Finance	L					L
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	H	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	H	H	H	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	M	H	H	H	H	H

REFERENCES:

1. Pappala, A.J., Huang,J., Han, J., and Hoyos, L.R., Ground Improvement and Geosynthetics; Geotechnical special publication No.207, Geo Institute, ASCE, 2010
2. Cox, B.R., and Grifiths S.C., Practical Recommendation for Evaluation and mitigation of Soil Liquefaction in Arkansas, (Project Report), 2010.
3. Day, R.W., Foundation Engineering Handbook, McGraw – Hill Companies, Inc. 2006.
4. Rowe, R.K., Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers, 2001.
5. Das, B.M., Principles of Foundation Engineering, Fourth Edition, PWS Publishing, 1999.
6. Moseley, M.P., Ground Treatment, Blackie Academic and Professionals, 1998.
7. Koerner, R.M., Designing with Geosynthetics, Third Edition, Prentice Hall 1997.
8. Hehn, R.W., Practical Guide to Grouting of Underground Structures, ASCE, 1996.
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10. Koerner, R.M. and Welsh, J.P., Construction and Geotechnical Engineering using Synthetic Fabrics, John Wiley, 1990.
11. Han,J., Principles and Practice of Ground Improvement, John Wiley and Sons, New Jersey, Canada 2015.
12. Jones, J.E.P., Earth Reinforcement and Soil Structure, Butterworths, 1985.
13. Manfred R. Hausmann, Engineering Principles of Ground Modifications, McGraw-Hill Publishing Company, New York, 1990.

SF5006 **SOIL STRUCTURE INTERACTION** **L T P C**
3 0 0 3

OBJECTIVES:

- Focus is on idealization of soil response to closely represent continuum behavior and interaction analysis between the soil-structure with reference to relative stiffness of beams, slabs and piles under different loading conditions.

UNIT I SOIL RESPONSE MODELS OF INTERACTION ANALYSIS 9

Introduction to soil – Foundation interaction problems, Soil behavior, Foundation behavior, Interface behavior, soil-foundation interaction analysis, soil response models, Elastic continuum, Winkler, Two parameter elastic models, Elastic – plastic behavior, Time dependent behavior.

UNIT II INFINITE AND FINITE BEAMS ON ELASTIC FOUNDATIONS 9

Infinite beam, General solution of the elastic line – concentrated and distributed loads on beams – Idealization of semi-infinite and finite beams. Classification of finite beams, different end conditions and loads – solutions - General method.

UNIT III PLATE ON ELASTIC MEDIUM 9

Infinite plate, elastic continuum, Winkler, Two parameters, Thin and thick plates, Analysis of finite plates, rectangular and circular plates, simple solution, ACI method, Analysis of highway and airfield pavements – solutions - General method.

UNIT IV ANALYSIS OF PILE AND PILE GROUPS 12

Elastic analysis of single pile – Solutions for settlement and load distribution – Simplified method for constructing load settlement curve to failure – Analysis of group settlement – Two pile interaction Analysis, Analysis of general groups – Theoretical solutions for free standing groups – Settlement of groups caused by compressible underlying strata – Use of design charts – Surface settlement around a group – Observed and predicted group behaviour.

UNIT V LATERALLY LOADED PILE 6

Load - deflection prediction for laterally loaded piles, subgrade reaction and elastic analysis, Analysis of pile group, pile raft system, solutions through influence charts.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to;

CO1	Select appropriate soil response model for interactive analysis.
CO2	Differentiate and perform interactive analysis for different beams.
CO3	Differentiate and perform interactive analysis for different plates.
CO4	Perform interactive analysis for single pile, two pile and multiple groups subjected to
CO5	Perform interactive analysis for single pile and multiple groups subjected to lateral loading.

REFERENCE:

1. Salgado, R., "The Engineering of Foundations", Tata McGraw Hill Education Private Limited, New Delhi, 2011.
2. Saran, S, "Analysis and Design of Substructures", Taylor & Francis Publishers, 2006
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CO – PO Mapping - SOIL STRUCTURE INTERACTION

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences			H	H		H
PO2	Problem analysis	M	M	H	H	H	H
PO3	Design / development of solutions			M	H	H	H
PO4	Investigation	M	M	M	H	H	M
PO5	Modern Tool Usage		M		M		M
PO6	Individual and Team work			M	M	M	M
PO7	Communication					L	L
PO8	Engineer and Society				M	M	M
PO9	Ethics				M	M	M
PO10	Environment and Sustainability				M	M	M
PO11	Project Management and Finance					L	L
PO12	Life Long Learning	M	M	M	M	M	M
PSO1	Knowledge of Geotechnical Engineering discipline	M	M	M	H	H	M
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	M	M	M	M	M
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues				H	H	H

SF5007 DYNAMICS OF SOILS AND FOUNDATIONS L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of dynamics – dynamic behaviour of soils – effects of dynamic loads and the various design methods.

UNIT I THEORY OF VIBRATION 9

Nature of dynamic loads – vibrations of single degree freedom system – free vibrations of spring – mass systems – forced vibrations – viscous damping, Transmissibility – Principles of vibration measuring instruments effect of Transient and Pulsating loads – vibrations of multi degree freedom system.

UNIT II DYNAMIC SOIL PROPERTIES AND BEHAVIOUR 9

Dynamic stress – strain characteristics – principles of measuring dynamic properties – Laboratory Techniques – Field tests – Factors affecting dynamic properties - Typical values- Dynamic bearing capacity – Dynamic earth pressure.

UNIT III FOUNDATIONS FOR RECIPROCATING MACHINES 9

Types of Machines and Foundations – General requirements – Modes of vibration of a rigid foundation, block method of analysis – Linear Elastic weightless spring method – Elastic half – space method – Analog models ; Design of Block foundation -- Codal Provisions

UNIT IV FOUNDATION FOR IMPACT AND ROTARY MACHINES 9

Dynamic analysis of impact type machines – Design of Hammer foundations – use of vibrator Absorbers – design – Codal recommendation. Special consideration for Rotary machines – Design criteria – Loads on Turbo Generator Foundation – method of analysis – Design; Dynamic soil – structure – Interaction, Codal Provisions.

UNIT V INFLUENCE OF VIBRATION AND REMEDIATION 9

Mechanism of Liquefaction–Influencing factors--Evaluation of Liquefaction potential based on SPT-Force Isolation – Motion Isolation – use of spring and damping materials – vibration control of existing machine foundation – screening of vibration – open trenches – Pile Barriers – salient construction aspects of machine Foundations.

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course, the student is expected to be able to;

CO1	Differentiate different type of dynamic loads and theory of vibration of different systems
CO2	Select different dynamic properties from different testing principles and applications
CO3	Perform analysis and design of reciprocating machines based on different methods.
CO4	Perform analysis and design of impact and rotary machines based on different
CO5	Asses influence of vibration from different dynamic source and design suitable remediation

REFERENCES:

1. Kameswara Rao, N.S.V., "Dynamics soil tests and applications", Wheeler Publishing, New Delhi, 2000.
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3. Krammer S.L., "Geotechnical Earthquake Engineering", Prentice hall, International Series, Pearson Education (Singapore) Pvt. Ltd., 2004.
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7. A. K. Chopra, Dynamics of Structures, Theory and Applications to Earthquake Engineering, 5th edition, Pearson Education*, 2017*.

CO – PO Mapping - DYNAMICS OF SOILS AND FOUNDATIONS

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences			M	M		M
PO2	Problem analysis	M	M	H	H	H	H
PO3	Design / development of solutions			H	H	H	H
PO4	Investigation			H	H	H	H
PO5	Modern Tool Usage		M		M		M
PO6	Individual and Team work			M	M	M	M
PO7	Communication					L	L
PO8	Engineer and Society			H	H	H	H
PO9	Ethics					H	H
PO10	Environment and Sustainability			M	M	H	M
PO11	Project Management and Finance					L	L
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	M	M	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	M	H	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues			H	H	H	H

SF5008 GEOTECHNICAL EARTHQUAKE ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To understand the dynamics of earth and its response, effect on earth structure and measures to mitigate the effects.

UNIT I ELEMENTS OF EARTHQUAKE SEISMOLOGY 6

Mechanism of Earthquakes - Causes of earthquake - Earthquake Fault sources - Elastic Rebound theory - Seismic wave in Earthquake shaking - Definition of earthquake terms - Locating an earthquake - Quantification of earthquakes.

UNIT II THEORY OF VIBRATION 9

Nature of dynamic loads – vibrations of single degree freedom system – free vibrations of spring – mass systems – forced vibrations – viscous damping, Transmissibility – Principles of vibration measuring instruments effect of Transient and Pulsating loads – vibrations of multi degree freedom system.

UNIT III GROUND MOTION CHARACTERISTICS 10

Strong Motion Records -characteristics of ground motion - Factors influencing ground motion - Estimation of frequency content parameters - Seismic site investigations - Evaluation of Dynamic soil properties.

UNIT IV DESIGN GROUND MOTION 10

Wave propagation Analysis - Site Amplification, Ground Response Analysis - Method of analysis - One Dimensional Analysis - Equivalent linear Analysis – shear beam Analysis - site effects - Design Ground Motion - Developing Design Ground Motion. Application of software package - codal recommendations.

UNIT V SEISMIC STABILITY ANALYSIS 10

Assessment of liquefaction potential based on SPT-N value – permanent settlement – displacement prediction – Mitigation of liquefaction induced damage – Microzonation for intensity – liquefaction – Bearing capacity analysis – Effects of Pile foundation – Response of slopes – Evaluation of slope stability – Pseudostatic – Newmark's study of Block analysis – Dynamic analysis – Earthpressure due to ground shaking – Dynamic analysis.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to

CO1	Explain interior structure of earth, different causes, location and quantification of earthquake
CO2	Differentiate different type of dynamic loads and theory of vibration of different systems
CO3	Evaluate dynamic properties of soils and ground motion characteristics
CO4	Estimate the design ground motion based on the ground response analysis
CO5	Analyze and design different types of foundations, slopes and retaining walls for seismic loading and assess liquefaction potential and mitigation of liquefaction induced damage.

REFERENCES:

1. Kameswara Rao, N.S.V., Dynamics soil tests and applications, Wheeler Publishing - New Delhi, 2000.
2. Krammer S.L., Geotechnical Earthquake Engineering, Prentice Hall,Iinternational Series, Pearson Education (Singapore) Pvt. Ltd., 2004.
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CO – PO Mapping - GEOTECHNICAL EARTHQUAKE ENGINEERING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences		H		M	M	M
PO2	Problem analysis			M	M	H	M
PO3	Design / development of solutions			H	H	H	H
PO4	Investigation		M	H	H	H	H
PO5	Modern Tool Usage			M	H	H	H
PO6	Individual and Team work				H	H	H
PO7	Communication					L	L
PO8	Engineer and Society	H	H	H	H	H	H
PO9	Ethics			M	H	H	H
PO10	Environment and Sustainability			M	M	M	M
PO11	Project Management and Finance				M		M
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	H	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	M	M	H	H	M
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues				H	H	H

SF5009 MECHANICS OF UNSATURATED SOILS L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge in assessing both physical and engineering behaviour of unsaturated soils, measurement and modeling of suction – water content and suction – hydraulic conductivity of unsaturated soils.

UNIT I STATE OF UNSATURATED SOIL 6

Definition – Interdisciplinary nature of unsaturated soil – soil classification – Nature and practice – stress profiles, stress state variables - material variables – constitutive law – suction potential of soil water

UNIT II PHYSICS OF SOIL WATER SYSTEM 9

Physical properties of Air and water – partial pressure and relative Humidity Density of moist air – surface Tension – cavitations of water. Solubility of Air in water – Air – water solid interface – vapor pressure lowering – soil water characteristic-curve. Capillary tube model – contacting sphere model. Young Laplace equation – Height of capillary rise – Rate of capillary rise – capillary pore size distribution – theoretical basis – determination – laboratory method.

UNIT III STRESS STATE VARIABLES AND SHEAR STRENGTH 12

Effective-stress – stress between two spherical particles – Hysteresis in SWCC – stress parameter, stress tensor – stress control by Axis Translation - analytical representation of stress – volume change characteristics. Extended Mohr – Coulomb criterion – shear strength parameters – Interpretation of Direct shear test results and Tri axial test results – unified representation of failure envelope – Influence of suction in earth pressure distribution.

UNIT IV STEADY AND TRANSIENT FLOWS 9

Driving mechanism – Permeability and Hydraulic conductivity – capillary barriers – steady infiltration and evaporation – Vapor flow – Air diffusion in water. Principles for pore liquid flow – Rate of infiltration, Transient suction and moisture profiles. Principles for Pore Gas flow – Barometric pumping Analysis.

UNIT V MATERIAL VARIABLE MEASUREMENT AND MODELLING 9

Measurement of total suction – psychrometers – Filter paper measurement of matric suction – High Air Entry disks – Direct measurements – Tensiometers – Air-translation technique – Indirect measurements – Thermal conductivity sensors – measurement of osmotic suction – squeezing technique – soil water characteristic curves and Hydraulic conductivity models.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to

CO1	Explain stress state variables, material variables and constitutive law of unsaturated soil
CO2	Explain the physics of soil-water mechanism, relationship of models.
CO3	Explain and determine the soil-water characteristic curve and the shear strength of unsaturated soil
CO4	Explain the principles of vapour flow, air diffusion, pore liquid flow and rate of infiltration in unsaturated soil.
CO5	Measure the material variables and select the suitable soil models.

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1. Fredlund, D.G., Rahardjo, H. and Fredlund, M.D., Unsaturated Soil Mechanics in Engineering Practice, John Wiley & Sons, INC, New Jersey, 2012.
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4. Ning Lu, Laureano R. Hoyes and Lakshmi Reddi, Advances in unsaturated soil, seepage and Environmental Geotechnics, ASCE., Geotechnical special publication No.148.
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CO – PO Mapping - MECHANICS OF UNSATURATED SOILS

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences		M		M	M	M
PO2	Problem analysis			M	M	H	M
PO3	Design / development of solutions			M	M	H	M
PO4	Investigation			M	M	M	M
PO5	Modern Tool Usage		M		M	M	M
PO6	Individual and Team work		M			M	M
PO7	Communication					L	L
PO8	Engineer and Society					L	L

PO9	Ethics	L					L
PO10	Environment and Sustainability	L	L	L	L	L	L
PO11	Project Management and Finance	L	L	L	L	L	L
PO12	Life Long Learning			M	M	H	M
PSO1	Knowledge of Geotechnical Engineering discipline	H	M	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	M	M	M	H	M
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues				H	H	H

SF5010 GEOSYNTHETICS AND REINFORCED SOIL STRUCTURES L T P C
3 0 0 3

OBJECTIVES:

- To understand the mechanism of the reinforcement, its influence in the shear strength and design concept for various applications in geotechnical engineering.

UNIT I PRINCIPLES AND MECHANISMS OF SOIL REINFORCEMENT 9

Historical Background – Principles - Concepts and Mechanisms of reinforced earth – Soil – Geosynthetics interaction mechanism – interface resistance – Factors influencing interaction – Strain compatability.

UNIT II REINFORCING MATERIALS AND THEIR PROPERTIES 9

Materials used in reinforced soil structures, fill materials, reinforcing materials metal strips, Geotextile, Geogrids, Geomembranes, Geocomposites and Geojutes, Geofoam, Natural fibers - facing elements – Influence of environmental factors on the performance of Geosynthetic materials – Physical – Mechanical – Hydraulic and Endurance properties testing.

UNIT III DESIGN FOR SOIL REINFORCEMENT AND SEPARATION 9

Reinforcing the soil - Geotextiles and Geogrids –Retaining wall – Embankments – Basal reinforcement – piled embankment – unpaved roads – paved roads – railway tracks – Shallow foundations – seismic aspects.

UNIT IV DESIGN FOR FILTRATION, DRAINAGE AND CONTAINMENT 9

Geotextile filter – Filtration Mechanism – Factors affecting filter behaviour – Filtration design – Drains – Drainage in embankments – erosion control silt fences – Containment ponds – Reservoirs and Canals – Hydraulic tunnels – River bed and bank protection.

UNIT V DESIGN OF SLOPES 9

Type and orientation of Geosynthetics – Function of reinforcement against slope failure – Stability analysis – Design aspects – Seismic aspects – General construction aspects.

TOTAL : 45 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to

CO1	Explain various principles and mechanism of soil reinforcement.
CO2	Select different reinforcing materials based on functions to determine their properties
CO3	Design geosynthetics as a reinforcement and/or a separator for different reinforced structures.
CO4	Design geosynthetics as a filter, drainer and as a containment for different reinforced
CO5	Analyze and design reinforced slopes for static and seismic loading.

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CO – PO Mapping - GEOSYNTHETICS AND REINFORCED SOIL STRUCTURES

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	H					H
PO2	Problem analysis			H	H	H	H
PO3	Design / development of solutions			H	H	H	H
PO4	Investigation		M	H	H	H	H
PO5	Modern Tool Usage			M	M	M	M
PO6	Individual and Team work		M	M	M	M	M
PO7	Communication					L	L
PO8	Engineer and Society			H	H	H	H
PO9	Ethics			H	H	H	H
PO10	Environment and Sustainability			H	H	H	H
PO11	Project Management and Finance					L	L
PO12	Life Long Learning			M	M	M	M
PSO1	Knowledge of Geotechnical Engineering discipline	M	M	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	M	H	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues			H	H	H	H

SF5011 ROCK MECHANICS AND APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:

- Students are expected to classify, understand stares-strain characteristics, failure criteria, and influence of insitu stress in the stability of various structures and various technique to improve the insitu strength of rocks.

UNIT I CLASSIFICATION OF ROCKS 9

Types of Rocks - Index properties and classification of rock masses, competent and incompetent rock - value of RMR and ratings in field estimations.

UNIT II STRENGTH CRITERIA OF ROCKS 9

Behaviour of rock under hydrostatic compression and deviatric loading - Modes of rock failure - planes of weakness and joint characteristics - joint testing, Mohr - Coulomb failure criterion and tension cut-off. Hoek and Brown Strength criteria for rocks with discontinuity sets.

UNIT III INSITU STRESSES IN ROCKS 9

Insitu stresses and their measurements, Hydraulic fracturing, flat jack, over coring and under coring methods - stress around underground excavations – Design aspects of openings in rocks - case studies.

UNIT IV SLOPE STABILITY AND BEARING CAPACITY OF ROCKS 10

Rock slopes - role of discontinuities in slop failure, slope analysis and factor of safety - remedial measures for critical slopes – Bearing capacity of foundations on rocks – case studies

UNIT V ROCK REINFORCEMENT 8

Reinforcement of fractured and joined rocks - shotcreting, bolting, anchoring, installation methods - case studies.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to

CO1	Classify the Rock mass and rate the quality of rock for tunnelling and foundations works and suggest the safer length of tunnelling and stand up time.
CO2	Apply the knowledge of engineering and understand the stress – strain characteristics and failure criteria of rock and apply them to arrive at the shear strength parameters of rocks to be used for the design of structures resting on rock and also for the design of underground excavation in rocks.
CO3	Apply the knowledge of engineering and assess the influence of insitu stress in the stability of various underground excavations and also acquire the knowledge of design of opening in rocks.
CO4	Apply the knowledge on rock mechanics and analyse the stability of rock slopes and arrive at the bearing capacity of shallow and deep foundations resting on rocks considering the presence of joints. design the foundations resting on rocks. Able to carryout suitable foundation for the structure resting on rock.
CO5	Improve the insitu strength of rocks by various methods such as rock reinforcement and rock support. Able to select suitable support system considering the interaction between rock and support. Also capable of executing the same in the field.

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2. Hudson, A. and Harrison, P., Engineering Rock mechanics – An introduction to the principles, Pergamon publications, 1997.
3. Hoek, E and Bray, J., Rock slope Engineering, Institute of Mining and Metallurgy, U.K. 1981.
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7. Wittke, W., Rock Mechanics. Theory and Applications with case Histories, Springerverlag, Berlin, 1990.
8. Waltham, T, Foundations of Engineering Geology, Second Edition, Spon Press, Taylor & Francis Group, London and New York, 2002.
9. Ramamurthy T. , “Engineering in Rocks for Slopes Foundations and Tunnels”, PHI Learning Pvt. Ltd., 2007.

CO – PO Mapping – Rock Mechanics and Applications

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	M	H	H	H	M	H
PO2	Problem analysis	M	H	H	H	M	H
PO3	Design / development of solutions	M	H	H	H	H	H
PO4	Investigation	H	M	H	M	L	M
PO5	Modern Tool Usage	L	H	M	H	H	H
PO6	Individual and Team work	M	M	M	H	H	M
PO7	Communication	L	L	M	M	L	L
PO8	Engineer and Society	M	M	H	H	H	H
PO9	Ethics	H	L	L	L	H	M
PO10	Environment and Sustainability	L	M	M	H	H	H
PO11	Project Management and Finance	M	M	H	H	H	H
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	H	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	M	M	H	H	M
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	M	M	H	H	H	H

SF5012 EARTH AND ROCK FILL DAMS L T P C
3 0 0 3

OBJECTIVES:

- Students are expected to learn reasons for failure and damages of embankments and slopes, various methods of analysis of slopes and remedial techniques to protect the slopes.

UNIT I DESIGN CONSIDERATION 9

Design consideration, Factors influencing design, Types of earth and rock fill dams, Design details, Provisions to control pore pressure.

UNIT II SLOPE STABILITY AND SEEPAGE ANALYSIS 8

Stability of infinite and finite slopes, Method of Slices, Bishop's method, Flow nets, Stability conditions during construction, Full reservoir and drawdown - cut off walls – Trenches – Importance of drainage and filters.

UNIT III HYDRAULIC FRACTURING 9

Introduction, Conditions and mechanisms for hydraulic fracturing, Failure criterion for hydraulic fracturing – cubic specimen with a crack – core with a transverse crack – core with a vertical crack, strike–dip of easiest crack spreading; factors affecting hydraulic fracturing, self-healing of a core crack.

UNIT IV FAILURE AND DAMAGES 9

Failure and damages, Nature and importance of failures in embankment and foundation - Piping, Differential settlement, Foundation slides, Earthquake damage, creep and anisotropic effects, Reservoir wave action, Dispersive piping.

UNIT V SLOPE PROTECTION MEASURES 10

Special design problems, Slope protection, Filter design, Foundation treatment, Earth dams on pervious soil foundation, Application of Geosynthetic materials in filtration. Treatment of rock foundation, Construction Techniques, Quality control and performance measurement.

TOTAL: 45 PERIODS

OUTCOME:

. On completion of the course, the student is expected to be able to

CO1	Assess the causes of failure and damage of embankments and slopes.
CO2	Apply the knowledge of engineering and analyse the stability of slopes for various seepage conditions and apply the concept in the design of earth and rock fill dams.
CO3	Apply the knowledge of engineering and assess the stability of dam against hydraulic fracturing and suggest suitable remedial measure.
CO4	Understand the nature of failures and damages in earth and rock fill dams and apply the concept in field to avoid distress.
CO5	Recommend suitable remedial measures to protect the slopes and implement quality control and monitor its performance

CO – PO Mapping – Earth and Rock fill Dams:

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	M	H	H	H	M	H
PO2	Problem analysis	M	H	H	M	M	M
PO3	Design / development of solutions	L	H	H	L	H	M
PO4	Investigation	H	M	H	M	L	M
PO5	Modern Tool Usage	L	H	M	M	M	M
PO6	Individual and Team work	M	M	M	H	H	M
PO7	Communication	L	L	L	M	L	L
PO8	Engineer and Society	M	M	H	H	M	M
PO9	Ethics	M	L	M	L	M	M
PO10	Environment and Sustainability	L	L	M	H	H	M
PO11	Project Management and Finance	M	M	H	L	L	M
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	H	H	H	H	H	H
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	M	M	H	M	M
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	M	M	H	H	H	H

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1. Rowe, R.K., Geotechnical and Geoenvironmental Engineering Handbook, Kulwer Academic Publishers, 2001.
2. Anderson, M.G., and Richards, K.S., Slope Stability, John Wiley, 1987.
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9. Jun-Jie Wang, Hydraulic Fracturing in Earth-rock Fill Dams, John Wiley & Sons, 2014.

SF5013 GEOTECHNICS OF UNDERGROUND STRUCTURES L T P C
3 0 0 3

OBJECTIVES:

- Students mainly focused in visualizing and critically analyzing the behavior of underground structures with reference to various supporting systems under different loading conditions due to induced earth pressure on the underground structures.

UNIT I GROUND MOVEMENTS AND ITS EFFECTS 9

Understanding of the ground – Building response to ground movements – concept of limiting tensile strain – strains in simple rectangular beams – ground movement due to tunneling and excavation - lateral supporting systems – retaining walls – factors influencing on the selection of the retaining system – case history.

UNIT II ANALYSIS OF UNDERGROUND SUPPORTING SYSTEMS 9

Underground supporting system analysis **-** free and fixed earth support method – shear failure of strutted walls – push in – basal heave - upheaval – sand boiling - Stress and deformation analysis of excavation: simplified method – beam on elastic foundation method – finite element method.

UNIT III DESIGN OF UNDERGROUND SUPPORTING SYSTEMS 9

Principles of retaining wall design – types of wall support systems - design of structural elements – Permanent situations – bottom-up/top-down construction sequences – Props – Tied systems – Soil berms – Design of ground anchors – Retaining wall as part of complete underground structure – resistance to vertical and lateral actions

UNIT IV DESIGN OF TUNNEL 10

Longitudinal and transverse profile of tunnel structure - tunnel protection against fire - advanced systems of anti-water insulation of underground structures - loading types of shallow and deep tunnels, rock mass classification - mining technologies of deep excavation - shield technology, execution technology of shallow underground structures, sewerage objects - trenchless technologies.

UNIT V PROTECTION OF ADJACENT BUILDINGS 8

Protection of building using the behaviour of excavation and tunneling induced deformation – building protection by auxiliary methods – construction defects and remedial measures – building rectification methods.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to

CO1	Understand various types of supporting systems used for excavations and analyse ground movement due to various activities like excavations
CO2	Analyse underground supporting system using mathematical, analytical and numerical methods
CO3	Design various underground supporting systems using mathematical and numerical approach
CO4	Understand the concept of tunnelling, analyse and design the tunnel in different ground
CO5	protect the adjacent building due to underground construction using various methods.

CO – PO Mapping – GEOTECHNICS OF UNDERGROUND STRUCTURES

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	M	M	M	M	M	M
PO2	Problem analysis	M	H	M	M	M	M
PO3	Design / development of solutions	L	L	H	H	M	M
PO4	Investigation	L			L	L	L
PO5	Modern Tool Usage	L	L	L	L		L
PO6	Individual and Team work	M				L	M
PO7	Communication					L	L
PO8	Engineer and Society	L					L
PO9	Ethics	L					L
PO10	Environment and Sustainability					L	L
PO11	Project Management and Finance					L	L
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical Engineering discipline	M	M	M	M	M	M
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	H	H	H	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	M	H	H	H	H	H

REFERENCES:

1. Chang – Yu Ou, Deep Excavation Theory and Practice, Taylor & Francis Group, London, UK, 2006.
2. Holtz, R.D. and Kovaces, W.D., An Introduction to Geotechnical Engineering, Prentice – Hall, Inc., Englewood Cliffs, NJ, 1981.
3. Terzaghi, K. and Peck, R. B, Soil Mechanics in Engineering Practice, John Wiley & Sons, New York, 1967.
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SF5014 MARINE GEOTECHNIQUES L T P C
3 0 0 3

OBJECTIVES:

- Students mainly focused in understanding the physical and engineering properties of marine soil deposits and select suitable marine foundation as per project requirements.

UNIT I MARINE SOIL DEPOSITS 9

Offshore environment, Offshore structures and foundations, Specific problems related to marine soil deposits, Physical and engineering properties of marine soils

UNIT II BEHAVIOR OF SOILS SUBJECTED TO REPEATED LOADING 9

Effect of wave loading on offshore foundations, Behavior of sands and clays under cyclic loading, Laboratory experiments including repeated loading, Cyclic behavior of soils based on fundamental theory of mechanics, Approximate engineering methods which can be used for practical cases

UNIT III SITE INVESTIGATION IN THE CASE OF MARINE SOIL DEPOSITS 9

Challenges of site investigation in marine environment, Different site investigation techniques, sampling techniques, Geophysical methods, Recent advancements in site investigation and sampling used for marine soil deposits

UNIT IV FOUNDATIONS IN MARINE SOIL DEPOSITS 9

Different offshore and nearshore foundations, Gravity platforms, Jack-up rigs, pile foundations. cassions, spudcans

UNIT V MARINE FOUNDATIONS SUBJECTED TO WAVE LOADING 9

Cyclic behavior of soils, empirical models, elastic-plastic models, FEM analysis of marine foundations subjected to wave loading

TOTAL : 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Understand the physical and engineering properties of marine soil deposits
CO2	explain the effect of wave loading on physical and engineering properties of marine soil deposits
CO3	execute investigation program for marine soil deposits
CO4	design suitable marine foundation as per project requirement
CO5	develop numerical model and design marine foundation subjected to wave loading

CO – PO Mapping - MARINE GEOTECHNIQUES

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	H	M	M	M	M	M
PO2	Problem analysis	M	H	M	H	H	H
PO3	Design / development of solutions	L	L	L	M	H	M
PO4	Investigation	M	H	H	M	L	M
PO5	Modern Tool Usage	M	M	H	H	H	H
PO6	Individual and Team work	M	M	M	M	H	M
PO7	Communication	L	L		M	M	M
PO8	Engineer and Society	M		M	L	M	M
PO9	Ethics			M	M	M	M
PO10	Environment and Sustainability	L		M		L	L
PO11	Project Management and Finance	L				L	L
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Geotechnical	M	M	H	H	H	H

	Engineering discipline						
PSO2	Critical analysis of Geotechnical Engineering problems and innovation	M	M	H	H	H	H
PSO3	Conceptualization and evaluation of engineering solutions to geotechnical engineering issues	M	M	H	H	H	H

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1. H. G. Poulos. “Marine Geotechnics”, Unwin Hyman Ltd, London, UK, 1988
2. D. V. Reddy and M. Arockiasamy, “Offshore Structures”, *Volume: 1*, R.E. Kreiger Pub and Co., 1991
3. D. Thomson and D. J. Beasley, “Handbook of Marine Geotechnical Engineering”, US Navy, 2012

OPEN ELECTIVE COURSES (OEC)

OE5091 BUSINESS DATA ANALYTICS L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
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Business Data Analytics

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

OE5092 INDUSTRIAL SAFETY LT P C
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING 9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn ,Foundation Engineering Handbook, Chapman & Hall London,2013.
4. Higgins & Morrow , Maintenance Engineering Handbook,Eighth Edition,2008

OE5093 OPERATIONS RESEARCH LT P C
3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method,Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II **9**

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III **9**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS **L T P C**
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS **9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT **9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member,Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL:45 PERIODS

OUTCOMES

CO1 – Understand the costing concepts and their role in decision making
CO2– Understand the project management concepts and their various aspects in selection
CO3– Interpret costing concepts with project execution
CO4– Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE5095 COMPOSITE MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓✓	✓	✓	✓						✓	
CO3			✓	✓	✓		✓				✓	
CO4			✓	✓	✓		✓				✓	
CO5				✓	✓		✓					

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 **WASTE TO ENERGY** **L T P C**
3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNITI INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNITII BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNITV BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓		✓							✓

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX5092 **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS 6
Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES 6
Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS 6
Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6
Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

AX5094 **VALUE EDUCATION** **L T P C**
2 0 0 0

OBJECTIVES

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.

Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

Suggested reading

1. Chakroborty, S.K.“Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

AX5095 **CONSTITUTION OF INDIA** **L T P C**
2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:
District's Administration head: Role and Importance, • Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION:
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:
- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

Suggested reading

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX5096	PEDAGOGY STUDIES	L	T	P	C
		2	0	0	0

OBJECTIVES
Students will be able to:
- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do‘s and Don’t’s in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING

1. ‘Yogic Asanas for Group Tarining-Part-I”:Janardan Swami Yoga bhyasi Mandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses-29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont’s) - Verses-71,73,75,78 (do’s)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

Suggested reading

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari’s Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.