ANNA UNIVERSITY, CHENNAI

NON-AUTONOMOUS AFFILIATED COLLEGES

M.E. SOIL MECHANICS AND FOUNDATION ENGINEERING

REGULATIONS 2021

CHOICE BASED CREDIT SYSTEM

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

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

PEO1 Gain knowledge and skills in Soil Mechanics and Foundation Engineering which will enable them to have a career and professional accomplishment in the public or private sector organizations

PEO2 Become consultants in Soil Mechanics and Foundation Engineering and solve complex real life issues related to analysis, design and maintenance of structures under various environmental conditions.

PEO3 Contribute to the enhancement of knowledge in Soil Mechanics and Foundation Engineering by performing quality research in institutions of international repute or in Research organizations or Academia.

PEO4 Practice their profession with good communication, leadership, ethics and social responsibility and formulate solutions that are technically sound, economically feasible, and socially acceptable.

PEO5 Graduates will function in multi-disciplinary teams and adapt to evolving technologies through life-long learning and innovation

2. PROGRAMME OUTCOMES (POs):

PO #	Programme Outcomes
1	An ability to independently carry out research/investigation and development work to solve practical problems.
2	An ability to write and present a substantial technical report/document
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

3. PROGRAM SPECIFIC OUTCOMES (PSOs):

Graduates of the program M.E. Soil Mechanics and Foundation Engineering will be able to

PSO #	Programme Specific Outcomes	
PSO1	Knowledge of Soil Mechanics and Foundation Engineering discipline	Acquire in-depth knowledge of Soil Mechanics and Foundation Engineering discipline, with an ability to evaluate, analyze and synthesize existing and new knowledge in the structural design.
PSO2	Critical analysis of Soil Mechanics and Foundation Engineering issues and innovation	Critically analyze complex Soil Mechanics and Foundation 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 Design issues	Conceptualize and solve Soil Mechanics and Foundation Engineering problems, evaluate potential solutions and arrive at technically feasible, economically viable and environmentally sound solutions with due consideration of health, safety, and socio cultural factors

MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

		COURSE NAME	PO1	PO2	PO3
YEAR I	SEMESTER I	Advanced Mathematical Methods	1.8	0.8	3
		Properties and Behaviour of Soils	3	3	2
		Strength and Deformation Behaviour of Soils	3	3	2
		Subsurface Investigation and Instrumentation	3	3	2
		Theory of Geomechanics	3	3	2
		Research Methodology and IPR	3	2	2
		Audit course I*	-	-	-
		Advanced Soil Mechanics Laboratory – I	3	3	2
	SEMESTER II	Deep Foundations	3	2	2
		Earth and Earth Retaining Structures	3	2	2
		Ground Improvement Techniques	3	2	2
		Shallow Foundations	3	3	2
		Program Elective I	-	-	-
		Program Elective II	-	-	-
		Audit course II*	-	-	-
		Advanced Soil Mechanics Laboratory – II	3	2	2
YEAR II	SEMESTER III	Program Elective III	-	-	-
		Program Elective IV	-	-	-
		Program Elective V	-	-	-
		Open Elective	-	-	-
		Design Studio	3	2	2
		Practical Training (2 weeks)	3	2	2
		Project Work I	-	-	-
	SEMESTER IV	Project Work II	-	-	-

PROFESSIONAL ELECTIVE COURSES [PEC]

S. NO.	COURSE TITLE	PO1	PO2	PO3
1.	Environmental Geotechnology	3	2	2
2.	Geology for Geotechnical Applications	3	2	2
3.	Finite Element Method in Geotechnical Engineering	3	2	2
4.	Soil Structure Interaction	3	2	2
5.	Mechanics Of Unsaturated Soils	3	2	2
6.	Dynamics of Soils and Foundations	3	3	2
7.	Geotechnical Earthquake Engineering	3	3	2
8.	Earthquake Resistant Design of Foundations	3	2	2
9	Rock Mechanics and Applications	3	2	2
10.	Earth and Rock Fill Dams	3	2	2
11.	Geotechnics for Underground Structures	3	2	2
12.	Geosynthetics and Reinforced Soil Structures	3	2	2
13.	Marine Geotechniques	3	2	2
14.	Pavement Engineering	3	2	2

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M.E. SOIL MECHANICS AND FOUNDATION ENGINEERING
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CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABUS
SEMESTER I

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4153	Advanced Mathematical Methods	FC	4	0	0	4	4
2.	SF4101	Properties and Behaviour of Soils	PCC	3	0	0	3	3
3.	SF4102	Strength and Deformation Behaviour of Soils	PCC	3	0	0	3	3
4.	SF4103	Subsurface Investigation and Instrumentation	PCC	3	0	0	3	3
5.	SF4104	Theory of Geomechanics	PCC	4	0	0	4	4
6.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
7.		Audit course I*	AC	2	0	0	2	0
PRACTICALS								
8.	SF4111	Advanced Soil Mechanics Laboratory – I	PCC	0	0	4	4	2
			TOTAL	**21**	**0**	**4**	**25**	**21**

*** Audit Course is Optional**

SEMESTER II

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	SF4201	Deep Foundations	PCC	3	0	0	3	3
2.	SF4202	Earth and Earth Retaining Structures	PCC	3	0	0	3	3
3.	SF4203	Ground Improvement Techniques	PCC	3	0	0	3	3
4.	SF4204	Shallow Foundations	PCC	3	0	0	3	3
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
7.		Audit course II*	AC	2	0	0	2	0
PRACTICALS								
8.	SF4211	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	COURSETITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective III	PEC	3	0	0	3	3
2.		Professional Elective IV	PEC	3	0	0	3	3
3.		Professional Elective V	PEC	3	0	0	3	3
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	SF4311	Design Studio	PCC	0	0	4	4	2
6.	SF4312	Practical Training (2 weeks)	EEC	0	0	0	0	1
7.	SF4313	Project Work I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**16**	**28**	**21**

SEMESTER IV

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	SF4411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS: 74

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4153	Advanced Mathematical Methods	3	1	0	4	1

PROFESSIONAL CORE COURSES (PCC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	SF4101	Properties and Behaviour of Soils	3	0	0	3	1
2.	SF4102	Strength and Deformation Behaviour of Soils	3	0	0	3	1
3.	SF4103	Subsurface Investigation and Instrumentation	3	0	0	3	1
4.	SF4104	Theory of Geomechanics	4	0	0	4	1
5.	SF4111	Advanced Soil Mechanics Laboratory - I	0	0	4	2	1
6.	SF4201	Deep Foundations	3	0	0	3	2
7.	SF4202	Earth and Earth Retaining Structures	3	0	0	3	2
8.	SF4203	Ground Improvement Techniques	3	0	0	3	2
9.	SF4204	Shallow Foundations	3	0	0	3	2
10.	SF4211	Advanced Soil Mechanics Laboratory - II	0	0	4	2	3
11.	SF4311	Design Studio	0	0	4	2	3
					TOTAL CREDITS	**31**	

LIST OF PROFESSIONAL ELECTIVE COURSES [PEC]

SEMESTER II, ELECTIVE I

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	SF4001	Environmental Geotechnology	3	0	0	3	3
2.	SF4002	Geology for Geotechnical Applications	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	SF4003	Finite Element Method in Geotechnical Engineering	3	0	0	3	3
2.	SF4004	Soil Structure Interaction	3	0	0	3	3
3.	SF4005	Mechanics of Unsaturated Soils	3	0	0	3	3

SEMESTER III, ELECTIVE III

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	SF4006	Dynamics of Soils and Foundations	3	0	0	3	3
2.	SF4007	Geotechnical Earthquake Engineering	3	0	0	3	3
3.	SF4008	Earthquake Resistant Design of Foundations	3	0	0	3	3

SEMESTER III, ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	SF4009	Rock Mechanics and Applications	3	0	0	3	3
2.	SF4010	Earth and Rock Fill Dams	3	0	0	3	3
3.	SF4011	Geotechnics for Underground Structures	3	0	0	3	3

SEMESTER III, ELECTIVE V

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	SF4012	Geosynthetics and Reinforced Soil Structures	3	0	0	3	3
2.	SF4013	Marine Geotechniques	3	0	0	3	3
3.	SF4014	Pavement Engineering	3	0	0	3	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1
TOTAL CREDITS						**2**	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	SF4312	Practical Training (4 Weeks)	0	0	0	2	3
2.	SF4313	Project Work I	0	0	12	6	3
3.	SF4411	Project Work II	0	0	24	12	4
TOTAL CREDITS						**20**	

AUDIT COURSES (AC)
Registration for any of these courses is optional to students

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AX4091	English for Research Paper Writing	2	0	0	0	**1/2**
2.	AX4092	Disaster Management	2	0	0	0	
3.	AX4093	Constitution of India	2	0	0	0	
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0	

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OIC431	Blockchain Technologies	3	0	0	3
2.	OIC432	Deep Learning	3	0	0	3
3.	OME431	Vibration and Noise Control Strategies	3	0	0	3
4.	OME432	Energy Conservation and Management in Domestic Sectors	3	0	0	3
5.	OME433	Additive Manufacturing	3	0	0	3
6.	OME434	Electric Vehicle Technology	3	0	0	3
7.	OME435	New Product Development	3	0	0	3
8.	OBA431	Sustainable Management	3	0	0	3
9.	OBA432	Micro and Small Business Management	3	0	0	3
10.	OBA433	Intellectual Property Rights	3	0	0	3
11.	OBA434	Ethical Management	3	0	0	3
12.	ET4251	IoT for Smart Systems	3	0	0	3
13.	ET4072	Machine Learning and Deep Learning	3	0	0	3
14.	PX4012	Renewable Energy Technology	3	0	0	3
15.	PS4093	Smart Grid	3	0	0	3
16.	CP4391	Security Practices	3	0	0	3
17.	MP4251	Cloud Computing Technologies	3	0	0	3
18.	IF4072	Design Thinking	3	0	0	3
19.	MU4153	Principles of Multimedia	3	0	0	3
20.	DS4015	Big Data Analytics	3	0	0	3
21.	NC4201	Internet of Things and Cloud	3	0	0	3
22.	MX4073	Medical Robotics	3	0	0	3
23.	VE4202	Embedded Automation	3	0	0	3
24.	CX4016	Environmental Sustainability	3	0	0	3
25.	TX4092	Textile Reinforced Composites	3	0	0	3
26.	NT4002	Nanocomposite Materials	3	0	0	3
27.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

SUMMARY

Name of the Programme: M.E SOIL MECHANICS AND FOUNDATION ENGINEERING						
SL. 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	00	06	09	00	15
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	
	TOTAL CREDIT	**21**	**20**	**21**	**12**	**74**

MA4153 ADVANCED MATHEMATICAL METHODS

L	T	P	C
4	0	0	4

OBJECTIVES *:*

- The main objective of this course is to provide the student with a repertoire of mathematical methods that are essential to the solution of advanced problems encountered in the fields of applied physics and engineering. This course covers a broad spectrum of mathematical techniques such as Laplace Transform, Fourier Transform, Calculus of Variations, Conformal Mapping and Tensor Analysis. Application of these topics to the solution of problems in physics and engineering is stressed.

UNIT I LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Laplace transform : Definitions – Properties – Transform 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 Poisson's equations.

UNIT III CALCULUS OF VARIATIONS 12

Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems – 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 completion of the course, the student is expected to be able to

CO1	Application of Laplace and Fourier transforms to the initial value, initial–boundary value and boundary value problems in Partial Differential Equations.
CO2	Maximizing and minimizing the functions that occur in various branches of Engineering Disciplines.
CO3	Construct conformal mappings between various domains and use conformal mapping in studying problems in physics and engineering, particularly fluid flow and heat flow problems.
CO4	Understand tensor algebra and its applications in applied sciences and engineering and develops the ability to solve mathematical problems involving tensors.
CO5	Competently use tensor analysis as a tool in the field of applied sciences and related fields.

REFERENCES :

1. Andrews L.C. and Shivamoggi, B., "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. Elsgolc, L.D., "Calculus of Variations", Dover Publications Inc., New York, 2007.
3. Mathews, J. H., and Howell, R.W., "Complex Analysis for Mathematics and Engineering", 6th Edition, Jones and Bartlett Publishers, 2011.
4. Kay, D. C., "Tensor Calculus", Schaum's Outline Series, Tata McGraw Hill Edition, 2014.
5. Naveen Kumar, "An Elementary Course on Variational Problems in Calculus ", Narosa Publishing House, 2005.
6. Saff, E.B and Snider, A.D, "Fundamentals of Complex Analysis with Applications in Engineering, Science and Mathematics", 3rd Edition, Pearson Education, New Delhi, 2014.
7. Sankara Rao, K., "Introduction to Partial Differential Equations", 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
8. Spiegel, M.R., "Theory and Problems of Complex Variables and its Applications", Schaum's Outline Series, McGraw Hill Book Co., 1981.
9. Ramaniah. G. "Tensor Analysis", S. Viswanathan Pvt. Ltd., 1990.

COs- PO's & PSO's MAPPING

	PO01	PO02	PO03	PO04	PO05	PO06
CO1	1	-	3	-	-	-
CO2	2	1	3	-	-	-
CO3	2	1	3	-	-	-
CO4	2	1	3	-	-	-
CO5	2	1	3	-	-	-
Avg.	**1.8**	**0.8**	**3**	**-**	**-**	**-**

SF4101 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 ORIGIN OF SOILS 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 SWELL - SHRINK AND COMPACTION BEHAVIOUR OF SOILS 10

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

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

Engineering properties - Compressibility, shear strength and permeability behaviour of fine and coarse grained soils – mechanisms and factors influencing engineering properties – basics of 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 of soil based on index properties
CO2	understanding of the clay mineralogy and its intricacies and consequences.
CO3	Understand the volume change with response to compaction and seasonal moisture variations.
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

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
6. Grim, R.E., Applied Clay Mineralogy, McGraw Hill, New York, 1966.
7. Lambe, T.W. and Whitman, R.V. Soil Mechanics, John Wiley & Sons, New York, 1979.
8. Das, B.M.,Principles of Geotechnical Engg, PWS Publishing Comp, Boston, 1998
9. McCarthy D.F., Essentials of Soil Mechanics & Foundations, Prentice-Hall, 2002.
10. Robert D. Holtz and William D. Kovacs, “An Introducion to Geotechnical Engineering”, Prentice Hall (UK) International, London, 1981.
11. Gopal Ranjan and A.S.R Rao, ‘Basic and Applied Soil Mechanics’, New Age International (P) Limited, New Delhi, 2000.
12. Knappett J.A. and R.F. Craig, ‘Craig’s Soil Mechanics’, Span Press, 711 Third Avenue, New York, NY 10017, 2012

COs- PO’s & PSO’s MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	2	1
2	3	3	3	3	-	-
3	3	3	2	3	2	2
4	3	3	2	-	3	2
5	3	3	2	3	2	2

SF4102 STRENGTH AND DEFORMATION 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.

REFERENCES:

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2. Braja, M, Das., "Advanced soil mechanics", CRC Press, fifth edition, 2019.
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4. Lambe, T.W. and Whitman R.V. "Soil Mechanics in S.I. Units John Wiley, India, PvtLtd. 2008.
5. Wood, D.M., "Soil behaviour and Critical State Soil Mechanics", Cambridge University Press, New York, 1990.

6. Graham Barnes, "Soil Mechanics Principles and Practices", Macmillan Press Ltd., London, 2002.
7. Braja, M. Das, "Principles of Geotechnical Engineering", Brooks/Cole, Thomson Learning Academic Resource, Center, Fifth Edition, 2002.
8. Malcolm D. Bolton, "A guide to soil mechanics", Universities Press (India) Private Ltd., Hyderabad, India, 2003.
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10. Braja, M. Das, "Fundamentals of Geotechnical Engineering", Brooks/Cole, Thomson Learning Academic Resource, Center, 2000.
11. Muni Budhu, Soil Mechanics and Foundations, John Wiley and Sons, Inc., third edition, 2011.
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COs- PO’s & PSO’s MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	2	1
2	3	2	2	3	2	1
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SF4103 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 of exploration program - methods of exploration - exploration for preliminary and detailed design, spacing and depth of bores, data presentation. - Geophysical exploration and interpretation - reflection, refraction and resistivity: Spectral analysis of surface waves (SASW), Multichannel Analysis of Surface Waves *(*MASW*),* 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

REFERENCES:

1. Hunt, R.E., Geotechnical Engineering Investigation Manual, McGraw Hill,1984.
2. Winterkorn, H.F. and Fang, H.Y., Foundation Engineering Hand Book, a Nostrand Reinhold 1994.
3. Alam Singh and Chowdhary, G.R., Soil Engineering in Theory and Practice, Volume-2, Geotechnical testing and instrumentation, CBS Publishers and Distributors, New Delhi, 2006.
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5. Dunnicliff, J., and Green, G.E., Geotechnical Instrumentation for Monitoring Field Performance, John Wiley, 1993.
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COs- PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
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SF4104 **THEORY OF 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

REFERENCES:

1. Aysen, A., Problem solving in Soil Mechanics, Taylor & Francis, London, First Indian Print, 2011.
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RM4151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

UNIT I RESEARCH DESIGN 6

Overview of the research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentations.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of the concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS 6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL:30 PERIODS

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1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 12e (2018).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2012.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", December 2018.

SF4111 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; Expanding volume 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.

REFERENCES:

1. Alam Singh and Chowdary, G.R., Soil Engineering in Theory and Practice (Vol.2) Geotechnical Testing and Instrumentation, CBS Publishers and Distributors,NewDelhi,2006.
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3. Head, K.H., Manual of Soil Laboratory Testing Vol.III, Second Edition, John Wiley &Sons, 1998.
4. Bowles, J.E., Engineering properties of soils and their measurements, McGraw Hill, 1992.

5. Das, B.M., Soil Mechanics Laboratory Manual, Engineering Press, Austin, 1997
6. Al-Khataji, A.W. and Anderstand, O.B., Geotechnical Engineering & Soil Testing, Sounders College Publishing, Fort Worth, 1992.
7. "Soil Engineering Laboratory Instruction Manual", Published by the Engineering College Cooperative Society, Chennai, 1996.
8. Lambe T.W., Soil Testing for Engineers", John Wiley and Sons, New York, 1990.
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10. SP : 36 (Part 2) – 1987, 'Compendium of Indian Standards on Soil Engineering', Bureau of Indian Standards, New Delhi.
11. I.S. Code of Practice (2720): Relevant Parts, as amended from time to time.

COs- PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	3	2	3	2	3
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SF4201 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 – 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 and API 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.

UNIT V CAISSONS 6

Necessity of caisson – type and shape - Stability of caissons – principles of analysis and design – tilting of caisson – construction - IS codal provision - IRC guide lines.

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.

REFERENCES:

1. Das, B.M., Principles of Foundation Engineering, Design and Construction, Fourth Edition, PWS Publishing, 1999.
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3. Tomlinson, M.J. Foundation engineering, ELBS, Longman Group, U.K. Ltd., England 1995.
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7. Donald, P., Coduto, Foundation Design Principles and Practices, Prentice Hall, Inc. Englewood Cliffs, New Jersey, 1996.
8. Varghese P.C.," Foundation Engineering", PHI Learning Private Limited, New Delhi, 2005.
9. Reese,L.C., Isenhower,W.M. and Wang,S.T. Analysis and Design of Shallow and Deep Foundations, John Wiley and Sons, New York, 2005.
10. Varghese P.C.," Design of Reinforced Concrete Foundations", PHI Learning Private Limited, New Delhi, 2009.
11. Reese, L. C. and Van Impe, W. F., Single Piles and Pile Groups Under Lateral Loading, Taylor and Francis, London, 2011.

COs- PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
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5	3	3	2	3	2	2

SF4202 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.

REFERENCES:

1. Clayton, C.R.I., Militisky, J. and Woods, R.I., Earth pressure and Earth-Retaining structures, Second Edition, Survey University Press, 1993.
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COs- PO's & PSO's MAPPING

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5	3	3	2	3	2	2

SF4203 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 column – 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

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
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SF4204 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

Types of foundation – Types of Shallow foundation, their applicability – Selection of type of foundation – conceptual design principles – General and additional considerations – Depth of foundations – IS codal provisions.

UNIT II BEARING CAPACITY 9

Theories of bearing capacity – Ultimate and Safe Bearing capacities in Homogeneous - Layered soilsand Rocks - Evaluation of bearing capacity from in-situ tests– Bearing capacity of foundations in slopes – 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. 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 – Elastic half space approach - Winkler foundation – Structural design of Shallow foundation – Codal provisions.

UNIT V FOUNDATION FOR SPECIAL CONDITIONS 9

Foundation design in relation to ground movements - Foundation on compressible fills, expansive soils – Foundation for tower – special considerations for foundation for seismic zones and offshore environment. - Codal Provisions.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Differentiate various 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

REFERENCES:

1. Bowles, J.E., "Foundation Analysis and Design, 5th Edition, McGraw Hill, New York, 1995.
2. Swami Saran, "Soil Dynamics and Machine Foundation, Galgottia Publications Pvt. Ltd., New Delhi-110002, 1999.
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15. Varghese, P.C. "Design of Reinforced Concrete Foundations”, Prentice-Hall of India, New Delhi, 2009.

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SF4211 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 - Cyclic triaxial 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 strength index – Brazilian test – Direct shear test – Uniaxial compressive strength test – dispersibility test.

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

Model test on foundation elements – measurement of strains and deflections - Field tests - Plate load test – static cone penetration test – standard penetration test – pressure meter test - Block vibration 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

REFERENCES:

1. Alam Singh and Chowdary, G.R., Soil Engineering in Theory and Practice (Vol.2) Geotechnical Testing and Instrumentation, CBS Publishers and Distributors, NewDelhi,2006.
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9. "Soil Engineering Laboratory Instruction Manual", Published by the Engineering College Co-operative Society, Chennai, 1996.
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11. I.S. Code of Practice (2720): Relevant Parts, as amended from time to time.

COs- PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	3	3
2	3	2	2	3	2	3
3	3	3	2	3	2	3
4	1	2	2	2	3	3
5	2	3	2	2	3	2

SF4311 **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.

COs- PO's & PSO's MAPPING

CO	PO			PSO		
	1	2	3	1	2	3
1	3	2	2	3	3	3
2	3	2	2	3	2	3
3	3	3	2	3	3	2

SF4312 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

Articulation Matrix

CO	PO			PSO		
	1	2	3	1	2	3
1	3	2	2	3	2	2
2	3	2	2	3	2	2
3	2	2	2	3	2	2
4	3	2	2	2	3	2

SF4313 PROJECT WORK 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.

TOTA: 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.

CO-PO-PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	2	2
2	3	2	2	2	2	2
3	2	2	2	2	3	2
4	2	3	2	2	2	2

SF4411 **PROJECT WORK 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.

CO-PO-PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	3	3	3	3	2
2	3	2	3	3	3	2
3	3	3	3	3	3	2
4	2	3	2	3	3	2

ANNA UNIVERSITY
PROGRESS THROUGH KNOWLEDGE

PROFESSIONAL ELECTIVE COURSES

SF4001 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- Environmental laws and regulations

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.

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.

REFERENCES:

1. Daniel B.E, Geotechnical Practice for waste disposal, Chapman & Hall, London, 1993.
2. Hari D. Sharma and Krishna R.Reddy, Geo-Environmental Engineering – John Wiley and Sons, INC, USA, 2004.
3. Westlake, K., Landfill Waste pollution and Control, Albion Publishing Ltd., England, 1995.

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6. Ott, W.R., Environmental Indices, Theory and Practice, Ann Arbor, 1978.
7. Fried, J.J., Ground Water Pollution, Elsevier, 1975.
8. ASTM Special Tech. Publication 874, Hydraulic Barrier in Soil and Rock, 1985.
9. Lagrega, M.d., Buckingham, P.L., and Evans, J.C., Hazardous Waste Management, McGraw Hill, Inc. Singapore, 1994.

Articulation Matrix

CO	PO			PSO		
	1	2	3	1	2	3
1	3	2	2	3	2	1
2	3	2	3	3	2	1
3	3	3	2	3	2	2
4	3	2	3	2	2	2
5	3	2	2	1	2	1

SF4002 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

OUTCOMES:

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
CO5	Analyse the slopes and decide the suitable methods for improving slope stability and manage unstable slopes efficiently.

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
3. Krynine and Judd, Principles of Engineering Geology and Geotechnics, CBS Publishers and Distributors Pvt ltd., ebook edition, 2008.
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5. Sathya Narayanaswami Engineering Geology, Dhanpat Raj and Co.1710, NaiSarak, Delhi, 2000.
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Articulation Matrix

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	2	3
2	3	2	2	3	2	2
3	3	3	2	3	1	2
4	2	2	2	3	2	1
5	2	3	1	2	2	2

SF4003 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

OUTCOMES:

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

REFERENCES:

1. Cook, R.D., Malkus, D.S., and Plesha, M.E., Concepts and applications of finite element analysis, John Wiley, New York., 1989.
2. Krishnamoorthy.C.S., Finite element analysis Theory and Programming, Tata McGraw-Hill, New Delhi, 1990.
3. Naylor, Pande, Finite elements in geotechnical engineering, Simpson and Tabb., Pineridge Press Ltd, Swansea, U. K, 1981.
4. Zienkiewicz, O.C., The Finite Element Method, 3rd Edition, Tata McGraw-Hill publishing Co., New Delhi, 1983.
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8. Potts. D. M. and Zdravkovic, L., Finite Element Analysis in GeotechnicalEngineering: Application, Thomas Telford, London, 2001.
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Articulation Matrix

CO	PO			PSO		
	1	2	3	1	2	3
1	3	2	2	3	2	3
2	3	2	2	3	2	3
3	3	3	2	2	2	2
4	2	2	2	2	2	2
5	3	3	2	3	2	3

SF4004 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
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.
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3. Hemsley, J.A, "Elastic Analysis of Raft Foundations", Thomas Telford, 1998.
4. Poulos, H.G., and Davis, E.H., "Pile Foundation Analysis and Design", John Wiley, 1980.
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Articulation Matrix

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	2	1
2	3	2	2	3	2	1
3	3	2	1	3	2	2
4	3	2	1	3	2	2
5	2	3	2	3	1	2

SF4005 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

OUTCOMES:

- 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.
2. Ning Lu and William, J. Likes, Unsaturated Soil Mechanics, John Wiley & sons, INC. New Jersey, 2004
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5. Jean- Louis Briaud., Geotechnical Engineering: Unsaturated and Saturated soils, John Wiley & Sons, INC, New Jersey, 2013.

Articulation Matrix

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	2	2
2	3	3	2	3	2	3
3	3	2	3	2	1	2
4	3	2	2	2	1	2
5	2	3	3	3	2	3

SF4006 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

OUTCOMES:

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.
2. Moore, P.J., "Analysis & Design of Foundations for Vibrations", Oxford & IBH, 2006.
3. Krammer S.L., "Geotechnical Earthquake Engineering", Prentice hall, International Series, Pearson Education (Singapore) Pvt. Ltd., 2004.
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Articulation Matrix

CO	PO			PSO		
	1	2	3	1	2	3
1	3	2	2	3	2	2
2	3	3	2	3	2	2
3	3	3	3	3	1	3
4	3	3	2	3	1	2
5	3	3	3	3	2	3

SF4007 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 – Earth pressure due to ground shaking – Dynamic analysis.

TOTAL: 45 PERIODS

OUTCOMES:

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.
3. Kameswara Rao, Vibration Analysis and Foundation Dynamics, Wheeler Publishing, New Delhi, 1998.
4. Wai-Fah Chen and CgharlesScawthem, Earthquake Engineering Hand book, Caspress,2003.
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Articulation Matrix

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
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2	3	3	2	3	2	2
3	2	3	1	3	2	2
4	2	2	1	2	1	1
5	3	3	2	2	2	1

SF4008 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 – mechanisms and failure theories 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 ~~– essential~~ criteria for design of foundations in liquefiable soils – structural design of foundations subjected to earthquake loading.

TOTAL: 45 PERIODS

OUTCOMES:

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

REFERENCES:

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.
5. Terzaghi and Peck, R. B, Soil Mechanics in Engineering Practice, John Wiley & Sons, New York, 1967.
6. Poulos H.G. and Davis E.H., Pile foundation analysis and design, John Wiley and Sons, 1980.
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9. Steven L. Kramer, Geotechnical Earthquake Engineering, Prentice Hall, New Delhi, 1996.
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Articulation Matrix

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2	3	2	1	3	2	3
3	3	2	3	3	2	2
4	3	2	1	3	2	2
5	3	2	3	3	2	3

SF4009 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

OUTCOMES:

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.

REFERENCES:

1. Goodman, R.E., Introduction to rock mechanics, John Willey and Sons, 1989.
2. Hudson, A. and Harrison, P., Engineering Rock mechanics – An introduction to the principles, Pergamon publications, 1997.
3. Hoek, E and Bray, J., Rock slope Engineering, Institute of Mining and Metallurgy, U.K. 1981.
4. Hoek, E and Brown, E.T., Underground Excavations in Rock, Institute of Mining and Metallurgy, U.K. 1981.
5. Obvert, L. and Duvall, W., Rock Mechanics and the Design of structures in Rock, John Wiley, 1967.

6. Bazant, Z.P., Mechanics of Geomaterials Rocks, Concrete and Soil, John Wiley and Sons, Chichester, 1985.
7. Wittke, W., Rock Mechanics. Theory and Applications with case Histories, Springerverlag, Berlin, 1990.
8. 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.

Articulation Matrix

CO	PO			PSO		
	1	2	3	1	2	3
1	3	2	2	3	2	2
2	3	2	1	3	2	2
3	3	2	2	3	1	3
4	3	2	1	3	2	3
5	3	2	3	3	1	3

SF4010 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

OUTCOMES:

- 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

REFERENCES:

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.
3. Sherard, J.L., Woodward, R.J., Gizienski, R.J. and Clevenger, W.A., Earth and Earth rock dam, John Wiley, 1963.
4. Chowdhury, D.F., Slope analysis, Prentice Hall, 1988.
5. McCarthy, D.F., Essentials of Soil Mechanics and Foundations: Basic Geotechnics,Sixth Edition, Prentice Hall, 2002.
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7. Chandhar, R.J., Engineering Developments and Applications, Thomas Telford, 1991
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9. Jun-Jie Wang, Hydraulic Fracturing in Earth-rock Fill Dams, John Wiley & Sons, 2014.

Articulation Matrix

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	2	2
2	3	3	1	3	2	1
3	3	2	1	2	2	2
4	3	3	1	2	1	2
5	3	2	3	3	2	1

SF4011 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

OUTCOMES:

- 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
CO5	Protect the adjacent building due to underground construction using various methods.

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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5. Hausman, M. R., Engineering Principles of Ground Modification, McGraw – Hill Publishing Company, New York, 1990.
6. Bowles, J. E. Foundation Analysis and Design, 4th Ed. McGraw – Hill Book Company, New York, USA, 1988.
7. Hoek, E., Brown, E.T., Underground excavations in rock, The Institution of Mining and Metallurgy, London, SW7 2BP, England, 1980.
8. Goel, R.K. and Dwivedi, R.D., A Short-Term course on Underground Engineering, Central Institute of Mining and Fuel Research Regional Centre, Roorkee, 2010.
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10. Kolymbas, D., Tunnelling and tunnel mechanics: A rational approach to tunnelling, 2nd corrected printing © 2008, Springer – Verlag Berlin Heidelberg, Italy, 2005.
11. Lunardi, P., Design and construction of tunnels, Springer – Verlag Berlin Heidelberg, Italy, 2008.
12. John Burland, Tim Chapman, Hilary Skinner and Michael Brown, ICE manual of geotechnical engineering, Volume II, ICE publication, Londan, U.K, 2012.

Articulation Matrix

CO	PSO			PSO		
	1	2	3	1	2	3
1	3	2	2	3	2	2
2	3	1	2	3	1	2
3	3	3	3	3	2	1
4	3	2	1	3	1	1
5	3	3	3	3	3	2

SF4012 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 – 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 REINFORCED SLOPES 9

Type and orientation of Geosynthetics – Function of reinforcement against slope failure – Stability analysis – Design aspects – Embankments – Basal reinforcement – seismic aspects - General construction aspects.

TOTAL : 45 PERIODS

OUTCOMES:

- 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
CO5	Analyze and design reinforced slopes for static and seismic loading.

REFERENCES:

1. Jewell, R.A., Soil Reinforcement with Geotextile, CIRIA, London, 1996.
2. Jones, C.J.F.P., Earth Reinforcement and Soil Structures, Earthworks, London, 1982.
3. Koerner, R.M., Designing with Geosynthetics, Third Edition, Prentice Hall, 1997.

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10. John Burland, Tim Chapman, Hilary Skinner, Michael Brown., "Geotechnical Design Construction and verification – ICE Manual of Geotechnical Engineering volume-II" ICE Publishing, UK., 2012.

Articulation Matrix

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1	3	2	2	3	2	1
2	3	2	2	3	2	2
3	3	1	2	3	1	1
4	3	2	2	3	1	2
5	3	1	3	3	2	1

SF4013 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

Marine environment, Physical and engineering properties of marine soils - Specific problems related to marine soil deposits.

UNIT III BEHAVIOR OF SOILS SUBJECTED TO REPEATED LOADING 9

Effect of wave loading on foundations of marine structures, Behavior of marine deposits under cyclic loading, Cyclic behavior of soils based on fundamental theory of mechanics, Approximate engineering methods

UNIT II 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

REFERENCES:

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

Articulation Matrix

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1	3	2	2	3	2	2
2	3	2	1	3	3	2
3	3	2	2	2	2	2
4	3	2	1	3	2	3
5	3	2	3	2	3	3

SF4014 **PAVEMENT ENGINEERING** **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
CO5	Select suitable stabilizers based on mechanism and requirements for construction with quality control in the field.

REFERENCES:

1. Wright, P.H., Highway Engineers, John Wiley & Sons, Inc., New York, 1996.
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4. Croney, D., Design and Performance of Road Pavements, HMO Stationary Office, 1979.
5. Design and Specification of Rural Roads (Manual), Ministry of rural roads, Government of India, New Delhi, 2001.
6. Guidelines for the Design of Flexible Pavements, IRC:37 - 2001, The Indian roads Congress, New Delhi.
7. Guideline for the Design of Rigid Pavements for Highways, IRC:58-1998, The Indian Roads Congress, New Delhi.
8. O' Flaherty, C.A., Highways – The location, Design, Construction & Maintenance of Pavements, Fourth Edition, Elsevier, 2006.
9. Bell. P.S., Developments in Highway Engineering, Applied Sciences publishers, 1978.

Articulation Matrix

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4	3	2	2	2	1	2
5	3	3	2	3	2	1

AUDIT COURSES

AX4091 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

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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.

AX4092 **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

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.

AX4093 **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:Roleof 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

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

AX4094	நற்றமிழ் இலக்கியம்	L T P C 2 0 0 0

UNIT I சங்க இலக்கியம் 6

1. தமிழின்துவக்கநூல்தொல்காப்பியம்
   – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கைஇன்னிசைஅரங்கம்
3. குறிஞ்சிப்பாட்டின்மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரைநிறுத்தியஔவையார்

UNIT II அறநெறித்தமிழ் 6

1. அறநெறிவகுத்ததிருவள்ளுவர்
   - அறம்வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்
2. பிறஅறநூல்கள்- இலக்கியமருந்து
   – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை
   (தூய்மையைவலியுறுத்தும்நூல்)

UNIT III இரட்டைக்காப்பியங்கள் 6

1.கண்ணகியின்புரட்சி
- சிலப்பதிகாரவழக்குரைகாதை
  சமூகசேவைஇலக்கியம்மணிமேகலை
  - சிறைக்கோட்டம்அறக்கோட்டமாகியகாதை

UNIT IV அருள்நெறித்தமிழ் 6

1. சிறுபாணாற்றுப்படை
   - பாரிமுல்லைக்குத்தேர்கொடுத்தது,
   பேகன்மயிலுக்குப்போர்வைகொடுத்தது,
   அதியமான்ஔவைக்குநெல்லிக்கனிகொடுத்தது,
   அரசர்பண்புகள்
2. நற்றிணை
   - அன்னைக்குரியபுன்னைசிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம்நியமம்விதிகள்
4. தர்மச்சாலையைநிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனேவள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) -நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்
   ஆகியவை பற்றிய செய்திகள்

UNIT V நவீனதமிழ்இலக்கியம் 6

1. உரைநடைத்தமிழ்,
- தமிழின்முதல்புதினம்,
- தமிழின்முதல்சிறுகதை,
- கட்டுரைஇலக்கியம்,
- பயணஇலக்கியம்,
- நாடகம்.
2. நாட்டுவிடுதலைபோராட்டமும்தமிழ்இலக்கியமும்,
3. சமுதாயவிடுதலையும்தமிழ்இலக்கியமும்,
4. பெண்விடுதலையும்விளிம்புநிலையினரின்மேம்பாட்டில்தமிழ்இலக்கியமும்,
5. அறிவியல்தமிழ்,
6. இணையத்தில்தமிழ்,
7. சுற்றுச்சூழல்மேம்பாட்டில்தமிழ்இலக்கியம்.

TOTAL: 30 PERIODS

<u>தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்</u>

1. தமிழ்இணையகல்விக்கழகம் (Tamil Virtual University)- www.tamilvu.org
2. தமிழ்விக்கிப்பீடியா (Tamil Wikipedia)-https://ta.wikipedia.org
3. தர்மபுரஆதீனவெளியீடு
4. வாழ்வியல்களஞ்சியம் - தமிழ்ப்பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக்களஞ்சியம் - தமிழ்வளர்ச்சித்துறை (thamilvalarchithurai.com)
6. அறிவியல்களஞ்சியம் - தமிழ்ப்பல்கலைக்கழகம், தஞ்சாவூர்

OPEN ELECTIVES

OIC431 BLOCKCHAIN TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

UNIT IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

CO1: Understand and explore the working of Blockchain technology
CO2: Analyze the working of Smart Contracts
CO3: Understand and analyze the working of Hyperledger
CO4: Apply the learning of solidity to build de-centralized apps on Ethereum
CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O’Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

OIC432 **DEEP LEARNING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS **6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS **9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK **10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT IV NATURAL LANGUAGE PROCESSING USING RNN **10**

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING **10**

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data
CO2: Implement Image Segmentation and Instance Segmentation in Images
CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)
CO4: Traffic Information analysis using Twitter Data
CO5: Autoencoder for Classification & Feature Extraction

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

OME431 VIBRATION AND NOISE CONTROL STRATEGIES L T P C
3 0 0 3

OBJECTIVES

- To appreciate the basic concepts of vibration in damped and undamped systems
- To appreciate the basic concepts of noise, its effect on hearing and related terminology
- To use the instruments for measuring and analyzing the vibration levels in a body
- To use the instruments for measuring and analyzing the noise levels in a system
- To learn the standards of vibration and noise levels and their control techniques

UNIT I BASICS OF VIBRATION 9

Introduction – Sources and causes of Vibration-Mathematical Models - Displacement, velocity and Acceleration - Classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear vibration - Single Degree Freedom Systems - Vibration isolation - Determination of natural frequencies

UNIT II BASICS OF NOISE 9

Introduction - Anatomy of human ear - Mechanism of hearing - Amplitude, frequency, wavelength and sound pressure level - Relationship between sound power, sound intensity and sound pressure level - Addition, subtraction and averaging decibel levels - sound spectra -Types of sound fields - Octave band analysis - Loudness.

UNIT III INSTRUMENTATION FOR VIBRATION MEASUREMENT 9

Experimental Methods in Vibration Analysis.- Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings - Vibration Exciters - Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments -. System Identification from Frequency Response -Testing for resonance and mode shapes

UNIT IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS 9

Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters - Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

UNIT V METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL 9

Specification of Vibration Limits – Vibration severity standards - Vibration as condition Monitoring Tool – Case Studies - Vibration Isolation methods - Dynamic Vibration Absorber – Need for Balancing - Static and Dynamic Balancing machines – Field balancing - Major sources of noise - Noise survey techniques – Measurement technique for vehicular noise - Road vehicles Noise standard – Noise due to construction equipment and domestic appliances – Industrial noise sources and its strategies – Noise control at the source – Noise control along the path – Acoustic Barriers – Noise control at the receiver -- Sound transmission through barriers – Noise reduction Vs Transmission loss - Enclosures

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.
5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

REFERENCES:

1. Singiresu S. Rao, “Mechanical Vibrations”, Pearson Education Incorporated, 2017.
2. Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd., 2007.

3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2000.
4. William T. Thomson, “Theory of Vibration with Applications”, Taylor & Francis, 2003.
5. G.K. Grover, “Mechanical Vibrations”, Nem Chand and Bros.,Roorkee, 2014.
6. A.G. Ambekar, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., 2014.
7. David A. Bies and Colin H. Hansen, “Engineering Noise Control – Theory and Practice”, Spon Press, London and New York, 2009.

OME432 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To learn the present energy scenario and the need for energy conservation.
- To understand the different measures for energy conservation in utilities.
- Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
- To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
- To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT I ENERGY SCENARIO **9**

Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.

UNIT II HEATING, VENTILLATION & AIR CONDITIONING **9**

Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.

UNIT III LIGHTING, COMPUTER, TV **9**

Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.

UNIT IV ENERGY EFFICIENT BUILDINGS **9**

Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.

UNIT V ENERGY STORAGE TECHNOLOGIES **9**

Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Understand technical aspects of energy conservation scenario.
2. Energy audit in any type for domestic buildings and suggest the conservation measures.
3. Perform building load estimates and design the energy efficient landscape system.
4. Gain knowledge to utilize an appliance/device sustainably.
5. Understand the status and current technological advancement in energy storage field.

REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment

3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001
4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com)
6. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
7. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
8. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

OME433 ADDITIVE MANUFACTURING L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.

UNIT III VAT POLYMERIZATION 9

Stereolithography Apparatus (SLA)- Materials -Process -Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION 9

Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation - Bio-Additive Manufacturing Computer Aided Tissue Engineering (CATE) – Case studies

POWDER BASED PROCESS

Selective Laser Sintering (SLS): Process –Mechanism– Typical Materials and Application- Multi Jet Fusion - Basic Principle-– Materials- Application and Limitation - Three Dimensional Printing - Materials -Process - Benefits and Limitations. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters -Materials - Benefits -Applications.

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES 9

Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

TOTAL: 45 PERIODS

REFERENCES:

1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.

2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590
4. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
5. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

OME434 ELECTRIC VEHICLE TECHNOLOGY L T P C
3 0 0 3

UNIT I NEED FOR ELECTRIC VEHICLES 9

History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges

UNIT II ELECTRIC VEHICLE ARCHITECHTURE 9

Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.

UNIT III ENERGY STORAGE 9

Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell

UNIT IV ELECTRIC DRIVES AND CONTROL 9

Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor -drives and control , AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers

UNIT V DESIGN OF ELECTRIC VEHICLES 9

Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

TOTAL: 45 PERIODS

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained - Wiley, 2003.
4. Ehsani, M, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2005

OME435	NEW PRODUCT DEVELOPMENT	L	T	P	C
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COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.
2. Identfying opportunity and planning for new product design and development.
3. Conducting customer need analysis; and setting product specification for new product design and development.
4. Generating, selecting, and testing the concepts for new product design and development.
5. Appling the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCTDESIGN & DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development – Duration and Cost of Product Development – The Challenges of Product Development – The Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations.

UNIT II OPPORTUNITY DENTIFICATION & PRODUCT PLANNING 9

Opportunity Identification: Definition – Types of Opportunities – Tournament Structure of Opportunity Identification – Effective Opportunity Tournaments – Opportunity Identification Process – Product Planning: Four types of Product Development Projects – The Process of Product Planning.

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

Identifying Customer Needs: The Importance of Latent Needs – The Process of Identifying Customer Needs. Product Specifications: Definition – Time of Specifications Establishment – Establishing Target Specifications – Setting the Final Specifications

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

Concept Generation: Activity of Concept Generation – Structured Approach – Five step method of Concept Generation. Concept Selection: Methodology – Concept Screening and Concepts Scoring. Concept testing: Seven Step activities of concept testing.

UNITV INDUSTRIAL DESIGN & PROTOTYPING 9

Industrial Design: Need and Impact–Industrial Design Process. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Apply the principles of generic development process; and understand the organization structure for new product design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.
4. Generate, select, and test the concepts for new product design and development.
5. Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, “Product Design and Development “McGraw-Hill Education; 7 edition, 2020.

REFERENCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.
2. Rosenthal S.,“Effective Product Design and Development”, Business One Orwin,Homewood, 1992,ISBN1-55623-603-4.

3. Pugh.S,"Total Design Integrated Methods for Successful Product Engineering", Addison Wesley Publishing,1991,ISBN0-202-41639-5.
4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

OBA431 SUSTAINABLE MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY 9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainabilityperformances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II CREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman's stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model. Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1. Familiarise the students with the concept of small business
CO2. In depth knowledge on small business opportunities and challenges
CO3. Ability to devise plans for small business by building the right skills and marketing strategies
CO4. Identify the funding source for small start ups
CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME's.

OBA433 INTELLECTUAL PROPERTY RIGHTS L T P C
3 0 0 3

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS 9

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES 9

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS 9

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Understanding of intellectual property and appreciation of the need to protect it
CO2: Awareness about the process of patenting
CO3: Understanding of the statutes related to IPR
CO4: Ability to apply strategies to protect intellectual property
CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

OBA434 ETHICAL MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVE

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY 9

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS 9

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT 9

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT 9

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Role modelling and influencing the ethical and cultural context.
CO2: Respond to ethical crises and proactively address potential crises situations.
CO3: Understand and implement stakeholder management decisions.
CO4: Develop the ability, knowledge, and skills for ethical management.
CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

ET4251 IoT FOR SMART SYSTEMS LT P C
3 0 0 3

COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE 9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture**,** IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9

PROTOCOLS:

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS 9

Services/Attributes: Big-Data Analytics for IOT, Dependability,Interoperability, Security, Maintainability.

Embedded processors for IOT :Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES 9

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.
CO2: Compare and contrast different platforms and infrastructures available for IoT
CO3: Explain different protocols and communication technologies used in IoT
CO4: Analyze the big data analytic and programming of IoT
CO5: Implement IoT solutions for smart applications

REFERENCES:

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.
9. Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
10. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, “ Smart Grid Technology and Applications”, Wiley, 2015.
13. UpenaDalal,”Wireless Communications & Networks,Oxford,2015.

ET4072 MACHINE LEARNING AND DEEP LEARNING L T P C

3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks

3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS 9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS 9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

PX4012 RENEWABLE ENERGY TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:
To impart knowledge on
- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION 9
Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO_2 Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS 9
Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9
Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9
Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9
Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:
After completion of this course, the student will be able to:
CO1: Demonstrate the need for renewable energy sources.
CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
CO3: Design a stand-alone and Grid connected PV system.
CO4: Analyze the different configurations of the wind energy conversion systems.
CO5: Realize the basic of various available renewable energy sources

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford UniversityPress, 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

PS4093 **SMART GRID** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.
CO2: Explain the function of Smart Grid.
CO3: Experiment the issues of Power Quality in Smart Grid.
CO4: Analyze the performance of Smart Grid.
CO5**:** Recommend suitable communication networks for smart grid applications

REFERENCES

1. Stuart Borlase ‘Smart Grid: Infrastructure, Technology and Solutions’, CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, ‘Smart Grid: Technology and Applications’, Wiley, 2012.
3. Mini S. Thomas, John D McDonald, ‘Power System SCADA and Smart Grids’, CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, ‘Communication Networks for Smart Grids’, Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

CP4391 **SECURITY PRACTICES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY 9

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II NETWORK SECURITY 9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT 9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012

6. Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

MP4251 CLOUD COMPUTING TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization —- Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE 12

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III AWS CLOUD PLATFORM - IAAS 9

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

UNIT IV PAAS CLOUD PLATFORM 9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

UNIT V PROGRAMMING MODEL 9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Employ the concepts of virtualization in the cloud computing
CO2: Identify the architecture, infrastructure and delivery models of cloud computing
CO3: Develop the Cloud Application in AWS platform
CO4: Apply the concepts of Windows Azure to design Cloud Application
CO5: Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing, MCGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest,—Virtualization: A Beginner"s Guidell, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W. Ritting house and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

IF4072 DESIGN THINKING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I UX LIFECYCLE TEMPLATE 8

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

UNIT II CONTEXTUAL INQUIRY 10

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING 9

Design-informing models: second span of the bridge . Some general "how to" suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

UNIT IV UX GOALS, METRICS, AND TARGETS 8

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V ANALYSING USER EXPERIENCE 10

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design

Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

SUGGESTED ACTIVITIES:

1: Hands on Design Thinking process for a product
2: Defining the Look and Feel of any new Project
3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
4: Identify a customer problem to solve.
5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Build UI for user Applications
CO2: Use the UI Interaction behaviors and principles
CO3: Evaluate UX design of any product or application
CO4: Demonstrate UX Skills in product development
CO5: Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012
3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153 PRINCIPLES OF MULTIMEDIA

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3	0	0	3

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION **9**

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA 9

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS 9

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS 9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Suggested Activities:

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS 9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

Suggested Activities:

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Handle the multimedia elements effectively.
CO2: Articulate the concepts and techniques used in multimedia applications.
CO3: Develop effective strategies to deliver Quality of Experience in multimedia applications.
CO4: Design and implement algorithms and techniques applied to multimedia objects.
CO5: Design and develop multimedia applications following software engineering models.

REFERENCES:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017

DS4015 BIG DATA ANALYTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

UNIT I INTRODUCTION TO BIG DATA 9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II SEARCH METHODS AND VISUALIZATION 9

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies –Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III MINING DATA STREAMS 9

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV FRAMEWORKS 9

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE 9

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays -Lists -Data frames -Classes, Input/output, String manipulations

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: understand the basics of big data analytics
CO2: Ability to use Hadoop, Map Reduce Framework.
CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.
CO4: gain knowledge on R language
CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

REFERENCE:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

NC4201 INTERNET OF THINGS AND CLOUD L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT 9

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

UNIT II PROTOCOLS FOR IoT 9

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS 9

Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION 9

Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

UNIT V IoT AND CLOUD 9

IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core -Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1: Understand the various concept of the IoT and their technologies..
CO2: Develop IoT application using different hardware platforms
CO3: Implement the various IoT Protocols
CO4: Understand the basic principles of cloud computing.
CO5: Develop and deploy the IoT application into cloud environment

REFERENCES

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley publishers, 2015.
4. Simon Walkowiak, “Big Data Analytics with R” PackT Publishers, 2016
5. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2015.

MX4073 MEDICAL ROBOTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS 9

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

Sensors and Actuators

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS 9

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning

Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS 9

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS 9

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Describe the configuration, applications of robots and the concept of grippers and actuators
CO2: Explain the functions of manipulators and basic kinematics
CO3: Describe the application of robots in various surgeries
CO4: Design and analyze the robotic systems for rehabilitation
CO5: Design the wearable robots

REFERENCES

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008
8. Howie Choset, Kevin Lynch, Seth Hutchinson, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, “An Introduction to Robot Technology”, Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011
11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

VE4202 EMBEDDED AUTOMATION L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

UNIT I INTRODUCTION TO EMBEDDED C PROGRAMMING 9

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT II AVR MICROCONTROLLER 9

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS 9

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT IV VISION SYSTEM 9

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

UNIT V HOME AUTOMATION 9

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor - Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: analyze the 8-bit series microcontroller architecture, features and pin details
CO2: write embedded C programs for embedded system application
CO3: design and develop real time systems using AVR microcontrollers
CO4: design and develop the systems based on vision mechanism
CO5: design and develop a real time home automation system

REFERENCES:

1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.
2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.

CX4016 ENVIRONMENTAL SUSTAINABILITY

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UNIT I INTRODUCTION 9

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

UNIT II CONCEPT OF SUSTAINABILITY 9

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

UNIT III SIGNIFICANCE OF BIODIVERSITY 9

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

UNIT IV POLLUTION IMPACTS 9

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

UNIT V ENVIRONMENTAL ECONOMICS 9

Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

TOTAL : 45 PERIODS

REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

TX4092 TEXTILE REINFORCED COMPOSITES L T P C

3 0 0 3

UNIT I REINFORCEMENTS 9

Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

UNIT II MATRICES 9

Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

UNIT III COMPOSITE MANUFACTURING 9

Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

UNIT IV TESTING 9

Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS 9

Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

TOTAL: 45 PERIODS

REFERENCES

1. BorZ.Jang,“Advanced Polymer composites”,ASM International,USA,1994.
2. Carlsson L.A. and Pipes R.B., “Experimental Characterization of advanced composite Materials”,SecondEdition,CRCPress,NewJersey,1996.
3. George LubinandStanley T.Peters, “Handbook of Composites”, Springer Publications,1998.
4. Mel. M. Schwartz, “Composite Materials”, Vol. 1 &2, Prentice Hall PTR, New Jersey,1997.
5. RichardM.Christensen,“Mechanics of compositematerials”,DoverPublications,2005.
6. Sanjay K. Mazumdar, “Composites Manufacturing: Materials, Product, and Process Engineering”,CRCPress,2001

NT4002 NANOCOMPOSITE MATERIALS L T P C
3 0 0 3

UNIT I BASICS OF NANOCOMPOSITES 9

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES 9

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES 9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL : 45 PERIODS

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

BY4016 IPR, BIOSAFETY AND ENTREPRENEURSHIP L T P C
3 0 0 3

UNIT I IPR 9

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY 9

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS 9

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT 9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS

REFERENCES

1. Bouchoux, D.E., "Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal", 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., "Biological Safety: Principles and Practices", 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., "Intellectual Property Rights for Engineers", 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., "Patent Law", 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., "Genetically Modified Organisms and Biosafety: A Background Paper for Decision- Makers and Others to Assist in Consideration of GMO Issues" 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, "Entrepreneurial Development", S.Chand & Company LTD, New Delhi, 2007.