SYLLABUS M.TECH. (CIVIL ENGINEERING)

(SOIL MECHANICS)

AUTONOMOUS REGULATIONS 2017

(Effective for the batches admitted in 2017-18 onwards)

DEPARTMENT OF CIVIL ENGINEERING

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES (A)

(Affiliated to AU, Approved by AICTE & Accredited by NBA)

SANGIVALASA, Bheemunipatnam Mandal, Visakhapatnam District-531162

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES (AUTONOMOUS)
DEPARTMENT OF CIVIL ENGINEERING

M.TECH. 2 YEAR DEGREE COURSE STRUCTURE

(Effective for the M.Tech. students admitted into first year from the academic year 2017-18)

M.TECH. I Year - I Semester

Code	*Subject*	*Periods*				*Sessional Marks*	*End Exam*	*Total Marks*	*Credits*
		L	*T*	*P*	**Total**				
PCIVSMFE111	Advanced Soil Mechanics	3	1	-	4	40	60	100	4
PCIVSMFE112	Soil Science	3	1	-	4	40	60	100	4
PCIVSMFE113	Advanced Foundation Engineering	3	1	-	4	40	60	100	4
PCIVSMFE114	Earth and Earth Retaining Structures	3	1	-	4	40	60	100	4
PCIVSMFE115	Numerical Methods in Geotechnical Engineering	3	1	-	4	40	60	100	4
PCIVSMFE116	Professional Elective – I (a) Geotechnics of Problematic Soils (b) Pavement Analysis and Design (c) Reliability Analysis	3	1	-	4	40	60	100	4
PCIVSMFE117	Seminar	-	3	-	3	50	50	100	2
PCIVSMFE118	Soil Engineering Lab	-	-	3	3	50	50	100	2
PCIVSMFE119	MOOC*	-	-	-	-	-	-	-	2
Total		**18**	**9**	**3**	**30**	**340**	**460**	**800**	**30**

M.TECH. I Year – II Semester

Code	*Subject*	*Periods*				*Sessional Marks*	*End Exam*	*Total Marks*	*Credits*
		L	*T*	*P*	**Total**				
PCIVSMFE121	Ground Improvement Techniques	3	1	-	4	40	60	100	4
PCIVSMFE122	Geoenvironmental Engineering	3	1	-	4	40	60	100	4
PCIVSMFE123	Geosynthetics and Reinforced Soil Structures	3	1	-	4	40	60	100	4
PCIVSMFE124	Dynamics of Soils and Foundations	3	1	-	4	40	60	100	4
PCIVSMFE125	Rock Mechanics	3	1	-	4	40	60	100	4
PCIVSMFE126	Professional Elective – II (a) Finite Element Methods for Geotechnical Engineering (b) Geotechnics of Underground Structures (c) Marine Sub-Structures	3	1	-	4	40	60	100	4
PCIVSMFE127	Design Project	-	3	-	3	50	50	100	2
PCIVSMFE128	Advanced Geotechnical Engineering Lab	-	-	3	3	50	50	100	2
PCIVSMFE129	MOOC*	-	-	-	-	-	-	-	2
Total		**18**	**9**	**3**	**30**	**340**	**460**	**800**	**30**

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES (AUTONOMOUS)
DEPARTMENT OF CIVIL ENGINEERING

M.TECH. 2 YEAR DEGREE COURSE STRUCTURE

(Effective for the M.Tech. students admitted into first year from the academic year 2016-17)

M.TECH. II Year – I Semester

Code	*Subject*	*Periods / Week*	*Sessional Marks*	*End Exam Marks*	*Total Marks*	*Credits*
PCIVSMFE211	Dissertation (Preliminary)	12	100	-	100	6
Total		**12**	**100**	**-**	**100**	**6**

M.TECH. II Year – II Semester

Code	*Subject*	*Periods / Week*	*Sessional Marks*	*End Exam Marks*	*Total Marks*	*Credits*
PCIVSMFE221	Dissertation (Final)	12	-	100	100	14
Total		**12**	**-**	**100**	**100**	**14**

***** *Massive Open Online Course: Method of evaluation will be decided by a Departmental Committee constituted for this purpose and students are graded accordingly*

The student has to do at least ONE Professional Elective and ONE MOOC course. All Courses are compulsory except one Professional Elective and one MOOC course.

ADVANCED SOIL MECHANICS

PCIVSMFE 111 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective:

The course contents enable the students to know the engineering properties of soils and determine the shear strength of cohesive and granular soils.

Course outcomes:

By the end of the course the students will be able to

1. Know the engineering properties of soils.
2. Understand the shrinkage and consolidation behaviour of soils.
3. Determine the shear strength of cohesive and granular soils.
4. Understand the deformation characteristics of soils.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	3	3	2	3	1	2	2	1	1	2	2	2	3	2	2
	2	3	3	3	2	1	2	2	1	1	2	2	3	3	2	2
	3	3	3	3	2	2	3	3	1	1	2	2	3	3	2	2
	4	3	3	3	2	1	3	3	1	1	2	2	3	3	2	2

SYLLABUS

UNIT – I

Engineering properties of soils: Engineering properties of granular soils, influence of clay phase, Atterberg limits, Activity, influence of exchangeable cations and pH, effects of organic matter.
Principle of effective stress: force distribution in a particulate system, inter particle forces, inter granular pressure. Shrinkage: Factors affecting shrinkage, Formation of cracks, Measurement of shrinkage

UNIT – II

Consolidation: Review of theory of one dimensional consolidation, laboratory consolidation tests, Estimation of total compression, Time and load deformation curves, load increment ratio, Soil structure in consolidation and compression – Sand drains – effect smear zone.

UNIT – III

Yield and failure: Principal Stresses and Principal planes; Mohr Circle of stress & strain; determination of pole - Concept of Yield and failure in soils, Yield criteria, Failure theories, Laboratory triaxial test for strength measurements.
Granular soil strength: Introduction, Friction Properties, Apparent friction Parameters, Sliding and interlocking friction, Laboratory measurement of Granular soil strength, measurement of friction angle, stress and strain, intrinsic friction angle, Volumetric strain.

UNIT – IV

Cohesive soil strength: Analytical and physical strength parameters, Porewater pressure, Components of Pore water pressure for fully saturated soil, Pore pressures in partially saturated clay, Pore water measurements, Skempton's Parameters, Pore pressure coefficients - laboratory determination – Stress Paths for various loading conditions – Undrained shear strength of anisotropic clay.

UNIT – V

Introduction to Critical state soil mechanics: Effect of intermediate principle stress, anisotropy, Resistance to cyclic loading and liquefaction, Strength of mixed soils, Deformation characteristics, Elastic and plastic Deformation.

TEXT BOOKS

1. Mitchell, J. K. (2005), "Fundamentals of Soil Behaviour", John Wiley& sons, New Jersey, 3rd edition.
2. Yong, R. N. and Warkentin, B. P. (1975), "Soil Properties and Behaviour", Elsevier, New York.

REFERENCES

1. Das, B.M. (2008), "Advanced Soil Mechanics", Taylor & Francis, New York, 3rd edition.
2. Terzaghi, K. (1966), "Theoretical Soil Mechanics", John Wiley, New York.
3. Terzaghi, K. (1960), From Theory to Practice in Soil Mechanics. New York, NY: John Wiley and Sons Inc.
4. Davis, R.O. and Selvadurai, A.P.S. (1996), "Elasticity and Geomechanics", Cambridge University Press, Cambridge.
5. Scott, R.F. (1965), "Principles of Soil Mechanics", Addison –Wesley, London.
6. Wood, D.M (2007), "Soil Behaviour and Critical State Soil Mechanics", Cambridge university press, Cambridge.
7. Lambe, T. W. and Whitman, R. V. (2012), "Soil Mechanics-SI version", John Wiley &Sons, New York, 2nd edition.
8. Atkinson, J.H. and Bransby, P.L. (2000), "The mechanics of soils: An introduction to critical state soil mechanics", McGraw-Hill, New York.
9. Budhu, M. (2007), "Soil Mechanics and Foundations", Wiley-India edition, New Delhi.
10. Relevant NPTEL Courses

SOIL SCIENCE

PCIVSMFE 112 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives:

The course enables to understand the formation of soils, their mineralogy and various **mechanisms** involved in soil water interaction.

Course Outcomes:
At the end of the course the student will be able to:

1. Understand the Formation, Nature and Mineralogy soils
2. Gain knowledge about the Soil Fabric Structure and its characterisation
3. Apply concepts of water movement in Saturated and Unsaturated soils to measure unsaturated hydraulic conductivity.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	2	2	3	2	1	2	2	1	1	-	-	2	3	2	2
	2	2	2	2	2	2	2	2	1	-	1	1	2	2	2	2
	3	2	2	1	2	1	1	2	1	-	1	-	2	2	1	2

SYLLABUS

UNIT – I

Soil Formation: Introduction: Weathering: Origin of clay minerals and clay genesis – soil profiles and their development. Sediment erosion – transport and deposition.
Nature of Soil: Particle size composition – Measurement of Pore size distribution – Principles of sedimentation analysis – Interpretation of accumulation Curves.

UNIT – II

Soil Mineralogy: Silicate Crystals - Surfaces – Gravel, Sand and Silt particles – Biogenic and Geochemical processes – Non-clay Mineral Characteristics.
Structural units of layer silicates – classification of clay minerals – Intersheet and InterLayer bonding – The 1:1 Minerals – Smectite Minerals – Mica like clay minerals – other clay minerals.

UNIT – III

Soil Fabric and Structure: Introduction – Structure and Fabric – Granular Soil packing – clay soil Fabric – Fabric classification – Particle arrangement in fabric units – First and Second order fabric characterization – Pore spaces and fabric – Techniques for direct fabric viewing – Quantification of fabric – Fabric characteristics from sedimentation.

UNIT – IV

Mechanism of Soil Water interactions – structures properties of adsorbed water – clay water electrolyte system. Ion distribution in clay water system - elements of double layer theory –

Influence of system variables on double layer theory – Limitations of Gouy-Chopman diffused double layer model – Energy and force of repulsions – long range attraction – Cation exchange.

UNIT – V

Flow through Soils: Soil water – capillarity - saturated flow: darcy's equations, determination of permeability in the field, Kozeny-Carmen Relationship – layered soils – factors effecting saturated flow – seepage force – Quicksand condition – Two dimensional flow - flownets and their characteristics – phreatic line for earthdams - uplift pressure – exit gradient – piping – filter criteria

Unsaturated flow: unsaturated flow equations for no volume change; for volume change cases Measurement of unsaturated hydraulic conductivity.

TEXT BOOKS

1. Mitchell, J. K. (1976), "Fundamentals of Soil Behaviour", John Wiley & Sons Inc.
2. Yong, R.N. and Warkentin B.P., (1975), "Soil Properties & Behaviour", Elsevier Scientific Publishing Company.

REFERENCES

1. Das, B.M. (2008), "Advanced Soil Mechanics", Taylor & Francis, New York, 3rd edition.
2. Lambe, T. W. and Whitman, R. V. (2012), "Soil Mechanics-SI version", John Wiley &Sons, New York, 2nd edition.
3. Atkinson, J.H. and Bransby, P.L. (2000), "The mechanics of soils: An introduction to critical state soil mechanics", McGraw-Hill, New York.
4. Relevant NPTEL Courses

ADVANCED FOUNDATION ENGINEERING

PCIVSMFE 113 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective:

The course contents enable the students to learn the basic aspects of geotechnical engineering, analysis and structural design of foundations and retaining structures.

Course outcomes:

By the end of the course the students will be able to

1. Understand the basic concepts of foundation design.
2. Analyze the settlement of footings.
3. Understand the design and construction procedure of deep foundations
4. Design the foundations for transmission line towers.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	3	3	2	3	1	2	2	1	1	2	2	2	3	2	2
	2	3	3	3	2	1	2	2	1	1	2	2	3	3	2	2
	3	3	3	3	2	2	3	3	1	1	2	2	3	3	2	2
	4	3	3	3	2	1	3	3	1	1	2	2	3	3	2	2

SYLLABUS

UNIT – I

Foundation Design-general Principles: Types of Foundations, Basic requirement of a foundation, computation of loads, Design steps.

Shallow Foundations-I: Introduction, location and depth of foundation, Bearing Capacity of footings, Local and Punching shear failure, Skempton's Bearing capacity factor, footings on layered soils, Bearing capacity from penetration tests, Bearing capacity from Plate load test, factor of safety, soil pressure for structural design in normal and swelling soils.

UNIT – II

Shallow Foundations-II: Settlement of footings: Settlement from penetration tests, Stress path method for Settlement calculation, Settlement of footings on slope, Allowable Bearing Pressure, Allowable Bearing pressure of Raft foundation, Floating Raft, Uplift capacity of footings, Modulus of sub grade reaction. Beams on elastic foundation, design of circular and annular rafts.

UNIT – III

Pile Foundations: Introduction, Classification of piles, Bearing capacity of piles, Pile load test, Negative skin friction, Vertical pile subjected to lateral load, lateral load capacity of single pile, Batter piles under lateral loads, uplift capacity of piles, pile groups, Bearing capacity of a pile group, settlement of pile group, Negative skin friction in a pile group, uplift capacity of a pile group, Lateral pile load test, ultimate lateral load resistance of pile group,

Hrennikoff's method, proportioning and design of pile foundations, bored piles – secant piles, tangent piles, intermittent piles, V – piles, Static installation, Box Jacking, piled raft.

UNIT – IV

Bridge substructures: Introduction, Elements of bridge substructures, determination of maximum flood discharge, determination of maximum depth of scour, depth of foundation, allowable bearing pressure, lateral stability of well foundation. Well foundations, Types of well foundations, sinking stresses in wells, tilts and shifts, sinking of wells, Design aspects of components of well foundations, Lateral stability of Well foundation.

UNIT – V

Foundations of Transmission Line Towers: Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.

TEXT BOOKS

1. Teng, W.C. (1983), "Foundation Design", John Wiley, New York.
2. Swami Saran (2006), "Analysis and Design of Substructures", Taylor& Francis, London, 2nd edition.

REFERENCES

1. Bowles, J.E. (2007), "Foundation Analysis and Design", McGraw-Hill, New York, 5th edition.
2. Vargheese, P.C. (2005), "Foundation Engineering", Prentice Hall of India, New Delhi.
3. Gopal Ranjan and Rao, A.S.R. (2007), "Basic and Applied Soil Mechanics", New Age International, New Delhi.
4. Poulos, H. G. and Davis, E. H. (1980), "Pile Foundation Analysis and Design", John wiley & sons, New York.
5. Tomlinson, M. J. (2001), "Foundation Design and Construction" , Prentice Hall, England, 7th edition.
6. Salgado, R. (2008), "The Engineering of Foundations", McGraw-Hill, Boston
7. Relevant I.S. Codes
8. Relevant NPTEL Courses

EARTH AND EARTH RETAINING STRUCTURES

PCIVSMFE 114 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective:

The course contents enable the students to understand the earth pressure concepts and design principles of retaining structures.

Course outcomes:

By the end of the course the students will be able to

1. Understand the basic concepts of earth pressure theories.
2. Learn the design procedure of sheet pile walls
3. Know the types of bracing systems and cellular cofferdams.
4. Understand the construction techniques and design criteria of earth and rock fill dams.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	3	2	2	2	1	2	2	1	1	2	2	3	3	3	2
	2	3	3	3	2	1	2	2	1	1	3	3	3	3	2	2
	3	3	3	2	2	2	2	2	1	1	2	2	3	3	3	2
	4	3	3	3	2	2	2	2	1	1	3	3	3	3	2	2

SYLLABUS

UNIT – I

Earth Pressure: Basic concepts, Rankine and Coulomb earth pressure theories, Determination of active and passive pressures: Culmann's Graphical method, logarithmic spiral methods, friction circle method. Consideration of surcharge, seepage, earth quack, wave effect, stratification, type of backfill, wall friction and adhesion.

UNIT – II

Rigid Retaining Walls: Uses, types, stability and design principles of retaining walls, backfill drainage, settlement and tilting.

Sheet Pile Walls: Types, Design of cantilever sheet pile walls in granular and Cohesive soils; Design of anchored sheet pile walls by free and fixed earth support methods, Rowe's theory of moment Reduction, Design of anchors, Diaphragm Walls – construction, trench cutter.

UNIT – III

Braced excavations: Types of sheeting and Bracing systems, lateral earth pressure on sheeting in sand and clay, Design components of braced cuts. Cellular cofferdams: Types – Diaphragm and Circular type, Design by TVA method. Stability of cellular cofferdams, cellular cofferdams in rocks and soils.

UNIT – IV

Earth and Rock fill dams: Earth dams : Selection of Site, types of earthen dams, design criteria, stability analysis: upstream and down stream for steady seepage, rapid draw down, end of construction; Seepage, Uplift Control, filters and drains.

UNIT – V

Construction and Causes of Failure of earth dams: Construction - Hydraulic, Seepage and Structural Failure; Instrumentation and performance observations in earth dams. Rock Fill Dams: Types, Design parameters, Advantages over other types of dams

TEXT BOOKS

1. Arora, K.R. (2014), "Soil Mechanics and Foundation Engineering", Standard Publishers, New Delhi, 7th edition.
2. Bharat Singh and Sharma, H. D. (1976), "Earth and Rockfill Dams", Sarita Prakashan, India.

REFERENCES

1. Rowe, R.K. (2001), "Geotechnical and Geoenvironmental Engineering Handbook", Springer, New York.
2. Narasinga Rao, B.N.D. (2015), "Soil Mechanics and Foundation Engineering", Wiley Publishers, New Delhi, 1st Edition.
3. Taylor, D.W. (1967), "Fundamentals of Soil Mechanics", John Wiley, New York.
4. Das, B. M. (2016), "Principles of Foundation Engineering", Cengage learning, Boston, 8th edition.
5. Purushothama Raj, P. (1995), "Geotechnical Engineering", Tata McGraw Hill, New Delhi.
6. Hsai-Yang Fang (2004), "Foundation Engineering Handbook", CBS publishers & distributors, New Delhi, 2nd edition.
7. Clayton, C.R.I., Rick, I.W. and Andrew, J.B. (2014), "Earth pressure and earth-retaining structures", CRC press, Florida, 3rd edition.
8. Relevant NPTEL Courses

NUMERICAL METHODS IN GEOTECHNICAL ENGINEERING

PCIVSMFE 115 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective:

The course contents enable the students to know how complicated problems in engineering, which can not otherwise be solved, can be analyzed using numerical techniques.

Course outcomes:

By the end of the course the students will be able to

1. The students understand the procedure and applicability of different numerical methods and optimization techniques.
2. The students acquire knowledge needed to solve complicated engineering problems using numerical methods and optimization techniques.
3. The students will be able to develop computer program/applications for solving various mathematical methods involved in structural/geotechnical engineering.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	2	1	2	2	2	2	1	1	2	2	1	2	2	1	2
	2	3	2	1	2	2	1	2	2	2	2	1	2	3	2	2
	3	3	2	2	2	1	1	2	2	2	2	1	2	2	3	2

SYLLABUS

UNIT – I

Flexibility matrix method: Basics, formulation of method, application to two dimensional problems, Stiffness matrix method: Element & global stiffness matrix, rotation, translation, Matrix, translation to axis transformation, application to two-dimensional problems

UNIT – II

Solution of linear system of equations: Gaussian Elimination – Gauss Jordan Method – Gauss Siedel iteration method – Factorization method – Ill conditioned matrix. Numerical integration: Newton Cotes closed quadrature – Trapezoidal rule – Simpson's 1/3rd rule – 3/8 th rule – Newton Cotes open quadrature – Gaussian quadrature – Romberg integration.

UNIT – III

Partial differential equations: Laplace, Poisson and wave equation – Explicit and implicit methods. Solution of ordinary differential equations: Initial value problem – Euler's method – Picard's method – Taylor series – Predictor corrector methods – Runge-Kutta methods – Boundary value problems.

UNIT – IV

Solution of system of non linear equation: Newton-Raphson method. Curve fitting – Power curve – Exponential curve – Hyperbola –Cubic spline. Optimisation techniques: Linear

programming – Simplex method – transportation problem – Non linear, Geometric and dynamic programming – elementary ideas.

UNIT – V

Application to Geotechnical Problems: Programming of simple geotechnical problems related to shallow and deep foundation, seepage, settlement etc.

TEXT BOOKS

1. Desai, C.S. & Christian, S.T. (1977), "Numerical methods in geotechnical engineering", McGraw Hill
2. Gerald (2003), "Applied Numerical Analysis", Pearson Education, New Delhi.

REFERENCES

1. Yashwant Kanetkar (1999), " Let us C", BPB publication, New Delhi
2. Akai T J (1994), "Applied Numerical methods for Engineers", John Wiley & Sons New York
3. Chapra, S.C. and Canale, R.P. (1985), "Numerical methods for Engineers", Tata Mc.Graw Hill Publishing Co. Ltd., New York.
4. Krishnamurthy, E. V. and Sen, S. K. (1986), "Numerical algorithms", East- West Press Pvt Ltd., New Delhi.
5. Rajasekharan, S. (1986), "Numerical methods in Science and Engineering", Wheeler & Co. Pvt. Ltd., New Delhi.

Elective - I

GEOTECHNICS OF PROBLEMATIC SOILS

PCIVSMFE 116 (a) **Credits: 3**

Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40

End Exam: 3 hours End Exam Marks: 60

Course Objectives:

To identify and classify various problematic soils and adopt foundation techniques for different problematic soils

Course Outcomes:

At the end of this course, the students will be able to:

1. Learn about the behaviour of expansive soil under various moisture conditions.
2. Identify expansive soils based upon various swell properties.
3. Understand about properties of soft clays and organic soils.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	2	2	1	2	1	1	2	1	1	-	-	1	2	2	1
	2	2	2	2	2	1	2	2	1	-	1	1	1	2	3	2
	3	2	1	1	2	1	2	2	1	-	1	-	1	2	1	2

SYLLABUS

Unit – I

Introduction: Type of Damages and Heave, seasonal moisture variation, active zone, mechanism of swelling. Factors influencing heave, estimation of heave.

Unit – II

Identification and classification of expansive soil: swell potential, differential swell pressure. Free swell ratio, swelling pressure, Determination of swelling pressure, early methods-free swell ratio method, effective plasticity index.

Unit – III

Foundation techniques in expansive soils: foundation isolation, rigid foundations-underreamed pile foundation, Reinforced Slab-on-Grade Foundations.

Unit - IV

Control of soil moisture fluctuations, surface grading, subsurface drains, moisture barriers. Altering soil properties-controlled soil excavation and backfill, prewetting. Lime stabilization.

Unit – V

Soft clays: Geology of soft marine clays, mineralogy, physical properties, shear strength and compressibility, foundation types.

Organic and peaty soils, **Collapsible soils:** Geotechnical properties, foundation types.

TEXT BOOKS

1. Narasinga Rao, B.N.D. (2015), "Soil Mechanics and Foundation Engineering", Chapter - 24, Foundations on Expansive Soils, pp. 1039-1080, Wiley Publishers, New Delhi, 1st Edition.

REFERENCES

1. Ola, S.A. "Tropical soils in engineering practice", Balkema publications.
2. Metcaff, J. B., Butterworth,(1972), "Soil stabilization principles and practice",
3. Relevant NPTEL Courses

PAVEMENT ANALYSIS AND DESIGN

PCIVSMFE 116 (b) **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective

The course content enables students to learn the design of pavements and pavement management systems.

Course Outcomes

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

1. Categorize the types of pavements and design the flexible and rigid pavements.
2. Design the heavy duty pavements.
3. Learn the Concept of pavement evaluation and type of pavement distress.
4. Learn environment effects and pavement maintenance.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	3	2	-	1	3	2	1	1	2	2	2	2	2	2	2
	2	2	3	-	3	2	2	1	1	2	1	2	2	3	2	2
	3	3	2	2	2	1	2	1	1	1	1	2	1	2	2	2
	4	3	3	2	2	2	2	1	1	2	2	2	2	3	2	2

UNIT – I

Pavement types, stress distribution pavements - theoretical and actual Sub grade conditions and traffic loading. Design principle and methods for flexible and rigid pavements.

UNIT – II

Design of heavy duty pavements. Concrete block pavements.

UNIT – III

Evaluation of pavement condition, pavement instrumentation: Types of pavement distresses, their origins and remedy.

UNIT – IV

Roughness and skid resistance. Environmental effects and influences.

UNIT – V

Pavement maintenance, overlays. Pavement management systems.

TEXT BOOKS

1. Khanna, S.K. and Justo C.E.G. (2011), "Highway Engineering", Nem Chand & Bros Roorkee, 9th Edition.
2. Yang H. Huang (2012), "Pavement Analysis and Design", Pearson Education, New Jersey, 2nd Edition.

REFERENCES

1. Yoder, E.J. and Witczak, M.W. (1991), "Principles of Pavement Design", John Willey and Sons, New York, 2nd Edition
2. IRC – 37 – 2012, "Guideline for Design of Flexible Pavements", Indian Roads Congress, New Delhi.

RELIABILITY ANALYSIS

PCIVSMFE 116 (c) **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives:

The course enables to enlighten the concepts of reliability based design in geotechnical engineering.

Course Outcomes:

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

1. Basic understanding of the principles of reliability
2. Gain knowledge in Basic statistics like Data reduction techniques, Histograms, etc.
3. Design geotechnical structures on the principle of reliability based design with enhanced and optimal partial factors of safety.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	2	2	1	2	1	1	2	1	1	-	-	1	2	2	1
	2	2	2	2	2	1	2	2	1	-	1	1	1	2	3	2
	3	2	1	1	2	1	2	2	1	-	1	-	1	2	1	2

SYLLABUS

UNIT – I

Concepts of Structural Safety: General, Design methods.
Basic Statistics: Introduction, Data reduction, Histograms, Sample correlation.

UNIT – II

Probability Theory: Introduction, Random events, Random variables, Functions of random variables, Moments and expectation, Common probability distribution, Extremal distribution.

UNIT – III

Resistance Distributions and Parameters: Introduction, Statistics of properties of concrete, Statistics of properties of steel, Statistics of strength of bricks and mortar, Dimensional variations, Characterization of variables, Allowable stresses based on specified reliability.
Probabilistic Analysis of Loads: Gravity loads, Wind load.

UNIT – IV

Basic Structural Reliability: Introduction, Computation of structural reliability. Monte Carlo Study of Structural Safety: General, Monte Carlo method, Applications.
Level 2 Reliability Methods: Introduction, Basic variables and failure surface, First-order second-moment methods (FOSM).

UNIT – V

Reliability Based Design: Introduction, Determination of partial safety factors, Safety checking formats, Development of reliability based design criteria, Optimal safety factors, Summary of results of study for Indian standard – RCC design. Reliability of Structural Systems: Preliminary concepts as applied to simple structures.

TEXTBOOKS

1. Ranganatham. R. (2006), "Structural Reliability Analysis and Design", Jaico Publishing House.
2. Melchers, R.E. (1999), "Structural Reliability", Wiley – Blackwell Publisher, 2nd Edition.

SEMINAR

PCIVSMFE 117 **Credits: 3**
Instruction: 3 Tutorial / week Sessional marks: 50
End Exam: - End Exam Marks: 50

Course Objectives:

The objective of this course is

1. To develop an overview of geotechnical engineering and its importance.
2. To promote teamwork and lifelong learning among the students.

Course Outcomes:

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

1. Improve the communication skills and cultivate lifelong learning.
2. Broaden their knowledge about Geotechnical Engineering and its significance
3. Update their knowledge on the latest developments in geotechincal engineering.
4. Understand the environmental, safety, economical and sustainability aspects of any geotechnical engineering structure.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	-	-	-	-	-	-	-	-	-	3	-	2	-	-	-
	2	2	2	2	2	2	2	2	-	-	-	-	-	2	2	2
	3		2	2	2	2	2	2	-	-	-	-	-	2	2	2
	4	-	-	2	-	-	2	2	-	-	-	-	-	2	-	2

SYLLABUS

Each student has to select a topic and collect about 10 papers with at least 5 journal papers and prepare a report and give a seminar at the end the semester.

SOIL ENGINEERING LAB

PCIVSMFE 118 **Credits: 3**
Instruction: 3 Practical / week Sessional marks: 50
End Exam: 3 hours End Exam Marks: 50

Course Objectives:

To enable a student to understand the various index and engineering properties of soil by experimentation

Course Outcomes:

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

1. Determine index and engineering properties of different soils and understand their behaviour.
2. Gain basic knowledge towards geophysical testing techniques.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	2	2	2	3	2	1	1	1	3	3	1	2	3	2	2
	2	2	1	2	2	1	2	1	1	2	2	2	2	2	2	2

SYLLABUS

Soil Laboratory

1. Determination of hygroscopic content, specific gravity and gradation characteristics of soils.
2. Determination of Atterberg Limits of soils.
3. Determination of compaction characteristics of soils.
4. Determination of permeability of soils by using constant head method.
5. Determination of permeability of soils by using variable head method.
6. Determination of consolidation characteristics of soils.
7. Determination of shear strength parameters of soils using direct shear test.
8. Determination of shear strength parameters of soils using unconfined compression strength test.
9. Determination of shear strength parameters of soils using triaxial compression test (UU).
10. Determination of Swell Pressure using Swell-Consolidation test/Constant volume method.

GROUND IMPROVEMENT TECHNIQUES

PCIVSMFE 121 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective:

The course content enables students to learn the different techniques for enhancing engineering properties of soil.

Course Outcomes:

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

1. Explain the method of Ground Improvement by Mechanical Stabilization.
2. Learn the grouting techniques.
3. Learn the concept of Vertical drains, its construction and design principles.
4. Outline the Soil Nailing and Dewatering Techniques.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	2	2	3	2	2	2	2	2	1	1	1	1	2	2	1
	2	2	2	3	2	3	2	2	1	1	-	2	1	2	2	2
	3	3	2	3	2	3	2	2	2	1	1	2	2	3	2	2
	4	3	2	3	2	3	2	3	1	2	1	2	2	3	2	2

SYLLABUS

UNIT – I

Introduction – Need for Ground Improvement, Objectives of Ground Improvement, Classification of Ground Improvement Methods, Mechanical Stabilization- Triangular Chart Method and Rothfutch Method, Blasting, Dynamic Compaction/ Consolidation, Compaction piles – Micro piles: Design methods and construction techniques.

UNIT – II

Soil & Foundation Grouting – Grouting Equipments, Applications, Classification of grouting based on Materials, Grouting Technique and Sequence of Operation, Soilcrete, Soilfrac, grouting in rocks,

UNIT – III

Vertical Drains- Sand Drains, Vacuum Consolidation, Prefabricated - Principle, Band Drains or Wick Drain, Geosynthetic Drains, Construction, Advantages and Disadvantages, Stone Columns – Mechanism of load transfer, Design principles, Construction of stone column- Vibro Compaction, Vibro Replacement, Vibro Composer and Case bore hole Methods, Geotextile Coated Stone Columns, Preloading.

UNIT – IV

In- Situ Soil Mixing – Types of In-situ Soil Mixing, Benefits and Applications, Ground Freezing and Ground Heating.
Soil Nailing – Components, Types of soil nailing systems, Equipment used, Construction of Soil Nailing System, Stability Analysis, Application, Advantages, Gabions.
Methods to improve rock mass – rock bolting and rock anchors - Beach management system.

UNIT – V

Seepage Control & Dewatering- Definition, Objectives, Methods of Dewatering- Open Sumps and Ditches, Well point Systems, Deep Well Systems, Vertical Sand Drains, Electro-Osmosis, Cut off wall, Selection of Dewatering System, Cathodic protection of marine structures.

TEXT BOOKS

1. Purushothama Raj, P. (1999), "Ground Improvement Techniques", Laksmi Publications, New Delhi.
2. Narasinga Rao, B.N.D. (2015), "Soil Mechanics and Foundation Engineering", Wiley Publishers, New Delhi, 1st Edition.

REFERENCES

1. Hausmann, M. R. (1990), "Engineering Principles of Ground Modifications", McGraw Hill Pub Co., New York.
2. Moseley, M.P. and Kirsch, K. (2004), "Ground Treatment", Spon Press, New York, 2nd Edition.
3. Das, Braja M. (2016), "Principles of Foundation Engineering", Cengage learning, Boston, 8th Edition.
4. Nayak, Narayan V (1996), "Foundation Design Manual: For Practising Engineers and Civil Engineering Students", Dhanpat Rai, New Delhi, 4th Edition.
5. Relevant NPTEL Courses

GEOENVIRONMENTAL ENGINEERING

PCIVSMFE 122 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives:
From this course students will learn the following

1. To characterize waste based upon its source and safe transport and disposal of waste without any contamination.

Course Outcomes:
1. Learn about various sources and characteristics of site.
2. Understand about classification of waste and environmental concerns of waste.
3. Know about the safe transport and disposal methods of hazardous waste.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	1	2	1	2	1	2	3	1	1	1	-	1	2	1	2
	2	1	2	1	2	1	2	3	1	-	1	-	1	1	2	1
	3	2	2	2	2	1	2	3	1	-	1	1	1	2	2	2

SYLLABUS

UNIT – I

Sources and Site Characterization: Scope of Geoenvironmental Engineering, Various Sources of Contaminations, Need for contaminated site characterization; and Characterization methods.

UNIT – II

Solid and Hazardous Waste Management: Classification of waste, Characterization solid wastes, Environmental Concerns with waste, waste management strategies.

UNIT – III

Contaminant Transport: Transport process, Mass-transfer process, Modelling, Bioremediation, and Phytoremediation. Remediation Techniques: Objectives of site remediation, various active and passive methods, remediation NAPL sites, Emerging Remediation Technologies.

UNIT – IV

Landfills: Types of landfills, Site Selection, Components of Waste Containment system, Leachate collection system, Cover system, Gas collection system.

UNIT – V

Soil erosion and conservation – causes of soil erosion, factors contributing to erosion – climatic factors, topographical factors, vegetation factors. Erosion control – cropping systems, gullies, check dams, contouring, wind striping, ridging, bank protection.

TEXT BOOKS

1. Sharma, H. D. and Reddy, K. R. (2004), "Geoenvironmental Engineering", John Wiley & Sons

REFERENCES

1. Rowe, R. K. (2001), "Geotechnical & Geoenvironmental Engineering Handbook", Kluwer Academic
2. Reddi, L. N. and Inyang, H. I. (2000), "Geoenvironmental Engineering Principles and Applications", Marcel. Dekker, Inc., New York .
3. LaGrega, M. D., Buckingham, P. L. and Evans, J. C. (2001), "Hazardous Waste Management", McGraw-Hill, New York.
4. Daniel, D. E. (1993), "Geotechnical practice for waste disposal", Chapman and Hall, London.
5. Oweis, I.S. and Khera, R.P. (1998), "Geotechnology of Waste Management", PWS Publishing Co., New York, 2nd Edition.
6. Bagchi, A. (2004), "Design of Landfills and Integrated Solid Waste Management", John Wiley & Sons, New Jersey, 3rd Edition.
7. Relevant NPTEL Courses

GEOSYNTHETICS AND REINFORCED SOIL STRUCTURES

PCIVSMFE 123 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective:

The course content enables students to learn the use of Geosynthetics in Civil Engineering, modern concepts of Soil Reinforcement, design principles and ease of their applicability to construction practices.

Course Outcomes:

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

1. Explain the significance of Geosynthetics, Properties of Geotextiles and its application.
2. Design with Geotextiles.
3. Learn the Concept of Reinforced Earth.
4. Design the Reinforced Earth Retaining Walls, Reinforced Pavements, and Landfills.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	3	2	2	1	3	2	3	1	2	2	2	2	2	2	2
	2	2	3	3	3	2	2	2	1	2	1	2	2	3	2	2
	3	3	2	3	2	1	2	2	1	1	1	2	1	2	2	2
	4	3	3	3	2	2	2	3	2	2	2	2	2	3	2	2

SYLLABUS

UNIT – I

Geosynthetics-Types, Functions, Applications, Raw materials, Manufacturing methods.

UNIT – II

Properties of Geotextiles- Physical Properties, Mechanical Properties, Hydraulic Properties, Survivability and Durability.

Tests on Geotextiles- Mass per unit area, Nominal Thickness, Apparent Opening Size, Characteristic Opening Size, Tensile Strength-Strip Tensile Strength, Wide Width Tensile Strength, Grab Tensile Strength, Seam strength, Static Puncture test- CBR push through test, Rod Puncture Test, Dynamic Puncture Test- Cone Drop test, Permittivity, Transmittivity.

UNIT – III

Designing with Geosynthetics: Designing with Geotextiles-Design Methods, Designing for separation, Designing for Highway Reinforcement, Designing for Filtration, Designing for drainage, Designing for Multiple functions, Construction Methods and Techniques using Geotextiles. Designing with Geogrid, Geonets, Geomembranes, Geocomposites

UNIT – IV

Reinforced Earth: Concept, Effects of Reinforcement on soils – Equal Confining and Pseudo Cohesion Concepts, Materials, Friction Coefficient – Definition, Laboratory determination, Factors affecting fiction coefficient; Telescope and Hitex Methods of construction, Application of Reinforced Earth – Binquet & Lee's Approach for analysis of foundations with reinforcement layers.

UNIT – V

Reinforced Earth Retaining Walls: Introduction, Stability Mechanisms, Design of Reinforced Earth Retaining Wall, Advantages over conventional Retaining Walls
Reinforced Pavements: Benefits of placing reinforcement in flexible pavement layers, design of reinforced pavements by Giroud and Noiray approach and modified CBR Method.
Landfills: Geosynthetic applications for land fill liners, covers and other components

TEXT BOOKS

1. Venkatappa Rao, G. and Suryanarayana Raju, G.V.S. (1990), "Engineering with Geosynthetics", Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. Koerner, R. M., (2012) "Designing with Geosynthetics", Xlibris Corp, New York, 6th Edition.

REFERENCES

1. Siva Kumar Babu, G.L. (2006), "An Introduction to Soil Reinforcement and Geosynthetics", Universities Press, Hyderabad.
2. Robert M. Koerner (1991), "Construction and Geotechnical Methods in Foundation Engineering", McGraw Hill, New York.
3. Hausmann, M. R. (1990), "Engineering Principles of Ground Modifications", McGraw Hill Pub Co., New York.
4. BS 8006:2010, "Code of practice for strengthened/reinforced soils and other fills".
5. FHWA-NH1-00-043, (2014) "Mechanically stabilized earth walls and reinforced soil slopes design and construction guidelines".
6. John, N.W.M. (1999), "Geotextiles", Blackie, New York, 2nd Edition.
7. Relevant NPTEL Courses

DYNAMICS OF SOILS AND FOUNDATIONS

PCIVSMFE 124 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives:

The course enables to understand the theory of vibrations, dynamic properties of soil and apply them in design foundations for machines.

Course Outcomes:
At the end of the course the student will be able to

1. Understand the concept of vibrations in soil-structure medium.
2. Know the dynamic properties of soil and their importance
3. Gain knowledge about the importance of designing machine foundations.
4. Demonstrate the ability to design machine foundations

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	2	2	1	2	1	2	3	1	1	1	-	1	2	2	3
	2	2	2	2	2	1	2	3	1	-	1	-	1	2	2	3
	3	2	2	2	2	1	2	3	1	-	1	1	1	2	2	3
	4	2	2	2	2	1	2	3	1	-	1	1	1	2	2	3

SYLLABUS

UNIT – I

Theory of Vibrations: Free and forced vibrations with and without damping for single mass system with single degree freedom, Logarithmic Decrement and Damping Ratio, Principles of Design of Vibration measuring Devices, Transmissibility of force, vibrations of Two degree freedom system, vibrations of Systems under transient loads.

UNIT – II

Natural frequency of foundation soil system- Barkan's Method, Pressure Bulb Concept, Pauw's Analogy, Tschebetorioff's concept of reduced natural Frequency

UNIT – III

Dynamic Soil Properties: Tests for determination of dynamic soil properties - Cyclic Plate load test, Block vibration test, Up Hole, down Hole and Cross Hole wave Propagation tests, Hammer Test, Resonant Column Test, Seismic Reflection and Refraction tests.

UNIT – IV

Design of Machine Foundation: Types of Machine Foundations, design criteria, Degrees of Freedom of Block foundation, Analysis of Block foundations under sliding, rocking, yawing and Coupled motions, Design Aspects and Construction details of foundations for reciprocating and Impact,

UNIT – V

Vibration Isolation - Passive and active isolation - use of springs and damping materials construction aspects of machine foundations.

TEXT BOOKS

1. Swami Saran, (1999),"Soil Dynamics and Machine Foundations", Galgotia Publications Private Ltd, New Delhi, 2nd Edition.
2. N. S. V. Kameswara Rao, (1998),"Vibration Analysis and Foundation Dynamics", Wiley New Delhi, 1st Edition

REFERENCES

1. Das, B. M. and Ramana, G.V. (2010),"Principles of Soil Dynamics", CL Engineering, Punjab, 2nd Edition.
2. Narasinga Rao, B.N.D. (2015), "Soil Mechanics and Foundation Engineering", Wiley Publishers, New Delhi, 1st Edition.

ROCK MECHANICS

PCIVSMFE 125 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective

The course content enables students to learn the Rock structure, properties, strength and failures.

Course Outcomes

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

1. Classify the rocks and defects in rocks.
2. Learn the different properties of rocks.
3. Learn the different tests on rocks.
4. Outline the Creep behaviour, strength and failure of rock.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	2	2	3	2	2	2	2	2	1	1	1	1	2	2	1
	2	2	2	3	2	3	2	2	1	1	-	2	1	2	2	2
	3	3	2	3	2	3	2	2	2	1	1	2	2	3	2	2
	4	3	2	3	2	3	2	3	1	2	1	2	2	3	2	2

UNIT – I

Introduction: Structure of the Earth, Classification of Rocks - Igneous Rocks, Metamorphic Rocks and Sedimentary Rocks, Sequence of formation of Different groups of Rocks, Rock cycle.

Sub-Surface Exploration: Introduction – Planning and stages in sub-surface exploration – Methods of exploration – Test pit – Trenches – Seismic refraction and Electrical resistivity method – Methods of Boring – Types of soil sample – Design Features of soil sampler – standard penetration test – static and dynamic cone penetration test – Pressuremeter test – Rock exploration – Core boring – Core Recovery – RQD - bore log – preparation of sub-soil investigation report.

UNIT – II

Defects in Rock Mass- Strike and Dip, Bedding Planes, Joints, Faults, Folds, Unconformity and their Civil Engineering Importance.

Physical and index Properties of Rocks: Texture, Structure, Composition, Colour, Grain Size, Durability and Rock Quality Designation.

Mechanical Properties: Compressive Strength, Tensile Strength, Shear Strength, Point Load Strength, Scale Effect, Elasticity, Plasticity, Poisson's Ratio, Deformability, Hardness.

UNIT – III

Laboratory Testing on Rocks: Sampling, Sample Preparation, Specimen, Uniaxial Compressive Strength test, Tensile strength test, Brazillian test, flexure strength Test, Flexural strength Test, Shear Strength Test, Test for Elastic Constants

UNIT – IV

Insitu Tests on Rocks: Deformability- Cable Jacking Test, Pressure Tunnel Test, Bore hole Test, Shear Tests- Single Jack Test, Strength Test- Pressuremeter Test, Dilatometer Test, Stress Relief Techniques, Insitu Stress?, Hydro fracturing technique, Flat Jack Techniques, Indirect Methods.

UNIT – V

Strength and Failure of Rocks: Failure Criteria in Rock Masses, Yield Criteria of Failure Theories- Maximum Stress Theories, Maximum Elastic Strain Theories, Constant Elastic Strain Energy Theory, Maximum Shear Stress Theory, Mohr's Theory, Coulomb Theory, Griffith's Theory of Fracture Initiation- Stress Around Boundary of an open flow and Equations defining Fracture Initiation.
Foundation on rocks: Estimation of bearing capacity – stress distribution in rocks – settlement in rocks – pile foundation in rocks.

TEXTBOOKS

1. Verma, B. P. (2006), "Rock Mechanics for Engineers", Khanna Publishers, New Delhi, 3rd Edition.
2. Ramamurthy, T. (2007), "Engineering in Rocks for Slopes, Foundations and Tunnels", PHI Learning Private Limited, New Delhi, 2nd Edition.

REFERENCES

1. Brown, E.T. (1981), "Rock Characterisation, Testing and Monitoring", Pergamon Press, London, 1st Edition.
2. Singh, B. and Goel, R. K. (1999), "Rock Mass Classification Systems – A Practical Approach in Civil Engineering", Elsevier Publisher, New York, 1st Edition.
3. Narasinga Rao, B.N.D. (2015), "Soil Mechanics and Foundation Engineering", Wiley Publishers, New Delhi, Chapter – 14, pp. 529 – 578, 1st Edition.
4. Richard, E. Goodman (1989), "Introduction to Rock Mechanics", John Wiley & Sons, New York, 2nd Edition.
5. Relevant NPTEL Courses

FINITE ELEMENT METHODS FOR GEOTECHNICAL ENGINEERING

PCIVSMFE 126 (a) **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives:

The course enables to understand the concept of finite element analysis and its applications in geotechnical engineering.

Course Outcomes:
At the end of the course the student will be able to

1. Understand in general how finite elements are obtain to approximate the solutions of differential equations
2. Apply finite element methods to classical geotechnical problems like settlement, seepage, consolidation, slope stability, etc.
3. Obtain insight into the soil properties needed for finite element analysis

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	3	2	2	2	3	2	3	1	1	1	-	2	3	2	3
	2	3	2	2	2	3	2	3	1	-	1	-	2	3	2	2
	3	3	2	2	2	3	2	3	1	-	1	1	2	3	2	3

SYLLABUS

UNIT – I

Introduction: Concepts of FEM, Steps involved in Finite Element Analysis Procedure, Merits and Demerits. Principles of Elasticity: Stress equations, Strain-Displacement relationships in matrix form, Plane stress, Plane strain and axi-symmetric bodies of revolution with axi-symmetric loading.

UNIT – II

Element Properties: Concept of an element, various element shapes, Displacement models, Generalized coordinates, Shape functions, Convergent and Compatibility requirements, Geometric invariance, Natural coordinate system - area and volume coordinates.

UNIT – III

Generation of Element Stiffness and Nodal Load Matrices, Isoparametric Formulation: Concept, Different isoparametric elements for 2D analysis, formulation of 4-noded and 8-noded isoparametric quadrilateral elements, Lagrangian elements, Serendipity elements.

UNIT – IV

Assemblage of Elements: Discretization of a structure, numbering systems, Aspect ratio its effects, Assemblage, Direct Stiffness method, Interface Elements.

UNIT – V

Geotechnical Applications Sequential construction, Excavations and embankments, Bearing capacity and Settlement analysis.

TEXT BOOKS

1. Chandrupatla, R. T. and Ashok D. B., (2011) "Introduction to Finite Element in Engineering", Pearson, Hyderabad, 4th Edition.
2. Cook, R.D., Malkus, D. S., Michael, E. P. and Robert J. W., (2001), "Finite Elements Analysis – Concepts & Applications" John Wiley & Sons, New Delhi, 4th Edition

REFERENCES

1. Desai, C. S. and J.F. Abel, (1972), "Introduction to the Finite Element Method", Van Nostrand Reinhold Company.
2. Zienkiewicz, O. C., (1971), "Finite element Methods", McGraw-Hill Publishers, New Delhi,
3. Krishna Murthy, C. S., (1994), "Finite element analysis - Theory and programming", Tata McGraw-Hill.

GEOTECHNICS OF UNDERGROUND STRUCTURES

PCIVSMFE 126 (b) **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective:

The course contents enable the students to learn about various underground structures and their design concepts.

Course outcomes:

By the end of the course the students will be able to

1. Know about the types of conduits and soil pressure on conduits.
2. Learn the construction of earth tunnels.
3. Learn the design concepts of tie backs and braced cuts.
4. Understand the soil nailing concepts.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	3	2	2	2	1	2	2	1	1	2	1	3	3	3	2
	2	3	2	2	2	2	2	2	1	1	2	1	3	3	3	2
	3	3	3	3	2	1	2	2	1	1	2	1	3	3	3	2
	4	3	3	2	2	2	2	2	1	1	2	1	3	3	3	2

SYLLABUS

UNIT – I

Arching in soils: prerequisites and features of arching, Theory of arching in soils, Application of arching in cohesive frictional soils.

UNIT – II

Soil pressures on conduits: Loads on ditch, negative and positive projecting conduits, Bedding conditions for conduits and types of conduits, Pressures in silos, Janssen's theory for pressures in silos.

UNIT – III

Stresses: Stresses in Vicinity of Vertical Shafts, Tunnels, Construction of Earth Tunnels. Retaining Systems for Underground Excavations.

UNIT – IV

Braced Cuts: Lateral Earth pressure on Sheeting, Types of Sheeting and Bracing Systems, Design of Braced Cuts
Tie Backs: Components, advantages over Braced Cuts, Design concepts

UNIT – V

Soil Nailing: Components of nailing system, Driven and Grouted Nails, Design of nailing system, anchored Spider Netting. Types of Anchorage Systems for anchored Sheet pile walls, Design of anchorages, considerations in positioning of anchorages.

TEXT BOOKS

1. Leonards, G.A. (1962), "Foundation Engineering", McGraw-Hill, New York.
2. Shamsher Prakash, Gopal Ranjan and Swami Saran (1987) "Analysis and Design of Foundations and Retaining Structures", Sarita Prakasha, Meerut, 2nd edition.

REFERENCES

1. Arora, K.R. (2014), "Soil Mechanics and Foundation Engineering", Standard Publishers, New Delhi, 7th edition.
2. Das, B.M. (2017), "Fundamentals of Geotechnical Engineering", Cengage learning, Boston, 5th edition.
3. Purushothama Raj, P. (1995), "Geotechnical Engineering", Tata McGraw Hill, New Delhi.
4. Relevant NPTEL Courses

MARINE SUBSTRUCTURES

PCIVSMFE 126 (c) **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives:

The course enables to understand various marine sub-structures, their working and preliminarily design of the sub-structures

Course Outcomes:
At the end of the course the student will be able to

1. Understand the definition and purpose of marine or sub-structures.
2. Gain knowledge about the load calculations on sub-structures.
3. Apply the concepts of the preliminary design concepts of marine sub-structures.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	2	2	2	2	1	2	2	1	1	-	-	2	2	2	2
	2	2	2	2	2	2	2	2	1	-	1	1	2	2	2	2
	3	2	2	2	2	1	2	2	1	-	1	-	2	2	2	2

SYLLABUS

UNIT – I

Introduction: Offshore definition, Purpose of Offshore Structures, Classification and Examples, Various types of Offshore Structures – Jacket Platforms, Semi submersibles, Tension Leg Platforms, Gravity Platforms Guyed Towers, Articulated Towers.
Load Calculations: Environmental loads on offshore structures due to a)Wind b) Wave c) Current d) Ice e) Earth quake, Functional loads, Buoyant Forces, Installation forces, Soil structure interaction. Wave force calculation on a Jacket platform and Semi submersible.

UNIT – II

Introduction, Coastal Protection works – Seawall – Groins – Structural aspects – Sand dunes – Vegetation – Beach nourishment.
Break waters – Types – Selection of site and type – Effects on the beach – Design principles of Rubble mound, vertical wall and composite Breakwaters – Stability of Rubble Structures.

UNIT – III

Wharves and Jetties – Types – Materials of Construction – Design Principles – Deck for fenders – Types – Design.
Dolphins – Mooring Accessories.

UNIT – IV

Submarine Pipelines – Route selection and Diameter / wall thickness calculations; Pipeline stability, free span calculations; Concrete coated pipelines and pipe-in-pipe insulated pipelines; Design using DNV 81 code.

UNIT – V

Preliminary design aspects of offshore structures. Construction, Towing and installation procedure of Jacket platforms and Gravity platforms.

TEXT BOOKS

1. Mark Randolph and Susan Gourvenec, (2011), "Offshore Geotechnical Engineering", CRC Press.

REFERENCES

1. Poulos, H.G., (1988), "Marine Geotechnics", Spon Press, London, UK.

DESIGN PROJECT

PCIVSMFE 127 **Credits: 3**
Instruction: 3 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course objectives:

The objective of this course is to provide exposure to the students to the practical aspects of Civil Engineering projects

Course outcomes:

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

1. Investigate and analyze at least one complex geotechnical engineering problem with substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
2. Select and apply appropriate techniques, resources, and modern engineering and IT tools to complex civil engineering activities with an understanding of the limitations.
3. Demonstrate knowledge and understanding of the engineering and management principles and apply these in designing at least one geotechnical engineering structure.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO	1	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-
	2	-	-	-	-	2		-	-	-	-	-	-	-	2	-
	3	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-

SYLLABUS

The students should carry out typical foundation design under varying soil conditions or revision of IS codes & IRC guidelines or any project suggested by course instructor. The design project may consist of

1. Soil and Structural Design of Combined footings, rafts
2. Design of Pile Groups
3. Design of Laterally loaded Piles
4. Design of well Foundations
5. Landfill Design
6. Reinforced Soil Structures
7. Design of Bulk heads
8. Case studies
9. Any other suitable topic

ADVANCED GEOTECHNICAL ENGINEERING LAB

PCIVSMFE 128 **Credits: 3**
Instruction: 3 Practical / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives:

To enable a student to understand the various physical properties of Geosynthetics by experimentation

Course outcomes:

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

1. Determine physical properties of different types of Geosynthetics.
2. Gain basic knowledge towards rock specimen preparation and testing.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	2	2	2	3	2	1	1	1	3	3	1	2	3	2	2
	2	2	1	2	2	1	2	1	1	2	2	2	2	2	2	2

SYLLABUS

Geosynthetics Laboratory

1. Determination of physical properties of Geotextiles, Geogrids and Geomembranes
2. Determination of A.O.S of geotextiles
3. Determination of Grab and wide width tensile strengths of geotextiles
4. Determination of Interfacial frictional characteristics of Geotexiles with Fill material using modified direct shear test.
5. Determination of CBR Puncture Resistance of geotextiles
6. Determination of in plane and cross plane permeability of geotextiles

Demonstration

7. Evaluation of long term flow ability of geotextiles by Gradient ratio test
8. Cone Drop Test on geotextiles

Rock Mechanics Laboratory

1. Water absorption test for rock specimens
2. Point Load Test
3. Unconfined Compression Test on Rock specimens
4. Split Tensile Strength of Rock using Brazilian Test

Computational Laboratory

Students have to solve geotechnical problems using relevant software.