SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING

M.Tech Degree Program (CBCS)

Curriculum & Syllabi for Geotechnical Engineering

(w.e.f 2019-20)

MAY, 2018

PROGRAMME OBJECTIVES

1. To make students learn the principles of soil and rock mechanics. Understand different problems Associated with geotechnical engineering. Explain how to select design soil/rock parameters for Design purpose based on the subsurface exploration. Develop Analysis and Design procedure for Various geotechnical structures.
2. Students should gain competency in the design of shallow/deep foundations, earth retaining Structures, embankment and earthen dams, underground structures. Can assess stability of slopes and apply preventive measures for stability.

PROGRAMME OUTCOMES (POs)

1. Students will learn soil and rock behavior. Students will be able to perform various laboratory and in-situ tests on soil/rock to find out design parameters.
2. Students can design shallow/deep foundations, earth retaining structures, embankment and earthen dams, tunnel support systems for given site conditions.
3. Student can compute factor of safety to assess stability of slopes and apply preventive measures for stability.
4. Student can develop numerical models to estimate response of various geotechnical structures under different loadings.

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. To prepare programme graduates with foundation knowledge to perform analysis and design various geotechnical structures for work on site and quality control systems.
2. T o provide programme graduates with entrepreneur skills to take up individual projects or work in teams in the field of geotechnical engineering and in multidisciplinary environments.
3. To inculcate in programme graduates an interest towards research work in the relevant domain or appropriate domains for providing sustainable solutions to the Civil Engineering Problems.

M. Tech (GEOTECHNICAL ENGINEERING) – I Semester

Course Code	Course Title	Scheme of Instruction (Hours/Week)				No. of Credits	Scheme of Evaluation		
		Lecture	Tutorial	Practical	Total		Sessional Marks	Semester End Examination Marks	Total
GTPC01	Advanced Soil Mechanics	3	-	-	3	3	40	60	100
GTPC02	Advanced Foundation Engineering	3	-	-	3	3	40	60	100
Professional Elective- I Any One from the Following		3	-	-	3	3	40	60	100
GTPE11	Soil Structure Interaction								
GTPE12	Ground Improvement Techniques								
GTPE13	Pavement Analysis and Design								
Professional Elective- II Any One from the Following		3	-	-	3	3	40	60	100
GTPE21	FEM in Geomechanics								
GTPE22	Environmental Geotechnology								
GTPE23	Critical State Soil Mechanics								
GTCP01	Geotechnical Engineering Lab - 1	-	-	4	4	2	40	60	100
GTCP02	Geotechnical Engineering Lab - 2	-	-	4	4	2	40	60	100
GTPA01	Audit Course-I	2	-	-	-	-	-	-	-
PGPC41	Research Methodology and IPR	2	-	-	-	2	40	60	100
	Total	16	-	8	20	18	280	420	700

M. Tech (GEOTECHNICAL ENGINEERING) – II Semester

Course Code	Course Title	Scheme of Instruction (Hours/Week)				No. of Credits	Scheme of Evaluation		
		Lecture	Tutorial	Practical	Total		Sessional Marks	Semester End Examination Marks	Total
GTPC03	Dynamics of soils and foundations	3	-	-	3	3	40	60	100
GTPC04	Subsurface investigations and instrumentation	3	-	-	3	3	40	60	100
Professional Elective- III Any One from the Following		3	-	-	3	3	40	60	100
GTPE31	Offshore Geotechnical Engineering / Marine Geotechniques								
GTPE32	Computational Geomechanics								
GTPE33	3. Engineering rock mechanics								
Professional Elective- IV Any One from the Following		3	-	-	3	3	40	60	100
GTPE41	Earth Retaining Structures								
GTPE42	Design of underground excavations								
GTPE43	Physical and Constitutive Modelling in Geomechanics								
GTCP03	**Sub soil exploration**	-	-	4	4	2	40	60	100
GTCP04	**Numerical Analysis Lab**	-	-	4	4	2	40	60	100
GTPA02	Audit Course-II	2	-	-	-	-	-	-	-
GTMP01	Mini Project	2	-	-	-	2	100	-	100
	Total	16	-	8	20	18	340	360	700

M. Tech (GEOTECHNICAL ENGINEERING) – III Semester

Course Code	Course Title	Scheme of Instruction (Hours/Week)				No. of Credits	Scheme of Evaluation		
		Lecture	Tutorial	Practical	Total		Sessional Marks	Semester End Examination Marks	Total
Professional Elective- V Any One from the Following		3	-	-	3	3	40	60	100
GTPE51	Stability analysis of slopes								
GTPE52	Foundations on weak rocks								
GTPE53	Geotechnical earthquake engineering								
Open Elective- I Any One from the Following		3	-	-	3	3	40	60	100
GTOE11	Business Analytics								
GTOE12	Industrial Safety								
GTOE13	Operations Research								
GTOE14	Cost Management of Engineering Projects								
GTOE15	Composite Materials								
GTOE16	Energy Generation from Waste								
GTPD01	Major project: Phase-I Dissertation	--	-	20	20	10	100	-	100
	Total	6	-	20	26	16	180	120	300

M. Tech (GEOTECHNICAL ENGINEERING) – IV Semester

Course Code	Course Title	Scheme of Instruction (Hours/Week)				No. of Credits	Scheme of Evaluation		
		Lecture	Tutorial	Practical	Total		Sessional Marks	Semester End Examination Marks	Total
GTPD02	Major project: Phase-II Dissertation	-	-	32	32	16	40	60	100
Total		-	-	32	32	16	40	60	100

GTPC01 ADVANCED SOIL MECHANICS

L / week	**: 3Hrs**	**Sessional Marks**	**: 40**
University Exam	**: 3 Hrs**	**End Exam Marks**	**: 60**

UNIT I

COMPRESSIBILITY OF SOILS consolidation theory (one, two, and three dimensional consolidation theories), consolidation in layered soil and consolidation for time dependent loading, determination of coefficient of consolidation (Casagrande method and Taylors method)

UNIT II

STRENGTH BEHAVIOR OF SOILS Mohr Circle of Stress; UU, CU, CD tests, drained and undrained behavior of sand and clay, significance of pore pressure parameters; determination of shear strength of soil; Interpretation of triaxial test results.

UNIT III

STRESS PATH Drained and undrained stress path; Stress path with respect to different initial state of the soil; Stress path for different practical situations.

UNIT IV

CRITICAL STATE SOIL MECHANICS Critical state parameters; Critical state for normally consolidated and over consolidated soil; Significance of Roscoe and Hvorslev state boundary surface; drained and undrained plane. Critical void ratio; effect of dilation in sands; different dilation models.

UNIT V

ELASTIC AND PLASTIC DEFORMATIONS elastic wall; introduction to yielding and hardening; yield curve and yield surface, associated and non-associated flow rule.

References

1. Atkinson, J.H. and Bransby, P.L, The Mechanics of Soils: An introduction to Critical Soil Mechanics, McGraw Hill, 1978.
2. Atkinson J.H, An introduction to the Mechanics of soils and Foundation, McGraw- Hill Co., 1993.
3. Das, B.M., Advanced Soil Mechanics, Taylor and Francis, 2nd Edition, 1997.

4. Wood, D.M., Soil Behavior and Critical State Soil Mechanics, Cambridge University Press, 1990.
5. Craig, R.F., Soil Mechanics, Van Nostrand Reinhold Co. Ltd., 1987.
6. Terzaghi, K., and Peck, R.B., Soil Mechanics in Engineering Practice, John Wiley & Sons, 1967.
7. Lambe, T.W. and Whitman, R.V., Soil Mechanics, John Wiley & Sons, 1979.

Course Outcome

1. The students obtain the complete knowledge on Strength and Compressibility of soil mass of soil mass.
2. To learn importance of stress paths on strength Characteristics.
3. The students are able to develop mathematical models for solving different problems in soil mechanics using critical state frame work.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	3	2	1	1			3	
CO2			2					
CO3				3			3	

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPC02 ADVANCED FOUNDATION ENGINEERING

L / week	**: 3Hrs**	**Sessional Marks**	**: 40**
University Exam	**: 3 Hrs**	**End Exam Marks**	**: 60**

UNIT I

SHALLOW FOUNDATIONS Requirements For Satisfactory Performance Of Foundations, Methods Of Estimating Bearing Capacity, Settlements Of Footings And Rafts, Proportioning Of Foundations Using Field Test Data, IS Codes.

UNIT II

PILE FOUNDATIONS Methods Of Estimating Load Transfer Of Piles, Settlements Of Pile Foundations, Pile Group Capacity And Settlement, Negative Skin Friction Of Piles, Laterally Loaded Piles, Pile Load Tests, Analytical Estimation Of Load- Settlement Behavior Of Piles, Proportioning Of Pile Foundations, Lateral And Uplift Capacity Of Piles.

UNIT III

WELL FOUNDATION IS and IRC codal provisions, elastic theory and ultimate resistance methods

UNIT IV

FOUNDATIONS ON PROBLEMATIC SOILS Foundations for collapsible and expansive soils

UNIT V

COFFER DAMS Various Types, Analysis And Design Foundations.

References

1. Bowles. J.E., Foundation Analysis and Design, Tata McGraw-Hill International Edition, 5th Edn, 1997.
2. Das B.M., Shallow Foundations: Bearing capacity and settlement, CRC Press, 1999.
3. Tomlinson M.J., Pile design and construction Practice, Chapman and Hall Publication, 1994.
4. Poulos, H. G. and Davis, F. H., “Pile Foundation Analysis and Design”, Wiley and Sons. 1980

Course Outcomes

1. The students will be able to analyse and proportion shallow foundation.
2. To learn load transfer mechanisms and proportioning of deep foundations.
3. To comprehence design aspects of foundations in problematic soils
4. The students will be able to assess the type of foundations to be recommended for construction design of coffer dams.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1		3	2			3	3	
CO2		3	2				2	2
CO3	2	2		2		2		
CO4								2

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPE11 SOIL STRUCTURE INTERACTIONS

L / week	**: 3Hrs**	**Sessional Marks : 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

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UNIT I: Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behavior, Foundation behavior, Interface behavior, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behavior, Time dependent behavior.

UNIT II: Beam on Elastic Foundation- Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness.

UNIT III: Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.

UNIT IV: Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.

UNIT V: Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis.

References

1. Selvadurai, A.P.S, Elastic Analysis of Soil-Foundation Interaction, Elsevier, 1979.
2. Poulos, H.G.,and Davis, E.H.,Pile Foundation Analysis and Design, John Wiley, 1980.
3. Scott, R.F., Foundation Analysis, Prentice Hall, 1981.
4. Structure Soil Interaction-State of Art Report, Institution of Structural Engineers,
5. ACI 336. (1988), Suggested Analysis and Design Procedures for combined footings and Mats, American Concrete Institute.

Course Outcomes

1. The student is exposed to soil foundation interaction behavior
2. The student learns analysis of structures using soils modeling soil as elastic half space and descretes springs.
3. The student will be able to analyse settlements and load distributions in piles and pile groups subjected to vertical and lateral loads.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1		2	2					
CO2							2	2
CO3			3					2

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GTPE12 GROUND IMPROVEMENT TECHNIQUES

L / week	**: 3Hrs**	**Sessional Marks : 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

INTRODUCTION: situations Where Ground Improvement Becomes Necessary

MECHANICAL MODIFICATION: Dynamic Compaction, Impact Loading, Compaction By Blasting, Vibro-Compaction; Pre-Compression, Stone Columns; Hydraulic Modification: Dewatering Systems, Preloading And Vertical Drains, Electro-Kinetic Dewatering

UNIT II

CHEMICAL MODIFICATION; Modification By Admixtures, Stabilization Using Industrial Wastes, Grouting

UNIT III

THERMAL MODIFICATION: Ground Freezing And Thawing.

UNIT IV

SOIL REINFORCEMENT: Reinforced Earth, Basic Mechanism, Type Of Reinforcements, Selection Of Stabilization/Improvement Of Ground Using Geotextiles, Goegrid, Geomembranes, Geocells, Geonets, And Soil Nails.

UNIT V

APPLICATION OF SOIL REINFORCEMENT: shallow foundations on reinforced earth, design of reinforced earth retaining walls, reinforced earth embankments structures, wall with reinforced backfill, analysis and design of shallow foundations on reinforced earth, road designs with geosynthetics.

References

1. Hausmann, M.R., Engineering Principles of Ground Modification, McGraw-Hill
2. International Editions, 1990.
3. Yonekura, R., Terashi, M. and Shibazaki, M. (Eds.), Grouting and Deep Mixing, A.A. Balkema, 1966.
4. Moseley, M.P., Ground Improvement, Blackie Academic & Professional, 1993.

5. Xanthakos, P.P., Abramson, L.W. and Bruce, D.A., Ground Control and Improvement, John Wiley & Sons, 1994.
6. Koerner, R. M., Designing with Geosynthetics, Prentice Hall Inc. 1998.
7. Shukla, S.K., Yin, Jian-Hua, "Fundamentals of Geosynthetic Engineering", Taylor & Francis.

Course Outcomes

1. Assess the site or ground conditions and judge for adopting ground improvement techniques for a particular structure and site conditions.
2. Select suitable compaction techniques or stabilization methods for improving engineering properties of soils in shallow layers.
3. To modify ground conditions by freezing and thermal methods.
4. Select suitable reinforced earth methods for stabilizing soils in retaining walls and slopes.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1			2			2		
CO2			3				2	2
CO3								
CO4			3			2		2

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPE13 PAVEMENT ANALYSIS AND DESIGN

L / week	**: 3Hrs**	**Sessional Marks : 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

Philosophy of design of flexible and rigid pavements,

UNIT II

Analysis of pavements using different analytical methods,

UNIT III

Selection of pavement design input parameters – traffic loading and volume,

UNIT IV

Material characterization, drainage, failure criteria, reliability,

UNIT V

Design of flexible and rigid pavements using different methods, Comparison of different pavement design approaches, design of overlays and drainage system.

References:

1. Yang and H. Huang, Pavement Analysis and Design, Pearson Prentice Hall, 2004.
2. Yoder and Witzech, Pavement Design, McGraw-Hill, 1982.
3. Sharma and Sharma, Principles and Practice of Highway Engg., Asia Publishing House, 1980.
4. Teng, Functional Designing of Pavements, McGraw- Hill, 1980.

Course Outcomes (COs)

The students will be able to

1. Assess the factors affecting the performance of pavements.
2. Identifying failure criteria and design flexible and rigid pavements.
3. Compare and select suitable pavement design approaches, overlays, and design aspects.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1		2	2			3		
CO2							2	2
CO3								

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GTPE22 ENVIRONMENTAL GEOTECHNOLOGY

L / week	**: 3Hrs**	**Sessional Marks**	**: 40**
University Exam	**: 3 Hrs**	**End Exam Marks**	**: 60**

UNIT I

SOIL AS A MULTIPHASE SYSTEM; Soil-environment interaction; Properties of water in relation to the porous media; Water cycle with special reference to soil medium.

UNIT II

SOIL MINERALOGY; significance of mineralogy in determining soil behavior; Mineralogical characterization.

UNIT III

MECHANISMS OF SOIL-WATER INTERACTION: Diffuse double layer models; Force of attraction and repulsion; Soil-water-contaminant interaction; Theories of ion exchange; Influence of organic and inorganic chemical interaction.

UNIT IV

CONCEPTS OF WASTE CONTAINMENT; Sources, production and classification of wastes, Environmental laws and regulations, physico-chemical properties of soil, ground water flow and contaminant transport, desirable properties of soil; contaminant transport and retention; contaminated site remediation.

UNIT V

SOIL CHARACTERIZATION TECHNIQUES; volumetric water content; gas permeation in soil; electrical and thermal properties; pore-size distribution; contaminant analysis. contaminated site characterization, estimation of landfill quantities, landfill site location, design of various landfill components such as liners, covers, leachate collection and removal, gas generation and management, ground water monitoring, end uses of landfill sites,

References

1. Mitchell, J.K and Soga, K., Fundamentals of Soil Behavior, John Wiley and Sons Inc., 2005.
2. Fang, H-Y., Introduction to Environmental Geotechnology, CRC Press,1997.
3. Daniel, D.E, Geotechnical Practice for Waste Disposal, Chapman and Hall, 1993.

4. Rowe, R.K., Quigley, R.M. and Booker, J.R., Clay Barrier Systems for Waste Disposal Facilities, E & FN Spon, 1995.
5. Rowe, R.K, Geotechnical and Geoenvironmental Engineering Handbook, Kluwer
6. Academic Publishers, 2001.
7. Reddi, L.N. and Inyang, H.F, Geoenvironmental Engineering - Principles and Applications, Marcel Dekker Inc, 2000.
8. Sharma, H.D. and Lewis, S.P, Waste Containment Systems, Waste Stabilization and Landfills: Design and Evaluation, John Wiley & Sons Inc., 1994.

Course Outcomes

1. Students can understand Soil-environment interaction, Soil mineralogy and
2. Mechanisms of soil-water interaction
3. Students can lean ground water flow and predict contaminant transport phenomenon.
4. Can apply remediation techniques for contaminated site.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1		3	2			3		
CO2								
CO3								
CO4								2

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GTPE23 CRITICAL STATE SOIL MECHANICS

L / week	**: 3Hrs**	**Sessional Marks : 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

SOIL BEHAVIOR: State of stress and strain in soils, Stress and strain paths and invariants, behavior of soils under different laboratory experiments.

UNIT II

THE CRITICAL STATE LINE and the Roscoe surface: Families of undrained tests, Families of drained tests, the critical state line, drained and undrained surfaces, The Roscoe surface.

UNIT III

BEHAVIOR OF OVER CONSOLIDATED SAMPLES: The Hvorslev surface: Behavior of Over consolidated samples, drained and undrained tests, The Hvorslev surface, complete State Boundary Surface, Volume changes and pore water pressure changes.

UNIT IV

BEHAVIOUR OF SANDS: The critical state line for sands, Normalized plots, the effect of dilation, Consequences of Taylor's model.

UNIT V

BEHAVIOR OF SOILS BEFORE FAILURE: Elastic and plastic deformations, Plasticity theory, Development of elastic-plastic model based on critical state soil mechanics, The Cam-clay model, The modified Cam-clay model.

References:

1. J. H. Atkinson and P. L. Bransby, “The mechanics of soils: An introduction to
2. critical state soil mechanics”, McGraw Hill, 1978.
3. D. M. Wood, “Soil behaviour and critical state soil mechanics”, Cambridge University Press, 1990

4. B. M. Das, "Fundamental of geotechnical engineering", Cengage Learning, 2013

Course Outcomes

The students will be able to :

1. Acquire fundamentals concept of Stresses and Strains and their states in soils.
2. Comprehend the critical state line and the Roscoe surface.
3. Gain knowledge on Cam-Clay model for analyzing the the plastic behaviour of soils before failure.
4. Familiarize with the Development of constitutive laws for geotechnical materials including linear or nonlinear elastic (hyperbolic), linear elastic perfectly plastic, and non-linear elastic-plastic models based on the Critical State Soil Mechanics theory.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	2		2			2		
CO2								
CO3		2	2					
CO4			2					2

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTCP01 GEOTECHNICAL ENGINEERING LAB - 1

Practicals / week : 4Hrs **Sessional Marks : 40**

University Exam : 3 Hrs **End Exam Marks : 60**

LIST OF PRACTICAL'S:

1. Determination of Moisture Content and Specific gravity of soil

2. Grain Size Distribution Analysis and Hydrometer Analysis

3. Atterberg Limits (Liquid Limit, Plastic limit, Shrinkage limit)

4. Visual Classification Tests

5. Vibration test for relative density of sand iclusive of in-situ density test.

6. Standard and modified proctor compaction test

7. Falling head permeability test and Constant head permeability test

8. Consolidation test.

Course Outcomes (COs):

The students will be able to:

1. Determine all Index Properties for Cohesive and Cohsionless Soils
2. Determine Density Index for Cohesionless Soils.
3. Determine Compaction Characteristics for Cohesive Soils
4. Determine Permeability Characteristics for Cohesive and Cohesionless Soils.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	2	3	3	2		3	2	1
CO2	2	3	1			2	2	
CO3		3	2	1		2	3	
CO4	2		3	2		2	2	

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTCP02 GEOTECHNICAL ENGINEERING LAB - 2

Practicals / week :	**4Hrs**	**Sessional Marks**	**: 40**
University Exam :	**3 Hrs**	**End Exam Marks**	**: 60**

LIST OF PRACTICALS

1. Unconfined compression test
2. Direct shear test
3. Tri-axial compression test – UU, CU, CD tests
4. Laboratory vane shear test
5. Swelling Characteristics (Swell Pressure, Swell Potentiol and swelling Index) by Free-Swell Odo-Meter method.
6. Swelling Characteristics by Constant Volume Method.

Course Outcomes (COs):

The students will be able to:

1. Determine Unconfined Compressive Stress for Cohesive Soils.
2. Determine shear parameter for Cohesionless Soils.
3. Determine Swelling Characteristics by different methods.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	3	3	2	2		2	2	3
CO2	3	3	2	2		2	3	2
CO3	2	3	3	2		2	2	2

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPC41 - RESEARCH METHODOLOGY AND IPR

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT 1

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT 2

Effective literature studies approaches, analysis Plagiarism, Research ethics.

UNIT 3

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT 4

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

UNIT 5

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT 6

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3. Ranjit Kumar, 2nd Edition , “Research Methodology: A Step by Step Guide for beginners”
4. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
5. Mayall , “Industrial Design”, McGraw Hill, 1992.
6. Niebel , “Product Design”, McGraw Hill, 1974.
7. Asimov , “Introduction to Design”, Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016.
9. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008.

Course Outcomes

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

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & Nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1								
CO2								
CO3								
CO4								
CO5								

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GTPC03 DYNAMICS OF SOILS AND FOUNDATIONS

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

FUNDAMENTALS OF VIBRATIONS: single, two and multiple degree of freedom systems, vibration isolation, vibration absorbers, vibration measuring instruments.

UNIT II

WAVE PROPAGATION: elastic continuum medium, semi-infinite elastic continuum medium, soil behavior under dynamic loading.

UNIT III

DYNAMIC ELASTIC CONSTANTS OF SOIL: determination of dynamic elastic constants, various methods including block resonance tests, cyclic plate load tests, wave propagation tests, oscillatory shear box test.

UNIT IV

MACHINE FOUNDATIONS: Design criteria for machine foundations; Elastic homogeneous half space and lumped parameter solutions, analysis and design of foundations for reciprocating and impact type machines, turbines, effect of machine foundation on adjoining structures.

UNIT V

BEARING CAPACITY OF FOUNDATIONS: Introduction to bearing capacity of dynamically loaded foundations, such as those of water towers, chimneys and high rise buildings.

VIBRATION ISOLATION: Active and passive types of isolation – Screening of vibrations – Isolation in existing machine foundations.

References

1. Das, B.M., “Fundamentals of Soil Dynamics”, Elsevier,1983.
2. Steven Kramer, “Geotechnical Earthquake Engineering”, Pearson,2008.
3. Prakash, S., Soil Dynamics, McGraw Hill, 1981.
4. Kameswara Rao, N.S.V., Vibration analysis and foundation dynamics, Wheeler Publication Ltd., 1998.
5. Richart, F.E. Hall J.R and Woods R.D., Vibrations of Soils and Foundations, Prentice Hall Inc., 1970.
6. Prakash, S. and Puri, V.K., Foundation for machines: Analysis and Design, John Wiley & Sons, 1998.

Course Outcomes

1. Students understands theory of vibration and resonance phenomenon, dynamic amplification
2. Students understand propagation of body waves and surface waves through soil.
3. Student exposed to different methods for estimation of dynamic soil properties required for design purpose.
4. Students apply theory of vibrations to design machine foundation based on dynamic soil properties and bearing capacity.
5. Students can predict dynamic bearing capacity and methods of vibration isolation.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	3	3	2	2			2	2
CO2		2				2		
CO3		2		3		2	3	2
CO4		2	3					2
CO5						2		2

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPC04 SUBSURFACE INVESTIGATION AND INSTRUMENTATION

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT - I GENERAL

Purpose of soil exploration – Planning a sub-surface exploration – Stages in sub-surface exploration – Depth of exploration – Lateral extent of exploration.

UNIT - II OPEN EXCAVATION AND BORINGS OF EXPLORATION

Pits and Trenches – Drifts and shafts – Auger Borings – Wash borings – Rotary drilling – Percussion drilling – Core drilling.

UNIT - III SOIL SAMPLES AND SAMPLERS

Types of soil samples – Disturbed samples – Undisturbed samples – Design features affecting the Sample Disturbance – Split Spoon Samplers – Scraper Bucket Samplers – Shellby Tubes and Thin walled Samplers – Piston Samlers – Denison Samplers – Hand-curved Samplers.

UNIT – IV IN-SITU TESTING

Standard Penetration Tests – Cone Penetration Tests – In-situ Vane Shear Test – Plate Load Test – Field Permeability Tests – In-situ Tests Using Pressure meter – Observation of Ground Water Table.

UNIT – V GEOPHYSICAL METHODS

Seismic Methods – Electrical Resistivity Methods – Electrical Profiling Method – Electrical Sounding Method – Common Soil Tests – Sub-soil Investigation Report.

References

1. Subsurface exploration and sampling of soils for Civil Engineering purposes by Hvorslev, M.J., Waterways Experiment Station, Vicksburg, Mississipi, 1949.

2. Foundation Engineering by S.P.Brahma Tata Mc Graw-Hill Publishing Company Limited, New Delhi, 1985.
3. Analysis and Design of Foundations and Retaining Structures by Shamsher Prakash, Gopal Ranjan and Swami Saran, Sarita Prakasham, Meerut, 1979.
4. Soil Mechanics & Foundation Engineering, Vol.2 by V.N.S. Murthy, Sai Kripa Technical Consultants, Bangalore.
5. Geotechnical Engineering by C.Venkatramaiah, Wiley Eastern Ltd., New Delhi. Relevant I.S. Codes.

Course Outcomes

1. Students can plan subsurface investigation based on the requirement of civil engineering project and site condition. Can finalize depth and number of boreholes
2. Students can execute different subsurface exploration tests, collect Disturbed / undisturbed samples for laboratory tests and can suggest design parameters.
3. Student exposed to different methods for estimation of soil properties required for design purpose.
4. Students can develop instrumentation scheme for monitoring of critical sites

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	3	3	2	2		2	2	
CO2	3	3	2	2		3		
CO3		2	3	3		2		3
CO4							2	

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPE31 MARINE GEOTECHNIQUES

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

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

UNIT II

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

UNIT III

SITE INVESTIGATION IN THE CASE OF MARINE SOIL DEPOSITS: 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: Different offshore and near shore foundations, Gravity platforms, Jack-up rigs.

UNIT V

DEEP FOUNDATIONS AND ANCHORS: Pile foundation – Axial capacity – Lateral capacity – Deflections – Construction – Anchored foundations.

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

Course Outcomes

The student is introduced to

1. Physical and Engineering properties of marine soils and problems specific to marine soil deposits.
2. Behavior of sands and clays under cyclic loading
3. Site investigation in marine environment including Geophysical methods.
4. Assess the factors governing the choice of the most suitable type of foundation for a given marine Structure.
5. Select the type of foundation for a given marine Structure.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	3	2				3	2	
CO2		3		2				
CO3	2	2					2	
CO4	2	3	2	2				3
CO5		3		3			2	2

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPE32 COMPUTATIONAL GEOMECHANICS

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

SOLUTION OF LINEAR EQUATIONS Jacobi's method, Gauss Seidal method, Successive over relaxation method.

UNIT II

FINITE DIFFERENCE METHOD Two point Boundary value problems – Disichlet conditions, Neumann conditions; ordinary and partial differential equations.

UNIT III

CORRELATION AND REGRESSION ANALYSIS Correlation - Scatter diagram, Karl Pearson coefficient of correlation, Limits of correlation coefficient; Regression –Lines of regression, Regression curves, Regression coefficient, Differences between correlation and regression analysis.

UNIT IV

ONE-DIMENSIONAL CONSOLIDATION - Theory of consolidation, Analytical procedures, Finite difference solution procedure for multilayered systems.

UNIT V

FLOW THROUGH POROUS MEDIA - Geotechnical aspects, Numerical methods, Applications and Design analysis.

References

1. S. Chandrakant., Desai and John T. Christian, "Numerical Methods in Geotechnical Engineering", Mc. Graw Hill Book Company, 1977.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering computations", Third edition, New Age International (P) Ltd. Publishers, New Delhi.

3. D.J. Naylor and G.N. Pande, “Finite Elements in Geotechnical Engineering”, Pineridge.

Course Outcomes

Student is able to understand

1. Solution of linear equations
2. Finite difference form of ordinary and partial differential equations
3. Difference between correlation and regression analysis.
4. Apply finite difference technique to solve complex consolidation and seepage problems in Geotechnical Engineering.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	2			2		2		2
CO2		2		2				
CO3	2			3				
CO4	2			3		2		3

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPE33 ENGINEERING ROCK MECHANICS

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

ROCK Formation of rocks, Physical properties, Classification of rocks and rock masses, Elastic constants of rock; Insitu stresses in rock. Application of Rock mechanics in Civil Engineering

UNIT II

ROCK TESTING Laboratory and Field tests including field sampling

UNIT III

DISCONTINUITIES IN ROCK MASSES Discontinuity orientation, Effect of discontinuities on strength of rock ;

UNIT IV

STRENGTH BEHAVIOUR Compression, Tension and Shear, Stress-Strain relationships, Rheological behavior

UNIT V

STRENGTH/ FAILURE CRITERION Mohr-Coulomb, Griffith theory, Hoek and Brown, strength and other strength criteria. Stresses in rock near underground openings;

References

1. Hudson J.A. and J.P. Harrison. Engineering Rock Mechanics: an Introduction to the Principles, 1997. Elsevier, Oxford
2. Goodman, R.E. Introduction to Rock Mechanics, John Wiley & Sons.
3. Ramamurthy, T., “Engineering in Rocks”, PHI Learning Pvt. Ltd.
4. Jaeger, J.C. and Cook, N.G.W, Fundamentals of Rock Mechanics, Chapman and Hall, 1976.

5. Wyllie, D.C., Foundations on Rock, E & FN Spon. 2nd Edition, 1992.

Course Outcomes

1. Assess the Physical and Mechanical properties of rocks.
2. Adopt direct & indirect methods of rock exploration.
3. Conduct different laboratory tests on rocks and analyse the results for rock properties
4. Stress Strain behavior under Compressive, tension and Shear
5. Strength criteria functions applied to Rocks.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	3	3	3	2		3		
CO2	3	3	2	3				2
CO3	3	3	2	3				2
CO4	2			3		2		
CO5	2	3		3			3	2

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPE41 EARTH RETAINING STRUCTURES

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

EARTH PRESSURE: Rankine and Coulomb theories, active, passive and pressure at rest; concentrated surcharge above the back fill, earth pressure due to uniform surcharge, earth pressure of stratified backfills, saturated and partially saturated backfill.

UNIT II

RETAINING WALLS: Proportioning of retaining walls, stability of retaining walls, mechanically stabilized retaining walls/reinforced earth retaining walls

UNIT III

SHEET PILE WALL: Free earth system, fixed earth system

BULKHEADS: Bulkheads with free and fixed earth supports, equivalent beam method, Anchorage of bulkheads and resistance of anchor walls, spacing between bulkheads and anchor walls, resistance of anchor plates.

UNIT IV

BRACED EXCAVATIONS: Earth pressure against bracings in cuts, Heave of the bottom of cut in soft clays.

UNIT V

TUNNEL AND CONDUIT: Stress distribution around tunnels, Types of conduits, Load on projecting conduits; Arching and Open Cuts: Arching in soils.

References

1. Das, Braja M., "Principles of Foundation Engineering", PWS Publishing. 1998
2. Bowles. J.E., Foundation Analysis and Design, Tata McGraw-Hill International Edition, 5th Edn, 1997.

Course Outcomes (COs)

The students will be able to:

1. Develop an understanding of the fundamental concepts that governs the behaviour of Earth and Earth Retaining Structures.
2. Analyze and Design Retaining Walls,
3. Analyze and Design Braced Cuts,
4. Analyze and Design Shafts, Tunnels and Underground Conduits.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	2	3	3	2		2	2	2
CO2	2	3	2	3			2	2
CO3	3	3	2					2
CO4	2	2	3	2		2	2	3

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPE42 DESIGN OF UNDERGROUND EXCAVATIONS

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

Introduction, planning of and exploration for various underground construction projects, stereographic projection method, principle and its application in underground excavation design.

UNIT II

Elastic stress distribution around tunnels, stress distribution for different shapes and under different in-situ stress conditions, Greenspan method, design principles, multiple openings, openings in laminated rocks, elasto-plastic analysis of tunnels, Daemen's theory

UNIT III

Application of rock mass classification systems, ground conditions in tunneling, analysis of underground openings in squeezing and swelling ground, empirical methods, estimation of elastic modulus and modulus of deformation of rocks; uniaxial jacking / plate jacking tests, radial jacking and Goodman jacking tests, long term behavior of tunnels and caverns, New Austrian Tunneling Method (NATM), Norwegian Tunneling Method (NTM), construction dewatering.

UNIT IV

Rock mass-tunnel support interaction analysis, ground response and support reaction curves, Ladanyi'selasto-plastic analysis of tunnels, design of various support systems including concrete and shotcrete linings, steel sets, rock bolting and rock anchoring, combined support systems, estimation of load carrying capacity of rock bolts

UNIT V

In-situ stress, flat jack, hydraulic fracturing and over coring techniques and USBM type drill hole deformation gauge, single and multi-point bore hole extensometers, load cells, pressure cells, etc.

Instrumentation and monitoring of underground excavations, during and after construction, various case studies.

References

1. Hoek, E and and Brown, E. T.," Underground Excavations in Rocks", Institute of Mining Engineering.
2. Obert, L. and Duvall, W.I., "Rock Mechanics and Design of Structures in Rocks", John Wiley.
3. Singh, B. and Goel, R.K.,"Rock Mass Classification- A Practical Engineering Approach", Elsevier.
4. Singh, B. and Goel, R.K., "Tunnelling in Weak Rocks", Elsevier

Course Outcomes

1. Students can plan exploration for various underground projects.
2. Students can understand the use of elastic and plastic analysis in the design of underground support system.
3. Students can classify rock masses and select suitable method for advising tunnels.
4. Design of various tunnel support system.
5. Students will have idea about the field tests generally conducted during and after construction of under structures.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	2	3				2	2	
CO2	2	2		2		2	2	
CO3	3	3		2		2	2	2
CO4		2	2	2		2	2	
CO5	3	2				2	3	2

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPE43 PHYSICAL AND CONSTITUTIVE MODELLING IN GEOMECHANICS

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

ROLE OF CONSTITUTIVE MODELING Importance of laboratory testing with relation to constitutive modeling; Elasticity: linear, quasi linear, anisotropic;

UNIT II

PLASTICITY BASICS: yield criteria, flow rule, plastic potential, hardening/softening; Rate Independent Plasticity: mohr-coulomb, nonlinear failure criteria, Drucker Prager, and cap models;

UNIT III

CRITICAL STATE SOIL MECHANICS: critical state concept, cam clay models, simulation of single element test using cam clay,

UNIT IV

CONSOLIDATION, drained and undrained triaxial test; Stress dilatancy theory;

UNIT V

WORK HARDENING PLASTICITY THEORY: formulation and implementation; Applications of elasto-plastic models; Special Topics: hypoelasticity-plasticity, disturbed state concept.

References

1. Hicher and Shao, “Constitutive Modeling of Soils and Rocks”, John Wiley. 2008
2. C.S. Desai and H. J. Siriwardane, “Constitutive Laws for Engineering Materials with
3. Emphasis on Geologic Materials”, Prentice-Hall, Inc., New Jersey. 1984
4. David M Potts and LidijaZdravkovic, “Finite Element Analysis in Geotechnical Engineering Theory and Application”, Thomas Telford. 1999

5. C.S. Desai, “Mechanics of Materials and Interfaces: The Disturbed State Concept”, CRC Press LLC. 2000
6. A.P.S. Selvadurai, M.J. Boulon, “Mechanics of Geomaterial Interfaces, Elsevier.

Course Outcomes

1. Stress strain models of elasticity of isotropic and anisotropic models.
2. Students can understand theory of plasticity and various yield criteria and flow rule.
3. Students can apply critical state concept to consolidation and triaxial soil behavior.
4. Students can understand the application aspects of elastic plastic models.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	2			3				2
CO2	2		2				2	2
CO3	2	2		2		2		2
CO4							2	2

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTCP03 SUB SOIL EXPLORATION

L / week	**: 4Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

LIST OF PRACTICALS

1. Field vist
2. Field sampling and transports
3. Determination of Identification tests.
4. Determination of Engineering properties
5. Assessment of Allowable Bearing Pressure of foundations.

Course Outcomes (COs)

1. Evaluate vertical and lateral extent of exploration; identify, select, and plan different stages of subsurface exploration for various civil engineering projects.
2. Discriminate, Classify and analyses different techniques of exploration to be adopted in rocks and soils.
3. Discriminate different types of soil samples, samplers and judge the appropriateness of a sample or sampler for practical cases accounting for the safety and economy.
4. Evaluate different in-situ methods of tests to determine engineering properties of soils and locate Ground water table required for safe and economic design of foundations.
5. Methods of planning, executing, implementing, interpreting, and reporting subsoil investigations based on geophysical methods.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1		3					2	
CO2	3	2	2			2		2
CO3	2	2						2
CO4	2	3		2		2	2	2
CO5	2	2		2				2

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTCP04 NUMERICAL ANALYSIS LAB

L / week : 4Hrs **Sessional Marks 40**

University Exam : 3 Hrs **End Exam Marks : 60**

SYLLABUS CONTENTS

1. Develop and Analysis of laboratory tests results using Spread sheets
2. Develop and analysis of Spread sheets for stress distribution, Bearing Capacity and settlements
3. Curve fitting

Course Outcomes (COs)

Student can be

1. Develop and Analysis of laboratory tests results using Spread sheets
2. Develop and analysis of Spread sheets for stress distribution for different loading conditions.
3. Determine Bearing Capacity of given soil sample.
4. Able to determine settlements

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	3	2					2	2
CO2				3				
CO3		3		2			2	
CO4	2	2		3			2	2

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPE51 STABILITY ANALYSIS OF SLOPES

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

SLOPES Types and causes of slope failures, mechanics of slope failure, failure modes.

UNIT II

STABILITY ANALYSIS Infinite and finite slopes with or without water pressures; concept of factor of safety, pore pressure coefficients, Mass analysis, Wedge methods, friction circle method ; Method of slices, Bishop's method, Janbu's method, Morgenstern and Price, Spencer's method.

UNIT III

STABILITY ANALYSIS IN THE PRESENCE OF SEEPAGE Two dimensional flow – Laplace equation and it's solution, graphical method, determination of phreatic line, flow nets in homogeneous and zoned earth dams under steady seepage and draw-down conditions, seepage control in earth dams, influence of seepage on slope stability stability analysis of dam body during steady seepage.

UNIT IV

STRENGTHENING MEASURES: stabilization of slopes by drainage methods, surface and subsurface drainage, use of synthetic filters, retaining walls, stabilization and strengthening of slopes, shotcreting, rock bolting and rock anchoring.

UNIT V

Instrumentation and monitoring of slopes, slope movements, warning devices, maintenance of slopes

References:

1. Chowdhary R and ChowdharyI , ”Geotechnical Slope Analysis”, CRC Press.
2. Harr M.E.,” Ground Water and Seepage”, McGraw Hill. 1962

Course Outcomes

1. Identifying types and causes of slope failures.
2. Student will be able to check the stability of earthen dams
3. The safety measures to be undertaken to prevent the instability of slopes, earthen dams and embankments.
4. Understand maintenance and monitoring of slopes.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	2	2	3			2		
CO2	2	2	2				2	
CO3	2	2	3			2	2	2
CO4	2		3				2	

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPE52 FOUNDATIONS ON WEAK ROCKS

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

Engineering properties of weak rocks, different rock mass classification systems, relative merits and demerits. Failure criteria for weak rocks, bi-linear Mohr-Coulomb failure criterion, Hoek and Brown criterion and modified Hoek and Brown failure criterion etc.

UNIT II

Effect of structural planes on rock foundations, possible modes of failure of foundations on rocks/ rock masses, determination of in-situ shear strength of rocks and rock masses

UNIT III

Requirements for satisfactory performance of foundations, bearing capacity of foundations on rocks and rock masses, allowable bearing pressure of rock foundations using a nonlinear failure criterion, monotonic and cyclic plate load tests. Pressure-settlement characteristics, effect of layering, anisotropy, heterogeneity andinelasticity

UNIT IV

Shallow foundations, shallow foundations on sloping ground, raft foundations, stilt foundations, foundations for suspension bridges, transmission line towers, framed buildings etc, treatment of foundations - open joints, solution cavities, weak seams

UNIT V

Piles in weak rocks, bearing capacity and settlement of piles, piles in stratified rock masses, field load tests on piles in weak rocks, behaviour of bored / driven piles in soft / weathered rocks.

References

1. Wyllie Duncan C.," Foundations on Rock: Engineering Practice", E&FN Spon, Taylor and Francis.

2. Hudson J.A. and J.P. Harrison. Engineering Rock Mechanics: an Introduction to the Principles, 1997. Elsevier, Oxford
3. Singh, B. and Goel, R.K.,"Rock Mass Classification- A Practical Engineering Approach", Elsevier.
4. Ramamurthy, T., "Engineering in Rocks", PHI Learning Pvt. Ltd.
5. Hoek, E., "Practical Rock Engineering", Rock science.

Course Outcome

The students will be able to

1. Understand Rock mass classification and its Engineering properties.
2. Determine engineering properties of in-situ rocks and modes of failure associated.
3. Assess allowable Bearing pressure.
4. Design different types of foundations planned over rock mass.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	3	2						
CO2	3	2						
CO3	2		3					
CO4	2	3		2		3		2

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTPE53 GEOTECHNICAL EARTHQUAKE ENGINEERING

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

EARTHQUAKE SEISMOLOGY Causes of earthquake, Plate tectonics, Earthquake fault sources, Seismic waves, Elastic rebound theory, Quantification of earthquake, Intensity and magnitudes, Earthquake source models.

UNIT II

EARTHQUAKE GROUND MOTION Seismograph, Characteristics of ground motion, Effect of local site conditions on ground motions, Design earthquake, Design spectra, Development of site specification and code-based design.

UNIT III

GROUND RESPONSE ANALYSIS One-dimensional ground response analysis: Linear approaches, Equivalent linear approximation of non-linear approaches.

UNIT IV

LIQUEFACTION AND LATERAL SPREADING Liquefaction related phenomena, Liquefaction susceptibility: Historical, Geological, Compositional and State criteria. Evaluation of liquefaction by cyclic stress and cyclic strain approaches, Lateral deformation and spreading, Criteria for mapping liquefaction hazard zones.

UNIT V

Seismic design of foundations, Seismic slope stability analysis: Internal stability and weakening instability and Seismic design of retaining walls.

References

1. Steven Kramer, “Geotechnical Earthquake Engineering”, Pearson,2008.
2. Seco e Pinto, P., Seismic behaviour of ground and Geotechnical structure, A. A.
3. Naeim, F., The Seismic Design Handbook, Kluwer Academic Publication, 2ndEdition, 2001.
4. Ferrito, J.M, Seismic design criteria for soil liquefaction, Tech. Report of Naval Facilities service centre, Port Hueneme, 1997.

Course Outcomes

1. Students will know the causes and quantification of earthquake.
2. Student will be exposed to the effect of earthquake and ground motion.
3. Student will be able to understand Ground response analysis and Liquefaction effects.
4. Student will be able to understand the seismic design of foundation

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	2	3	3			2	2	
CO2		2	3			2	2	
CO3			2	2			2	3
CO4			2	2		2		3

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTOE11 BUSINESS ANALYTICS

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT II

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology

UNIT III

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT IV

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT V

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

UNIT VI

Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Reference

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

Course Outcomes

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionable insights.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1				2		2	2	
CO2			2	2		2		
CO3				3			3	
CO4				2		2	2	

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTOE12 INDUSTRIAL SAFETY

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of

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

References

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Course Outcomes

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionable insights.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1				2		2	2	
CO2			2	2		2		
CO3				3			3	
CO4				2		2	2	

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**

GTOE13 OPERATIONS RESEARCH

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

UNIT II

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

UNIT III

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

UNIT IV

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

UNIT V

Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008.
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010.

Course Outcomes

1. Students should able to apply the dynamic programming to solve problems of discreet and Continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	3			2		2		2
CO2				2			2	
CO3						2	2	
CO4			2	2				2

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GTOE14 COST MANAGEMENT OF ENGINEERING PROJECTS

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

INTRODUCTION AND OVERVIEW OF THE STRATEGIC COST MANAGEMENT PROCESS

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

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

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

References

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

Course Outcome

1. Students should able to apply the dynamic programming to solve problems of discreet and Continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	2						2	2
CO2								3
CO3			2					2
CO4		2		3		2		3

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GTOE15 COMPOSITE MATERIALS

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

EARTHQUAKE SEISMOLOGY Causes of earthquake, Plate tectonics, Earthquake fault sources, Seismic waves, Elastic rebound theory, Quantification of earthquake, Intensity and magnitudes, Earthquake source models.

UNIT II

EARTHQUAKE GROUND MOTION Seismograph, Characteristics of ground motion, Effect of local site conditions on ground motions, Design earthquake, Design spectra, Development of site specification and code-based design.

UNIT III

GROUND RESPONSE ANALYSIS One-dimensional ground response analysis: Linear approaches, Equivalent linear approximation of non-linear approaches, Computer code "SHAKE".

UNIT IV

Liquefaction and lateral spreading - Liquefaction related phenomena, Liquefaction susceptibility: Historical, Geological, Compositional and State criteria. Evaluation of liquefaction by cyclic stress and cyclic strain approaches, Lateral deformation and spreading, Criteria for mapping liquefaction hazard zones.

UNIT V

Seismic design of foundations, Seismic slope stability analysis: Internal stability and weakening instability and Seismic design of retaining walls.

Text Books

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

References

1. Steven Kramer, "Geotechnical Earthquake Engineering", Pearson,2008.
2. Seco e Pinto, P., Seismic behaviour of ground and Geotechnical structure, A. A.
3. Naeim, F., The Seismic Design Handbook, Kluwer Academic Publication, 2ndEdition, 2001.
4. Ferrito, J.M, Seismic design criteria for soil liquefaction, Tech. Report of Naval Facilities service centre, Port Hueneme, 1997.

Course Outcome

1. Students should able to apply the dynamic programming to solve problems of discreet and Continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis Student should able to model the real world problem and simulate it

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	2						2	2
CO2								3
CO3			2					2
CO4		2		3		2		3

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GTOE16 WASTE TO ENERGY

L / week	**: 3Hrs**	**Sessional Marks 40**
University Exam	**: 3 Hrs**	**End Exam Marks : 60**

UNIT I

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

References

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I &II, Tata McGraw Hill Publishing Co. Ltd., 1983.

3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Course Outcomes

1. Students should able to apply the dynamic programming to solve problems of discreet and Continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis Student should able to model the real world problem and simulate it.

PO&PSO / CO	PO1	PO2	PO3	PO4		PSO1	PSO2	PSO3
CO1	2						2	2
CO2								3
CO3		2		3		2		3

***1: Low Correlated, 2: Moderately Correlated, 3: Highly Correlated**