ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech., Programme: Geotechnical Engineering (GTE),
Duration: 2 years (Four Semesters)

Abbreviation used:

AC	Audit course	LC	Lab Course	PA	Practical Assessment
PC	Professional Core	PR	Project/ Practical/ Internship	L	Lecture
PE	Professional Elective	SE	Seminar/ Expert Lecture/ Etc.	T	Tutorial
OE	Open Elective	IA*	Internal Assessment	P	Practical
MC	Mandatory/ Common Course	EA	End-Semester Assessment		

Subject Code Format:

A1	A2	B3	C4	C5	C6
School/ Dept. (Offering) **BH:** Basic Sciences and Humanities **CS:** Computer Sciences **EE:** Electrical Sciences **EI:** Electronic Sciences **IP:** Infrastructure and Planning **MS:** Mechanical Sciences **BT:** Biotechnology **TE:** Textile Engineering		**Level** **1:** UG/ Int. Msc. (1st Year) **2:** UG/ Int. Msc. (2nd Year) **3:** UG/ Int. Msc. (3rd Year) **4:** UG/ Int. Msc. (4th Year) **5:** UG/ Int. Msc. (5th Year) **6:** PG (1st Year) **7:** PG (2nd Year) **8:** Ph.D.	**0:** AC **1:** PC **2:** PE **3:** OE **4:** MC **5:** LC **6:** PR **7:** SE **8:** **9:**	**Serial Number (01 to 99)** 01/ 03/…/ 19: Odd Sem. (GTE) 21/ 23/…/ 39: Odd Sem. (STE) 41/ 43/…/ 59: Odd Sem. (WRE) 61/ 63/…/ 79: Odd Sem. (URP) 81/ 83/…/ 99: Odd Sem. (Prog-5) 02/ 04/…/ 20: Even Sem. (GTE) 22/ 24/…/ 40: Even Sem. (STE) 42/ 44/…/ 60: Even Sem. (WRE) 62/ 64/…/ 80: Even Sem. (URP) 82/ 84/…/ 98: Even Sem. (Prog-5)	

1st Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 1	IP6101	Advanced Geo-mechanics	3	0	0	3	40	60	-	100
2	PC 2	IP6103	Ground Improvement Technique	3	0	0	3	40	60	-	100
3	PE 1 (Any One)	IP6201	Earth Retaining Structures	3	0	0	3	40	60	-	100
		IP6203	Transportation Geo-technics								
		IP6205	Rock Mechanics								
4	MC 1	BH6401	Mathematical Methods in Engineering	3	0	0	3	40	60	-	100
5	MC 2	MS6403	Research Methodology and IPR	2	0	0	2	40	60	-	100
6	LC 1	IP6501	Advanced Geotechnical Engineering Lab	0	0	4	2	-	-	100	100
7	LC 2	IP6503	Computational Geotechnics Lab	0	0	4	2	-	-	100	100
8	AC 1	Any One from the List of AC 1 (Appendix-I)		2	0	0	0	40	60	-	100
			Total	**16**	**0**	**8**	**18**	**240**	**360**	**200**	**800**

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2nd Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 3	IP6102	Advanced Foundation Engineering	3	0	0	3	40	60	-	100
2	PC 4	IP6104	Dynamics of Soils and Foundation	3	0	0	3	40	60	-	100
3	PE 2 (Any One)	IP6202	Soil Structure Interaction	3	0	0	3	40	60	-	100
		IP6204	Subsoil Exploration and Soil Testing								
		IP6206	Geo-environmental Engineering								
4	PE 3 (Any One)	IP6208	Finite Elements in Geo-mechanics	3	0	0	3	40	60	-	100
		IP6210	Geo-synthetics and Reinforced Soil Structures								
		IP6212	Offshore Geo-mechanics								
5	OE 1	Any One from the List of OE 1 (Appendix-I)		3	0	0	3	40	60	-	100
6	PR 1	IP6602	Project (Specialization Related)	0	0	4	2	-	-	100	100
7	LC 3	IP6502	Geotechnical Engineering Design Practice	0	0	4	2	-	-	100	100
8	AC 2	Any One from the List of AC 2 (Appendix-I)		2	0	0	0	40	60	-	100
			Total	**15**	**0**	**8**	**19**	**240**	**360**	**200**	**800**

3rd Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PE 4* (Any One)	IP7201	Ground Water and Flow through porous Media	3	0	0	3	40	60	-	100
		IP7203	Geotechnical Earthquake Engineering								
		IP7205	Stability Analysis of slopes, Embankments and Dams								
2	PR 2	IP7601	Dissertation (Phase-I)	0	0	24	12	-	-	100	100
			Total	**3**	**0**	**24**	**15**	**40**	**60**	**100**	**200**

* Virtual/Online Course either offered by OUTR or available in MOOCs platform (No physical class)

4th Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PR 3	IP7602	Dissertation (Phase-II)	0	0	32	16	-	-	100	100
			Total	**0**	**0**	**32**	**16**	**-**	**-**	**100**	**100**

Credits and Maximum Marks

Sl. No.	Semester	Credits	Maximum Marks
1	1st	18	800
2	2nd	19	800
3	3rd	15	200
4	4th	16	100
	Total	68	1900

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1st Semester

PC 1	IP6101	Advanced Geo-mechanics	3	0	0	3

Course Objective:

1. To strengthen the theoretical platform and provide insight for solving various practical geotechnical problems.
2. To obtain a thorough understanding of soil formation and effect of particle size on strength properties of soil.
3. To determine soil consolidation time and associated settlements for different types of soil.
4. To predict and control deformation and failure of soil
5. To acquire a deep understanding of strength behaviour of soil using various methods to address several geotechnical concerns
6. To ensure stability of soil and limit deformation while controlling groundwater flow.

Module I

Soils, rocks and groundwater*:* Geology and genesis of soils and Soil formation- Types of soils and their characteristics; Soil-air-water interaction; Particle sizes and shapes, their impact on engineering properties, Concept of effective stress principle of effective stress, indices and phase relationships, soil-water behavior.

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)

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

Module III

Theories of failure: 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. Elastic and plastic deformations: elastic wall; introduction to yielding and hardening; yield curve and yield surface, associated and non-associated flow rule.

Text/References Books:

1. B M Das, Advanced Soil Mechanics, Taylor and Francis Wood, D.M., Soil Behaviour and Critical State Soil Mechanics, Cambridge University Press, 1991.
2. Bolton, M.D., A Guide to Soil Mechanics, Cambridge University Press, 1991.
3. Salgado, R., The Engineering of Foundations, McGraw Hill, 2008.
4. Atkinson, 'Critical State Soil Mechanics'
5. McCarthy D.F., Essentials of Soil Mechanics & Foundations, Prentice-Hall, 2002.

Course Outcome:

CO1: Analyze advanced soil strength testing and stress paths results considering drained and undrained behavior
CO2: Interpret constitutive equation to solve various geotechnical problems
CO3: Appraise the shear strength of soils and rocks
CO4: Draw on various soil models to define soil behavior
CO5: Investigate stability of soil and rock slopes
CO6: Explain and Apply earth pressure theories to design basic retaining walls and other geotechnical structures

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	H	H	M	M	L	L	M	L	M	H	M	H	H	H
CO2	H	H	H	H	H	L	M	M	M	H	H	M	H	M	H
CO3	H	H	H	H	M	M	L	L		L	M	L	H	M	H
CO4	M	H	M	M	H	L	M	M	L	H	M	L	M	L	M
CO5	H	H	H	M	M	L	L	M		M	M	M	H	M	H
CO6	H	H	H	M	H	M	L	M		M	M	M	H	L	M

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PC 2	IP6103	Ground Improvement Technique	3	0	0	3

Course Objectives:

1. To know about Necessity of ground improvement
2. To explain the various methods of ground improvement technique.
3. To explain the Field compaction and its control.
4. To explain about soil stabilization and principles of grouting.
5. To explain the Use of geo-synthetics and geo-cells in construction work.
6. To analyze and design the dewatering System

Module I

Introduction: Engineering properties of soft, weak and compressible deposits; Role of Ground Improvement in Foundation Engineering, Methods of Ground Improvement: Selection of Suitable ground improvement techniques

Module II

Mechanical Stabilization: Suitability of soil, blending of borrow materials, method of compaction, effect of compaction on various soil parameters, field compaction and its control

Chemical Stabilization: using lime, cement, bitumen, salt, disperse sand

In-place Stabilization Techniques: Vibro-Compaction, Blasting, Compaction Pile, Heavy Tamping, Dynamic Compaction, De-Watering, Preload and Consolidation, Electro-Osmosis, Thermal Stabilization, Grouting, Soil Nailing, Stone Columns, Chemical Columns

Module III

Reinforced Soil: Mechanical Reinforced Material, Reinforced Soil Interaction, Geosynthetics, Principles, Analysis & Design of Reinforced Retaining Structure, Embankment & Slopes: Ground Improvement Techniques for Geotechnical Earthquake Engineering, Case Studies for GIT

Text/Reference Books:

1. Hausmann, M.R., Engineering Principles of Ground Modification, McGraw-Hill International Editions, 1990.
2. Yonekura, R., Terashi, M. and Shibazaki, M. (Eds.), Grouting and Deep Mixing, A.A. Balkema, 1966.
3. Moseley, M.P., Ground Improvement, Blackie Academic & Professional, 1993.
4. Xanthakos, P.P., Abramson, L.W. and Bruce, D.A., Ground Control and Improvement, John Wiley & Sons, 1994.
5. Koerner, R. M., Designing with Geosynthetics, Prentice Hall Inc. 1998.
6. Shukla, S.K., Yin, Jian-Hua, "Fundamentals of Geosynthetic Engineering", Taylor & Francis.
7. NV NAAYAK: Foundation Design Manual, Dhanpat Rai & Sons

Course Outcomes:

CO1: Understand the Necessity of ground improvement
CO2: Explain the various methods of ground improvement techniques
CO3: Explain the Field compaction and its control
CO4: Know about soil stabilisation and principles of grouting
CO5: Explain and apply the Use of geo-synthetics and geo-cells in construction work
CO6: Analyse and design of the dewatering System

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12	PSO1	PSO2	PSO3
CO1	M	H		M	H		H			M	H	M	H		M
CO2	H	H	M	H	H		H			M	H	H	H		M
CO3	H	H	H	H	H		M			M	M	M	H		M
CO4	H	H	M	H	H	L	M			M	L	H	H		M
CO5	H	H		H	H		H			M	H	H	H		M
CO6	H	H		H	H		M			M	M	M	H		M

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PE 1	IP6201	Earth Retaining Structures	3	0	0	3

Course Objective:

1. To understand Theories of earth pressure:
2. To study the types of Retaining Wall
3. To design the retaining Wall
4. To understand and analyze Sheet pile and cofferdam
5. To understand and analyze stability of the earth dam
6. To analyse the seismic stability of earth retaining structures.

Module I

Earth pressure, introduction, earth pressure as a stability problem, concept of strain dependence of developed stresses, active, at rest and passive conditions, plastic equilibrium, various theories related with E.P. Distillation, Rankine, Coulomb and Hansen theoretical derivation and graphical construction with different geometric and boundary conditions.

Module II

Types of retaining walls. Gravity, Cantilever, Counter fort. Basement or foundation retaining walls. Design principles of retaining walls, abutments and wing walls; allowable bearing capacity settlement tilting. Safety against general slip failure.
Sheet pile and Cofferdam. Type, material, method of construction, distribution of earth pressure and related approximation. Distinction between Sheet Pile and Retaining wall, analysis and design; Deep Excavation and Braced -Cuts

Module III

Earth - structure - Definition features of an earth dam, stability analysis of slope, total - vs. - effective stress analysis. Stability of earth dams during different stages - during and at end of construction, steady seepage, and sudden draw down, estimation of pore water pressure - use of stability charts. Seismic Stability of Earth Retaining Structure

Text/Reference Books:

1. J.L.Sherard, R.J.Woodward, S.F.Gizienski, and W.A. Clevenger, Earth and Earth –Rock Dams Engineering Problems of Design and Construction, John Wiley and Sons, New York, 1963.
2. R F Craig, Soil Mechanics, Chapman and Hall(ELBS)
3. C. Justin and Hinds, Engineering for Dams Vol. 2 & 3.
4. S. Leliavsky, 'Design of Dams for Percolation and Erosion', Chapman and Hall.

Course Outcome:

CO1: Explain various Theories of earth pressure:
CO2: Analyze different types of Retaining Wall
CO3: Design a retaining Wall
CO4: Design a Sheet pile and cofferdam
CO5: Investigate the stability of the earth dam
CO6: Investigate the seismic stability of earth retaining structures.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO1	PSO 2	PSO3
CO1	L	M	L	L	H		M			M		H	M		H
CO2	L	M	L	M	H		M			M		H	M		H
CO3	H	H	M	H	H		M			M		H	H		H
CO4	H	H	M	H	H		M			M		H	H		H
CO5	H	H	M	H	H		M			M		H	H		H
CO6	H	H	M	H	H		M			M		H	H		H

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PE 1	IP6203	Transportation Geo-technics	3	0	0	3

Course Objective:

1. To make students understand the Importance of Geo-Techniques in transportation engineering.
2. To explain the geotechnical properties of geo-materials properties.
3. To explain the behavioral characteristic of compacted geometries.
4. To explain the dynamic behaviors of geo-materials using Compaction technology.
5. To explain in detail modeling advanced transportation system.
6. A case study on sustainable infrastructure construction in transportation.

Module I

Introduction: Aspects of geotechnics for roads, highways, railways and airfields; Geotechnical properties of geomaterials (soils, rocks, soil and rock mixtures, and recycled and alternative materials) for rational and sustainable design and construction.

Module II

Behaviour of compacted geomaterials, behaviour of stabilized geomaterials (mixtures of soils with - cement, lime, fly ash, polymers and other kind of geomaterials), geosynthetics and reinforcement of constructed layers and interlayers.
Compaction technology, compaction management, maintenance technology, climatic effects such as freezing and thawing, embankments for highways and railways, transition zones, dredging, underwater geotechnics for infrastructure purposes.

Module III

Modeling of multi-layered structures and supporting ground under dynamic and repeated loads. Case studies applicable to sustainable transportation infrastructure construction.

References:

1. Advances in Transportation Geotechnics: Proceedings of the International Conference held in Nottingham, UK, 25-27 August 2008.
2. Advances in Transportation Geotechnics II - Proceedings of the 2nd International Conference on Transportation Geotechnics, ICTG 2012.
3. TeruoNakai, Constitutive Modeling of Geomaterials: Principles and Applications

Course Outcome:

CO1: Understand importance of geo-techniques in transportation engineering.
CO2: Evaluate geotechnical parameter of geo-materials.
CO3: Evaluate geotechnical behaviors of compacted geo-materials.
CO4: Application of geo-materials in transportation engineering.
CO5: Understand modeling of advanced transportation systems.
CO6: Understand the sustainability of infrastructure in transportation engineering.

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
CO 1	H	M	L	L	L				L	M	L	H	H	L	L
CO 2	M	H	M	L	M				L	L	L	M	M	L	L
CO 3	M	H	M	L	H				L	L	L	H	M	L	L
CO 4	L	H	H	M	M		L		L	L	L	M	M	L	M
CO 5	L	H	M	H	H		M		L	L	L	M	M	M	M
CO 6	L	H	M	M	H		H		L	L	L	M	M	L	M

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PE 1	IP6205	Rock Mechanics	3	0	0	3

Course Objective:

1. To make students understand Importance of rock mechanics to engineering problems.
2. To make students understand application of rock mechanics to engineering problems.
3. To explain the determination of rock properties using different laboratory and field test.
4. To explain dynamic properties of rock properties.
5. To explain in detail tunnel design.
6. To make student understand of stabilization of rock using ground improvement techniques.

Module I

Introduction, Importance and application of rock mechanics to engineering problems; Classification, Lithological classification of rocks, Engineering classification of intact and fissured rocks, Classification of fissures, joints and faults; Engineering properties of rocks.

Module II

Rock Testing: Laboratory and Field tests; Simple methods of determining in-situ stresses, Borehole over covering technique, Bore hole deformation gauges, Evaluation of rock stresses and deformation around tunnels;
Strength Behaviour: Compression, Tension and Shear, Stress-Strain relationships, Rheological behavior; Strength/ Failure

Module III

Criterion: Coulomb, Mohr, Griffith theory of brittle strength and other strength criteria. Stresses in rock near underground openings; Application of rock mechanics in Civil Engineering: Rock tunneling, Rock slope stability, bolting, blasting, grouting and rock foundation design.

Text/Reference Books:

1. W. Farmer, Engineering Behavior of Rocks, Chapman and Hall Ltd.
2. R. E. Goodman, Introduction to Rock Mechanics
3. P.R. Sheorey, Empirical Rock Failure Criteria, Balkema, Rotterdam, 1997
4. V.S. Vutukuri and R D Lama, Hand Book on Mechanical Properties

Course Outcome:

CO1: Understand Engineering properties of rocks.
CO2: Application of rock mechanics in civil engineering**.**
CO3: Evaluate Engineering properties of rocks.
CO4: Evaluate dynamic properties of rocks.
CO5: Analysis rock stresses and deformation around tunnels.
CO6: Application of ground improvement techniques in rock structure.

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	M	H	M	L	L				L	L	L	L	M	L	L
CO 2	L	H	M	M	M		L		L	L	L	M	M	L	M
CO 3	M	H	H	M	L				L	L	L	L	M	L	L
CO 4	M	H	H	M	L				L	L	L	H	M	L	L
CO 5	L	H	H	M	M		L		L	L	L	H	M	L	M
CO 6	L	H	M	M	L		L		L	L	L	M	M	L	M

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MC 1	BH6401	Mathematical Methods in Engineering	3	0	0	3

Refer Appendix-I for detailed Syllabus.

MC 2	MS6403	Research Methodology and IPR	2	0	0	2

Refer Appendix-I for detailed Syllabus.

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LC 1	IP6501	Advanced Geotechnical Engineering Lab	0	0	4	2

Course Objective:

1. To make students understand the concept of various soil parameters.
2. To explain the geotechnical properties in-situ experiments.
3. To make student determine the geotechnical properties using laboratory and field method.

Syllabus

Field Density Test, Swelling Pressure Test, Static and Cyclic Triaxial Test, Standard Penetration test; Field vane shear test; Cone penetration tests; Plate load test (both field and laboratory); Pile load tests; Non-destructive testing of piles; Pressure meter test; Dilatometer Test, Geophysical Exploration; Field Visit.

Course Outcomes:

CO1: Evaluate soil characteristics.
CO2: Understand the benefit from hands-on learning during field visits to reinforce theoretical knowledge.
CO3: Evaluate the soil characteristics in field condition.
CO4: Analysis the soil characteristics in both field and laboratory condition.

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	H	H	M	H	M		L	L	L	L	L	M	H	M	H
CO 2		L	H	M	M		M	L	L	L	L	H	M	H	H
CO 3		L	H	M	H		L	L	M	L	L	H	M	M	H
CO 4		L	H	H	M		L	L	L	L	L	H	H	M	H

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LC 2	IP6503	Computational Geotechnics Lab	0	0	4	2

Course Objective:

1. To get introduced to various software used in Geotechnical Analysis.
2. To learn MATLAB software for geotechnical analysis
3. To learn GEOSTUDIO & GEO-5 software to solve geotechnical problems
4. To learn PLAXIS & L-PILE software to solve geotechnical problems

Syllabus

Introduction to MATLAB and some Geotechnical free softwares (DEEPSOIL, OpenSeesPL, GEO-STUDIO, GEO5, L-PILE, CYCLIC 1D, etc.) to solve problems related to Civil Engineering/Geotechnical Engg.

Course Outcomes:

CO1: Know the various softwares used in Geotechnical Analysis.
CO2: Use MATLAB software for geotechnical analysis
CO3: Use GEOSTUDIO & GEO-5 software to solve geotechnical problems
CO4: Use PLAXIS & L-PILE software to solve geotechnical problems.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO1	PSO 2	PSO3
CO1	L	M	L	M	H							H	H		M
CO2	H	H	M	H	H							H	H		H
CO3	H	H	H	H	H							H	H		H
CO4	H	H	H	H	H							H	H		H

AC 1	Any One from the List of AC 1 (Appendix-I)	2	0	0	0

Refer Appendix-I for detailed Syllabus.

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2nd Semester

PC 3	IP6102	Advanced Foundation Engineering	3	0	0	3

Course Objective:

1. To make students understand Allowable total and differential settlement of structures.
2. To explain in detail of shallow foundation, deep foundations, Caission foundation.
3. To analyze foundations on problematic soils

Module I

Shallow foundation: Requirements for satisfactory performance of foundations, method of estimating bearing capacity Effect of eccentricity, inclined load, layered soil interface, foundation in slope, settlement of footing and rafts, proportion using field test data, IS Code

Module 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, IS Code Methods

Module III

Caission foundation: IS and IRC codal provisions, elastic theory and ultimate resistance methods, Shrinking, Method of Construction

Foundations on problematic soils: Foundations for collapsible and expansive soil

Text/Reference Books:

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:

CO1: Evaluate Bearing capacity factors and settlement.
CO2: Design the shallow foundations
CO3: Design of pile foundation
CO4: Understand the Caission foundation
CO5: Design of various shallow and deep foundations in accordance with various codal provisions
CO6: Analysis of foundations on problematic soils

COs	PO1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
CO1	H	H	H	L	L	M			L	L	M	M	H	M	L
CO2	H	H	H	H	L	H		L	L	M		M	H	H	M
CO3	H	H	H	L	L	L		L	L	M		M	H	M	L
CO4	H	H	M	L	L	L		L	L	L		M	H	M	L
CO5	H	H	M	M	L	M	L	M	M	H	M	H	H	M	L
CO6	H	M	L	M		L	L	L				L	H		M

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech., Programme: Geotechnical Engineering (GTE),
Duration: 2 years (Four Semesters)

PC 4	IP6104	Dynamics of Soils and Foundation	3	0	0	3

Course Objective:

1. To understand deep into various aspects of soil dynamics and theory behind different types of vibrations.
2. To develop an idea on each topic in logical progression with reference to recent developments in structure-soil-structure dynamics.
3. To understand and apply the theories of wave propagation in elastic media, evaluate dynamic properties of soil by various lab and field-testing methods.
4. To familiarise and provide knowledge on liquefaction and its assessment.
5. To gain practical knowledge of machine foundation design with different loading types
6. To identify different vibration isolation methods with a brief idea about various screening methods.

Module I

Soil Dynamics: Introduction: Soil mechanics and soil dynamics, problems of dynamic loading on soil structure. Theory of vibrations: Introduction, definitions, properties of simple harmonic motion, free vibrations of spring-mass system, Equations for free and forced vibrations with and without viscous damping.

Module II

Wave Propagation: Waves in semi-infinite body; Waves in layered medium; Earthquake waves – P-wave, S-wave, Rayleigh wave and Love wave. Dynamic Soil Properties: Introduction, measurement of dynamic soil properties (Stress and strain controlled cyclic tri-axial tests, stress-strain behavior of cyclically loaded soils, strength of cyclically loaded soils.

Introduction to Liquefaction of soils: Liquefaction mechanism, factors affecting liquefaction, assessment of liquefaction potential. Machine Foundations: Types of machines; Basic design criteria; Methods of analysis; Mass-Spring-Dashpot model; Elastic-Half-Space theory; Tschebotarioff's reduced natural frequency method; Types of foundations; Modes of vibrations; Vertical, sliding, torsional (yawing) and rocking (and pitching) modes of oscillations;

Module III

Design guidelines of Machine Foundations as per codes; Typical design problems for reciprocating, Impact and rotary machine foundations.

Vibration isolation and screening: force isolation, motion isolation, active and passive screening.

Text/Reference Books:

1. Geotechnical Earthquake Engineering by Steven L. Kramer, Low Price Edition, Pearson Education, www.pearsoned.co.in
2. Geotechnical Earthquake Engineering ByIkuoTowhata, Springer.
3. Soil Dynamics by ShamsherPrakash, McGraw-Hill Book Company
4. Soil Behaviour in Earthquake Geo-technics by Kenji Ishihara, Clarendon Press, Oxford
5. Theory of Vibrations with Applications by W. T. Thomson and M. D. Dahleh, Low Price Edition, Pearson Education, www.pearsoned.co.in

Course Outcome:

CO1: Understand soil dynamics and analyze problems of dynamic loading with relation to various types of vibrations.
CO2: Develop an idea on logical progression about structure-soil structure dynamics with reference to recent development.
CO3: Understand the aspects of wave propagation in elastic media thereby apply the same to understand the waves generated during earthquake and also evaluate the dynamic soil properties by field and laboratory tests.
CO4: To assess and develop an idea on liquefaction and its mechanism.
CO5: Analyze and design machine foundations subjected to different loading types.
CO6: Identify different vibration isolation methods.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	H	M	L	L	L		M		M			H	L	M
CO2	M	H	M	M	M	M		M		L			H	M	M
CO3	L	M	H	M	H	L		M	M	L			L	H	H
CO4	H	H	M	M	M	H	M	L		H			M	M	L
CO5	M	H	H	M	L	M		H		M	M	M	H	M	M
CO6	M	L	L	M	L	L				L	L	L	H	L	M

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Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech., Programme: Geotechnical Engineering (GTE),
Duration: 2 years (Four Semesters)

PE 2	IP6202	Soil Structure Interaction	3	0	0	3

Course Objective:

1. To provide an understanding of the relevance and significance of soil-structure interaction in the case of different types of structures
2. To explain the soil respond according to their stiffness.
3. To make student evaluate Numerical analysis of finite plates.
4. To understand Beam on Elastic Foundation.
5. To make student understand Elastic Analysis of Pile
6. To explain the soil structure interaction in seismic condition.

Module I

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

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

Module III

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.

Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Sub-grade reaction and elastic analysis, Interaction analysis, Pile raft system, Solutions through influence charts.

Introduction to Seismic soil structure interaction, Kinematic interaction, Inertial Interaction

Text/Reference Books:

1. Foundation Design by Teng W.C (1969), Prentice Hall, NJ.
2. Tomlinson M.J. (1986), Foundation Design and Construction, 5th edition, John Wiley, Newyork
3. Bowles J.E., Foundation Analysis and Design, 5th edition, Mc-GrawHill, Newyork
4. Tomlinson M. J., Pile Design and Construction Practice, 1977 Viewpoint publications,London
5. Desai, C. S., and Abel, J.F., Introduction to the Finite Element Method: A Numerical Method for Engineering Analysis, Van Nostrand Reinhold Co., New York, 1972. Tenth Reprint. Translated into Japanese and Chinese (Peking). Asian (Indian) Edition, Taiwanese Edition.
6. N.P. Kurien, Design of Foundation Systems : Principles & Practices, Narosa, New Delhi 1992,
7. E.S. Melerski, Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation, Taylor and Francis, 2006.
8. L.C. Reese, Single piles and pile groups under lateral loading, Taylor & Francis, 2000
9. G. Jones, Analysis of Beams on Elastic foundation, Thomas Telford, 1997
10. Selvadurai, A.P.S.," Elastic analysis of soil foundation interaction. Elsevier Science Ltd.
11. Soil structure interaction: numerical analysis and modelling / edited by John W.
Bull. London; New York: E & FN Spon, 1994.

Course Outcome:

CO1: Analyze and able understand soil-foundation interaction problems.
CO2: Understand soil response according to their stiffness**.**
CO3: Evaluate and analyze the finite plate.
CO4: Analyze and able to estimate beams of finite length.
CO5: Analysis the elastic analysis pile.
CO6: Understand soil structure interaction in seismic condition.

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	M	H	M	L	M		L		L	L	L	M	M	L	L
CO 2	L	H	M	M	L		L		L	L	L	M	M	L	M
CO 3	L	H	M	M	L		L		L	L	L	H	H	L	M
CO 4	L	H	M	M	M		L		L	L	L	H	H	L	M
CO 5	L	H	L	M	L		L		L	L	L	H	H	L	H
CO 6	L	H	H	M	M		M		L	L	L	H	H	L	M

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School/ Department: School of Infrastructure and Planning
Course: M. Tech., Programme: Geotechnical Engineering (GTE),
Duration: 2 years (Four Semesters)

PE 2	IP6204	Subsoil Exploration and Soil Testing	3	0	0	3

Course Objective:

1. To know about various subsoil exploration methods and its suitability for the specific site.
2. To execute different subsurface exploration tests, collect disturbed/undisturbed samples for laboratory tests so as to construct detailed borelog profile.
3. To understand and evaluate the dynamic soil properties by field and laboratory tests and analyse the stress-strain behaviour and strength of loaded soils.
4. To know the principles and working of various instruments required for finding different geotechnical parameters.
5. To explain in detail advanced topics on in-situ soil testing.
6. To predict strength of rock mass with respect to various Civil Engineering applications

Module I

Planning of Exploration and experimental programme, investigations, exploration for preliminary design, exploration for detailed design. Methods of boring, types of samples & sampling. Preparation of detail borelog profile.

Module II

Measurement of dynamic soil properties (laboratory and field tests – Stress and strain controlled cyclic tri-axial tests, seismic reflection and refraction test, seismic up-hole/down hole test, dilatometer and pressure meter tests, cone penetration test, dynamic cone penetration test, suspension logging test, in-situ permeability tests, Plate load test and cyclic plate load test; Presentation and processing of soil exploration data and its interpretation;

Module III

Rock coring percussion drilling, rock probing, Rock testing (Lab and fiels tests), Electrical resistivity method.

Advanced topics on in-situ soil testing: Spectral analysis of Surface wave, Multichannel analysis of Surface wave, ground penetration radar.

Text/Reference Books:

1.Head, K.H., Manual of Soil Laboratory Testing, Vols. 1 to 3, 1981.
2.Compendium of Indian Standards on Soil Engineering, Parts 1 and II, 1987–1988.
3.Engineering Principles of Ground Modifications – Hausmann, McGraw Hill
4.Subsurface Exploration and Sampling of Soils for Civil Engg. Purposes – Hvorslev M J

Course Outcomes:

CO1: Know about various subsoil exploration methods and its suitability for the specific site.
CO2: Execute different subsurface exploration tests, collect disturbed/undisturbed samples for laboratory tests so as to construct detailed borelog profile.
CO3: Understand and evaluate the dynamic soil properties by field and laboratory tests and analyze the stress-strain behaviour and strength of cyclically loaded soils.
CO4: Know about the principles and working of various instruments required for the measurement of dynamic soil properties.
CO5: Explain in detail advanced topics on in-situ soil testing.
CO6: Predict strength of rock mass with respect to various Civil Engineering applications by performing various tests on rock.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	POI11	PO12	PSO1	PSO2	PSO3
CO1	M	L	H	M	H	M	L	M	M	L	M	H	M	L	H
CO2	M	L	H	H	H	H	L	M	M	L	M	M	H	L	M
CO3	H	M	M	H	H	M	M	H	H	L	L	M	M	M	H
CO4	H	M	L	H	M	L	M	H	M	L	M	M	H	M	H
CO5	M	H	L	M	H	M	L	M	H	M	L	M	M	L	H
CO6	H	M	L	M	M	L	M	H	L	M	L	M	M	L	L

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Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech., Programme: Geotechnical Engineering (GTE),
Duration: 2 years (Four Semesters)

PE 2	IP6206	Geo-environmental Engineering	3	0	0	3

Course Objectives:

1. To acquire thorough knowledge about waste generation and its impact on environment
2. To define the engineering properties of various generated waste and its role on subsurface contamination.
3. To impart knowledge of methods of analysis and design of various landfill systems.
4. To describe the main processes of clay-water interactions and their influence on behaviour of barrier systems.
5. To understand several concepts of waste remedial techniques and its usefulness.
6. To explain the concept of ash pond disposal process and stability analysis.

Module I

Introduction: Types & forms of waste, engineering properties (determination and typical values), subsurface contamination, Effect of contamination on soil

Module II

Selection of waste disposal sites: Site selection – selection criteria and rating; Municipal and hazardous waste landfill: Types- Dry cell, wet cell, bioreactor, Design- clay liners, geosynthetic clay liners for waste containment, cover and gas collection system.

Module III

Ash disposal: Ash Disposal facilities- Dry disposal, Wet disposal, Design of ash containment system, Stability of ash dykes;
Contaminant transport through porous media: mechanisms- advective and dispersion
Remediation: Principle- planning, source control, soil washing, bioremediation.

References:

1. K. R. Reddy and H D Sharma, “Geoenvironmental Engineering: Site Remediation, waste containment, and emerging waste management technologies”, John Willey, 2004.
2. R N. Yong, “Geo Environmental Engineering: Contaminated Ground: Fate of Pollutions and Remediation”, Thomson Telford, 2000.
3. L N Reddy and H.I. Inyang, “Geoenvironmental Engineering: Principles and Applications”, Marcel Dek, 2000
4. Sharma H.D. and Reddy K.R., Geo-environmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, John Wiley, New Jersey, 2004.
5. Geotechnical Practice for Waste Disposal: D.E. Daniel Chapman and Hall, London (1993)

Course Outcome:

CO1: Explain various types, forms and engineering properties of wastes
CO2: Analyze contaminant migration in soil using coupled flow and reactive diffusion-advection equations.
CO3: Design a single or double composite landfill liner satisfying groundwater quality requirements
CO4: Evaluate the performance of ash pond and examine the stability analysis of ash dykes considering field conditions.
CO5: Execute a proper channel for ash disposal and design ash containment system
CO6: Define different liner system and its utility

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	L	L	L			M	H	M		L	M	L	H	M	
CO2	M	H	H	M	M		H	M		M	M	L	H	L	H
CO3	H	H	H	M	M	L	H	L		M	L	M	M	L	M
CO4	H	H	H	M	H	L	H	M	M	H	H	M	H	L	L
CO5	H	M	M	L	H		H	M	L	H	M	L	H		M
CO6	M	M	H	M	H	M	H	H	L	M	M	M	M		L

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Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech., Programme: Geotechnical Engineering (GTE),
Duration: 2 years (Four Semesters)

PE 3	IP6208	Finite Elements in Geo-mechanics	3	0	0	3

Course Objectives:

1. To gain knowledge of the key concepts of linear finite element analysis and application in modelling geotechnical problems.
2. To introduce a geotechnical finite element software
3. To obtain deep understanding on concept of domain discretization and a variational framework of the equations of mechanics
4. To use analytical methods for solving Partial differential equations
5. To develop an analytical model that is able to predict the state of stresses and deformations of the soil subjected to external loads.

Module I

Basic concepts – Discretization of continuum, typical elements, the element characteristic matrix, element assembly and solution for unknowns – Applications.

Module II

Variational principles, variational formulation of boundary value problems, variational methods approximation such as Ritz and weighted residual (Galerkin) methods, Applications.Displacements based elements, finite elements for axial symmetry. One-dimensional problems of stress, deformation and flow, assembly, convergence requirements, Finite elements analysis of two-dimensional problems. The linear and quadratic triangle, Natural coordinates. Plane strain and axisymmetric models.

Module III

Isoparametric formulation – Isoparametric bar element – plane bilinear isoparametric element – refined elements – Numerical integration techniques.

Use of FEM to Problems in soils and rocks, Introduction to non-linearity. Description and application to consolidation, seepage and soil – structure interaction problems.

Text/Reference Books:

1. Cook, R.D., Malkus, D.S., and Plesha, M.E., Concepts and Applications of Finite Element Analysis, John Wiley, 1989.
2. Reddy, J.N., An Introduction to the Finite Element Method, McGraw Hill, 1984.
3. Chadrupatla, R.T., and Belegundu. A.D, Introduction to Finite Elements in Engineering, Third Edition, Prentice- Hall, 2006.
4. Rockey, K.C., Erans, H.R., Griffiths, D.W., and Nethercot, D.A., The Finite Element method, Grostry Lockwood Staples, London, 1975.
5. Rajasekaran, S., Finite Element Analysis in Engg Design, Wheller Publishing, Allahabad, 1993.
6. Smith, I.M., Programming the Finite Element Method with Application to Geomechanics, John Wiley and sons, New Delhi, 2000.
7. Gupta, O.P. Finite and Boundary Element Methods in Engineering, Oxford & IBH Publishing Co., Pvt. Ltd., New Delhi, 2000.
8. Rao, S.S. The finite element method in Engg, Butterworth – Heinemann., 1998.
9. Potts, D.M. and Zdramcovic, L., Finite Element analysis in Geotechnical Engineering – Application, Thomas Telford, 2001.
10. Shen, J. and Kushwaha. R.L., Soil-Machine Interaction – A finite element perspective, MoralDikker, Inc. 1998.

Course Outcomes:

CO1: To Apply finite element methodologies to a wide range of geotechnical engineering problems and connection with the laws of continua.
CO2: To understand thoroughly the concept of different soil models.
CO3: To analyze and apply finite element software during practical classes which will help in their current and future research work.
CO4: To identify element properties and Iso-parametric elements
CO5: To Appraise and determine the one-dimensional problems of stress, deformation and flow.
CO6: To explain the use of FEM to the problems in soils and rocks, and its application in the field as well as industrial practices

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	H	H	H	H	L	M	L	M	M	L	M	H	L	M
CO2	M	H	H	H	M	M	L			L	M	M	H	M	L
CO3	H	H	H	M	H	M	M	L	L	M	M	H	H	M	M
CO4	H	H	H	M	M	M	L		L	M	M	L	H	L	M
CO5	M	H	M	M	H	L	M	L	L	M	H	L	H	M	L
CO6	H	H	H	H	M	M	L	L	M	M	M	M	H	L	M

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Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech., Programme: Geotechnical Engineering (GTE),
Duration: 2 years (Four Semesters)

PE 3	IP6210	Geo-synthetics and Reinforced Soil Structures	3	0	0	3

Course Objectives:

1. To Identify the type of Geosynthetics and their relevance in geotechnical field
2. To Understand the mechanism of formation of different Geosynthetics
3. To Analyse and compute different properties of Geosynthetics
4. To Apply the knowledge for designing the structures using Geosynthetics materials.
5. To Understand the design of geosynthetics to apply it in improvement in bearing capacity.
6. To Understand the reinforcement design using geosynthetics for slope stability problems.

Module I

Principles and mechanisms of soil reinforcement: Historical Background-Initial and Recent developments of Geosynthetics & Reinforced Soil; Principles, Concepts and Mechanisms of reinforced earth soil through Mohr Circle Analysis

Module II

Reinforcing materials and their properties: Metallic stips, Natural Fibers, Geocells, Manufacturing Process & Types, Properties-physical properties, mechanical properties, hydraulic properties & endurance properties; Methods of Testing-Techniques for testing of different index properties, strength properties, Apparent Opening Size, In-plane and cross-plane permeability tests, assessment of construction induced damage, extrapolation of long-term strength properties from short term tests.

Module III

Durability of Reinforced Materials: Corrosion, pH, Temperature; Geo textiles – requirement for design of separation – Filtration – General behavior – filtration behind retaining wall, under drains, erosion control and silt fence – drainage design – Liners for liquid containment – Geo membrane and Geosynthetics clay liners (GCL)- Mining, agriculture and aquaculture applications: containment, filtration; Case studies.

Design of soil reinforcement**:** Reinforcing the soil-Geo textiles and Geo grids with seismic analysis – Embankments and slopes Internal and Overall Stability Analysis – reinforced walls – Bearing Capacity Improvement in Soft Soil, Modes of Failure– Road Way Reinforcement design following the Giroud and Noiray Approach – Slope Stabilization along with seismic analysis.

Text/Reference Books:

1. Jewell, R.A., Soil Reinforcement with Geotextile, CIRIA, London, 1996.
2. Jones, C.J.F.P., Earth Reinforcement and Soil Structures, Earthworks, London, 1982.
3. Koerner, R.M., Designing with Geosynthetics, Third Edition, Prentice Hall, 1997.
4. Muller, W.W. HDPE Geomembrances in Geotechnics, Springer, New York 2007.
5. John, N.W.M., Geotextiles, John Blackie and Sons Ltd., London, 1987.
6. Gray, D.H., and Sotir, R.B., Biotechnical and Soil Engineering Slope Stabilization: A practical Guide for Erosion control, John Wiley & Son Inc., New York, 1996.
7. RamanathaAyyar, T.S., Ramachandran Nair, C.G. and Balakrishna Nair, N., Comprehensive Reference Book on Coir Geotextile, Centre for Development for Coir Technology, 2002.
8. SivakumarBabu, G.L., An Introduction to Soil Reinforcement and Geosynthetics, University Press (India), Pvt. Ltd., Hyderabad, 2006.

Course Outcomes:

CO1: Identification of types of Geosynthetics and their relevance in geotechnical field
CO2: Understand the mechanism of formation of different Geosynthetics
CO3: Analyze and compute different properties of Geosynthetics
CO4: Apply the knowledge for designing the structures using Geosynthetics materials.
CO5: Design of geosynthetics for improvement in bearing capacity.
CO6: Reinforcement design using geosynthetics for slope stability problems.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	M	L	M	H		H			M	L	H	H		M
CO2	M	M	L	H	H		H			M	L	H	H		M
CO3	H	M	L	H	H		H			H	L	H	H		M
CO4	H	H	M	H	H		H			H	L	H	H		M
CO5	H	H	M	H	H		H			H	L	H	H		M
CO6	H	H	M	H	H		H			H	L	H	H		M

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Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech., Programme: Geotechnical Engineering (GTE),
Duration: 2 years (Four Semesters)

PE 3	IP6212	Offshore Geo-mechanics	3	0	0	3

Course Objectives:

1. To introduce different types of offshore structures & calculation of loads acting on it.
2. To understand fundamental theories and dynamics acting on offshore structures
3. To know about design practices opted for various environmental loading on offshore structures.
4. To get an idea about various site investigations and foundation methods used in marine soil deposit.
5. To perform static & dynamic analysis of different platforms.
6. To understand the layout of marine structures from functional and safety requirements.

Module I

Design of offshore platforms: Introduction, fixed and floating platforms, Design principles of Compliant platforms- Tension Leg Platforms and Spar platforms Semisubmersibles, Jack-ups, Concrete Gravity. Case Studies and general features- elements of hydrodynamics and wave theory-fluid structure interaction-Concept of Return waves – Extreme Loads on offshore structures-Morison equation- Maximum wave force on offshore structures-Wave forces on large structures-Linear diffraction theory, steel, concrete and hybrid platforms.

Module II

Design criteria. Environmental loading, Wind, wave, Buoyancy and Current loads after installation- -Stability during towing. Foundations: Site investigations. Piled foundation, Foundations for gravity structures, Sea bed anchors, Dredging methods and equipment. Foundation, renewable energy converters.

Module III

Materials and their behaviour under dynamic loading -Static and dynamic analysis of platforms and component- Statutory regulations-Allowable stresses – Regulations and codes of practice- Principles of static and dynamic analysis of jacket platforms-analytical modelling of jacket platforms.

Dynamic response in deterministic and in deterministic environment, codes of practice, analysis of fixed platform and semisubmersible related topics, offshore pipelines and riser geotechnics.

Text/Reference Books:

1.T. H. Dawson, Offshore Structural Engineering, Prentice Hall

2.W. J. Graff, Introduction to Offshore Structures, Gulf Publ. Co

3. B. McClelland, M. D. Reifel, Planning & Design of fixed Offshore Platforms, Van Nostrand.

4. API RP 2A, Planning, Designing and Constructing Fixed Offshore Platforms, API

5. Mark Randolph, Susan Gourvenec, Offshore Geotechnical Engineering, Spon Press.

Course Outcomes:

CO1: Understand and analyse different types of offshore structures & calculation of loads acting on it
CO2: Understand fundamental theories and dynamics acting on offshore structures.
CO3: Know about various environmental loading and use it in the designing of offshore structures.
CO4: Get an idea about various site investigations and can justify foundation methods used in marine soil deposit.
CO5: Analyze and design different platforms under static and dynamic loading.
CO6: Understand the layout of marine structures from functional and safety requirements.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	H	H	M	L	H	M	M	L	M	M	H	H	L	H
CO2	M	H	L	L	M	M	L	L	M	L	L	M	M		M
CO3	H	H	M	H	M	H	H	M	M	M	M	H	H	M	M
CO4	M	M	H	L	H	L	L	L	L	M	M	M	M	L	L
CO5	H	H	H	M	M	H	M	L	M	L	L	H	H	L	H
CO6	H	L	L	M	L	M	L	L	L	M	L	L	L	M	L

OE 1	Any One from the List of OE 1 (Appendix-I)	3	0	0	3

Refer Appendix-I for detailed Syllabus.

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech., Programme: Geotechnical Engineering (GTE),
Duration: 2 years (Four Semesters)

PR 1	IP6602	Project (Specialization Related)	0	0	4	2

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LC 3	IP6502	Geotechnical Engineering Design Practice	0	0	4	2

Course Objectives:

1. To develop the skills to manually design foundations, retaining structures, and sheet pile walls
2. To use geotechnical software tools for geotechnical designs

Syllabus

Design of various types Shallow, Deep Foundations manually, retaining structure, sheet pile wall. Using various available softwares, Field Visits.

Course Outcome:

CO1: Apply foundational knowledge to manually design shallow and deep foundations, retaining structures, and sheet pile walls
CO2: Utilize advanced software tools to model and analyze complex geotechnical problems in foundation and retaining wall design

CO3: Evaluate the stability of different types of foundations, retaining structures, and sheet pile walls through field visits, and provide recommendations for design improvements
CO4: Synthesize design concepts, software-based analysis, and practical field experience

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	M	M	L	L	L	L	L	L	L	L	L	L	L	L	L
CO2	M	M	L	L	L	L	L	L	L	L	L	L	L	L	L
CO3	M	M	L	L	L	L	L	L	L	L	L	L	L	L	L
CO4	M	M	L	L	L	L	L	L	L	L	L	L	L	L	L

AC 2	Any One from the List of AC 2 (Appendix-I)	2	0	0	0

Refer Appendix-I for detailed Syllabus.

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3rd Semester

PE 4	IP7201	Ground Water and Flow through porous Media	3	0	0	3

Course Objective:

1.To make students understand concepts of Soil Water
2.To provide brief explanation on consolidation theory
3.To explain in detail Ground water Hydraulics

Module I

Soil Water: Modes of occurrence of water in soils. Adsorbed water, capillary water, Capillary potential, capillary tension and soil suction. Effective and Neutral pressures in soil; unsaturated flow

Flow through a porous media: Darcy's Law, Validity of Darcy's Law, Permeability, Laboratory and Field Measurement of Permeability; Laplace equation; Flownet; steady radial flow to a well in confined and unconfined aquifer

Module II

Well Hydraulics: unsteady Radial Flow into confined aquifer, Non equilibrium Theis method of solution, Cooper-Jacob Method, Chow's method, Recovery of drawdown, unsteady Radial Flow into unconfined aquifer, Multiple well system

Module III

Geophysical Exploration: test drilling, surface and sub-surface investigation of groundwater, Artificial Recharge of Groundwater, Ground water Pollution, Ground Water Management

Text/Reference Books:

1. D.K.Todd, Groundwater Hydrology, Johnwiley and Sons
2. H. M. Raghunath, Ground Water, Willy Eastern Ltd.
3. C. Fitts, Ground Water Science, Elsevier Publications, U. S. A.
4. P. P. Raj, Geotechnical Engineering, Tata McGraw-Hill
5. A. Jumikis, Soil Mechanics, East West Press Pvt Ltd**.**

Course Outcome:

CO1: Explain the concepts of soil water, including modes of water occurrence in soils, capillary potential, and unsaturated flow
CO2: Apply Darcy's Law and assess the validity of this law in the context of flow through porous media
CO3: Evaluate permeability, both in the laboratory and in field measurements, and analyze the Laplace equation and flownets
CO4: Solve problems related to well hydraulics, including unsteady radial flow into confined and unconfined aquifers, using methods such as Theis, Cooper-Jacob, and Chow's methods
CO5: Investigate geophysical exploration techniques, groundwater test drilling, and artificial recharge methods
CO6: Examine issues related to groundwater pollution and groundwater management

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	M	L	L	L	L	L		L	L	L	L	L	L	L
CO2	M	M	L	L	L	L	L		L	L	L	L	L	L	L
CO3	L	L	M	M	L	L	L		L	L	L	L	L	L	L
CO4	L	L	L	M	L	L	L		L	L	L	L	L	L	L
CO5	L	L	L	L	M	L	L		L	L	L	L	L	L	L
CO6	L	L	L	L	L	M	L		L	L	L	L	L	L	L

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PE 4	IP7203	Geotechnical Earthquake Engineering	3	0	0	3

Course Objective:

1. To know the theories of formation of Earth, plate tectonics and continental drift.
2. To understand and analyse how and where earthquake occurs and to measure the size of an earthquake.
3. To understand and apply the theories of wave propagation in elastic media, evaluate dynamic properties of soil by various lab and field testing methods.
4. To perform ground response analysis and understand the local site effects.
5. To understand various earthquake induced hazards and different remedial measures (ground improvement methods).

Module I

Introduction, Seismic Hazards, seismic waves, internal structure of earth, Continental drift and plate tectonics, faults, elastics rebound theory, geometric notations, location of earthquakes, size of earthquakes. Strong ground motion measurement, ground motion parameters, estimation of ground motion parameters. Seismic Hazard Analysis: Identification and Evaluation of Earthquake Sources, deterministic seismic hazard analysis, probabilistic seismic hazard analysis.

Module II

Wave Propagation: Waves in unbounded media, waves in a semi – infinite body, waves in a layered media, attenuation of stress waves. Dynamic soil properties: Measurement of dynamic soil properties using field and laboratory tests (overview), stress strain behavior of cyclically loaded soils, strength of cyclically loaded soils. One – Dimensional Ground response Analysis – Linear and Non-Linear Approaches. Local Site Effects: Effect of local site conditions on ground motion, design parameters, development of design parameters.

Module III

Flow liquefaction, cyclic mobility, evaluation of liquefaction hazards, liquefaction susceptibility, initiation of liquefaction, effects of liquefaction. Soil Improvement for Remediation of Seismic Hazards: Densification techniques, Reinforcement Techniques, Grouting and Mixing techniques, Drainage techniques. Dynamic earth pressure and seismic slope stability analysis.

Text/Reference Books:

1. Geotechnical Earthquake Engineering by Steven L. Kramer, prentice Hall, 1st edition, 1996.
2. Geotechnical Earthquake Engineering Handbook by Robert W. Day, McGraw-Hill.2nd edition, 2010.
3. Geotechnical Earthquake Engineering ByIkuoTowhata, Springer.

Course Outcome:

After the completion of the course the students will be able to

CO1: Know the theories of formation of Earth, plate tectonics, continental drift, fault, how earth quake occurs and quantify the size of an earthquake.
CO2: Measure and estimate ground motion parameters, perform seismic hazard analysis and locate the epicentre of an earthquake.
CO3: Understand the aspects of wave propagation in elastic media and evaluate the dynamic soil properties by field and laboratory tests and analyse the stress-strain behaviour and strength of cyclically loaded soils.
CO4: Perform 1D ground response analysis and understand the local site effects due to ground motion.
CO5: Understand soil liquefaction and its effects and evaluate soil improvement and remediation of liquefaction hazards.
CO6: Evaluate the dynamic bearing capacity of foundations and perform seismic analysis and design of earth retaining structures and soil slopes.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	H			L	L	L	L	H	M	L
CO2	H	H	H	H	H	H		L	L	L	L	L	H	H	M
CO3	H	M	L	L	L	H		L	L	L	L	L	H	M	L
CO4	H	M	L	L	L	H		L	L	L	L	L	H	M	L
CO5	H	M	L	L	L	H		L	L	L	L	L	H	M	L
CO6	H	M	H	H	H	H		L	L	L	L	L	H	H	M

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PE 4	IP7205	Stability Analysis of slopes, Embankments and Dams	3	0	0	3

Course Objective:

1. Understand slope stability
2. To apply analysis methods for slope stability
3. To develop skills to design slopes for long-term stability
4. To perform comprehensive site investigations for analysis and design

Module I

Landslide phenomenon: Types and causes of slope failures, rock falls, deep failure of slopes and shallow debris flows, Practical applications

Module II

Stability analysis of infinite slopes with or without water pressures; Stability analysis of finite and Infinite slopes: concept of factor of safety, pore pressure coefficients, Mass analysis, Wedge methods, friction circle method; Method of slices, Bishop's method, Janbu's method; Effect of seepage, submerged and sudden draw down conditions

Module III

Design of slopes Short-term and Long-term stability analysis of slopes; Methods for stability analysis of slopes; Methods for enhancing stability of unstable slopes; design of slope in cutting, Embankments and Earth dams; Site Investigation: Reconnaissance, Preliminary and detailed investigation, Investigation for foundations; Advances in stability analysis of slopes.

Text/Reference Books:

1. L. W Abramson, T. S Lee, S Sharma and G M Boyce, Slope Stability and Stabilization Methods, Willey Interscience publications
2. B M Das, Principles of Geotechnical Engineering, Thomson Brooks/Cole
3. T W. Lambe and R V Whitman, Soil Mechanics, John Wiley & sons
4. V N S Murthy, Principles of Soil Mechanics and Foundation Engineering, UBS Publishers Private Ltd.

Course Outcomes:

After successful completion of the course, it is expected that student will be able to:

CO1: Identify and analyze slope failure types, causes, and their practical implications

CO2: Access infinite slope stability for various ground conditions

CO3: Assess various stability analysis methods of finite slopes

CO4: Evaluate advanced methods for slope stability analysis and synthesize effective strategies for enhancing the stability of unstable slopes

CO5: Apply short-term and long-term stability analysis methods to design stable slopes and earth structures

CO6: Perform comprehensive site investigations for reconnaissance, preliminary, and detailed slope stability assessments

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	L	L	L	L	M	L	L	L	L	L	L	H	M	M
CO2	M	H	M	M	L	M	L	L	L	L	L	L	H	L	L
CO3	L	M	H	L	L	L	L	L	L	L	L	L	L	L	L
CO4	L	M	L	H	M	L	L	L	L	L	L	L	L	L	L
CO5	L	L	L	L	H	M	L	L	L	L	L	L	L	L	L
CO6	L	L	L	L	L	L	H	M	M	L	L	L	L	L	L

PR 2	IP7601	Dissertation (Phase-I)	0	0	24	12

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4th Semester

PR 3	IP7602	Dissertation (Phase-II)	0	0	32	16