VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY

(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)

Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)

SYLLABUS

For

Master of Engineering Programmes

(M.Tech. Geotechnical Engineering)

(For admission in 2022-23 and onwards)

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

Proposed Scheme of Examination of M. Tech. Programme for Specialization: Geotechnical Engineering

Semester I

Sr. No.	Course Type	Course Type/Code	Course Name	Teaching Scheme			Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1		AHT-301	Advanced Mathematics	3	1	0	4	50	100	150
2	Core-I	CET-601	Advanced Soil Mechanics	3	1	0	4	50	100	150
3	Core-II	CET-602	Soil dynamics	3	1	0	4	50	100	150
4	Professional Elective-1	CET-603	Ground Improvement Techniques	3	0	0	3	50	100	150
		CET-604	Pavement Analysis and design							
		CET-605	Computational Geomechanics							
5	Professional Elective-2	CET-606	EarthquakeResistingDesignofStructure	3	0	0	3	50	100	150
		CET-607	Soil Structure Interaction							
		CET-608	FEM in Geomechanics							
6	Core	CEP-601	Advanced Soil Mechanics Lab	0	0	3	1	25	25	50
7	Core	CEP-602	Soil dynamics Lab	0	0	3	1	25	25	50
8	Mandatory course	(AHT-302)	Research Methodology and IPR	2	0	2	2	50	50	100
9	Audit-1	AHT-303	Technical Writing and Presentation Skill	2	0	0	NC	50	0	NC
			Total	**19**	**3**	**8**	**22**	**400**	**600**	**1000**
10	*Open Elective-1 (Optional)	CET-623	Disaster management	3	0	0	3	50	100	150
	*Open Elective-1 (Optional)	CET-523	Urban environmental management							

Semester II

Sr. No.	Course Type	Course Type/Code	Course Name	Teaching Scheme			Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	Core-III	CET-609	Advanced Foundation Engineering	3	0	0	3	50	100	150
2	Core-IV	CET-511	Sub Surface Investigation and Instrumentation	3	0	0	3	50	100	150
3	Professional Elective-3	CET-610	Engineering Rock Mechanics	3	0	0	3	50	100	150
		CET-611	Environmental Geotechnology							
		CET-612	Marine Geotechiques							
4	Professional	CET-613	Constitutive Modelling in Geomechnics	3	0	0	3	50	100	150

	Elective-4									
		CET-614	Design of Underground Excavations							
		CET-513	Earth Retaining Structures							
5	Open Elective-1	CET-317	Risk management in Construction	3	0	0	3	50	100	150
		CET-318	Environmental Impact Assessment							
		CET-319	Industrial Safety							
6	Core	CEP-603	Advanced Foundation Engineering Lab	0	0	3	1	25	25	50
7	Core	CEP-604	Sub Surface Investigation and Instrumentation Lab	0	0	3	1	25	25	50
8										
			Total	**15**	**0**	**6**	**17**	**300**	**550**	950
9	*Open Elective-2 (Optional)	CET-624	AIR POLLUTION CONTROL ENGINEERING	3	0	0	3	50	100	150

Semester III

Sr. No.	**Course Type**	**Course Type/Code**	**Course Name**	**Teaching Scheme**			**Credits**	**Internal Marks**	**External Marks**	**Total Marks**
				L	T	P				
1	Open Elective-2	CET-320	Business Analytics	3	0	0	3	50	100	150
		CET-321	Operations Research							
		CET-322	Cost Management of Engineering Projects							

2	Seminar	Seminar		0	0	4	2	100		100
3	Project	Project		0	0	10	5	100	150	250
4	Dissertation	Dissertation	Dissertation	0	0	12	6	300		300
			Total	**3**	**0**	**22**	**16**	**550**	**250**	**800**

Semester IV

Sr. No.	**Course Type**	**Course Type/Code**	**Course Name**	**Teaching Scheme**			**Credits**	**Internal Marks**	**External Marks**	**Total Marks**
				L	T	P				
1	Dissertation	Dissertation	Dissertation	0	0	28	14	250	450	700
			Total	**0**	**0**	**28**	**14**	**250**	**450**	**700**

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

Syllabus
Advanced Mathematics (AHT-301)

L:T:P:: 3:1:0 **Credits-4**

Course objectives:

From this course, students will be able to:

1. learn distinct methods of solving simultaneous equations.
2. well-versed with partial differential equations and their solutions and applications.
3. acquire the knowledge of transformation to ease the complex problems.
4. acquaintance with basics of random variables and their distribution for dealing with events by chance.
5. study different mathematical domains to deal with real-time engineering problems.

Learning outcomes:

1. Comprehend with engineering problems in different mathematical realm.
2. Learn analytical and numerical methods to deal with mathematical problems.
3. Understand how to model the engineering problems and their solutions.
4. Implement the solutions to real-time complex engineering problems.
5. Apprehend with mathematical methodology.

Course content:

Unit I: Solution of linear simultaneous equations: (8 hours)

Consistency, Iterative method, Convergence, Cholesky's (Crout's) method, Gauss-Jordan method, Gauss-Seidel iteration and relaxation methods, Solution of Eigenvalue problems, Smallest, largest, and intermediate Eigen values

Computer based algorithm and programme for these methods (non-evaluative)

Unit II: Partial differential equation and its applications: (10 hours)

Introduction and classification of partial differential equation, Four standard forms of non-linear partial differential equations and their solutions, linear equations with constant coefficients. Applications of partial differential equationsone and two-dimensional wave equation, one and two-dimensional heat equation, Two-dimensional Laplace's equation.

Syllabus
Advanced Mathematics (AHT-301)

L:T:P:: 3:1:0 **Credits-4**

Unit III: Transform calculus-I: **(8 hours)**

Laplace transform, Properties of Laplace transform, Inverse Laplace transform,Applications of Laplace transform, Fourier integral theorem, Fourier transforms, Application of Fourier transform

Unit IV: Transform calculus-II: **(8 hours)**

Z-transform, Properties of Z-transform, Shifting theorems, Initial and final value theorem, Convolution theorems, Inverse Z-transform, Application of Z-transform

Unit V: Basic probability theory: **(8 hours)**

Concept and laws of probability,Discrete and continuous random variable and their distributions; Some special distributions such as Binomial, Poisson, Negative Binomial, Geometric, Continuous uniform, Normal, Exponential, Weibull, Moments,Moment generating functions, Expectation and variance

Practical demo with statistical software like R, SPSS, SAS, etc. (non-evaluative)

Text Books / References:

1. B.S. Grewal, Engineering Mathematics, Khanna Publications, 44th edition.
2. F.B. Hilderbrand, Method of Applied Mathematics, PHI Publications, 2nd edition.
3. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand Publication, 20th edition.
4. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathmematical Statistics, S. Chand Publication, 4th edition.
5. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10th edition.
6. S. Ross, A First Course in Probability, Pearson Education, 8th edition.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

Syllabus

ADVANCED SOIL MECHANICS (CET – 601)

L: T: P:: 3:1:0 **Credits-4**

Course Objectives: Objectives of introducing this subject at first year level in Masters of civil engineering are:

- To understand the engineering properties of soil and identify the problematic soils.
- To evaluate the soil shear strength for different types of soil and in different conditions of weather.
- To analyse the soil behavior under loading and the stresses developed within soil mass for saturated and unsaturated conditions.
- To apply the knowledge of soil compressibility and consolidation theory in practice to estimate settlement.

Course Outcomes:

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

1. Know about the theory of elasticity and its application in Soil Mechanics.
2. Get a detailed idea about the pore water pressure due to undrained loading and seepage.
3. Get detailed information about consolidation in soil media.
4. Get a clear idea about shear stress and stress paths.
5. Understand the concept of Critical State Soil mechanics.

Syllabus:

UNIT-I **(8 hours)**

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 Taylor's method).

UNIT-II **(8 hours)**

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 **(8 hours)**

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 **(8 hours)**

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 **(8 hours)**

Elastic and Plastic Deformations: elastic wall; introduction to yielding and hardening; yield curve and yield surface, associated and non-associated flow rule.

Syllabus

ADVANCED SOIL MECHANICS (CET –601)

L: T: P: 3:1:0 **Credits-4**

Text Book:

1. Das, Braja, M., "Advanced Soil Mechanics", Taylor & Francis, 1983.
2. Terzaghi, K. and Peck, R.B., "Soil Mechanics in Engineering Practice", John Wiley, 1967.

Reference books:

3. Lambe, T. William and Whitman, Robert V., "Soil Mechanics", John Wiley, 2000.
4. Craig, R.F., "Soil Mechanics", Chapman & Hall, 1993.
5. Atkinson J.H, "An introduction to the Mechanics of soils and Foundation", McGraw- Hill Co., 1993.
6. Davis, R.O. and Selvadurai, E.P.S. "Elasticity and Geomechanics", Cambridge University Press, 1995.

Syllabus

SOIL DYNAMICS (CET – 602)

3L: 1T:0P **Credits-4**

Course Objectives:

- Study theory of vibrations for their application to solve dynamic soil problems.
- Calculate the dynamic properties of soils using laboratory and field tests.
- Study the phenomenon of liquefaction.
- Analyze and design machine foundations by Barkan's theory and elastic half space concept.
- Analyze and design vibration isolation systems.

Course Outcomes:

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

1. Understand the causes and quantification of earthquake.
2. Assess properties of soil effected by seismic wave propagation.
3. Design Ground Motion at a Site and Dynamic Response Analysis.
4. Determine the dynamic soil properties using various field tests (Standard penetration test, plate load test, block vibration test, SASW/MASW tests. etc).
5. Evaluate soil liquefaction potential.

Syllabus: **(8 hours)**

Introduction: Background and lessons learnt from damages in past earthquakes, Internal Structure of the Earth, Continental Drift and Plate Tectonics, Elastic Rebound Theory, Geometric Notation, Location of Earthquakes, Size of Earthquakes.

UNIT-II **(8 hours)**

Wave Propagation: Waves in unbounded media in one- and three-dimensional wave propagation; Waves in semi-infinite media; Waves in a layered medium; Attenuation of stress waves - material and radiation damping.

UNIT-III **(8 hours)**

Dynamic Soil Properties: Stress & strain conditions, concept of stress path, Measurement of seismic response of soil at low and high strain; Field tests - Seismic reflection, Seismic refraction, Steady-state vibration (Rayleigh Wave) test, Standard penetration test; Laboratory tests- Shaking table, Centrifuge tests and determination of soil-spring constant - cyclic plate load and block vibration test; Stress-strain behaviour of cyclically loaded soils; Evaluation of damping and shear modulus; Effect of strain level on the dynamic soil properties.

UNIT-IV **(8 hours)**

Ground Response Analysis: Introduction, one dimensional GRA-linear approach, Equivalent linear approximation of nonlinear response, Introduction of two and three dimensional GRA, Introduction to soil-structure interaction.

UNIT-V **(8 hours)**

Liquefaction: Introduction, liquefaction related phenomena – flow liquefaction and cyclic mobility, Factors affecting liquefaction, liquefaction susceptibility; historical criteria, geological criteria, compositional criteria, State Criteria; Evaluation of liquefaction potential, cyclic stress ratio, cyclic

Syllabus

SOIL DYNAMICS (CET – 602)

3L: 1T:0P **Credits-4**

Resistance ratio, Effects of liquefaction.

Text Book:

1. Kameshwara Rao, N.S.V, "Dynamic Soil Tests & Applications", Wheeler Publications, New Delhi. 2000.
2. Saran S. "Soil Dynamics & Machine Foundation", Galgotia Pub. Pvt. Ltd, New Delhi. 2006.

Reference books:

3. Ranjan G. and Rao A.S.R., "Basic and Applied Soil Mechanics", New Age Int. Ltd., New Delhi. 2000.
4. Day Robert W., "Geotechnical Earthquake Engineering Handbook", McGraw-Hill, New York. 2001.
5. Kramer S.L., "Geotechnical-Earthquake Engineering", Pearson Education – Indian Low-Price Edition, Delhi. 2004.

Syllabus

GROUND IMPROVEMENT TECHNIQUES (CET – 603)

3L: 0T:0P **Credits-3**

Course objectives:

- To impart knowledge of various problems associated with soil deposits and various methods to evaluate them.
- To impart knowledge of different techniques to improve the characteristics of soil.
- To impart knowledge of design techniques required to implement various ground improvement methods.

Course Outcomes:

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

1. Identify the necessity of ground improvement.
2. Understand the different types of ground modification can be done depending upon the site condition, type and purpose of structure to be constructed.
3. Understand the functions of geosynthetics and soil nailing in engineering constructions.

Syllabus:

UNIT-I **(8 hours)**

Introduction: Situations where ground improvement becomes necessary.

UNIT-II **(8 hours)**

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-III **(8 hours)**

Chemical Modification: Modification by admixtures, stabilization using industrial wastes, grouting

UNIT-IV **(8 hours)**

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 **(8 hours)**

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

Text Book:

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.

Syllabus

GROUND IMPROVEMENT TECHNIQUES (CET – 603)

3L: 0T:0P **Credits-3**

Reference books:

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.

Syllabus

PAVEMENT ANALYSIS AND DESIGN (CET – 604)

3L: 0T:0P **Credits-3**

Course objectives:

- To provide students with the knowledge about the fundamental properties and behaviour of earth materials, mathematical models, and methods of analysis for different conditions.
- To provide students with in-depth analysis and design of common geotechnical structures and solutions to real problems.
- To provide students with practical knowledge of pavement material and pavement behavioural analysis.

Course Outcomes:

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

1. Design flexible as well rigid pavements.
2. Appreciate the functions of various components of a pavement.
3. Identify the factors affecting design of pavements.
4. Evaluate performance of pavement and design the overlay on flexible and rigid pavement.

Syllabus:

UNIT-I **(8 hours)**

Philosophy of design of flexible and rigid pavements.

UNIT-II **(8 hours)**

Analysis of pavements using different analytical methods.

UNIT-III **(8 hours)**

Selection of pavement design input parameters – traffic loading and volume

UNIT-IV **(8 hours)**

Material characterization, drainage, failure criteria, reliability, design of flexible and rigid pavements using different methods.

UNIT-V **(8 hours)**

Comparison of different pavement design approaches, design of overlays and drainage system.

Text Book:

1. Yang and H. Huang, “Pavement Analysis and Design”, Pearson Prentice Hall, 2004.
2. Sharma and Sharma, “Principles and Practice of Highway Engg.” Asia Publishing House, 1980.

Reference books:

3. Yoder and Witzech, “Pavement Design”, McGraw-Hill, 1982.
4. Teng, “Functional Designing of Pavements”, McGraw- Hill, 1980

Syllabus

COMPUTATIONAL GEOMECHANICS(CET-605)

3L: 0T:0P **Credits-3**

Course Objectives:
The objective of this course is to introduce the student to modern numerical methods for the solution of coupled & non-linear problems arising in geo-mechanics / geotechnical engineering.

Course Outcomes:

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

1. Understand different numerical and statistical tools for analyzing various geotechnical engineering problems.
2. Apply probabilistic approach for selection of design parameters and compute their impact on risk assessment.

Syllabus:

UNIT-I **(8 hours)**

Solution of Linear & Non-linear Equations: Bisection, False Position, Newton-Raphson, Successive approximation method, Iterative methods. Jacobi's method, Gauss Seidal method, Successive over relaxation method.

UNIT-II **(8 hours)**

Finite Difference and Finite Element Method: Two-point Boundary value problems – Disichlet conditions, Neumann conditions; ordinary and partial differential equations, Fundamentals, Constitutive finite element models for soils.

UNIT-III **(8 hours)**

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 **(8 hours)**

One-Dimensional Consolidation - Theory of consolidation, Analytical procedures, Finite difference solution procedure for multilayered systems, Finite element formulation.

UNIT-V **(8 hours)**

Flow through Porous Media & Risk Assesment- Geotechnical aspects, Numerical methods, Applications and Design analysis, Flow in jointed media. Probabilistic site characterisation and design of foundations.

Text Book:

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

COMPUTATIONAL GEOMECHANICS(CET-605)

3L: 0T:0P **Credits- 3**

3. Computations", Third edition, New Age International (P) Ltd. Publishers, New Delhi.

Reference books:

4. D.J. Naylor and G.N. Pande, "Finite Elements in Geotechnical Engineering", PineridgePress Ltd., UK.
5. Sam Helwany, "Applied soil mechanics", John Wiley & sons, Inc.

Syllabus

EARTHQUAKE RESISTANT DESIGN OF STRUCTURE (CET-606)

3L: 0T:0P **Credits-3**

Course objectives:

- To Study the multimodal and multidirectional response spectrum analysis.
- To make students familiar regarding understanding the earthquake resistance design philosophy.
- To carry out lateral load analysis with reference to Indian standard code.
- To make students able to do seismic design and detailing of structures with reference to is code.

Course Outcomes:

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

1. Summaries engineering seismology and discuss the causes and effects of earthquakes.
2. Characterize different types of vibration for single degree freedom system.
3. Understand principle of vibration measuring instrument.
4. Analyze pulse or impulse loading using Duhamel's Integral.
5. Draw the response spectra for different ground condition and understand their application.
6. Draw the node shape for multi degree freedom system using different methods.

Syllabus:

UNIT-I **(8 hours)**

Introduction to Earthquake Parameters: Earthquake occurrences –Global Seismic Belts. Indian Seismic zoning map, their engineering implications: Damage survey, seismic intensity, isoseismal maps, and more commonly used earthquake parameters like epicenter, epicentral distance, origin time, focus, magnitude, and frequency. Elementary information on seismic wave propagation. Demonstration of seismographs to explain earthquake recording.

UNIT-II **(8 hours)**

Single Degree of Vibration Freedom System: Introduction to vibration problems, Undamped and Damped free vibration with viscous damping, Forced vibrations, Steady state, Vibration Isolation.

UNIT-III **(8 hours)**

Single Degree of Vibration Freedom System: Vibration Measuring Instruments, (Demonstration for determination of damping, frequency etc.), Response of undamped systems to time dependent force functions (Pulse/impulses), Duhamel's Integral, Response to ground motion, Response spectra.

UNIT-IV **(8 hours)**

Two Degree of Freedom System: Determination of natural frequency and mode shapes, Steady state forced vibrations, Undamped vibration absorbers.

Multi Degree of Freedom System: Rayleight's Method - Determination of fundamental frequency of simple systems, free vibrations of undamped systems – Determination of frequency and mode shapes by Holzer method, Stodola Method, Evaluation of earthquake forces in multi-storeyed buildings using response spectra.

UNIT-V **(8 hours)**

Earthquake Effects: Ground failures, Local site effects, Effects on ground and structure.

Introduction to IS Code: IS-1893, Codal Provisions for evaluation of earthquake forces on buildings.

Syllabus

EARTHQUAKE RESISTANT DESIGN OF STRUCTURE (CET-606)

3L: 0T:0P **Credits-3**

Text Book:

1. Damodarasamy, S. R. (2009). Basics of structural dynamics and aseismic design. PHI Learning Pvt. Ltd.
2. Shrikhande, M., & Agarwal, P. (2006). Earthquake Resistance Design Of Structure. First Revised Edition, PHI Learning Private Limited, New Dehli.

Reference books:

3. Chopra, A. K. (2007). Dynamics of structures. Pearson Education India.
4. Hu, Y. X., Liu, S. C., & Dong, W. (1996). Earthquake engineering. CRC Press.
5. Okamoto, S. (1984). Introduction to earthquake engineering. Steve Parish.

Syllabus

SOIL STRUCTURE INTERACTION (CET-607)

3L: 0T:0P **Credits-3**

Course objectives:
To learn various models used in the geotechnical engineering and its use during the analysis of soil-structure interaction problems.

Course Outcomes:

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

1. Apply different soil response models for specific problem based on the requirement.
2. Analyse footings/rafts resting on soil as beams/plates on elastic foundation and work out design bending moments/shear and displacements.
3. Compute pile response for various loading condition for design purpose.

Syllabus:

UNIT-I **(8 hours)**

Introduction to Earthquake Parameters: Earthquake occurrences –Global Seismic Belts. Indian Seismic Zoning.

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, and Time dependent behavior.

UNIT-II **(8 hours)**

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 **(8 hours)**

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

UNIT-IV **(8 hours)**

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 **(8 hours)**

Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts. An introduction to soil-foundation interaction under dynamic loads.

Text Book:

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.

Reference books:

SOIL STRUCTURE INTERACTION (CET-607)

3L: 0T:0P **Credits-3**

3. Structure Soil Interaction - State of Art Report, Institution of Structural Engineers, 1978.
4. ACI 336. (1988), "Suggested Analysis and Design Procedures for combined footings and Mats", American Concrete Institute.
5. Scott, R.F., "Foundation Analysis", Prentice Hall, 1981.

Syllabus

FEM IN GEOMECHANICS (CET-608)

3L: 0T:0P **Credits-3**

Course objectives:
Objectives of introducing this subject at first year level in Masters of civil engineering are:
1. To enable student with fundamentals of Finite element method.
2. To impart the knowledge and skill of analyzing physical problems with FE software.

Course Outcomes:

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

1. Understand the fundamentals of Finite element method.
2. Impart the knowledge and skill of analysing physical problems with FE software.
3. Understand the basic functions of FE based software and its applications in geotechnical engineering.
4. Select the appropriate element and mesh for FE analysis for given problem.
5. Evaluate the type of problem and develop the FE-model.
6. Estimate the stresses and strain in soil through FE analysis for given physical problem.

Syllabus:

UNIT-I **(8 hours)**

Stress-Deformation Analysis: One dimensional, two dimensional and three-dimensional formulations.

UNIT-II **(8 hours)**

Discretization of a Continuum: Elements, Strains, Stresses, Constitutive, Relations, Hooke's Law, Formulation of Stiffness Matrix, Boundary Conditions.

UNIT-III **(8 hours)**

Principles of Discretization: Element stiffness and mass formulation based on direct, variational and weighted residual techniques and displacements approach, Shape functions and numerical integrations, convergence.

UNIT-IV **(8 hours)**

Displacement Formulation: For rectangular, triangular and iso-parametric elements for two dimensional and axisymmetric stress analyses.

UNIT-V **(8 hours)**

Settlement Analysis: 2-D elastic solutions for homogeneous, isotropic medium, Steady Seepage Analysis: Finite element solutions of Laplace's equation, Consolidation Analysis: Terzaghi consolidation problem, Choice of Soil Properties for Finite Element Analysis.

Text Book:

1. Zienkiewicz O.C. and Taylor R.L., "Finite element methods (Vol I &Vol II)", McGraw Hill.
2. Bathe K.J., "Finite element procedures", PHI Ltd.

Syllabus

FEM IN GEOMECHANICS (CET-608)

3L: 0T:0P **Credits-3**

Reference books:

3. Potts D.M. and Zdravkovic L., "Finite Element Analysis in Geotechnical Engineering", Thomas Telford.
4. Chandrupatla, R.T. &Belegundu, A.D., "Introduction to Finite Elements in Engineering".

Syllabus

ADVANCED SOIL MECHANICS LAB(CEP-601)

0L: 0T:3P **Credits-1**

Course objectives:

- Ability to evaluate various soil characteristics.
- Ability to measure shear strength of soil.
- Student will be familiar with ASTM laboratory test standards and procedures. This include preparing soil samples for testing, performing the test, collecting and analyzing data, interpreting the results and writing technical reports.

Course Outcomes:

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

1. Understand the procedure for classifying coarse grained and fine-grained soils.
2. Evaluate the index properties of soil.
3. Determine the engineering properties of soil.
4. Interpret the results of compaction test for relative compaction in the field
5. Conduct experiments analyze and interpret results for geotechnical engineering design.
6. Compute and analyze the consolidation settlements.

Syllabus:

EXPERIMENTS:

1. To determination of Moisture Content and Specific gravity of soil
2. To determine the Grain Size Distribution Analysis and Hydrometer Analysis
3. To determine theAtterberg Limits (Liquid Limit, Plastic limit, Shrinkage limit)
4. To determine the Visual Classification Tests
5. To determine the Vibration test for relative density of sand
6. To determine the Standard and modified proctor compaction test
7. To determine the Falling head permeability test and Constant head permeability test
8. To determine the Consolidation test
9. To determine the Triaxial Shear Test (CU, CD, UU)
10. To determine the Field Density Test

Syllabus

SOIL DYNAMICS LAB (CEP-602)

0L: 0T:3P **Credits-1**

Course objectives:
This course will enable students to facilities to work on the dynamic strength and stability of soils by evaluating dynamic soil properties, index properties of soils and liquefaction resistance of soils. Highly sensitive element test facilities.

Course Outcomes:

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

1. Calculate the dynamic properties of soils using laboratory and field tests.
2. Determine shear strength of soil usingcyclic triaxial test and cyclic direct shear test.

Syllabus:

EXPERIMENTS:

1. To determine the Spectral analysis of surface waves (SASW) Test / Multi-channel analysis of surface waves (MASW) test
2. To determine the Seismic cross-hole test
3. To determine the Seismic down-hole / up-hole test
4. To determine the Seismic dilatometer test
5. To determine the Resonant column test
6. To determine the Piezoelectric bender element test
7. To determine the Cyclic triaxial test
8. To determine the Cyclic direct shear test
9. To determine the Block vibration test

Syllabus

Open Elective-1 (Optional) **Disaster Management(CET-623)**

3L: 0T:0 **Credits-3**

Course objectives:

- The main objective of the topic is to create awareness about and understanding of disasters and disaster mitigation measures. It deals with the subject in a structured manner.
- The topic classification of disasters, separate chapters on natural and man-made (anthropogenic) disasters, basic management concepts, four-cycle disaster management, organizational structures in India and other countries, NGOs, ethical issues and case studies.

Course Outcomes:

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

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Syllabus:

UNIT-I **(8 hours)**

Introduction Disaster: Definition, factors and significance; difference between hazard and disaster; natural and manmade disasters: difference, nature, types and magnitude. Repercussions of disasters and hazards: economic damage, loss of human and animal life, destruction of ecosystem. natural disasters: earthquakes, volcanisms, cyclones, tsunamis, floods, droughts and famines, landslides and avalanches, man-made disaster: nuclear reactor meltdown, industrial accidents, oil slicks and spills, outbreaks of disease and epidemics, war and conflicts.

UNIT-II **(8 hours)**

Disaster Prone Areas in India: Study of seismic zones; areas prone to floods and droughts, landslides and avalanches; areas prone to cyclonic and coastal hazards with special reference to tsunami; post-disaster diseases and epidemics.

UNIT-III **(8 hours)**

Disaster Preparedness and Management: Preparedness: monitoring of phenomena triggering a disaster or hazard; evaluation of risk: application of remote sensing, data from meteorological and other agencies, media reports: governmental and community preparedness.

UNIT-IV **(8 hours)**

Syllabus

Open Elective-1 (Optional) **Disaster Management (CET-623)**

3L: 0T:0 **Credits-3**

Risk Assessment: Disaster risk: concept and elements, disaster risk reduction, global and national disaster risk situation. Techniques of risk assessment, global co-operation in risk assessment and warning, people's participation in risk assessment. Strategies for survival.

UNIT-V **(8 hours)**

Disaster Mitigation meaning, concept and strategies of disaster mitigation, emerging trends in mitigation. Structural mitigation and non-structural mitigation, programs of disaster mitigation in india.

Text Book:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.

Reference books:

3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep&Deep Publication Pvt. Ltd., New Delhi.

Technical Writing and Presentation Skills (AHT-303)

L:T:P::2:0:0 **Non-credits**

Course Objectives:

- To develop effective writing and presentation skills in students.
- To develop textual, linguistic and presentation competencies instudents appropriate for their professional careers.

Course Outcomes:

After the successful completion of course, the students will be able to:

CO1: Write clearly and fluently to produce effective technical documents.

CO2: Demonstrate an appropriate communication style to different types of audiences both orally and written as per demand of their professional careers.

CO3: Communicate in an ethically responsible manner.

Course Contents:

WRITING SKILLS

Unit-I **(4 hours)**

Technical Writing-Basic Principles: Words-Phrases-Sentences, Construction of Cohesive Paragraphs, Elements of Style.

Unit-II **(4 hours)**

Principles of Summarizing: Abstract, Summary, Synopsis

Unit-III **(6 hours)**

Technical Reports: Salient Features, Types of Reports, Structure of Reports, Data Collection, Use of Graphic Aids, Drafting and Writing

PRESENTATION SKILLS

Unit-IV **(6 hours)**

Speaking Skills: Accuracy vs. Fluency, The Audience, Pronunciation Guidelines, Voice Control.

Unit-V **(8 hours)**

Professional Presentations: Planning, Preparing, Presentation Strategies, Overcoming, Communication Barriers, Using Technology, Effective Presentations.

References:

1. Kumar, Sanjay &PushpLata, “Communication Skills”, Oxford UniversityPress,2011.
2. Quirk & Randolph, “A University Grammar of English”, Pearson,2006.
3. Rutherford, Andrea J., “Basic Communication Skills for Technology”, Pearson 2007.
4. Rizvi, M Ashraf, “Effective Technical Communication”, McGraw Hill,2009.
5. Leigh, Andrew & Maynard, Michael, “The Perfect Presentation”, Random House.

6. Barker, Larry L., “Communication”, Prentice-Hall.
7. Lesikar&Flatley, “Basic Business Communication-Skills for Empowering the Internet Generation”, Tata McGraw-Hill.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

Syllabus

ADVANCED FOUNDATION ENGINEERING (CET-609)

3L: 0T:0P **Credit: 3**

Course Objectives: The objectives of this course are to impart knowledge and abilities the students to:

- Design a shallow foundation subjected to eccentric & inclined loads.
- Design of deep foundation i.e., piles based on settlement & bearing capacity criteria.
- Impart knowledge on earth pressure theories in design of gravity and cantilever retaining wall.
- Narrate the importance of apparent earth pressure diagrams in design of sheet piles & braced cuts.
- Design of foundations in Expansive soils.

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

1. Determine the earth pressures on foundations and retaining structures.
2. Analyze shallow and deep foundations.
3. Calculate the bearing capacity of soils and foundation settlements.

Syllabus:

UNIT-I **(8 hours)**

Planning of Soil Exploration for different projects, methods of subsurface exploration, methods of borings along with various penetration tests.

UNIT-II **(8 hours)**

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-III **(8 hours)**

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-IV **(8 hours)**

Well Foundation: IS and IRC Codal provisions, elastic theory and ultimate resistance methods.

UNIT-V **(8 hours)**

Foundations on Problematic Soils: Foundations for collapsible and expansive soil.

Text Book:

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.

Reference Books:

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 Son

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Syllabus

SUBSURFACE INVESTIGATION AND INSTRUMENTATION (CET-511)

3L: 0T:0P **Credit: 3**

Course Objectives:

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

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

1. Describe the phases of soil investigation in depth and identify the plan for soil investigation.
2. Identify various methods of soil investigation and soil sampling.
3. Illustrate various field test of soils and rocks.
4. Examine components of soil exploration report and estimate properties using correlations.
5. Work with relevant instrumentation required for characterizing the soil.

Syllabus:

UNIT-I **(8 hours)**

Introduction to Soil Exploration: Objectives of Site Investigation, Phases of investigation, Classification, Planning for Subsurface Exploration, Fact finding and Geological survey, Reconnaissance, Preliminary Exploration, Detailed Exploration, Codal Provisions.

UNIT-II **(8 hours)**

Methods of Investigations and Sampling: Trial pits/Trenches, Borings/drilling, Auger boring, Wash boring, Percussion drilling, Rotary drilling, Sample Disturbance, Disturbed Sample, Undisturbed Samples, Sampling by standard split spoon, Sampling by thin-wall tube, Sampling by Piston sampler.

UNIT-III **(8 hours)**

Geotechnical Investigation (Semi-direct methods): Vane Shear test, Standard Penetration Test, Pressuremeter Test, Cone Penetration Test, Dilatometer test, Rock core drilling, Sampling of rock, Core stacking, Rock Quality Designation (RQD), Total Core Recovery (TCR).

UNIT-IV **(8 hours)**

Geophysical Tests (Indirect methods): Seismic reflection survey, Seismic refraction survey, Electrical resistivity Survey, Applications, Advantages, Disadvantages and Limitations.

UNIT-V **(8 hours)**

Soil Exploration Report and Field Instrumentation: Components of Soil Exploration Report, Drafting of Reports, Graphic Presentations of Bore Log, Study of Sample Reports, And Field Instrumentation: Pressure meters, Piezometer, Pressure cells, Sensors, Inclinometers, Strain gauges etc.

Text Book:

1. Braja M. Das, “Principles of Geotechnical Engineering” Cengage.
2. Rajan & Rao, “Basic and applied Soil Mechanics”, New Age International Publishers.

Reference books:

3. Micheal Carter and Stephen P. Bentley “Soil Properties and their correlations”, Wiley Publications.
4. Latest version of relevant IS codes for various tests.

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Syllabus

ENGINEERING ROCK MECHANICS (CET-610)

3L: 0T:0P

Credit: 3

Course Objectives:
The objectives of the course are for the students to develop an understanding of the engineering properties of rocks, geological and engineering rock classifications, rock failure theories, in-situ stresses in rock, and the fundamental concepts and principles of rock mechanics. This course is the pre-requisite for Rock Mechanics II which covers the applications of rock mechanics principles in the design of foundations, slopes and underground openings in rock.

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

1. Comment upon the behaviour of in-situ stresses.
2. Interpret different failure criteria.
3. Describe the laboratory investigation of shear strength of rock joints.
4. Analyse the stability of slopes in rocks.
5. Propose foundation on rocks.
6. Explain the underground excavation methods.
7. Select support system for excavation in rocks.

Syllabus:

UNIT-I **(8 hours)**

Physical Properties and Classification- Types of rocks and their formations; Distribution of Rocks in Indian Mainland; Laboratory Testing of Rocks; Strength, Modulus and Stress-Strain Response of Rocks; Engineering Classification of Rocks.

UNIT-II **(8 hours)**

In-situ Stress Conditions- In-situ stresses; Deformability tests in rock mass; Field shear test; Hydrofracturing technique, Flat jack technique; Estimation of Stresses in Rock Mass; Underground opening in infinite medium, Elastic and Elasto-Plastic approach. Stress concentration for different shapes of opening, Zone of influence.

UNIT-III **(8 hours)**

Failure Criteria- Failure criteria for rock and rock masses; Mohr-Coulomb Yield Criterion, Drucker-Prager Criterion, Hoek-Brown Criterion, Tensile Yield Criterion; Strength and deformability of jointed rock mass; Fracture strength of jointed rock mass; Shear strength of Rock joints, Deformability of Rock joints, Concept of joint compliance.

UNIT-IV **(8 hours)**

Slopes and Foundations in Rocks- Stability of rock slopes, Modes of failure, Plane failure, Wedge failure, Circular failure, Toppling failure. Foundation on rocks, Estimation of bearing capacity, Stress distribution in rocks, Settlement in rocks, Pile foundation in rocks.

UNIT-V **(8 hours)**

Excavation Methods and Design of Support- Drilling and Blasting for Underground and Open Excavation; Stages of Excavation; TBM; Methods to improve rock mass responses.

Text Book:

Syllabus

ENGINEERING ROCK MECHANICS (CET-610)

3L: 0T:0P

Credit: 3

1. R. E. Goodman, “Introduction to Rock Mechanics”, John Wiley & Sons.
2. T. Ramamurthy, “Engineering in Rocks for Slopes, Foundation and Tunnels”, Editor Prentice Hall India Pvt. Ltd.
3. Jaeger, Cook and Zimmerman, “Fundamentals of Rock Mechanics”, Fourth Edition, Blackwell Publishing.

Reference books:

4. L. Obert and Wilbur I. Duvall, “Rock mechanics and the design of structures in rock”, John Wiley & Sons, Inc
5. J. A. Hudson and J. P. Harrison, “Engineering Rock Mechanics: An Introduction to the Principles”.
6. John Conrad Jaeger, Neville G. W. Cook, Robert Zimmerman, “Fundamentals of Rock Mechanics”, 4th Edition.

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Syllabus

ENVIRONMENTAL GEOTECHNOLOGY (CET-611)

3L: 0T:0P **Credit: 3**

Course Objectives: Objectives of introducing this subject are:
1. Explain the effects of pollutants in soil properties.
2. Awareness about the adverse effects of soil and ground water contaminants.
3. Analyse and apply the various techniques for remediation of the contaminants.

Course Outcomes: After the completion of this course, the student will be able to:
1. Understand soil environment interaction, composition, soil structure and its behaviour.
2. Specify site investigation techniques for characteristics of contaminated site.
3. Identify contaminant transport mechanisms in soils.
4. Specify site investigation techniques for characterization of contaminated site.
5. Understand the principles of soil treatment techniques.
6. Identify contaminants transport mechanism in soil.

Syllabus:

UNIT-I **(8 hours)**

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 **(8 hours)**

Soil Mineralogy- significance of mineralogy in determining soil behaviour; Mineralogical characterization.

UNIT-III **(8 hours)**

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 **(8 hours)**

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 **(8 hours)**

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, slurry walls and barrier systems, design and construction, stability, compatibility and performance, remediation technologies, stabilization of contaminated soils and risk assessment approaches.

Text Book:

1. Fang H-Y., “Introduction to Environmental Geotechnology”, CRC Press.
2. Daniel D.E, “Geotechnical Practice for Waste Disposal”, Chapman and Hall.
3. Rowe R.K, “Geotechnical and Geo-environmental Engineering Handbook”, Kluwer Academic Publishers.

Reference Books:

4. Mitchell J.K and Soga K., “Fundamentals of Soil Behavior”, John Wiley and Sons Inc.
5. Reddi L.N. and Inyang H.F, “Geo-environmental Engineering - Principles and Applications”, Marcel

Syllabus

ENVIRONMENTAL GEOTECHNOLOGY (CET-611)

3L: 0T:0P **Credit: 3**

6. Dekker Inc.
7. Sharma H.D. and Lewis S.P, "Waste Containment Systems, Waste Stabilization and Landfills: Design and Evaluation", John Wiley & Sons Inc.
8. Rowe R.K., Quigley R.M. and Booker J.R., "Clayey Barrier Systems for Waste Disposal Facilities", CRC Press.

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Syllabus

MARINE GEOTECHNIQUES (CET-612)

3L: 0T:0P **Credit: 3**

Course Objectives:

To understand differences between the soil and loading conditions of on-shore and offshore structures, various types of offshore foundation systems, and to evaluate the performance of offshore structures.

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

1. Analyze distribution of marine sediments along the Indian coasts.
2. Analyze geotechnical challenges in case of marine sediments.
3. Implement in-situ testing procedures for determining the properties of marine clays.
4. Analyze behavior of marine soil deposits under repetitive loading conditions.

Syllabus:

UNIT-I **(8 hours)**

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 **(8 hours)**

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 **(8 hours)**

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 **(8 hours)**

Foundations in marine soil deposits: Different offshore and nearshore foundations, Gravity platforms, Jack-up rigs, pile foundations. cassions, spudcans.

UNIT-V **(8 hours)**

Numerical modeling of marine foundations subjected to wave loading: Numerical modeling of cyclic behavior of soils, empirical models, elastic-plastic models, FEM analysis of marine foundations subjected to wave loading.

Text Book:

1. H. G. Poulos. “Marine Geotechnics”, Unwin Hyman Ltd, London, UK, 1988

Reference books:

2. D. V. Reddy and M. Arockiasamy, “Offshore Structures”, *Volume: 1*, R.E. Kreiger Pub and Co., 1991

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Syllabus

CONSTITUTIVE MODELLING IN GEOMECHANICS (CET-613)

3L: 0T:0P **Credit: 3**

Course Objectives: The course you will be able to:

- Understand principles and applications of methods available for modelling soil behavior.
- Recognize advantages and limitations of the different constitutive models.
- Understand how to select appropriate model parameters from available field and laboratory data.
- Understand how to apply a constitutive model using numerical methods (Finite Element Method, Finite Differences Method) available for engineering computer software (e.g., Plaxis, FLAC) to analyze a variety of geotechnical problems.

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

1. Summarise and compare the main features and uses of a constitutive model.
2. Select and justify parameters to be used in a constitutive model.
3. Implement constitutive modelling to assess the stability of a geotechnical structure.

Syllabus:

UNIT-I **(8 hours)**

Introduction to Constitutive Modelling- Importance of laboratory testing with relation to constitutive modelling; Stress/strain relationships, Elasticity: linear, quasi linear, anisotropic behavior.

UNIT-II **(8 hours)**

Simple Constitutive Models- Mohr-Coulomb models, Review s-t, p-q spaces, Introduction to critical state framework (with examples) with effects of pre-consolidation pressures and drained/undrained loading

UNIT-III **(8 hours)**

Modelling Aspects- Work done / energy balances, Plasticity, Normality rules and yield surfaces, Compare models with observed soil behaviours.

UNIT-IV **(8 hours)**

Extended Constitutive Models- Cam-clay models, Simulation of single element test using Cam-clay.

UNIT-V **(8 hours)**

Work Hardening Plasticity Theory- Formulation and implementation; Applications of elasto-plastic models; Special Topics: hypo elasticity-plasticity, disturbed state concept.

Text Book:

1. Hicher & Shao, “Constitutive Modelling of Soils and Rocks”, John Wiley and Sons.

Reference books:

2. C. S. Desai, “Mechanics of Materials and Interfaces”, CRC press.

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Syllabus

DESIGN OF UNDERGROUND EXCAVATIONS (CET-614)

3L: 0T:0P **credit: 3**

Course Objectives:
The students will learn theoretical aspects of tunnel and cavern excavation methods. The subject will help in understanding the applicability of excavation techniques with respect to ground conditions and its cost benefits.

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

1. Understand the use of elastic and plastic analysis in the design of underground support system.
2. Know about the field tests generally conducted during and after construction of under structures.

Syllabus:

UNIT-I **(8 hours)**
Introduction, planning of and exploration for various underground construction projects, stereographic projection method, principle and its application in underground excavation design.

UNIT-II **(8 hours)**
Elastic stress distribution around tunnels, stress distribution for different shapes and under different in-situ stress conditions, Greenspan method, design principles, multiple openings, and openings in laminated rocks, elasto-plastic analysis of tunnels, Daemen's theory.

UNIT-III **(8 hours)**
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 behaviour of tunnels and caverns, New Austrian Tunneling Method (NATM), Norwegian Tunneling Method (NTM), construction dewatering.

UNIT-IV **(8 hours)**
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 **(8 hours)**
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.

Text Book:

1. Hoek, E and and Brown, E. T.," Underground Excavations in Rocks", Institute of Mining Engineering.

Reference books:

2. Obert, L. and Duvall, W.I., "Rock Mechanics and Design of Structures in Rocks", John Wiley.

Syllabus

DESIGN OF UNDERGROUND EXCAVATIONS (CET-614)

3L: 0T:0P **credit: 3**

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.

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Syllabus

EARTH RETAINING STRUCTURES (CET-513)

3L: 0T:0P **Credit: 3**

Course Objectives:

- To understand lateral earth pressure theories and pressure theories and design of retaining walls.
- To design anchored bulkheads by different methods.
- To understand pressure envelops and design of various components in braced cuts and cofferdams.
- To understand stability of earth dams and its protection and construction.

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

1. Analyze the earth retaining structures for their stability against earth pressure.
2. Apply engineering knowledge for the designing of earth retaining structures in various site conditions.
3. Evaluation of retaining structures using appropriate design methods, factors of safety, earth pressure diagrams and check their stability.
4. Determine the required depth of penetration and embedment of free and fixed sheet pile walls in cohesion and cohesionless soils.
5. Evaluate anchored sheet pile walls in free and fixed earth support conditions, spacing between bulkheads and anchors, resistance of anchor plates.

Syllabus:

UNIT-I **(8 hours)**

Earth Pressure- Introduction to earth pressure – basic concepts, Earth Pressure Types, Rankine's theory, backfill features – soil type, surface inclination, loads on surface, soil layers, water level, Coulomb's theory, Effects due to wall friction and wall inclination, Graphical methods and their interpretations.

UNIT-II **(8 hours)**

Earth Retaining Structures- Types of earth retaining structures, Rigid Retaining Structures, Types, Empirical methods and Stability analysis. Flexible Retaining Structures, Types, Material, Design specifications and pressure distribution variations.

UNIT-III **(8 hours)**

Sheet Piles and Bulkheads- Sheet Piles and Bulkheads in Granular and Cohesive Soils - Materials Used for Sheet Piles – Free Earth and Fixed Earth Support Methods, Cantilever sheet piles, Anchored bulkheads, moment reduction factors, anchorage, Braced Excavation Types, Construction methods, Pressure distribution in sands and clays.

UNIT-IV **(8 hours)**

Seepage Analysis- seepage control in embankments and foundations, seepage analysis, stability analysis: upstream and down-stream for steady seepage, rapid draw down, end of construction, method of slices and Bishop's method, Coffer dams: Braced coffer dams – walls and supports, bottom heave and piping, Arching in Soils - Soil Pressures on Braced Walls and their Design.

UNIT-V **(8 hours)**

Slope Protection and Geo-synthetics- Slope protection, filters, embankment construction materials and construction, quality control, grouting techniques. Instrumentation and performance observations in earth dams, Drum- debris walls, Classification of Geo-synthetics, Functions and applications, Properties of Geo-textiles, Geo-grids and Geo-membranes.

Text Book:

Syllabus

EARTH RETAINING STRUCTURES (CET-513)

3L: 0T:0P **Credit: 3**

1. Terzaghi, K., "Theoretical Soil Mechanics", John Wiley, 1965.
2. Bowles, J.W., "Analysis and Design of Foundations", McGraw-Hill, 4th and 5th Ed. 1996.

Reference books:

3. Lambe, T.W. and Whitman, R.V., "Soil Mechanics", Wiley Eastern Limited, 1976.
4. Gulhati, K. Shashi and M. Datta, "Geotechnical engineering", Mc. Graw Hill Book Company, 2005.

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Syllabus

RISK MANAGEMENT IN CONSTRUCTION (CET-317)

3L: 0T:0P **Credit: 3**

Course Objectives:

- To train the students with the latest and the best in the rapidly Risk management in the fields of Construction Engineering.
- To understand the concept of construction risks.
- How to recognize potential risks.
- To know how to quantify the likelihood and potential impact of risks.
- Analyze potential risks and create strategies.

Course Outcomes: After studying this course, you should be able to:

1. Demonstrate knowledge of the range of financial and financial related risks facing organizations.
2. Understand the approach to risk management through risk identification, risk measurement and risk management (or mitigation).
3. Understand reputational risk.
4. Be able to apply theoretical and practical aspects of risk management techniques to achieve project goals.
5. Be able to apply knowledge and skills of modern construction practices and techniques.

Syllabus:

UNIT-I **(8 hours)**

Introduction: Concept risk management in construction, types of risks in risk management in construction, Importance of construction safety management, safety policy in construction. Study of safety policies, methods, equipment, training provided on any ISO approved construction Company, safety in office, working on sites of high-rise construction, deep excavation.

UNIT-II **(8 hours)**

Risk analyses: Tools and techniques, impact Potential impacts in risk, risk impact charts mind tools, risk prioritization, probability and risk response strategies. Execute risk management in plan, involves member of the teams.

UNIT-III **(8 hours)**

Construction safety management: Role of various parties, duties and responsibilities of top management, site managers, supervisor's etc. role of safety officers, responsibilities of general employees, safety committee, safety training, incentives and monitoring. Writing safety manuals, preparing safety checklists and inspection reports.

UNIT-IV **(8 hours)**

Safety in construction operations: Safety of accidents on various constructions sites such as buildings, dams, tunnels, bridges, roads, etc. safety at various stages of construction. Prevention of accidents. Safety measures. Safety in use of construction equipment e.g. Vehicles, cranes, hoists and lifts etc.

UNIT-V **(8 hours)**

Safety of scaffolding and working platforms: Safety while using electrical appliances. Explosives used, various safety equipment and gear used on site. First aid on site, safety awareness program, labor laws, legal requirement and cost aspects of accidents on site, incentive for safety.

Syllabus

RISK MANAGEMENT IN CONSTRUCTION (CET-317)

3L: 0T:0P **Credit: 3**

Text Book:

1. Amit Bijon dutta,"Understanding Risk management in construction" Evincepub publishing 2020.
2. Roger Flanagan,George Norman,"Risk management and construction"Wiley-Blackwell 1993.

Reference books:

3. Construction Safety Handbook – Davies V.S.Thomasin K, Thomas Telford, London.
4. ISI for safety in Construction – Bureau of Indian Standrads.
5. "Safety management" –Girimaldi and Simonds, AITBS, New Delhi.

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Syllabus

ENVIRONMENTAL IMPACT ASSESMENT (CET-318)

3L: 0T:0P **Credit: 3**

Course Objectives:

- To study the importance of EIA.
- To know the role of public in EIA studies.
- Understand phenomena of impacts in the environment.
- Know the impact quantification of various projects on the environment.

Course Outcomes:

1. Identify the objectives and scope of EIA.
2. Explicate the concept of EIA.
3. Illustrate the necessity of public participation in EIA studies.
4. Summarize the importance of Environmental Attributes.
5. Explain the phenomena of Impacts on environment.
6. Quantify impacts for various developmental projects.

Syllabus:

UNIT-I **(8 hours)**

Introduction to Eia: Definition, Evaluation of EIA in INDIA, Rapid and Comprehensive EIA, EIA, EIS, FONSI and NDS. Need for EIA studies, Baseline data, and Step-by-step procedure for conducting EIA, Advantages and Limitations of EIA, Hierarchy in EIA, Statutory requirements in EIA, MoEF guidelines in siting Developmental Projects.

UNIT-II **(8 hours)**

Objectives and Scope of Eia: Contents of EIA, Methodologies and Evaluation Techniques of EIA, Selection for specific projects.

UNIT-III **(8 hours)**

Public Participation in Eia: Elements of Effective Public Participation, Benefits and Procedures, EMP and DMP, Environmental Information System, Environmental Monitoring Systems, Public information network.

UNIT-IV **(8 hours)**

Environmental Attributes: Value functions, Environmental attributes - Construction project, Industrial project, Developmental projects - Construction and Operational Phase, Mitigation measures – On Air, Water, Land, Ecology and Socio-economic Environment.

UNIT-V **(8 hours)**

Environmental Impact Case Studies: Case studies on Human impact on Himalayan Ecosystem, Urban solid waste management with reference to Hyderabad City, Irrigation impacts of Upper Thunga Project (UTP) at Shimoga, Impact on air quality due to cement making – A case study of ACC limited, Madhukkarai, Coimbatore,Bhopal Gas tragedy.

Impact quantification study on - Water resource Developmental projects, Hazardous waste disposal sites, sanitary land filling, Mining projects, Thermal/Nuclear power plant and Pharmaceutical industries.

Text Book:

1. Environmental Impact Analysis, Urban & Stacey, Jain R.K.
2. Environmental Impact Assessment, Mc Graw Hill Inc, L.W. Canter (1996).
3. Environmental Impact Assessment and Management, Daya Publishing house, Hosetti B.B., Kumar A. (2014).

Reference books:

Syllabus

ENVIRONMENTAL IMPACT ASSESMENT (CET-318)

3L: 0T:0P **Credit: 3**

4. Guidelines for EIA of Developmental Projects, MoEF, GOI.
5. Environmental Quality management, south asian publishers pvt ltd., Bindu N. Lohani.

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Syllabus

INDUSTRIAL SAFETY (CET-319)

3L: 0T:0P **Credit: 3**

Course Objectives:

- To know about Industrial safety programs and toxicology, Industrial laws, regulations and source models.
- To understand about fire and explosion, preventive methods, relief and its sizing methods.

Course Outcomes: By the end of the course the students will be able to:

1. Analyze the effect of release of toxic substances
2. Understand the industrial laws, regulations and source models.
3. Apply the methods of prevention of fire and explosions.
4. Understand the relief and its sizing methods.

Syllabus:

UNIT-I **(8 hours)**

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 **(8 hours)**

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 **(8 hours)**

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 **(8 hours)**

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 **(8 hours)**

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.

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Syllabus

INDUSTRIAL SAFETY (CET-319)

3L: 0T:0P **Credit: 3**

Text Book:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

Reference books:

3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Syllabus

ADVANCED FOUNDATION ENGINEERING LAB (CEP-603)

0L: 0T:3P **Credit: 1**

Course objectives: This course enables the students to:

- To have a practical knowledge and hands on experience of advanced equipment's.
- To evaluate bearing capacity from field tests.
- To analyse and predict the behavior of soil from the experimental results**.**

Course Outcomes:

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

1. Evaluate the bearing capacity of soil using SPT, Plate load test etc.
2. Conduct experiments to analyse and interpret results for geotechnical engineering design in plaxis.

Syllabus:

Experiments:

1. To determination the plate load test.
2. To determination the standard penetration test.
3. To determination the standard cone penetration test.
4. To determination the dynamic cone penetration test.
5. To determination the field vane shear test.
6. To determination the triaxial test.
7. To know about the application of Plaxis software.

Syllabus

SUBSURFACE INVESTIGATION AND INSTRUMENTATION LAB (CEP-604)

0L: 0T:3P **Credit: 1**

Course objectives:

- To discuss the importance of site investigation.
- To narrate various exploration techniques.
- To describe soil sampling techniques.
- To train with in-situ sub soil exploration methods.
- To demonstrate instrumentation for sub soil exploration.

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

1. Perform various soil investigation tests.
2. Plan a soil investigation survey according to the structure and the sub-soil.
3. Choose the appropriate field instrumentation for a particular test.

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Syllabus:

Experiments:

1. To study of various boring tools and techniques.
2. To study of various sampling tools.
3. To determine the Cone Penetration Test.
4. To determine the Pressure meter Test.
5. To determine the Dilatometer Test.
6. To determine the Seismic Refraction Test.
7. To determine the Electrical resistivity Test.
8. To determine the Study of Field Instrumentation.

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Syllabus

Open Elective-2 (Optional) AIR POLLUTION CONTROL ENGINEERING (CET-624)

3L: 0T:0P **Credit: 3**

Course Objectives: Students will gain:

- The major problems in air pollution.
- About regulation pertinent to air pollution outcomes.
- How to control of air pollution.

Course Outcomes: Students will be able to:

1. Understand the fundamentals of origin, impacts and control of different air pollutants.
2. Explain the types, nature and behavior of air pollutants under the influence of atmospheric conditions.
3. Appraise the monitoring techniques and control measures to curb the air pollution, considering the standards limits.
4. Understand the technical aspects sound waves and controlling methods for vibration and noise pollution.

Syllabus:

UNIT-I **(8 hours)**

Air Pollution Control, Air Pollution Effects, Effects of Air Pollution on Human Health Air Pollution Control Laws and Regulations, Emission Standard, Air Quality Standard.

UNIT-II **(8 hours)**

Emission Estimates, Concentration Determination, Averaging, Standard Analytical Methods, isokinetic Sampling, Meteorology, Horizontal and Vertical Motion in the Atmosphere, Atmospheric Stability**.**

UNIT-III **(8 hours)**

Fixed-Box, Diffusion model, Gaussian Plume Derivation, Plume Rise, Pollutant Creation and Decay in the Atmosphere Air Pollution Control, Process Change, Pollution Prevention, Downstream Pollution Control Device.

UNIT-IV **(8 hours)**

Fluid Velocities in Air Pollution Control Equipment, Minimizing Volumetric Flow Rate and Pressure Drop, Calculations on Inert Flow rates, Combustion, Combustion Kinetics, Mixing in Combustion Reactions, Volume and Composition of Combustion Products, Nature of Particulate Pollutants, Settling Velocity and Drag Forces, Stoke Law, Particle Size Distribution Functions, Control of Primary Particulates, Wall Collection Devices, Working and designing of Centrifugal Separators, Electrostatic Precipitators (ESP), Surface Filters, Depth Filters, Scrubbers for Particulate Control, Control of Volatile Organic Compounds(VOCs), Control by Prevention, Substitution, Process Modification, Leakage Control - Control by Concentration and Recovery.

UNIT-V **(8 hours)**

Reduction chemistry of Sulfur, Absorbers and Strippers, Removal of SO2 from Rich and Lean Waste Gases, Control of Nitrogen Oxides,Zeldovich Kinetics of Thermal NO Formation, Air Pollutionfrom Motor Vehicles, Tailpipe Emissions, Lean Operation, Exhaust Gas Recirculation (EGR), Reduce Flame Quenching, Speed the Warm-up,Catalylic Treatment of Combustion Products, Air Pollutants and Global Climate, Global Warming, Greenhouse Gases.

Text Book:

Syllabus

Open Elective-2 (Optional) AIR POLLUTION CONTROL ENGINEERING (CET-624)

3L: 0T:0P **Credit: 3**

1. Noel de Nevers.2000. Air Pollution Control Engineering. 2nd Edn., McGraw Hill., New York.
2. Rao M.N. and H.V.N. Rao, 2010, Air Pollution, Tata – McGraw hill Pub. Co., New Delhi.

Reference Books:

3. Cheremisinoff, N.P., 2002. *Handbook of air pollution prevention and control*. Elsevier.
4. Clarke, A.G. Ed., 2012. *Industrial air pollution monitoring*. Springer Science & Business Media.
5. Cheremisinoff, N.P., 2002. *Handbook of air pollution prevention and control*. Elsevier.
6. Clarke, A.G. Ed., 2012. *Industrial air pollution monitoring*. Springer Science & Business Media.

Syllabus
Research Methodology and IPR (AHT-302)

L:T:P:: 2:0:0 **Credits-2**

Course Objectives: Students will be able to:

1. To understand the fundaments of research in today's world controlled by technology, ideas, concept, and creativity.
2. To understand different methods of research designing and data collections.
3. To understand the methods of report writing and its different methods of interpretations.
4. To understand research ethics and methods of research publications
5. 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 inturn brings about, economic growth and social benefits.

Course Outcomes:

1. To understand research problem formulation.
2. To study research design and method of data collections.
3. To study methods of report writing.
4. To follow research ethics.
5. To enhance student's competence to discover new inventions.

Syllabus Contents:

UNIT I: FUNDAMENTAL OF RESEARCH

Meaning of research; objectives of research; basic steps of research; criteria of good research; Research methods vs. Methodology. Types of research –criteria of good research; Meaning of research problem; selection of research problem; Approaches of investigation of solutions for research problem, Errors in selecting a research problem, Scope and objectives of research problem, Review of related literature- Meaning, necessity and sources.

Unit 2: RESEARCH DESIGN AND DATA COLLECTION

Research design: Types of research design- exploratory, descriptive, diagnostic and experimental;Variables- Meaning and types; Hypothesis- Meaning, function and types of hypothesis; Null/Alternative hypothesis; Sampling- Meaning and types of sampling; Probability and Non-Probability; Tools and techniques of data collection- questionnaire, schedule, interview, observation, case study, survey etc.

Unit 3:REPORT WRITING AND ITS INTERPRETATION

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

Syllabus
Research Methodology and IPR (AHT-302)

L:T:P:: 2:0:0 **Credits-2**

Unit 4:RESEARCH ETHICS AND SCHOLARY PUBLISHING

Ethics-ethical issues, ethical committees (human & animal); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism and its concept and importance for scholar.

Unit 5: INTELLECTUAL PROPERTY RIGHT (IPR)

IPR- intellectual property rights and patent law, commercialization, New developments in IPR; copy right, royalty, trade related aspects of intellectual property rights (TRIPS); Process of Patenting and Development; Procedure for grants of patents, Patenting under PCT;Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases.

Reference Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science &engineeringstudents'"
2. WayneGoddardandStuartMelville,"ResearchMethodology:AnIntroduction"
3. RanjitKumar,2ndEdition,"ResearchMethodology:AStepbyStepGuideforbeginners"
4. Halbert,"ResistingIntellectualProperty",Taylor&FrancisLtd,2007.
5. Mayall,"IndustrialDesign",McGrawHill,1992.
6. Niebel,"ProductDesign",McGrawHill,1974.
7. Asimov,"IntroductiontoDesign",PrenticeHall,1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age",2016.
9. T.Ramappa,"IntellectualPropertyRightsUnderWTO",S.Chand,2008