CIVIL ENGINEERING DEPARTMENT
SoS, ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.), 495009

EVALUATION SCHEME OF Pre-Ph. D COURSE WORK

EFFECTIVE FROM SESSION 2021-22

SN.	Name of the Subject	Subject Code	Periods / Week L – T – P	ESE Duration	ESE MARKS		Credits
					Max.	Min.	
1	Research Methodology in Engineering	ETPHDT00	3 – 1 – 0	3 Hrs.	100	40	4
2	Elective - I	**	3 – 1 – 0	3 Hrs.	100	40	4
3	Elective - II	**	3 – 1 – 0	3 Hrs	100	40	4
Total			**9 – 3 – 0**	-	**300**	**120**	**12**

Note: i) Duration of the semester will be 6 months.
ii) Candidate has to score minimum 55% of the aggregate marks in the course work in order to be eligible to continue in the program leading to the completion of Ph.D.
iii) The student may select any two elective papers from the following list of electives

L : Lecture, T: Theory, P: Practical, Max.: Maximum Marks in ESE; Min.: Minimum Pass Marks in each subject as 50%

LIST OF ELECTIVES

S.NO.	SUBJECT CODE	TITLE OF THE SUBJECT
		ELECTIVE-I & II
1	CEPHDT01	OPTIMIZATION TECHNIQUES
2	CEPHDT02	FINITE ELEMENT METHOD
3	CEPHDT03	STRUCTURAL DYNAMICS
4	CEPHDT04	ADVANCED CONCRETE TECHNOLOGY
5	CEPHDT05	CONCRETE FRACTURE MECHANICS
6	CEPHDT06	SPECIAL CONCRETES
7	CEPHDT07	MULTIMODAL TRANSPORTATION SYSTEM
8	CEPHDT08	DESIGN AND CONSTRUCTION OF RURAL ROADS
9	CEPHDT09	ADVANCED HIGHWAY MATERIALS
10	CEPHDT10	TRANSPORTATION GEOTECHNICS
11	CEPHDT11	GEO-ENVIRONMENTAL ENGINEERING
12	CEPHDT12	SOIL – STRUCTURE INTERACTION

PRE- PhD COURSE WORK COURSE STRUCTURE

ETPHDT00: RESEARCH METHODOLOGY IN ENGINEERING

4 Credits [3-1-0]

Module 1

Introduction and Design of research: Meaning, objectives and significance of research, types and parameters of research, research process, identification and definition of the research problem, definition of construct and variables, pure and applied research design, exploratory and descriptive design methodology, qualitative vs. quantitative research methodology, field studies, field experiments vs. laboratory experiments, research design in social and physical sciences.

Module 2

Data and Methods of Data Collection: Survey, assessment and analysis: data collection, primary and secondary sources of data, Collection of primary data through questionnaire and schedules. Collection of secondary data, processing and analysis of data. Sample survey, simple random sampling, stratified random sampling, systematic sampling, cluster sampling, area sampling and multistage sampling. Pilot survey, scaling techniques, validity & reliability.

Module 3

Data Analysis and Interpretation: Procedure for testing of hypothesis, the null hypothesis, determining levels of significance, Testing of hypothesis, type i and ii errors, grouped data distribution, measures of central tendency, measures of spread/dispersion, normal distribution analysis of variance: one way, two-way, chi square test, z test and its application, student's 'T' distribution, Univariate and Bivariate analysis, regression analysis.

Module 4

Report writing and presentation: Review of literature: historical survey and its necessity, layout of research plan, meaning, techniques and precautions of interpretation, types of report: technical report, popular report, report writing – layout of research report, mechanics of writing a research report. Writing bibliography and references.

Module 5

Research ethics, IPR and scholarly publishing: Ethics: Definition, moral philosophy, nature of moral judgments and reactions, Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publication duplicates and overlapping publications, salami slicing, Selective reporting and misrepresentation of data, Publication ethics: definition, introduction and importance, Publication's misconduct: definition, concept, problems that lead to unethical behavior and vice versa, Patents, Designs, Trade and Copyright. Process of Patenting and Development.

Reference Books:

1. Research in education, By J W Best and J V Kahn, Pearson/ Allyn and Bacon.
2. Research Methodology – Methods and Techniques, C K Kothari, New Age International.
3. Design and Analysis of Experiments, D C Montgomery, Wiley.
4. Applied Statistics & Probability for Engineers, D C Montgomery & G C Runger, Wiley.
5. Management Research Methodology: Integration of Principles, Methods and Techniques, K N Krishnaswamy, A I Sivakumar and M Mathiranjan, Pearson Education.

6. Research Methodology - Methods & Techniques, CR Kothri CR (1990), VishvaPrakashan, NewDelhi.
7. Research Methodology & Statistical Techniques, S Gupta (1999) Deep & Deep Publications, NewDelhi.
8. Research Methodology for Biological Sciences, N Gurumani (2007), MJP Publishers, Chennai.
9. Research Design:Qualitative, Quantitative &Mixed Method Approaches, JohnW. Creswell (2009), Sage Publication, USA

CEPhDT01: OPTIMIZATION TECHNIQUES

4 Credits [3-1-0]

Unit-I: Formulation of structural optimization Problem: Design Vector, Design Constraints, Constraint Surface, Objective Function, Objective Function Surfaces, Classification of Optimization Problems, Single-Variable Optimization, Multivariable Optimization with No Constraints, with Equality Constraints and with Inequality Constraints

Unit-II: Linear Programming: Simplex Method, Application to structural optimization.

Unit-III: Nonlinear Programming : One-Dimensional Minimization Methods, Unconstrained Optimization Techniques, Constrained Optimization Techniques.

Unit-IV: Optimal Control and Optimality Criteria Methods: Calculus of Variations, Optimal Control Theory, Optimality Criteria Methods, optimization of sections, steel and concrete structures, framed structures, bridge structures.

Unit-V: Modern Methods of Optimization: Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization, Optimization of Fuzzy Systems.

Artificial Intelligence and Artificial Neural Networks based approaches for structural optimization problems.

References

1. J.S. Arora, introduction | to Optimum Design, Elsevier, 2nd Edition, 2004.
2. K. Deb, Optimization for Engineering. Design: Algorithms & Examples, Prentice Hall India, 2006
3. S.S. Rao, Engineering Optimization: Theory & Practice, New Age International (P) Ltd, 3rd Edition,1996, Reprint : June, 2008
4. K. Deb,Multi-Objective Optimization Using Evolutionary Algorithms, John Wiley, 2003

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CEPhDT02: ADVANCED CONCRETE TECHNOLOGY

4 Credits [3-1-0]

Unit I: Portland cement: chemical composition, hydration of cement. Structure of hydrated cement, mechanical strength of cement gel, water held in hydrated cement paste and heat of hydration.

Unit II: Concrete: Properties of fresh and hardened concrete: Workability, bleeding, Segregation, compressive strength, tensile strength, Flexural strength, Factors affecting the strength of concrete. Modulus of Elasticity.

Unit III: Long term properties of concrete: shrinkage and creep, durability: permeability, thermal properties.

Unit IV: Chemical attack of concrete, air-entrained concrete, Effect of water quality in curing and manufacturing of concrete. Common deterioration of concrete structures-corrosion, carbonation and freezing-thawing.

Unit V: Recycled aggregates properties, recycled concrete properties, important parameters affecting the mechanical and strength properties of recycled concrete.

References

1. A.M. Neville, J.J. Brooks,Concrete Technology, Low Priced Edition, Pearson Education, 2004.
2. A J Martin, Mechanical behavior of engineering materials.
3. 3 M.S. Shetty, Concrete technology- Theory & Practice, S.Chand& Company New Delhi, 2
4. P.Mehta and P.M.Monteiro, Concrete: Microstructure, Properties and Materials, Mc Graw Hill BE

CEPhDT03: FINITE ELEMENT METHODS
(03-01-00 = 04 credits)

Course Content

Differential equilibrium equations - strain displacement relation - linear constitutive relation - special cases - Principle of stationary potential energy - application to finite element methods. Some numerical techniques in finite element analysis- calculus of variation, the Rayleigh-Ritz and Galerkin methods.

Displacement models - convergence requirements. Natural coordinate systems - Shape function. Interpolation function - Linear and quadratic elements - Lagrange and Serendipity elements - Strain displacement matrix - element stiffness matrix and nodal load vector.

Two dimensional isoparametric elements - Four node quadrilateral elements - triangular elements - Computation of stiffness matrix for isoparametric elements - numerical integration (Gauss quadrature) – Mess refinement - Convergence criteria for isoparametric elements.

Assemblage of elements – Direct stiffness method - Special characteristics of stiffness matrix - Boundary condition and reaction - Gauss elimination and LDLT decomposition - Basic steps in finite element analysis.

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Analysis of framed Structures - 2D truss element - 2D beam element. Analysis of plate bending: Basic theory of plate bending - displacement functions - plate bending Elements. Plane stress and plane strain analysis: Triangular elements - Rectangular elements, Eigen value and time dependent problems - discussion about preprocessors, postprocessors and finite element packages.

Reference Books

1. Krishnamoorthy, C. S, Finite Element Analysis - Theory and Programming, McGraw - Hill, 1995.
2. R. T. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, PHI Learning Pvt Ltd, New Delhi, 1997.
3. S. S. Bhavikatti, Finite Element Analysis, New Age Publishers, 2007.
4. David Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.
5. Chennakesava R. Alavala Finite Element Methods: Basic Concepts and Applications, Prentice Hall Inc., 2010.
6. J. N. Reddy, An introduction to the Finite Element Method, McGraw-Hill, New York, 2006
7. R. D. Cook, D. S. Malkus and M. E. Plesha, Concepts and Applications of Finite Element Analysis, Fourth Edition, Wiley, India, 2003.
8. K. J. Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, NJ, 1996
9. Fish and Belytschko, A First Course in Finite Elements, John Wiley, 2007.

CEPhDT04: STRUCTURAL DYNAMICS

(03-01-00 = 04 credits)

Course Content

Unit-I: Introduction to Dynamic analysis - Elements of vibratory systems and simple Harmonic Motion - Mathematical models of SDOF systems - Principle of Virtual displacements - Evaluation of damping resonance.

Unit-II: Fourier series expression for loading - (blast or earthquake) - Duhamel's integral - Numerical methods - Expression for generalized system properties - vibration analysis - Rayleigh's method - Rayleigh-Ritz method.

Unit-III: Evaluation of structural property matrices - Natural vibration - Solution of the Eigen value problem - Iteration due to Holzer and Stodola.

Unit-IV: Idealization of multi-storeyed frames - analysis to blast loading - Deterministic analysis of earthquake response - lumped SDOF system.

Unit-V: Differential equation of motion - Beam flexure including shear deformation. Basics of Earthquake Engineering Indian standards, Response Spectrum Concepts, Different analysis methods, Ductile detailing of buildings, Examples

Reference Books

1. Mario Paz, and William Leigh, Structural Dynamics, CBS, Publishers, 1987.
2. Roy R Craig, Jr., Structural Dynamics, John Wiley and Sons, 1981.

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3. A. K. Chopra "Dynamics of Structures Theory and Application to Earthquake Engineering" Pearson Education, 2001.
4. Clough and Penzien, Dynamics of Structures, McGraw Hill, 5 th Edition, 1975.
5. Srinivasan Chandrasekaran, Dynamic Analysis and Design of Ocean Structures, Springer, 2015

CEPhDT05: CONCRETE FRACTURE MECHANICS

(03-01-00 = 04 credits)

Course Content

Unit I: Review of theory of elasticity: Body and surface forces, strain and strain tensors, equilibrium equation, compatibility condition, plane stress, plane strain, Airy stress function, polar coordinate system.

Unit II: Basic modes of fracture, an atomic view of fracture, stress concentration effect of flaws, Griffith theory of brittle fracture, Irwin's modifications for elastic-plastic materials, dimensional analysis of fracture mechanics.

Unit III: Theories of linear elastic fracture mechanics, stress intensity factors, Fracture toughness, Energy release rate, Critical Energy release rate, Crack mouth opening displacement, R-Curve and J integral.

Unit IV: Tensile Behavior of Concrete, Strain localization effect, Fracture process zone, nonlinear behavior of concrete, softening function of concrete, Fracture energy.

Unit V: Definition and brief introduction of fracture parameters of various nonlinear concrete fracture models: cohesive crack model (CCM) or fictitious crack model (FCM), crack band model (CBM), two parameter fracture model (TPFM), size effect model (SEM), effective crack model (ECM), double-K fracture model (DKFM) and double-G fracture model (DGFM).

Reference Books

[1] David Broek, Elementary Engineering Fracture Mechanics, Sijthoff and Noordhaff, Alphen Aan Den Rijn, The Netherlands, 2001.

[2] Analysis of Concrete Structure by Fracture Mechanics, Ed L. Elfgren and S.P. Shah, Proc of Rilem Workshop, Chapman and Hall, London, 2001.

[3] Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New

[4] Delhi, India, 2009. K. Ramesh, e-Book on Engineering Fracture Mechanics, IIT Madras, 2007.

[5] Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, Wiley, India, 5th Edition, 2014.

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[6] Anderson, : Fracture Mechanics: Fundamentals and Applications, CRC press, 3rd Ed., 2005

[7] Kumar S, Barai SV (2011) Concrete Fracture Models and Applications. ISBN 9783642167638 (Hard Cover), Springer.

[8] Bazant ZP, Planas J (1998) Fracture and size effect in concrete and other quasibrittle materials, Florida, CRC Press.

[9] Surendra P. Shah, Stuart E. Swartz, Chengsheng Ouyang. Fracture Mechanics of Concrete: Applications of Fracture Mechanics to Concrete, Rock and Other Quasi-Brittle Materials. John Wiley & Sons.

CEPhDT06: SPECIAL CONCRETES

(03-01-00 = 04 credits)

Course Content

Unit-I: High Performance Concrete (HPC) - Introduction – Principles of HPC – Ingredients used for HPC – Production of HPC – Curing of HPC – Mechanism of HPC – Properties of HPC during the fresh and hardened state.

Unit-II: Durability of HPC - Acid Attack – Permeability – Scaling resistance – Chloride penetration – Resistance to sea water – sulfate attack – Alkali-aggregate reaction – Fire resistance

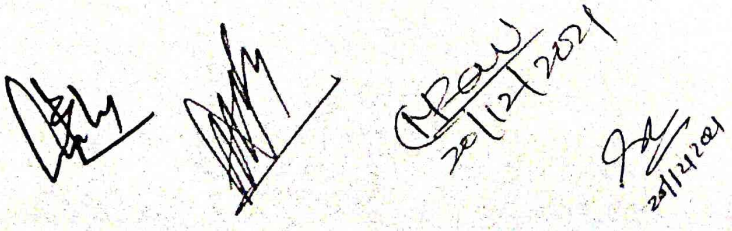
Unit-III: Mix design methods of HPC.

Unit-IV: Ultra-High Performance Concrete - Air-entrained HPC – Light-weight HPC – Heavy weight HPC – Fiber reinforced HPC – Confined HPC – Roller Compacted HPC – Ultra High Performance Concrete – Reactive powder Concrete - Bio concrete - Geopolymer concrete.

Unit-V: Self-Compacting Concrete - Introduction – Principles of SCC – Ingredients used for SCC – Mix design methods – Production and curing of SCC – Behavior of SCC under fresh and hardened state. Various Case Histories on HPC and SCC.

Reference Books

1. P. C. Aitcin, High Performance Concrete, E & FN SPON, 1998.
2. E. G. Nawy, Fundamentals of High Performance Concrete, John Wiley and Sons., 2nd Edition, 2000.
3. High Performance Concrete Structural Designers Guide published by FHWA, USA, 2005.
4. Geert De Schutter, Peter J. M. Bartos, Peter Domone, John Gibbs, SelfCompacting Concrete, Whittles Publishing, 2008.
5. Shetty M. S., Concrete Technology, S. Chand and Company Ltd. Delhi, 2003.



CEPhDT07: Multimodal Transportation System
(03-01-00 = 04 credits)

Course Content

Unit-I: Artificial Intelligence based Transportation System: Urbanization and transportation, Travel demand impacts of urbanization, Modal share, Motorization, Introduction to AI, components of transportation system that require optimization, role of AI in optimization of these components, congestion control, accident avoidance, active alert system design

Unit-II: Geographic information system-based transportation system: Introduction to GIS, sources of GIS, role of GIS in transportation, assessment of roads, and railways using GIS, case study of smart city GIS

Unit-III: Introduction of signal processing: Overview of Signal processing, Fundamentals of Image processing; Fundamental signals (1-D, 2-D and 3-D); Classification of systems; Characteristics of LTI/LSI systems. Application of Image Processing in Urban Transportation Systems

Unit-IV: Non-Motorized Transportation (NMT) Systems: Components of NMT, categories of NMT, planning smart cities to facilitate NMT, effect of NMT planning on healthcare

Unit-V: Pedestrian Safety: Urban Pedestrian Safety- Skyways, Intersection subways, halt stations, crossing measures, flexibility in accessibility, design of collision control systems for intersections to improve pedestrian safety

Reference Books

1. O. Flaherty C.A., "Traffic Engineering and Transport Planning", Butterworth Heinemann, Elsevier, Burlington, MA 2006.

2. M.A. Chowdhury and A. Sadek, Fundamentals of Intelligent Transportation Systems Planning, Artech House, 2010.

3. Gonzalez R. C. and Woods R. C., "Digital Image Processing", 2nd Ed., Pearson Education, 2007.

4.Jain A. K, "Fundamentals of Digital Image Processing", Prentice Hall, 2007.

CEPhDT08: Design and Construction of Rural Roads
(03-01-00 = 04 credits)

Course Content

Unit-I: Introduction about Rural Roads and Planning and Alignment: Importance of Rural roads, Classification of rural roads, Terrain classification, Socio-economic impact of rural roads. Data base for master plan, Concept of network planning, Rural Roads plan, Road alignment, Governing factors for route selection, Factors controlling alignment, Special considerations while aligning hill roads, Surveys, Detailed project report, Environmental issues.

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Unit-II: Geometric Design and Road Materials: Introduction, Design speed, Basic principles of geometric design, Elements, Horizontal and vertical alignment, Alignment compatibility, Lateral and vertical clearances. General, Soil and material surveys, Soil as road construction material, Aggregates for pavement courses, Materials for bituminous construction, Materials for semi-rigid and rigid pavement, Materials for special pavements Climatic suitability of concrete materials

Unit-III: Pavement Design, Specifications and Construction of Rural Roads: Introduction, Design parameters, Pavement components, Design of flexible pavement, Design of semi-rigid pavement, Design of rigid pavement, Drainage and Shoulders. General, Selection of construction materials and methodology, Earthwork, Sub-base, Base course, Bituminous constructions, Semi-rigid pavement construction, Concrete pavements, Equipment required for different operations.

Unit-IV: Use of Waste Materials in Rural Road Construction: Introduction, Significance of green roads, Fly ash for road construction, Iron & steel and copper slags, Recycled concrete aggregate, Other waste materials.

Unit-V: Quality Control Tests & Maintenance: General, Pre-requisite, Specifications and codes of practice, Quality control tests during pavement construction. Distresses/defects in pavements, Types of maintenance, Classification of maintenance activities, Maintenance norms of maintenance cost.

References:

1. Rural Roads Manual, IRC: SP 20-2002

2. Guidelines for the design of flexible pavements for low volume rural roads, IRC: SP: 72-2007

3. Geometric design standards for Rural (Non-Urban) Highways, IRC: 73-1980.

4. Guidelines for quality systems for road construction, IRC: SP: 57-2000.

CEPhDT09: Advanced Highway Materials
(03-01-00 = 04 credits)

Course Content

Unit-I: Aggregate: Nature and properties – aggregate requirements – types and processing – aggregates for pavement base – aggregate for bituminous mixture – aggregate for Portland Cement Concrete – light weight aggregate – tests on aggregate – specification.

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Unit-II: Bituminous Materials: conventional and modified binders – production – types and grade – physical and chemical properties and uses – types of asphalt pavement construction – principles of bituminous pavement construction – tests on bituminous materials. Bituminous Mix design – modified mixtures – temperature susceptibility and performance.

Unit-III: Cement /concrete based materials: Cement – properties – PCC mix design and properties – modified PCC – Mix Design – Behaviour – Performance – Tests on Cement and Concrete mixes. High Performance Concrete – low shrinkage – increased strength. Composites,

Unit-IV: Plastics and Geosynthetics: Plastics and polymerization process – properties – durability and chemical composition – Reinforced Polymer Composites – Geosynthetics – Dry Powdered Polymers – Enzymes.

Unit-V: Reclaimed / Recycled Waste Products: Reclaimed Materials – waste products in highway engineering and its applications – effect of waste products on materials, structure and properties – self healing and smart materials – locally available materials.

References:

1. P. T. Sherwood, Alternative Materials in Road Construction, Thomas Telford Publication, London,1997.

2. RRL, DSIR, Soil Mechanics for Road Engineers, HMSO, London , 1995

3. Koerner, R. M. Designing with Geosynthetics, Prentice Hall, Englewood Cliffs, New Jersey, U.S.A.

4. Shan Somayaji, Civil Engineering Materials, second edition, Prentice Hall Inc., 2001.

CEPhDT10: Transportation Geotechnics

(03-01-00 = 04 credits)

Course Content

Subgrade Soil: Classification, desirable properties, determination of soil strength, Swelling and Shrinkage characteristics, Road aggregates: classification, properties of aggregates, design of aggregate gradation; Cyclic response of soils, resilient and plastic behaviour of soils and aggregates, Effects of traffic loads, natural forces, and material quality. Current design practices; Principles and theoretical concepts of rigid and flexible pavements for highways and airfields;

Ground Improvement technics: Need for ground improvement, column methods : sand, stone and lime columns, soil nailing: root piles, soil reinforcement , functions of geosynthetics in soil, soil grouting: electro-chemical stabilization

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Pavement evaluation and performance; Utilization of recycled materials for sustainable pavements; Life cycle cost analysis. Highway embankments; Design and construction of embankments; Stage construction; Introduction to reinforced earth design and construction.

References:

1. Rajib B. Mallick, Tahar El-Korchi. Pavement Engineering: Principles and Practice. CRC Press, 2017.
2. Chakraborty P. and Das, A. Principles of Transportation Engg., PHI Publication, 1st Edition 2005
3. Papagiannakis A. T. and Masad, E. A. Pavement Design and Materials. Willey,2017

CEPhDT11: Geo-environmental Engineering
(03-01-00 = 04 credits)

Course Content

Unit-I: Fundamentals of Geoenviromental Engineering: Scope of geoenvironmental engineering - multiphase behavior of soil – role of soil in geoenvironmental applications – importance of soil physics, soil chemistry, hydrogeology, biological process – sources and type of ground contamination – impact of ground contamination on geoenvironment - case histories on geoenvironmental problems.

Unit-II: Soil-Water-Contaminant Interaction: Soil mineralogy characterization and its significance in determining soil behavior – soil-water interaction and concepts of double layer – forces of interaction between soil particles. Concepts of unsaturated soil – importance of unsaturated soil in geoenvironmental problems - measurement of soil suction - water retention curves - water flow in saturated and unsaturated zone. Soil-water-contaminant interactions and its implications – Factors effecting retention and transport of contaminants.

Unit-III: Waste Containment System: Evolution of waste containment facilities and disposal practices – Site selection based on environmental impact assessment –different role of soil in waste containment – different components of waste containment system and its stability issues – property evaluation for checking soil suitability for waste containment – design of waste containment facilities.

Unit-IV: Contaminant Site Remediation: Site characterization – risk assessment of contaminated site - remediation methods for soil and groundwater – selection and planning of remediation methods – some examples of in-situ remediation.

Unit-V: Advanced Soil Characterization: Contaminant analysis - water content and permeability measurements – electrical and thermal property evaluation – use of GPR for site evaluation - introduction to geotechnical centrifuge modeling.

References:

1. Rowe R.K.,"Geotechnical and Geoenvironmental Engineering Handbook" Kluwer Academic Publications, London, 2000.
2. Sharma H.D. and Reddy K.R.,"Geoenvironmental Engineering:Site Remediation, Waste Containment, and Emerging Waste Management Technologies" John Wiley & Sons, Inc., USA, 2004.

3. Yong, R. N.,"Geoenvironmental Engineering, Contaminated Soils,Pollutant Fate, and Mitigation" CRC Press, New York, 2001.

4. Alvarez-Benedi J. and Munoz-Carpena, R.,"Soil-WaterSolute Process Characterization:An Integrated Approach" CRC Press, New York, 2005.

5. Mitchell, J.K.,"Fundamentals of Soil Behavior" Wiley, 2005.

CEPhDT12: Soil – Structure Interaction
(03-01-00 = 04 credits)

Course Content

Unit-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 behaviour.

Unit-II : Beam on Elastic Foundation- Soil Models:Infinite beam, Two-parameters models, Isotropic elastic half space model, Analysis of beams of finite length, combined footings.

Unit-III : Plates on Elastic Continuum:Thin and thick rafts, Analysis of finite plates, Numerical analysis of finite plates.

Unit-IV: Analysis of Axially and Laterally Loaded Piles and Pile Groups: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, Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system,

References:

1. Selvadurai, A. P. S. – "Elastic Analysis of Soil-Foundation Interaction", 1979
2. Rolando P. Orense, Nawawi Chouw & Michael J. Pender – "Soil-Foundation-Structure Interaction", CRC Press, 2010 Taylor & Francis Group, London, UK.
3. "Soil Structure Interaction – The real behaviour of structures", the institution of structural engineers, London, March 1989.
4. Poulos, H. G., and Davis, E. H. – "Pile Foundation Analysis and Design", 1980
5. Scott, R. F. – "Foundation Analysis", Prentice Hall, Englewood Cliffs, 1981
6. Bowles, J. E. – "Foundation Analysis & Design", 5th Edition McGraw-Hill Companies, Inc. (1996)
7. Das, B. M. – "Principles of Foundation Engineering", 5th Edition Nelson Engineering (2004)