

INDIAN INSTITUTE OF TECHNOLOGY PATNA

Department of Civil and Environmental Engineering

Bachelor of Technology in *Civil Engineering*

REVISED CURRICULUM

1st Year:

First Semester:

Subject ID	Subject	L-T-P	Credits
CE111	Engineering Drawing	1-0-3	5
EE101	Electrical Sciences	3-1-0	8
HS103	Communicative English for Engineers	2-0.5-1	6
MA101	Mathematics - I	3-1-0	8
ME110	Workshop	0-0-3	3
PH103	Physics - I	3-1-0	8
PH110	Physics Laboratory	0-0-3	3
	NCC/NSS	0-0-0	0
	Sub-Total	12-3.5-10	41

Second Semester:

Subject ID	Subject	L-T-P	Credits
CB102 & CE102	Biology and Environmental Studies	3-0-0	6
CH103	Introductory Chemistry	3-1-0	8
CH110	Chemistry Laboratory	0-0-3	3
CS102	Programming and Data Structure	3-0-0	6
CS112	Programming and Data Structure Laboratory	0-0-3	3
EE103	Basic Electronics Laboratory	0-0-3	3
MA102	Mathematics - II	3-1-0	8
ME102	Engineering Mechanics	3-1-0	8
	NCC/NSS	0-0-0	0
	Sub-Total	15-3-9	45

2nd Year:

Third Semester:

Subject ID	Subject	L-T-P	Credits
MA201	Mathematics - III	3-1-0	8
HS2××	Humanities and Social Sciences Elective - I	3-0-0	6
CE203	Geomatics Engineering	3-0-0	6
CE211	Structural Mechanics	3-0-0	6
CE213	Fluid Mechanics	3-0-0	6
CE291	Fluid Mechanics Laboratory	0-0-3	3
CE293	Geomatics Engineering Laboratory	0-0-3	3
	Sub-Total	15-1-6	38

Fourth Semester:

Subject ID	Subject	L-T-P	Credits
××2××	Open Elective - I	3-0-0	6
HS4××	Humanities and Social Sciences Elective - II	3-0-0	6
CE214	Soil Mechanics	3-0-0	6
CE216	Civil Engineering Materials	3-0-0	6
CE218	Infrastructure Drawing and Estimation	1-0-3	5
CE220	Structural Analysis	3-0-0	6
CE292	Soil Mechanics Laboratory	0-0-3	3
	Sub-Total	16-0-6	38

3rd Year:**Fifth Semester:**

Subject ID	Subject	L-T-P	Credits
××3××	Open Elective - II	3-0-0	6
CE303	Water Supply and Wastewater Engineering	3-0-0	6
CE317	Foundation Engineering	3-0-0	6
CE319	Numerical Methods in Civil Engineering	3-0-0	6
CE321	Design of Reinforced Concrete Structures	3-0-0	6
CE391	Environmental Engineering Laboratory	0-0-3	3
CE393	Structural Engineering and Materials Laboratory	0-0-3	3
	Sub-Total	15-0-6	36

Sixth Semester:

Subject ID	Subject	L-T-P	Credits
HS3××	Humanities and Social Sciences Elective - III	3-0-0	6
CE314	Water Resources Engineering	3-0-0	6
CE318	Construction Planning and Management	3-0-0	6
CE320	Design of Steel Structures	3-0-0	6
CE324	Transportation Engineering	3-0-0	6
CE392	Transportation Engineering Laboratory	0-0-3	3
CE394	Water Resources Engineering Laboratory	0-0-3	3
	Sub-Total	15-0-6	36

4th Year:**Seventh Semester:**

Subject ID	Subject	L-T-P	Credits
××4××	Open Elective - III	3-0-0	6
CE491	Design Studio	0-0-3	3
CE495	Project - I	0-0-6	6
CE5××	Departmental Elective -I	3-0-0	6
CE5××	Departmental Elective -II	3-0-0	6
CE5××	Departmental Elective - III	3-0-0	6
	Sub-Total	12-0-9	33

Departmental Elective - I, II, and III	
CE511	Advanced Structural Mechanics
CE513	Advanced Foundation Engineering
CE515	Advanced Structural Analysis
CE517	Structural Dynamics
CE519	Air Pollution and Control
CE521	GIS in Water Resources
CE523	Soil Exploration
CE525	Highway Geometric Design
CE527	Infrastructure Economics, Laws and Professional Ethics
CE529	Machineries and Equipments in Infrastructure Engineering
CE531	Masonry Structures
CE533	Biological Processes for Water and Wastewater Treatment
CE535	Soil Dynamics
CE537	Solid and Hazardous Waste Management
CE539	Stochastic Hydrology
CE541	Urban and Regional Planning
CE543	Water Resources Management

Eighth Semester:

Subject ID	Subject	L-T-P	Credits
CE496	Project - II	0-0-18	18
CE5××	Departmental Elective - IV	3-0-0	6
CE5××	Departmental Elective - V	3-0-0	6
	<i>Sub-Total</i>	6-0-18	30

Departmental Elective - IV, V and VI	
CE510	Environmental Impact Assessment
CE514	Advanced Hydrology
CE516	Advanced Soil Mechanics
CE518	Advanced Structural Design
CE522	Advanced Water and Wastewater Engineering
CE524	Airport Engineering
CE526	Earthquake-Resistant Design of Structure
CE528	Railway Engineering
CE530	Geotechnical Earthquake Engineering
CE532	Ground Improvement Techniques and Reinforced Earth
CE534	Groundwater Hydrology
CE536	Industrial Pollution Control and Prevention
CE538	Project Economics, Valuation and Contracts
CE540	Integrated Region and Smart City
CE542	Open Channel Hydraulics
CE544	Site Remediation
CE546	Special Topics in Geotechnical Engineering
CE548	Theory of Plates and Shells
CE550	Traffic Engineering and Highway Safety
CE566	Physico-Chemical Processes for Water and Wastewater Treatment

Total Credits: 41+45+38+38+36+36+33+30 = 297

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COURSE DETAILS

Third Semester: .

CE203 | GEOMATICS ENGINEERING | 3-0-0-6 | Pre-requisites: Nil

Introduction to surveying; Linear measurements: Chain and tape surveying, precautions, errors and their corrections; Angular measurements: Compass surveying, types of compass, measurement of bearing, computations of angles from bearings; Accuracy, precision and errors; Theodolite Surveying; Plane table surveying, different methods; Leveling: Principle of levelling, types of levelling, adjustments; Contouring: Characteristics of contour, contour interval, methods of contouring; Tacheometric survey; Trigonometrical surveying; Curves: Simple circular curves, methods of setting out curves; Advanced survey instruments: Electronic Distance Measurement (EDM), Total station and Global Positioning System.

Texts/References:

- B.C Punmia, A.K.Jain & A.K.Jain, Surveying, Vol-I and Vol-II, Laxmi Publication Pvt., 1996.
- S.K.Duggal, Surveying, Vol-I and Vol-II, Mc.Graw Hill Publication, 2013.
- T. P. Kanetkar and S. V. Kulkarni, Surveying and Levelling, VoH and Vol-II, Pune Vidyarthi Griha Prakshan, 1972.
- G. W. Schofield, Engineering Surveying, Butterworth, Heinemann, New Delhi, 2001.
- K.R Arora, Surveying, Vol. I and II, Standard Book House, Delhi, 1998.

CE211 | STRUCTURAL MECHANICS | 3-0-0-6 | Pre-requisites: Nil

Simple bending theory, flexural and shear stresses, Stress / Strain Transformation unsymmetrical bending, shear centre. Thin walled pressure vessels, uniform torsion, buckling of column, combined and direct bending stresses.

" Different types of structures, Loads on the structural system, static and kinematic indeterminacy, Methods of Analysis: Equilibrium equations, compatibility requirements, Introduction to force and displacement methods, Analysis of trusses: plane truss, compound truss, complex truss and space truss, Three hinged arches and suspension cables, Bending moment and shear force diagram, Deflection of Beams, various methods for calculation of deflection.

Text books:

- Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, Mechanics of Materials, McGraw-Hill Education; 7th edition (2014).
- RC. Hibbeler, Mechanics of Materials, Prentice Hall; 9th edition (2013)
- C.S.Reddy, Basic Structural Analysis, Second Edition, Tata McGraw Hill, 2008.
- RC Hibbeler, Structural Analysis, Pearson Education, 6th edition, 2009.
- E. P. Popov, Engineering Mechanics of Solids, Dorling Kindersley (India) Pvt Ltd, 2nd edition.
- S.P Tomoshenko and D H Young. Elements of Strength of Materials. East West Press.

References:

- D.S.Prakash Rae, Structural analysis: Unified approach, Universities Press, 1996.
- CH. Norris, J.B. Wilbur and S.Utku, Elementary Structural Analysis, Tata McGraw Hill, 4th edition, 2003.
- L. S. Negi and R S. Sangjidi, Structural Analysis, Tata Mc. Craw, New Delhi, 1997.

CE213 | FLUID MECHANICS

| Pre-requisites: Nil

Fluid properties; Pressure measurement; Hydrostatic forces on plane and curved surfaces; Buoyancy and equilibrium; Stability, meta centric height; Types of flow; Continuity; Energy and momentum equations; Velocity distribution and velocity coefficients, practical applications; Navier-Stoke equation; Shear stress and pressure gradient; Flow through pipes, Hagen-Poiseuille equation; Turbulence, Prandtl's mixing length, eddy viscosity; Darcy-Weisbach equation for flow through pipes, friction factor, Moody diagram, minor losses, pipes in series and parallel, equivalent length, pipe network analysis; Water hammer; Boundary layer concept, drag coefficients, control of boundary layer; Dimensional analysis and similitude, Introduction to pumps and turbines.

Textbooks:

- V.L. Streeter and E.B. Wylie, Fluid Mechanics, McGraw Hill, 1997.
- P.N. Modi and S.M. Seth, Hydraulics and Fluid Mechanics, Standard Book House, 1998.
- V.T. Chow, Open Channel Flow, McGraw Hill, 1975.
- S.K. Garg, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 1992

Reference books:

- B.F. White, Fluid Mechanics, McGraw Hill, 1994.
- K. S. Massey, Mechanics of Fluids, Van Nostrand Reinhold Co., 1979.
- J. Frabzini, Fluid Mechanics with Engineering Applications, McGraw Hill, 1997.
- J.H. Spurk, Fluid Mechanics - Problems and Solutions, Springer, 2003

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CE291 | FLUID MECHANICS LABORATORY

| 0-0-3-3

| Pre-requisites:

Measurement of fluid pressure using various manometers and gauges, Experimental study on capillarity, Determination of coefficient of viscosity of a fluid using viscometer, Experimental study on stability of floating bodies, Study on fluid pressure distribution on immersed bodies, Study of different types of flow using Reynold's apparatus, Determination of friction factor in pipes using pipe friction apparatus, Experimental studies on centrifugal and reciprocating pumps, Experimental studies on impulse and reaction turbines.

Text books:

- P. N. Modi and S.M. Seth, Hydraulics and Fluid Mechanics, Standard Book House, 1998.
- K. L. Kumar, Engineering Fluid Mechanics, Eurasia Publishing Company (P) Ltd., New Delhi, 1999.

CE293 | GEOMATICS ENGINEERING LABORATORY

| 0-0-3-3

| Pre-requisites: Nil

Chain (tapes) surveying; Offsets, Compass surveying; Plane table survey; Theodolite surveying: Vertical and horizontal angle measurements, Theodolite Traversing; Triangulation and correction of errors; Leveling, computation of earth work; Contours; Tacheometric surveying; Trigonometric surveying; Total station; Setting out of buildings; Layout of simple circular curves.

TextjReference books:

- B.C. Punmia, A.K. Jain and A.K. Jain, Surveying, Vol. I and II, Laxmi Publications (P) Ltd., New Delhi, 1996.
- K.R. Arora, Surveying, Vol. I and II, Standard Book House, Delhi, 1998.
- T. P. Kanetkar and S. V. Kulkarni, Surveying and Levelling, Vol-I and Vol-II, Pune Vidyarthi Griha Prakshan, 1972.

[fourth Semester: ..

CE214 | SOIL MECHANICS | 3-0-0-6 | Pre-requisites: Nil

Review of geotechnical problems in civil and infrastructure engineering, Origin and classification of soils; Index properties of soil, Effective stress principle, Permeability of soil (soil - water systems - capillarity, flow, darcy's law, permeability, and tests for its determination, different heads, piping, quicksand condition), Stresses within soil, Shear strength of soil (Mohr - Coulomb strength criterion, direct and triaxial shear tests, drained, consolidated drained and undrained tests, NC and OC soils, dilation, pore pressures, Skempton's coefficients), Compaction (characteristics, water content - dry unit weight relationships, OMC, maximum dry unit weight, field compaction, quality control), Compressibility and consolidation characteristics (over consolidation ratio, determination of coefficients of consolidation and secondary compression, consolidation under construction loading), Settlement analysis (immediate settlement, consolidation and creep settlements), Soil Exploration (Characterization of ground, site investigations, methods of drilling, sampling, in situ test - SPT, CPT, plate load and dynamic tests, insitu permeability and groundwater level), Stability of Slopes

Text books:

V. N. S. Murthy, Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, CRC Press, Taylor & Francis Group, Third Indian Reprint, 2013.

- R. F. Craig, Craig's Soil Mechanics, Taylor & Francis Group, 7th Edition, 2004.

Reference books:

- Gopal Ranjan, and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International Publishers, 2nd Edition 2000.
- K. Terzaghi, R. B. Peck and G. Mesri, Soil Mechanics in Engineering Practice, John Wiley & Sons, 1996.
- B.M. Das, Principle of Geotechnical Engineering, Cengage Learning, eighth Edition, 2013

CE216 | CIVIL ENGINEERING MATERIALS | 3-0-0-6 | Pre-requisites: Nil

Introduction to building materials, Cement: Chemical composition, manufacturing, physical characteristics, hydration, properties of cement compounds, different types of cements, Aggregate: Coarse and fine aggregates, Influence of aggregate on the properties of concrete, aggregate selection. Fresh Concrete: Batching, Mixing, workability, effect of admixture, Hardened Concrete: mechanical properties of hardened concrete, Water-cement ratio, Porosity, Curing of concrete, High performance concrete, Design of concrete mix: IS code recommendation, Brick: Raw materials, drying and curing, Strength and durability, mortar for masonry and strength of masonry, Timber, Seasoning and conversions, properties, tests, defects in timbers, FRPs: Chemical compositions, mechanical and physical properties, Various types of FRPs, Metals: steel for reinforced concrete and prestressed concrete construction, structural steel sections, Deterioration of building materials: Corrosion, chloride and sulphate attack on concrete, alkali-aggregate reaction, acid aggregate reactions

Text books:

- S. Somayaji, Civil Engineering Materials, Prentice Hall, New Jersey, 2001.
- M. S. Mamlouk and J. P. Zaniewski, Materials for Civil and Construction Engineers, Pearson, Prentice Hall, Second edition, 2006.

Reference books:

- A. M. Neville and J. J. Brooks, Concrete Technology, Pearson Education, Fourth Indian reprint, 2004.
- N. Jackson and R. K. Dhir, Civil Engineering materials, Macmillan Fourth edition 1997.
- M. S. Shetty, Concrete Technology, S. Chand and Company Ltd. 2005.
- P. C. Aitcin, High Performance Concrete, E & Fn Spon, 1998.
- J. F. Shackelford and M. K. Muralidhara, Introduction to Material science for Engineers, Pearson Education, Sixth edition, 2007.

CE218

INFRASTRUCTURE DRAWING AND
ESTIMATION

1-0-3-5

Pre-requisites: Nil

Components of buildings: plan, elevation and section of buildings; Drawing of various details of residential buildings; Types of building: residential, industrial; brick masonry. Estimation: types of estimates, Central line method, short wall - long wall method, Modes of measurement, estimation of buildings, Specifications and analysis of rates.

Textbooks:

- S. S. Bhavikatti, M. V. Chitawa, Building Planning and Drawing, I K International Publishing House Pvt. Ltd, 2014
- M.G Shah, C.M Kale, Principles of Building Drawing, Macmillan Publishers India Limited, 2000.
- N. Kumara Swamy, A. Karneswara Rao, Building Planning and Drawing, Charotar Publishing House Pvt. Ltd.- Anand; 7th Revised edition (2013)
- B. N. Dutta, Estimating and Costing, Tagor Palli, Lucknow, 1991.
- G. H. Cooper, Building Construction and Estimating, McGraw-Hill, 1971.

Reference books:

- H. Banz, Building Construct. Details Prac. Drawings, CBS; 1ST edition, 2005
- G. H. Cooper, Building Construction and Estimating, McGraw-Hill, 1971.
- B.P. Verma, Civil Engineering Drawing & House Planning, Khanna Publishers, 2010.

CE 220

STRUCTURAL ANALYSIS

3-0-0-6

Pre-requisites: Nil Analysis

of indeterminate structures by force methods, flexibility coefficients, Energy methods: Principle of minimum potential energy, principle of virtual work, Castigliano's theorems, Reciprocal theorem, unit load method, Influence line and Rolling loads, beam, frames and arches, Muller-Breslau Principles and its applications to determinate and indeterminate structures.

Analysis of Beams and Frames: Moment Area method, Slope deflection method, Three Moment Equation, Moments distribution methods, effect of symmetry and antisymmetry, sway correction, Lateral load analysis: Portal and Cantilever methods, Matrix method of structural analysis, Displacement/Stiffness methods.

Textbooks:

- C.S. Reddy, Basic Structural Analysis, Second Edition, Tata McGraw Hill, 2005.
- RC. Hibbeler. Structural Analysis, Pearson Education, 6th edition, 2009.
- CiK. Wang, Intermediate Structural Analysis, Tata McGraw Hill, 1984.

Reference books:

- D.S. Prakash Rao, Structural analysis: Unified approach, Universities Press, 1996.
- C.H. Norris, J.B. Wilbur, S.Utku, Elementary Structural Analysis, Tata McGraw Hill, 4th edition, 2003.
- L. S. Negi and R. S. Jangjid, Structural Analysis, Tata Me. Graw, New Delhi, 1997.
- W. Weaver and J. M. Gere, Matrix analysis of framed structures, CBS Publishers, 2nd edition, 2004.
- C.S. Reddy, Basic Structural Analysis, Second Edition, Tata McGraw Hill, 2005.
- G.S. Pandit and S.P. Gupta, Structural Analysis - A matrix approach, Tata McGraw Hill, 2nd edition, 2008.
- C.H. Norris, J.B. Wilbur, S.Utku, Elementary Structural Analysis, Tata McGraw Hill, 4th edition, 2003.
- M.B. Kanchi, Matrix Methods of Structural analysis, Enlarged edition, Wiley Eastern Limited, 1993.

CE292

SOIL MECHANICS LABORATORY

0-0-3-3

Pre-requisites: Nil

Determination of field density of soil by sand replacement & core cutter methods, Specific gravity & relative density determination, Grain size distribution by sieve and hydrometer analysis, Atterberg limits, Compaction properties of soil, Permeability of soil, C. B. R, Direct shear test, Triaxial test, Demonstration for soil exploration techniques (SPT, CPT, etc.)

Text books:

- J. Bardet, Experimental Soil Mechanics, Upper Saddle River, Prentice Hall, USA, 1992.
- D. Fratta, J. Aguetant, and L. R. Smith, Soil Mechanics Laboratory Testing, Boca Raton, CRC Press, USA, 2007.

Reference books:

- V.N. S.Murthy, Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, CRC Press, Taylor & Francis Group, Third Indian Reprint, 2013.
- Gopal Ranjan, and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International Publishers, 2nd Edition 2000.

Fifth Semester:

CE303. | WATER SUPPLY AND WASTEWATER ENGINEERING | 13-0-0~6 | Pre-requisites: Nil

Environmental systems - natural and engineered; General requirement for water supply, sources, quality and quantity of water, intake, pumping and transportation of water; Basics of water quality parameters: Physical, chemical and biological characteristics of water and their significance, Environmental legislations and standards; Chemical reaction kinetics, Schematic and flow diagram of water treatment plant; Engineered systems for water treatment: sedimentation, coagulation, filtration, disinfection and adsorption; Water distribution system: Network of pipes, Distribution reservoir; Generation and collection of sewage (wastewater), Sewerage systems, Schematic and flow diagram of sewage treatment plant (STP); Primary, secondary and tertiary treatment of sewage (wastewater); Basics of microbiology, Biological wastewater treatment systems: Aerobic processes - activated sludge process and its modifications, trickling filter, Anaerobic Processes - anaerobic reactor - Vpfiow anaerobic sludge blanket (VASB) reactor, Wastewater recycling and reuse, Sludge handling, treatment and disposal, Visit to Sewage Treatment Plant (STP) and its infrastructure

Text books:

- H. S. Peavy, D. R. Rowe and George Tchobanoglous, Environmental Engineering, McGraw-Hill International Ed., 1985.
- M. L. Davis and D. A. Cornwell, Introduction to Environmental Engineering, McGraw-Hill, Inc., 2014.
- C. N. Sawyer, P. L. McCarty and G. F. Parkin, Chemistry for Environmental Engineers, McGraw- Hill, 1994.

Reference books:

- Metcalf & Eddy, Wastewater Engineering- Treatment and Reuse (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill, 4th Edn., 2004.
- Manual on Sewerage and Sewage Treatment Systems, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 2013.
- Manual on Water Supply and Treatment, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1999.

CE317 | FOUNDATION ENGINEERING | 3-0-0~6 | Pre-requisites: CE 204

Earth Pressure & Retaining Walls, Foundations classification (types of foundations, selection and uses), Shallow Foundation Analysis & Design (general requirement for satisfactory performance of shallow foundations, bearing capacity, general, local and punching shear failures, corrections for size, shape, depth, water table, compressibility) Determination of bearing capacity from field and laboratory tests, footings subjected to eccentric-inclined loads, footings on layered soils and slopes, contact pressure distributions, proportioning of shallow foundations - isolated, combined, circular, annular, raft, settlement of foundation), Deep Foundation Analysis & Design (selection of piles, bearing capacity of piles, pile groups, under-reamed piles, pre-cast, driven cast in situ and bored piles, shaft and base resistances, down drag, pile load tests, settlement of piles, pile group, various methods for laterally loaded pile analysis, Pier and well foundations), Ground Improvement techniques (Soil stabilization, preloading, vertical drains, stone columns, heavy tamping, grouting, geo-synthetics).

Textbooks:

- V. N. S. Murthy, Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, CRC Press, Taylor & Francis Group, Third Indian Reprint, 2013.
- J.E. Bowles, Foundation Analysis and Design, McGraw-Hill, 2001.
- V. N. S. Murthy, Advanced foundation Engineering, CBS Publishers & Distributers, 2011

Reference books:

- Gopal Ranjan, and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International Publishers, 2nd Edition 2000.

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CE319

NUMERICAL METHODS FOR CIVIL
ENGINEERS

3_0_0_6

Pre-requisites: Nil

Introduction to Numerical Methods: Objectives of numerical methods, sources of error in numerical solutions: truncation error, round off error, order of accuracy - Taylor series expansion. Roots of Equations: Graphical Methods, Bisection Method, Simple Fixed-Point Iteration, Newton-Raphson Method, Secant Method, modified Secant Method. Direct Solution of Linear systems: Naive Gauss elimination, LU Decomposition, matrix Inverse, error analysis and system condition, Gauss-Seidel, Causs-jordon, Jacobi iteration, Factorization, Cholesky decomposition. diagonal dominance, condition number, ill-conditioned matrices. Numerical Optimization: Newton's method in one and multiple dimension, Gradient Method. Curve Fitting: Linear Regression, Polynomial Regression, interpolation, spline fitting and their Civil Engineering application. Numerical Calculus: Trapezoidal and Simpson's rule for integration and their application. Solving Differential Equation: Euler's method, Runge-Kutta method, Boundary-Value and Eigenvalue Problem and their application, solving partial differential equation. Applicability of Numerical Methods in Civil Engineering: Exposure to software packages like MATLAB

Text/Reference books:

- S. Chapra and R. Canale, Numerical Methods for Engineers, 6th Ed., McGraw Hill, 2010.
- S. Guha and R. Srivastava, Numerical Methods: For Engineering and Science, 1st Ed., Oxford University Press, 2010.
- D. Dahlquist, and A. Bork, Numerical Methods, Prentice-Hall, Englewood Cliffs, N}, 1974.
- K. E. Atkinson, Numerical Analysis, John Wiley, Low Price Edition, 2004.
- J. D. Hoffman, Numerical Methods for Engineers and Scientists, McGraw-Hill, 2001.
- S. C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill 2008.

CE321

DESIGN OF REINFORCED CONCRETE
STRUCTURES

3_0_0_6

Pre-requisites: Nil

Introduction to reinforced concrete structures, Basic material properties: stress-strain relation of concrete and reinforcing steel, Design philosophy: assumptions and code of practice, Theory of singly reinforced members in bending, Design of simply supported and continuous beams with rectangular and flanged section, Limit state of collapse in shear, Design for bond, Design of one-way and two-way slab systems, Design of columns under uniaxial and biaxial bending, Design of footings and staircase.

Text books:

- S. U. Pillai and D. Menon, Reinforced Concrete Design, Tata McGraw-Hill, 3rd edition, 2009.
- P. C. Varghese, Limit State Design of Reinforced Concrete, Prentice Hall India, 2nd edition, 2008.

Reference books:

- M. L. Gambhir, Fundamentals of Reinforced Concrete Design, Prentice Hall India, 2006.
- A. K. Jain, Reinforced Concrete: Limit State Design, Nem Chand and Bros., 6th edition, 2002.
- J. Macgregor and J. K. Wight Reinforced Concrete: Mechanics and Design, Prentice Hall, 5th edition, 2008.
- R. Park and T. Paulay, Reinforced Concrete Structures, John Wiley and Sons, 1975.
- P. M. Ferguson, J. E. Breen and J. O. Jirsa, Reinforced Concrete Fundamentals, John Wiley and Sons, 5th edition, 1988.
- J. C. McCormac and R. H. Brown, Design of Reinforced Concrete, John Wiley and Sons, 9th edition, 2014.

CE391

ENVIRONMENTAL ENGINEERING
LABORATORY

0-0-3-3

Pre-requisites: Nil

Introduction to Laboratory: Identification of Common/General/Facilities/Equipment/ Chemicals/ Glassware; Weighing Chemicals and Making up Solutions.

Examination of Water/ Wastewater: Analytical methods of commonly encountered water/wastewater quality parameters;

Determination of pH, Eh, turbidity and conductivity; Determination of alkalinity, sulfate, solids, chloride and hardness of water/wastewater; Determination of COD, DO and BOD of water, Optimum coagulant dose and Determination of Pathogenic content (TC & FC) of water/wastewater.

Advance Instrumentations for Environmental Analysis: Demonstration of atomic absorption spectrometer, microwave digester, centrifuge, ion chromatography, TOC analyzer, etc.

Text books:

- Laboratory Manual
- C. N. Sawyer, P. L. McCarty and G. F. Parkin, Chemistry for Environmental Engineers, McGraw-Hill, 1994.

Reference books:

- APHA, Standard Methods Examination of Water and Wastewater, American Public Health Association, Washington DC, 2012.
- M. Radojevic and V. N. Bashkin, Practical Environmental Analysis. Royal Environmental Analysis, 1999.

CE393

STRUCTURAL ENGINEERING AND
MATERIALS LABORATORY

0-0-3-3

Pre-requisites: Nil

Normal consistency, Initial and Final Time of set; Test of coarse and fine aggregate: Fineness modulus, Moisture content and SSD condition, Unit weight and bulking of sand; Tests of concrete: workability, strength, destructive and non-destructive test; Admixtures; Mix Design; Testing of reinforcement bar in tension.

Bending moments in a beam, Deflection of beams & cantilevers, Unsymmetrical bending and shear centre, Pin jointed frameworks, Bending moments in a portal frame.

Text books:

- RC. Hibbeler, Structural Analysis, Pearson Education, 6th edition, 2009.
- M. S. Shetty, Concrete Technology, S. Chand and Company Ltd. 2005.

{}ixth Semester:

CE314 | WATER RESOURCES ENGINEERING | 3-0-0-6 | Pre-requisites: Nil

Introduction to irrigation; Importance of irrigation; Sources of irrigation water: Geographic distribution of water resources in India; Types of irrigation; Advantages and disadvantages of irrigation; Historical development of irrigation in Indian subcontinent; Present status and future requirements of irrigation in India; Various irrigation schemes of India. Soil and its properties; Soil-water relationship; Crops and crop seasons; Duty and delta of a crop; Infiltration; Consumptive use or Evapotranspiration; Irrigation requirement; Frequency of irrigation; Methods of irrigation; Quality of irrigation water. Definition and importance of Hydrology; Hydrologic cycle; Precipitation; Abstraction from Precipitation including infiltration and evaporation; Runoff and factors affecting runoff; Stream Flow; Hydrograph; Floods. Sediment transport; Design of irrigation canal/channel; Sub-surface flow: Aquifers and their properties; Ground water flow; Well hydraulics; Dams: Purpose and types; Factors governing the selection of particular type of dam; Spillways; Hydraulic Jump; Diversion Headwork: Weir(s) and Barrage; Cross drainage work: Aqueduct, Siphon aqueduct, Level crossing, Culvert; Water logging; Causes and preventive and curative measures of water logging; Drainage of irrigated lands, Saline and alkaline soils; Ground water depletion and associated problems due to excessive withdrawal of ground water. Definition and Causes of flood; Estimation of design flood and flood flow; Guidelines for choosing design floods as per (~WCRecommendations and IS Code; Flood routing; Flood control: Structural and non-structural measures.

Textbooks:

- G.L. Asawa, Elementary Irrigation Engineering, New Age International (P) Ltd., New Delhi, 1999
- Bharat Singh, Fundamentals of Irrigation Engineering, Nem Chand & Brothers, Roorkee, 1975.
- Orson W. Israelsen, Vaughn E. Hansen and Glen E. Stringham, Irrigation Principles and Practices, John Wiley & Sons Inc, 4th edition, 1980.
- KR. Arora, Irrigation Water Power and Water Resources Engineering, Standard Publishers Distributors, Delhi, 2002.

Reference books:

- K Subramaniya, Flow in Open Channels, McGraw Hill, 1997
- Todd O.K., Ground Water Hydrology, [ohn Wiley and Sons, 2000.

CE318 | CONSTRUCTION PLANNING AND | 3_0_0_6 | Pre-requisites: Nil
| MANAGEMENT

Construction as industry and its challenges, Role of construction management Methods of construction managements, .Basic requirements of construction management: Learning structures, Life cycle of construction projects: Examples of real (,)rojects and its learning requirements, Stages of awarding contract, types of contract, contract documents, arbitration and settlement of disputes, contract laws and handling of contracts, commissioning of project

Principles of estimation, Principles of general and detailed specifications, Site organization; Layout; Work study; Decision making processes; CPM and project monitoring; Maintenance management; Introduction to network based project management techniques: Defining activities and their interdependence, drawing of network, time and resource estimations, use of network as scheduling techniques, use of network as control techniques i.e. project monitoring, Construction Technology: construction of superstructure and substructures, Various construction methods: Excavation, Earth-moving, Drilling, Blasting, Dewatering, foundation, Finishing items, painting, flooring, brick works. Examples of construction of structures such as buildings, bridges, roads, tunnels, industrial structures, Quality Management and Construction safety, Use of information technology in construction industries, Automation in construction industry: a general discussion.

Text books:

- F. Harris, R. McCaffer and F. Edum-Fotwe, Modern Construction Management, Blackwell Publishing, 2006.
- C. J. Schexnayder and R. E. Mayo, Construction Management Fundamentals, McGraw Hill, New Delhi, 2003.

Reference books:

- J. Singh, Heavy Constructon-Planning, equipment and methods, Oxford & IBH Publishing Co. Pvt 1993.
- R.L. Peurifoy & C]. Schexnayder, Construction planning and equipment, and methods, 6th ed, McGraw-Hilt 2006.

- D.S.Berrie and B.e. Paulson, Professional construction management including e.M., Design construct and general contracting, Third edition, McGraw Hill International edition, 1992.
- L.S.Srinath, PERT and CPM principles and Applications, Third edition, Affiliated east-west press Pvt Ltd, 2001.
- D.G. Carmichael, Construction engineering Networks: Techniques, planning and management, Ellis Horwood Publishers Chichester 1989.
- K.K.Chitkara, Construction project management: planning, scheduling and controlling, Tata McGraw-Hill, 2008.

CE 320 | DESIGN OF STEEL STRUCTURES | 3-0-0-6 | Pre-requisites: Nil

Introduction: Steel structures, material properties, Limit states and design philosophies; analysis and design methods, Loads, partial safety factors and load combinations, analysis of roof for wind loads. Codes and standards. Section Classification: Plastic, compact, semi-compact, and slender sections. Tension members: Design based on net section including shear lag effects and block shear, lug angles. Compression members: Design for flexural and flexural-torsional buckling, Effective length factor: Sway and Non-sway frames, Local buckling, Built-up columns - Battens and lacings. Laterally Supported and Unsupported Beams: Design strength using shear-moment interaction; Built-up beams, Shear buckling strength, Plate girders and design of stiffeners, Lateral torsional buckling, Effect of restraints and effective length. Beam-Columns: Effect of axial load on flexure behaviour, P-M interaction and moment amplification, Flexural torsional buckling and Bi-axial bending. Connections: Structural fasteners - Rivets, bolts and welds, strength under combined stresses, Bolted and Welded Connections - Simple and Eccentric and Column bases (

Textbooks:

- Subramanian, N. (2010). Steel Structures: Design and Practice, Oxford University Press.
- Duggal, S.K. (2014). Limit State Design of Steel Structures, McGraw Hill.

Reference books:

- Bhavikatti, S. S. (2014). Design of Steel Structures (by Limit State Method as Per IS: 800-2007), IK International.
- Shiyekar, M. R. (2013). Limit State Design of Steel Structures, PHI Learning.
- Sai Ram, K. S. (2015). Design of Steel Structures, 2nd ed., Pearson Education.
- Gambhir, M. L. (2013). Fundamentals of Structural Steel Design, McGraw Hill.
- Segui, W.T. (2013). Design of Steel Structures, Cengage Learning.
- Galambos, T. V. and Surovek, A. E. (2008). Structural Stability of Steel: Concepts and Applications for Structural Engineers, Wiley.
- Edwin, M" Gaylord, J. and Stallmeyer, J. E. (1991). Design of Steel Structures, McGraw-Hill.
- Owen, G. and Davidson, B. (2012). Steel Designer's Manual- SCI.

CE 324 | TRANSPORTATION ENGINEERING | 13-0-0-6 | Pre-requisites: Nil **r:**

Introduction to transportation engineering; Road plans; Factors controlling highway alignment; Vehicle and drive characteristics, PIEV theory; Pavement materials and characterization: subgrade soil, aggregates, bituminous and modified binders, straight-run bitumen, cutback bitumen, tar; Pavement analysis and design: Flexible pavements, Rigid pavements; Geometric design of Highways: Cross sectional elements, Horizontal alignment, Vertical alignment; Highway Construction, Highway Maintenance, Analysis of Traffic Flow, Mixed traffic (PCU), Design of Traffic facilities.

Text books:

- P. Chakroborty and A. Das, Principles of Transportation Engineering, Prentice Hall India, 2003.
- S. K. Khanna and e. E. G. Justo, Highway Engineering, Nem Chand Bros., 2002.
- e. J. Khisty and B. K. Lall, Transportation Engineering: an introduction, Prentice Hall India, 2003.

Reference books:

- F. L. Mannering, W. P. Kilareski, and S.S. Washburn, Principles of Highway engineering and traffic analysis, John Wiley and Sons, 2005.
- e. S. Papa costas and P. D. Prevedouros, Transportation Engineering and Planning, Prentice Hall India, 2001.
- J. H. Banks, Introduction to Transportation Engineering, McGraw-Hill, 2002.
- S. K. Khanna and e. E. G. Justo, Highway Engineering, Nem Chand Bros., 2002.
- Y. H. Huang, Pavement Analysis and Design, Pearson Education, India 2008.

CE392 | TRANSPORTATION ENGINEERING | 0-0-3-3 | Pre-requisites: Nil
LABORATORY

Evaluation of road aggregates for various properties: Sieve analysis, Los Angeles/Deval's abrasion tests, Flakiness and elongation test, Impact test; Evaluation of bitumen for various properties: Softening point test, Penetration test, Viscosity test, Ductility test, Flash and fire point test, Stripping test; Bituminous mix design- Marshal mix design method; Headway studies: Free flow, Intermediate flow, High flow; Speed-Volume studies; O-O survey.

Text books:

- P. Chakroborty and A. Das, Principles of Transportation Engineering, Prentice Hall India.
- S. K. Khanna and C. E. G. Justo, Highway Engineering, Nem Chand Bros., 2002.
- N. A. Harold, Highway materials, Soil and Concrete, Prentice Hall, 2004.
- C. S. Papacostas and P.O. Prevedouros, Transportation Engineering and Planning, Hall India, 2001.

Reference books:

- IS Codes and IRC Codes.
- R.P. Roess, W.R. McShane, and E.s. Prassas, Traffic Engineering, Prentice Hall, 1990.
- Y. H. Huang, Pavement Analysis and Design, Pearson Education, India 2008.

CE394 | WATER RESOURCES ENGINEERING | 0-0-3-3 | Pre-requisites: Nil
LABORATORY

Open Channel Flow; Hydraulic Jump; Flow over Weirs (Broad Crested, Sharp crested, Crump); Forces on a sluice gate; Critical Depth; Verification of Darcy'S Law; Flow line Visulaization: Flood Hydrograph: Groundwater Abstraction.

Textbooks:

- P. N. Modi and S.M. Seth, Hydraulics and Fluid Mechanics, Standard Book House, 1998.

C-

CE491 DESIGN STUDIO

| 0-0-3-3

| Pre-requisites: Nil

Design and detailing of different elements of reinforced concrete multi storied buildings manually as well as using latest design and detailing softwares. Design of reinforced concrete retaining walls.

Numerical Modeling of Groundwater Flow and Solute Transport for an aquifer site using Advanced industry standard software GMS (Groundwater Modeling Systems).

Design of deep foundations for buildings and bridges.

Design of various unit operations of water treatment plant; Design of sewer and sewerage system; Design of various unit operations of sewage treatment plant.

Setting out of building plans using advanced survey equipments. The geometric and structural design of flexible pavements including their layout.

Textbooks:

- S. U. Pillai and D. Menon, Reinforced Concrete Design, Tata McGraw-Hill, 3rd edition, 2009.
- Manual on Sewerage and Sewage Treatment Systems, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 2013.
- Manual on Water Supply and Treatment, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1999.
- Bear, Jacob, Cheng, Alexander H.-D., Modeling Groundwater Flow and Contaminant Transport, Springer
- Freeze A, Cherry JA, Groundwater, Prentice Hall, 1979.
- V. N. S. Murthy, Advanced foundation Engineering, CBS Publishers & Distributers, 2011
- S. J. Arceivala and S. R. Asolekar, Wastewater Treatment for Pollution Control and Reuse, 3rd Edition, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 2006.

Reference books:

- J. E. Bowles, Foundation Analysis and Design, McGraw-Hill, 2001.
- J. Macgregor and J. K. Wight, Reinforced Concrete: Mechanics and Design, Prentice Hall, 5th edition, 2008.
- J. C. Crittenden, R. R. Trussell, D. W. Hand, K. J. Howe, G. Tchobanoglous, MWH's Water Treatment: Principles and Design, 3rd Edition, John Wiley & Sons, 2012.
- S. R. Qasim, Wastewater Treatment Plants: Planning, Design, and Operation, Second Edition, CRC Press, 1998.

CE511 ADVANCED STRUCTURAL MECHANICS

| 3-0-0-6

| Pre-requisites: Nil

Introduction to tensor algebra, Theory of stress, plane stress and plane strain, principal stresses and stress invariants, compatibility equations, equilibrium equations; Strain: deformation and velocity gradients, Lagrangian and Eulerian description and finite strain, small deformation theory, principal strains and strain invariants, compatibility conditions; Constitutive theory: St. Venant's principal, linear elasticity and generalized Hook's law; Airy stress function, two-dimensional elastostatics problems, torsion.

Classical concept of stability; Stability of discrete systems: linear and nonlinear behaviour; Stability of continuous systems: stability of columns: axial-flexural buckling, Stability of frames: member buckling versus global buckling, Basic concept of plates and shells

Text/Reference books:

- S. Timoshenko and J. N. Goodier, Theory of Elasticity, McGraw Hill Book Company, International Ed, 1970.
- Timoshenko, S. P. and Gere, J. M., "Theory of Elastic Stability". McGraw-Hill Book Co., Inc. New York, Second Edition, 1961.
- L S Srinath. Advanced Mechanics of Solids, McGraw Hill Education, 2010.

CE513 | ADVANCED FOUNDATION ENGINEERING | 3-0-0-6 | Pre-requisites: Nil

Static and dynamic bearing capacity of footings, bearing capacity of footings resting on layered soils and footing on or near slopes, tilt, rotation and horizontal displacement of foundations subjected to eccentric-inclined loads, foundations on rocks, seismic design of shallow foundations, analysis of raft foundations, circular and annular rafts, structural design of shallow foundations, pile foundations load capacity and settlements, various methods of analysis of laterally loaded pile foundations, uplift capacity, piles subjected to dynamic loads, seismic design of pile foundations, structural design of pile foundations, machine foundations for reciprocating machines, impact type, rotary machines such as turbines, turbo-generator, IS code provisions on foundations, codal provisions on structural and earthquake resistant design of foundations.

Text books:

- V.N.S.Murthy, Advanced foundation Engineering, CBS Publishers & Distributers, 2011.
- J.E. Bowles, Foundation Analysis and Design, McGraw-Hill, 2001.

Reference books:

- B.M. Das, Principles of Foundation Engineering, Cengage Learning, Eighth Edition, 2011.
- H. G. Poulos, and E. H. Davis, Pile Foundation Analysis and Design, Krieger Pub Co., 1990.

CE515 | ADVANCED STRUCTURAL ANALYSIS | 3-0-0-6 | Pre-requisites: Nil

Basics of structural analysis: static & dynamic loading, linear & nonlinear structural behaviour, geometric & material nonlinearity, hysteretic behaviour; Classical linear analysis of frames and trusses: displacement method, slope deflection equations & matrix displacement method, effect of foundation settlement and temperature; Geometric nonlinear analysis of frames and trusses: displacement method, nonlinear slope-deflection equations & nonlinear behaviour, linearized iterative matrix displacement method, geometric stiffness matrix, tangent stiffness matrix, P-6 effect, buckling of frames, tension structures; Material nonlinear analysis of frames: basics of plasticity, distributed plasticity & lumped plasticity, incremental nonlinear analysis.

Text Reference books:

- W. McGuire, R. H. Gallagher and R. D. Ziemian, Matrix Structural Analysis, Wiley, 2000.
- D. Menon, Advanced Structural Analysis. Alpha Science Inti Ltd, 2009.

CE 517 | STRUCTURAL DYNAMICS | 3-0-0-6 | Pre-requisites: Nil

(L Single Degree of Freedom System (SDOF): Equation of motion; Free undamped and damped response; Undamped and damped response to harmonic loading; Vibration isolation; Evaluation of damping parameter; Response to arbitrary periodic, step, pulse excitations and ground motion; Numerical evaluation of dynamic response.

Multi Degree of Freedom System (MDOF): Equations of motion (Influence coefficient method); Stiffness matrix; Lumped and consistent mass matrix; Proportional and Rayleigh damping matrix; Undamped free and forced response using modal superposition.

Continuous System: Equation of motion; Undamped free and forced response Concepts of Response spectrum, Computational and numerical methods, Fundamentals of Earthquake Engineering.

Text books:

- A. Chopra, Dynamics of Structures: Theory and Applications to Earthquake Engineering, Prentice Hall, 4th Edition, 2015.

Reference books:

- J. L. Humar, Dynamics of Structures, Balkema, 2002.
- R. W. Clough and J. Penzien, Dynamics of Structures, McGraw-Hill, 1975.
- L. Meirovitch, Elements of Vibration Analysis, McGraw-Hill, 1986.

CE519 | AIR POLLUTION AND CONTROL | 3-0-0-6 | Pre-requisites: Nil

Air pollution - sources and effects on the receptors, Atmospheric sources, sinks and transport; Effects of health and environment Air pollution system - gases and particulate, Criteria pollutants, Air pollution legislation, Ambient air quality and emission standards, Air pollution meteorology, Fate and dispersion of air pollutants, Particulate pollutant control techniques, Gaseous pollutant control techniques, Control of specific pollutants, Control technologies for removal of SO₂, NO_x, VOC, etc., Control technologies for motor vehicles, Design and drawing of various particle control devices.

Textbooks:

- K. Wark and C. F. Warner, Air Pollution-Its Origin and Control, Harper & Row, New York, 1981.
- N. D. Nevers, Air Pollution Control Engineering, McGraw Hill International Ed., 1985.

Reference books:

- e.D. Cooper and F.e. Alley, Air Pollution Control: A Design Approach, Waveland Press, 2002.

CE521 | GIS IN WATER RESOURCES | 3-0-0-6 | Pre-requisites: Nil

Basic principles of image interpretation and GIS; Interpretation of regional geological and geomorphological features; River basin studies; Identification of groundwater potential zones; Lake and wetland studies; Water quality mapping~ Vegetation Mapping and forestry applications; Applications in glaciology and snow hydrology; Applications in oceanography and coastal zone mapping; Mineral resources evaluation; Microwave remote sensing and its application in monitoring earth resources, snow surface, ocean and atmosphere; Application of thermal infrared data for mapping surface moisture and rock types and environmental studies.

Textbooks:

- Lynn E. Johnson, Geographic Information Systems in Water Resources Engineering, CRC Press, Taylor and Francis Group, 2008.

CE523 | SOIL EXPLORATION | 3-0-0-6 | Pre-requisites: Nil

Introduction: Planning for Subsurface Exploration,

Methodology: Site investigation methods, Drilling techniques, Sampling techniques, In-situ field testing,

Type of soil exploration methods: CPT, SPT, BPT, Types of samplers, Sample Disturbance, Correlations for Standard Penetration Test, Other In Situ Tests, Soil Exploration Report.

Text! Reference books:

- V. N. S. Murthy, "Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering", CRC Press, Taylor & Francis Group, First Indian Reprint, 2010.
- K. Terzaghi, R. B. Peck and G. Mesri, Soil Mechanics in Engineering Practice, John Wiley & Sons, 1996.

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CE525 | HIGHWAY GEOMETRIC DESIGN | 3~0-0-6 | Pre-requisites: Nil

Introduction and roadway function, Design controls: vehicles and drivers, speed, volume and access, Practical considerations in fixing the alignments, Route layout, Design of roadway cross-section, longitudinal drains, Estimate earthwork volumes. Sight distances for road segments and intersections, Fixing of gradients, Design of vertical and horizontal curves. Design speed; Sight distance, horizontal and vertical alignment, Intersection design considerations, Environmental considerations, and context sensitive solutions, Safety assessment.

Text/Reference books:

- J. H. Banks, Introduction to Transportation Engineering, McGraw-Hill, 2002.
- S. K. Khanna and C. E. G. Justo, Highway Engineering, Nem Chand Bros., 2002.
- American Association of State Highway and Transportation Officials (AASHTO), A Policy on Geometric Design of Highways and Streets, 5th Edition, 2004.

CE527

INFRASTRUCTURE ECONOMICS, LAWS
AND PROFESSIONAL ETHICS

13-0-0w6

1 Pre-requisites: Nil

Basics of Finance, Financial Needs of the Infrastructure Sector and Projects, Understanding Project Financing, Sources of Infrastructure Finance, Capital Markets and Infrastructure Financing, Macroeconomics in infrastructure, Private and Public Participation in Infrastructure Projects, Various Models of Financing Infrastructure Projects, Infrastructure Financing in Developing Countries, Financial Risk Management, Case Studies on Infrastructure Project Financing.

Aristotle on Ethics, Categories of ethics, Industrial development and ecological balance; rural and urban society; limit to growth; future shock; Municipal and panchayet laws; codes on building, roads, air traffic, railways, Energy and electricity, water quality and utilization, sharing of resources, environmental legislations, ISO, professional ethics: Honesty, Integrity, Transparency, confidentiality, Efficiency, Fair play, Objectivity, Confidentiality, Respectfulness and Obedience, Structural/infrastructural failure and litigation.

Text/Reference books:

- John R. Rowan and Samuel Zinaich [r., Ethics for the Professions, 1st edition, Wadsworth Publishing, 2002.
- W.B. Wendel, Professional Responsibility: Examples & Explanations, 2nd edition, Aspen Publishers, 2007.
- Richard D. Parsons, The Ethics of Professional Practice, 1st edition, Pearson, 2000.

- (1) B. C. Esty, Modern Project Finance: A Casebook, Wiley, 2003.
- E. R. Yescombe, Principles of Project Finance, Academic Press, 2002.

Various National Codes/Legislations/Standards.

CE529

MACHINERIES AND EQUIPMENT IN
INFRASTRUCTURE ENGINEERING

13-0-0-6

1 Pre-requisites: Nil

Engineering Fundamentals of Moving Earth - Rolling resistance, Effect of grade on tractive effort, Effect of altitude on performance of IC engines; Earthmoving, Excavating, and Lifting Equipment Selection - Bulldozers, Front-end Loaders, Scrapers, Trucks, Excavators, Backhoes, Front shovels, Cranes, and Forklifts; Piles and Pile-Driving Equipment; Production of Crushed-stone Aggregate; Concreting Equipment; Asphalt Mix Production and Placement - Asphalt Plants, and Paving Equipment; Estimating and Optimizing Construction Equipment System Productivity - Peurifoy's method of optimizing productivity, Phelps' Method, Optimizing hauling system based on loading facility; Estimation of Equipment Productivity - Mathematical models, Simulations; Scheduling Equipment-Intensive Horizontal Construction Projects - Linear scheduling method, Precedence diagramming method, Developing equipment resource packages; Scheduling Lifting Equipment for Vertical Construction; Equipment Financing Decision - Financing methods, Rental and lease contract considerations.

1
...Text books:

- D. G. Gransberg, C. M. Popescu and R. C. Ryan, Construction equipment management for engineers, estimators, and owners, Taylor & Francis, New York, 2006.
- R. L. Peurifoy, C. J. Schexnayder, A. Shapira and R. Schmitt, Construction planning, equipment, and methods, 8th ed., McGraw Hill, New York, 2010.

Reference books:

- D. A. Day and N. B.H. Benjamin, Construction equipment guide, 2nd ed., Wiley, New Jersey, 1991.
- F. Harris, Modern construction and ground engineering equipment and methods, 2nd ed., Longman, London, 1994.
- J. Singh, Heavy construction - planning, equipment and methods, 3rd ed., CRC Press, 2009.

CE 531 | MASONRY STRUCTURES

13-0-0-6

1 Pre-r~uisites: Nil

Properties of constituents: units - burnt clay, concrete blocks, mortar, grout, reinforcement; Masonry bonds and properties, masonry properties - compression strength; Stresses in masonry walls: vertical loads, vertical loads and moments - eccentricity & kern distance, lateral loads - in-plane, out-of-plane; Behaviour of masonry walls and piers: axial and flexure, axial-shear and flexure; Behaviour of Masonry Buildings: unreinforced masonry buildings - importance of bands and corner & vertical reinforcement, reinforced masonry buildings - cyclic loading & ductility of masonry walls;

Behaviour of masonry infills in RC frames; Structural design of masonry in buildings: methods of design - WSD, USD, seismic design - seismic loads, code provisions; Seismic evaluation and strengthening of masonry buildings: methods - in-situ, non-destructive testing; Construction practices and new materials.

Text/Reference books:

- Dayaratnam, P. (1987). Brick and Reinforced Brick Structures, Oxford & IBH Publishing Co. Pvt. Ltd.
- Drysdale, R. G. Hamid, A. H. and Baker, L. R. (1994). Masonry Structures: Behaviour & Design, Prentice Hall
- Hendry, A. W. (1998), Structural Masonry, Mc Millan, UK, 2nd edn,
- Hendry, A. W., Sinha, B.P. and Davies, S. R. (1997). Design of Masonry Structures, E&FN Spon, UK
- Sahlin, S. (1971). Structural Masonry, Prentice Hall, Englewood Cliffs, NJ
- Schneider, R. S. and Dickey, W. L. (1994). Reinforced Masonry Design, Prentice Hall, 3rd edn.
- Paulay, T. and Priestley, M. J. N. (1992). Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley.

CE533 BIOLOGICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT 3-0-0-6 | Pre-requisites: Nil

Water and wastewater characteristics, Natural and engineered environmental systems, Schematic and flow diagram of water and wastewater treatment plants, Preliminary and primary treatment, secondary treatment, tertiary treatment. Environmental microbiology and biochemistry, Stoichiometry and energetics of bacterial reactions, Kinetics of bacterial growth, Reactor kinetics, Aerobic and anaerobic processes, suspended growth, attached growth and hybrid processes, Biological reactors design and operation, Activated sludge process and its modifications, Trickling filter, trickling filter, Upflow anaerobic sludge blanket (UASB) reactor, Lagoon and oxidation pond, Biofilm reactors applications, Biological nutrients removal, Nitrification, Denitrification, Phosphorous removal, Bioprocesses for heavy metals removal.

Textbooks:

- S.J. Arceivala and S.R. Asolekar, Wastewater Treatment for Pollution Control and Reuse, 3rd Edition, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 2006.
- R. Mitchell, Environmental Microbiology, John Wiley, 1992.
- B.E. Rittmann, Environmental Biotechnology: principles and applications, McGraw-Hill, 2001.
- Metcalf & Eddy, Wastewater Engineering - Treatment and Reuse (Revised by Tchobanoglous, G., Burton, F.L. and Stensel, H.D.), Tata McGrawHill, 2004.

Reference books:

- L.D. Benefield, and C.W. Randall, Biological Process Design for Wastewater Treatment, Prentice-Hall, Englewood Cliffs, New Jersey, 1980.
- N. F. Gray, Biology of Wastewater Treatment, Oxford University Press, London, 1989.

CE535 | SOIL DYNAMICS | 3-0-0-6 | Pre-requisites: Nil

Principles of dynamics and vibrations:

Vibration of elementary systems-vibratory motion-single and Multi degree of freedom system-free and forced vibration with and without damping.

Waves and wave propagation in soil media:

Wave propagation in an elastic homogeneous isotropic medium- Raleigh, shear and compression waves.

Dynamic properties of soils:

Stresses in soil element, coefficient of elastic, uniform and non-uniform compression, shear effect of vibration dissipative properties of soils, Determination of dynamic soil properties, Field tests, Laboratory tests, Model tests, Stress-strain behavior of cyclically loaded soils, Estimation of shear modulus, Modulus reduction curve, Damping ratio, Linear, equivalent-linear and non-linear models, Ranges and applications of dynamic soil tests, Cyclic plate load test, Liquefaction.

Vibration isolation:

Vibration isolation technique, mechanical isolation, foundation isolation, isolation by location, isolation by barriers, active passive isolation tests.

Text books:

- Swami Saran, "Soil Dynamics and Machine Foundations", Galgotia Publications Pvt. Ltd, 1999.
- B. M. Das and G. V. Ramana, Principles of Soil Dynamics, 2nd edition, Cengage Learning, 2011.

Reference books:

- S. Prakesh & V. K. Puri, Foundation for machines, McGraw-Hill 1993.
- Kramar S.L., "Geotechnical Earthquake Engineering", Prentice Hall International series, Pearson Education (Singapore) Pvt. Ltd.

CE537 | SOLID AND HAZARDOUS WASTE MANAGEMENT | 3_0_0_6 | Pre-requisites: Nil

Sources, composition and properties of municipal solid waste, Generation of solid waste, Onsite handling, storage and processing including segregation, Collection of solid waste, Transfer and transport, Processing technique and equipment, Recovery of resources, Conversion products and energy, Composting and vermicomposting, Recycling, Incineration and pyrolysis, Disposal of solid waste including sanitary landfill, Planning, site and design aspects of solid waste engineering; Introduction to hazardous wastes, Definition of hazardous waste, The magnitude of the problem, Risk assessment, Environmental legislation, Characterization and site assessment, Waste minimization and resource recovery, Physico-chemical and biological treatment, Transportation of hazardous waste, Ground water contamination, Landfill disposal.

Text books:

- P. A. Vesilind, W. A. Worrel and D. R. Reinhart, Solid Waste Engineering, Thomson Brooks/Cole, First Edition, 2002.
- M. LaGrega, P. Buckingham, and J. Evans, Hazardous Waste Management, McGraw Hill, 2000.

Reference books:

- G. Tchobanoglous, H. Theisen, and S.A. Vigil, Integrated Solid Waste Management: Principles and Management Issues, McGraw Hill Book Company, Singapore, 1993.
- Charles A. Wentz, Hazardous Waste Management, McGraw-Hill, 1995.

CES39 | STOCHASTIC HYDROLOGY | 3-0-0-6 | Pre-requisites: Nil

Statistical methods in hydrology, probability distribution of hydrologic variables, hypothesis testing and goodness of fit, flood frequency analysis, single and multiple regression analysis, classification of time series, characteristics of hydrologic time series, statistical principles and techniques for hydrologic time series modelling, time series modelling of annual and non-periodic hydrologic time series (including AR, ARMA, ARIMA, and DARMA models), multivariate modelling of hydrologic time series, practical considerations in time series modelling applications.

Text books:

- Haan, C.T., Statistical Methods in Hydrology, First East-West Press Edition, New Delhi, 1995.
- Bras, R.L. and Rodriguez-Iturbe, Random Functions and Hydrology, Dover Publications, New York, USA, 1993.
- Clarke, R.T., Statistical Models in Hydrology, John Wiley, Chichester, 1994.

Reference books:

- Yevjevich V., Probability and statistics in Hydrology, Water Resources Publications, Colorado, 1972.
- Ang, A.H.S. and Tang, W.H., Probabilistic concepts in Engineering Planning Design, Vol. I, Wiley, New York, 1975.

CES41 | URBAN AND REGIONAL PLANNING | 3-0-0-6 | Pre-requisites: Nil

Definitions of town planning and urban design, levels of planning and steps for preparation of a town plan, survey techniques in planning and urban design, concepts, functions, components and preparation of a development plan. Planning concepts related to garden city, satellite towns and ribbon development. Introduction to analytical techniques in Town Planning and Urban Design. Concepts in Regional and Metropolitan planning, land subdivision regulations and zoning, Urban Design principles and criteria, Urban Scale and Spaces. Design for the Pedestrians. Waterfront Development. Principles of Urban Conservation. Principles of Streetscape Design. Urban design regulations and control,

the comprehensive role of urban design in town planning process.

Text/Reference books:

- Peter Hall and M.Tewdwr-Jones, Urban and regional planning, Routledge, Fifth Edition, 2010.
- Peter Hall, Urban and regional planning, Routledge, 4th Edition, 2002.
- K. V. Sundaram, Urban and regional planning in India, Vikas Pub. House, Fifth Edition, 1977.

CE543 | WATER RESOURCES MANAGEMENT | 3-0-0-6 | Pre-requisites: Nil

Economics of water resources systems: principles of engineering economics; Microeconomics and efficient resource allocation, conditions of project optimality; Planning for multipurpose water resource projects; Introduction to mathematical optimization techniques; Multiobjective optimization; Application of optimization techniques; Water resources planning under uncertainty; Stochastic planning models; Application of simulation models.

Text books:

- Q. Grafton and K. Hussey, Water Resources Planning and Management, Cambridge University Press, 2011
- Freeze A, Cherry JA, Groundwater, Prentice Hall, 1979.

[Eight Semester: .

CE510 | ENVIRONMENTAL IMPACT ASSESSMENT | Pre-requisites: Nil

Definition and Concepts of EIA, General Framework for Environmental Impact Assessment, ErA methodologies: Screening, Initial environmental examination (IEE), Full-scale EIA including scoping, identification, impact prediction and evaluation. Impact analysis on biophysical environment, geomorphological aspect, soil & water, socio-economic aspect, noise, transport etc, Environmental Impact Statement (EIS), Environmental statement procedures, environmental appraisal, Environmental Legislation. Introduction of the terms Environmental Risk Analysis, Cost Benefit Analysis, Life cycle Assessment, Case studies and EIA practices.

Textbooks:

- Kevin Hanna, Environmental Impact Assessment: Practice and Participation, Oxford University Press, 2009.
- John Glasson, Riki Therivel, Andrew Chadwick, Introduction to Environmental Impact Assessment, Routledge, 2012.
- John- Glasson; (edited: Peter Morris, Riki Therivel) Methods in Environmental Impact Assessment Routledge, 2009

Reference books:

- Larry Canter, Environmental Impact Assessment, McGraw-Hill, 1995.
- Y. Anjaneyulu. V.Manickam; Environmental Impact Assessment, BS Publication Wiley and Sons, Third Reprint, 2013

CE514 | ADVANCED HYDROLOGY | 3-0-0-6 | Pre-requisites: Nil

Hydrologic cycle, water budget equation, world water quantities, residence time, systems concept, transfer function operators, hydrologic model classification. Atmospheric circulation, water vapor, formation of rainfall, types and forms of precipitation, precipitable water, monsoon characteristics in India, rainfall measurement, density and adequacy of rain gauges; Thunderstorm Cell model, IDF relationships, spatial averaging methods of rainfall; Factors affecting evaporation, estimation and measurement of evaporation, energy balance method, aerodynamic method, Priestly-Taylor method, and pan evaporation. Soil moisture, porosity, saturated and unsaturated flow; Richard's equation, infiltration, Horton's Phillip's, and Green Ampt methods, parameter estimation, ponding time concepts. Catchment storage concept, Hortonian and saturation overland flow, streamflow hydrographs, base-flow separation. Phi-index, ERH & DRH, algorithm for abstraction using Green-Ampt equation, SCS method, overland and channel flow modeling, time area concepts, and stream networks. General hydrologic system model, response functions of a linear hydrologic systems and their inter-relationships, convolution equation; definition and limitations of a UH; UH derivation from single and complex storms; UH optimization using regression. matrix, and LP methods; Synthetic unit hydrograph, S-Curve, IUH. Probability concepts, random variables, laws of probability, PDFs & CDFs; Normal and Binomial distributions; Statistical parameters: expected value, variance, skewness, and peakedness; Fitting of a probability distribution, methods of moments and maximum likelihood: Testing the goodness of fit, Chi-square test; Frequency analysis: return period, probability plotting, Extreme value distributions, frequency factors, Log-Pearson distribution, confidence limits.

Text books:

- V.T. Chow, D.R. Maidment, and L.W. Mays, Applied Hydrology, McGraw Hill, 1998.
- K Subramaniya, Engineering Hydrology, McGraw Hill.

Reference books:

- Freeze A, Cherry JA, Groundwater, Prentice Hall, 1979.

CE516 | ADVANCED SOIL MECHANICS | 3-0-0-6 | Pre-requisites: Nil

Introduction: Geotechnical/ Geoenvironmental Engineering. Nature of Soil: Soil Composition, Index Properties, Soil Classification, Soil Structure: Clay-Water Forces, Interparticle Forces, Fabric, Environmental Factors. Shear Strength of Soils: Mohr-Coulomb Failure Theory, Response of Soils to Shearing Force. A Simple Model to interpret Shear Strength, Drained and Un-drained Strength, Laboratory and Field Tests, Factors Affecting Shear Strength, Useful Correlations. Slope Instability: Introduction, Infinite Slope, Finite Slope, Stability analyses: General, Ordinary & Bishop's Methods of slices, Spencer & Janbu Methods of Slope Stability Analysis, Application of software: SLOPE/W, Wedge Method, Stability

Charts, Time Dependent Changes in factor of Safety. Theory of Elasticity: Stress-Strain Relationship for various loading conditions, Elastic Stress Analysis, Introduction to Computer Program SIGMAW. Theory of Plasticity and Models for Soils: Elements of Plasticity, Yield Criteria (Mohr-Coulomb, Drucker-Prager), Post-yield Behavior, Flow Rule, Incremental Stress-Strain Relationship, Elastic-Perfectly Plastic Model, Hardening Plasticity Based Model.

Text books:

- V. N. S. Murthy, Advanced foundation Engineering, CBS Publishers & Distributers, 2011
- J.E. Bowles, Foundation Analysis and Design, McGraw-Hill, 2001.
- M. Tomlinson, J. Woodward, Pile Design and Construction Practice, CRC Press, Fifth Edition, 2007

Reference books:

- H. F. Winterkorn, H.Y. Fang, Foundation Engineering Handbook. Van Nostrand Reinhold; First edition, 1975
- B.M. Das, Principles of Foundation Engineering, Cengage Learning, Eighth Edition, 2011
- H. G. Poulos, and E. H. Davis, Pile Foundation Analysis and Design, Krieger Pub Co., 1990.

CE518 | ADVANCED STRUCTURAL DESIGN | 3-0-0-6 | Pre-requisites: Nil
Behaviour of Masonry Buildings: unreinforced masonry buildings, reinforced masonry buildings; Behaviour of masonry infill in RC frames: strut action; Structural design of masonry in buildings.

Design of reinforced concrete structures: capacity design concept, flexure design, shear design, strong-column weak-beam philosophy; Beam-column Joints; Collapse Mechanisms; Ductility of Reinforced Concrete Structures.

Design of steel structures: inelastic bending - curvature, plastic moments, design criteria - stability, strength, drift; Stability criteria: stability of beams - local buckling of compression flange & web, lateral-torsional buckling, stability of columns; Strength Criteria: beams - flexure, shear, torsion, columns - moment magnification factor, effective length, P-M interaction, bi-axial bending, joint panel zones; Drift criteria; Connections.

Design philosophies and procedures for liquid retaining structures.

Text/Reference books:

- S.U. Pillai and D. Menon, "Reinforced Concrete Design", Tata McGraw Hill, 3rd Edition, 2009.
- M.L. Gambhir, "Fundamentals of Reinforced Concrete Design", Prentice Hall of India Private Limited, 2006.
- MacGregor, J.G., and Wight, J.K., Reinforced Concrete Mechanics and Design, Pearson Prentice Hall, New Jersey, 2005
- T. Paulay and M. Priestley, "Seismic Design of Reinforced Concrete and Masonry Buildings", John Wiley and Sons Inc., 1992.
- P. Agarwal and M. Shrikhande, "Earthquake Resistant Design of Structures", Prentice-Hall of India Private Limited, 2006.
- S.K. Duggal, "Earthquake Resistant Design of Structures", Oxford University Press, 2007.
- N. Subramaniam, "Design of Steel Structures", Oxford University Press, 2008.

CE522 | ADVANCED WATER AND WASTEWATER ENGINEERING | 3_0_0_6 | Pre-requisites: Nil

Water requirements - Water demand, forecasting and management, Surface water and Ground water sources, Water quality and drinking water standards, Determination of reservoir capacity, Transportation and distribution of water, Distribution system design and analysis, Optimization of pipe network systems, Distribution reservoirs and service storage, Pumping and design considerations for pumps, Water treatment systems, Physico-chemical processes, Sedimentation, Coagulation, Flocculation, Granular media filtration, Disinfection, Water softening, Adsorption and ion exchange processes.

Wastewater- Sources, nature and characteristics, Estimation of wastewater flow rate and fluctuations, Estimation of storm water.

Combined and separate sewerage systems - Design, Sewer materials, Sewer appurtenances, Construction and

maintenance of sewers and pumping of sewage, Analysis of wastewater - determination of solids, COD, BOD, nutrients and their significance, BOD progression and its formulations.

Design of wastewater treatment systems - Primary, secondary and tertiary treatments, screens, grit chambers, sedimentation tanks, chemical precipitation, Biological treatment - objectives, methods and design of activated sludge and trickling filter units, Sewage sludge - its treatment, disposal and reuse, Effluent standards and disposal.

Text books:

- H. S. Peavy, D. R. Rowe and George Tchobanoglous, Environmental Engineering, McGraw-Hill International Ed., 1985.
- M. L. Davis and D. A. Cornwell, Introduction to Environmental Engineering, McGraw-Hill, Inc., 2014.
- C. N. Sawyer, P. L. McCarty and G. F. Parkin, Chemistry for Environmental Engineers, McGraw-Hill, 1994.
- Rumana Riffat, Fundamentals of Wastewater Treatment and Engineering, CRC Press, 2012

Reference books:

- Metcalf & Eddy, Wastewater Engineering- Treatment and Reuse (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill, 4th Edn., 2004.
Manual on Sewerage and Sewage Treatment Systems, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 2013.
Manual on Water Supply and Treatment, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1999.

CE524 AIRPORT ENGINEERING | 3-0-0-6 | Pre-requisites: Nil

Basic principles of airport facilities design to include aircraft operational characteristics, noise, site selection, land use compatibility, operational area, ground access and egress, terminals, ground service areas, airport capacity, and special types of airports, Airport planning, runway design, taxiway design, airport pavement design.

Text/Reference books:

- S.c. Rangwala. "Airport Engineering," 13th edition, Charotar Publishing house, 2013.
- Priyani V. "Highway and Airport Engineering," Charotar Publishinghouse, 1979.

CE526 EARTHQUAKE RESISTANT DESIGN OF STRUCTURE | 3_0_0_6 | Pre-requisites: Structural Dynamics & equivalent

C_ :-=ausefs of earthquakes and seismic waves, magnitude, intensity and energy release, characteristics of earthquakes ; Lique action; Seismic risk; EQ response of structures, single-degree-of freedom dynamics, concept o response spectra ad introduction to multi-degree-of-freedom systems; Design response spectrum, idealization of structures, response spectrum analysis, equivalent lateral force concepts; Philosophy of earthquake resistant design, ductility, redundancy & over-strength, damping, supplemented damping; Code provisions; Seismic behaviour of concrete, steel and masonry structures, material properties; Behaviour and analysis of members under cyclic loads; Seismic detailing provisions; Review of damage in past earthquakes.

Text/Reference books:

- S. K. Duggal, "Earthquake Resistant Design of Structures", Oxford University Press, 2013
- M. Shrikhande and Pankaj Agarwal, "Earthquake Resistant Design of Structures", Prentice hall India, 2006
- S.L. Kramer, Geotechnical Earthquake Engineering, Prentice Hall, 1996.
- Clough R.W. and Penzien J., 'Dynamics of Structures', McGraw-Hill, 2nd edition, 1992.
- Newmark N.M. and Rosenblueth E., 'Fundamentals of Earthquake Engg.', Prentice Hall, 1971.
- David Key, 'Earthquake Design Practice for Buildings', Thomas Telford, London, 1988.
- Paulay, T. and Priestley, M. J. N. (1992). Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley.

CE528 | RAILWAY ENGINEERING | 3-0-0-6 | Pre-requisites: Nil
 History of Indian railways and importance of railways; Factors controlling railway alignment; Components of railway track, functions and requirements; Geometric design of tracks; Analysis and design of track layers: Axle load, train speed considerations; Factors affecting the performance of ballast and subballast; Track drainage; Train resistance and tractive power requirements.

Text/Reference books:

- Coenraad Esveld., "Modern Rail Track Design", MRT productions.
- Buddhima Indraratna, Wadud Salim, Cholachat Rujikiatkarnjorn, "Advanced Rail Geotechnology - Ballasted Track", CRC Press, 2011.
- Saxena S.c. and Arora.s.P, "A Text Book of Railway Engineering", Dhanpat Rail Publications, 2013.

CE530 | GEOTECHNICAL EARTHQUAKE ENGINEERING | 3_0_0_6 | Pre-requisites: Nil

Introduction, Significant historical earthquakes, Continental drift and plate tectonics, Internal structure of earth, Sources of seismic activity, Size of the earthquake, Strong ground motion and its measurement, Ground motion parameters, Estimation of ground motion parameters, Seismic hazard analysis, Identification and evaluation of earthquake source:c Deterministic seismic hazard analysis, Probabilistic seismic hazard analysis, Wave propagation, Waves in unbounde " media, Waves in semi-infinite body, Waves in layered body, Dynamic soil properties and Measurement of dynamic soil properties, Ground response analysis, Local site effects and design of ground motions, Liquefaction, Evaluation of liquefaction hazards, Liquefaction susceptibility, Initiation and effects of liquefaction, Seismic slope stability analysis, Seismic design of retaining walls.

Text books:

- Kramar S.L, Geotechnical Earthquake Engineering, Prentice Hall International series, Pearson Education Pvt. Ltd.

Reference books:

- Ikuo Towhata, Geotechnical Earthquake Engineering, Springer series, 2008.

CE532 | GROUND IMPROVEMENT TECHNIQUES AND REINFORCED EARTH | 3_0_0_6 | Pre-requisites: Nil

Module I: Ground improvement

Soil compaction methods, compaction control; Soil stabilisation [using additives, sand drains, stone columns, lime columns, Grouting (types of grouts, methods of grouting), Soil reinforcement (using strips, geogrids, geotextiles(geomembranes); Dewatering methods; Soil nailing; Underpinning]

Module II: Reinforced earth

Ceo-synthetics (classification, functions, applications, properties & testing); Applications and advantages of reinforced soil structure; Principles, concepts and mechanism of reinforced soil; Soil-reinforcement interface friction; Behaviour of Reinforced earth walls (basis of wall design, internal and external stability condition, Codal provisions; Seismic design consideration); Bearing capacity improvement and design of foundations resting on reinforced soil; embankments on soft soils; Design of reinforced soil slopes, Indian experiences; Use of geosynthetics for separations, drainage and filtration; Use of geosynthetics in roads, airports and railways; Indian Road Congress, AASHTO and other relevant guidelines; randomly distributed fiber reinforced soil; Soil nailing; Geocell, PVD, Geosynthetics in Environmental Control (Liners for ponds and canals; covers and liners for landfills - material aspects and stability considerations); Use of jute, coir, natural Geotextiles, waste products such as scrap tire, LOPE and HOPE strips, as reinforcing material.

Text books:

- Koerner, R.M. "Designing with Geosynthetics", Prentice Hall, New Jersey, USA, 4th edition, 1999.

Reference books:

- [ie Han, Principles and Practice of Ground Improvement, Wiley Publishers, 2015.

- B.M.Das, Principle of Geotechnical Engineering, Cengage Learning, eighth Edition, 2013.
- V. N. S. Murthy, Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, CRC Press, Taylor & Francis Group, Third Indian Reprint, 2013.

CE534 | GROUNDWATER HYDROLOGY | 3-0-0-6 | Pre-requisites: Nil

Characteristic of ground water, Global distribution of water, Role of groundwater in water resources system and their management, groundwater column, aquifers, classification of aquifers. Hydrogeological cycle, water level fluctuations, Groundwater balance. Darcy's Law, Hydraulic conductivity, Aquifer transmissivity and storativity, Dupuit assumptions Storage coefficient - Specific yield Heterogeneity and Anisotropy, Direct and indirect methods for estimation of aquifer parameters. Governing equation for flow through porous medium - Steady and unsteady state flow - Initial and boundary conditions, solution of flow equations. Steady and unsteady flow to a well in a confined and unconfined aquifer - Partially penetrating wells - Wells in a leaky confined aquifer - Multiple well systems - Wells near aquifer boundaries - Hydraulics of recharge wells. Dynamic equilibrium in natural aquifers, groundwater budgets, management potential of aquifers, safe yield, seepage from surface water, stream-aquifer interaction, artificial recharge. Hydrodynamic dispersion- occurrence of dispersion phenomena, coefficient of dispersion - Aquifer advection dispersion equation and parameters - initial and boundary conditions - method of solutions, solution of advection dispersion equation.

Textbooks:

- Todd O.K., Ground Water Hydrology, John Wiley and Sons, 2000.
- Bear L Hydraulics of Groundwater, McGraw-Hill International, 1979.

Reference books:

- Freeze A, Cherry JA, Groundwater, Prentice Hall, 1979.

CE536 | INDUSTRIAL POLLUTION CONTROL AND PREVENTION | 3-0-0-6 | Pre-requisites: Nil

Introduction to Industrial Waste: Types of industries and industrial pollution, Types of industrial wastes - solid, liquid and gaseous wastes, Hazardous waste - definition and concept, Basics of water quality parameters, Basics of air pollution, Characteristics of industrial wastes, Effects of industrial wastes on environment and human health, Environmental standards and legislations;

Pollution Prevention and Cleaner Production: Waste minimization, Source reduction, Use of alternate raw materials, Process modifications, Recycle, reuse and byproduct recovery, Opportunities and barriers to cleaner production;

Waste Treatment Techniques: Physico-chemical and biological treatment of wastewater, Advanced techniques for treatment of industrial waste, Concept of common effluent treatment plant (CETP), Concept of zero discharge, Industrial sludge management, Industrial air pollution, Control of gaseous emissions.

Pollution Control in Major Industries - Case Studies: Manufacturing processes and flow sheets, Sources and characteristics of wastes, Waste treatment and disposal methods - Computer & IT industry and electronic waste (e-waste), Thermal power plants, Iron and steel, Metal plating, Fertilizer, Refinery, Tannery, Food industry, etc.

Text books:

- Eckenfelder [r., W.W., Industrial Water Pollution Control, 3rd Edition, McGraw-Hill, 2000.
- Wise, D.L. and Trantolo, D.J. (eds.), Process Engineering for Pollution Control and Waste Minimization, 1st Edition, Marcel Dekker, 1994.

Reference books:

- Ghassemi, A. (ed.), Handbook of Pollution Control & Waste Minimization, 2nd Edition, Marcel Dekker, 2002.
- Metcalf & Eddy, Wastewater Engineering - Treatment and Reuse (Revised by Tchobanoglous, G., Burton, F.L. and Stensel, H.D.), 4th Edition, Tata McGraw-Hill, 2004.

CE538 | PROJECT ECONOMICS, VALUATION AND CONTRACTS | 3_0_0_6 | Pre-requisites: Nil

Preparation of DPR; Preparation of expression of Interest (EOI); Selection of architect along with time schedule and payment terms; Approval of plan by the owner and the local authority; Preliminary estimate as per DSR/PWD schedule; Preparation of Drawings inviting tender, NIT, specifications and BOQ, Advertisement for e-tendering along with proper dates; Actual estimate based on revised values; Working drawings, Quality control and progress schedule.

Text/Reference books:

- L. Squire and H.G. Van der Tak, Economic Analysis of Projects, John Hopkins University Press, 1975.
- D.s. Berrie and B.C. Paulson, Professional Construction Management including eM., Design Construct And General Contracting, Third edition, McGraw Hill International edition, 1992.
- KK. Chitkara, Construction Project Management: Planning, Scheduling and Controlling, Tata McGraw-Hill, 2008.
- J. Parkin and D. Sharma, Infrastructure Planning, Thomas Telford, 1999.
- Various National Codes/Legislations/Standards.

CE 540 | INTEGRATED REGION AND SMART CITY | 13-0-0-6 | Pre-requisites: Nil

Sustainable Construction: planning, Need to design for change, Design for minimum waste and pollution, Design to minimize energy, water and materials in construction and in use, Sustainable Engineering and Industrial Ecology: Using methods that minimize environmental damage to provide sufficient food, water, shelter, and mobility for a growing world population, Greening Industrial Processes and Industrial Ecology, Designing products and processes so that wastes from one are used as inputs to another, Incorporating environmental and social constraints as well as economic considerations into engineering decisions, Sustainable Urban Management, Sustainable Development, Green economies, Innovation and Environmental Leadership

Text/Reference books:

- C. J. Lim, and Ed Liu, Smart cities and Eco-Warriors, Routledge, 1st ed., 2010.

CE542 | OPEN CHANNEL HYDRAULICS | 3-0-0-6 | Pre-requisites: Nil

Difference between Open Channel Flow and Pipe Flow, Types of Channel, Geometric parameters of a channel, Classification of Open Channel Flow, Continuity and Momentum equation. Resistance flow formula, Velocity distribution, Equivalent roughness coefficient, Velocity coefficients, Uniform flow in rigid boundary channel, Uniform flow in mobile boundary channel. Concept of Specific Energy, Critical Depth, Alternate depth, Specific Force, Sequent depth. Governing equation of GVF, Classification of Gradually Varied Flow, Computation of GVF profile, Rapidly Varied Flow, hydraulic Jump, Flow over a Hump, Flow in Channel Transition. Concept of best hydraulic section, Design of rigid boundary canal, design of channel in alluvial formation- Kennedy's theory, Lacy's theory, Method of Tractive force, Free board in canal. Wave and their classification, Celerity of wave, Surges, Characteristic equation.

Text books:

- K Subramaniya, Flow in Open Channels, McGraw Hill, 1997.
- V.T. Chow, Open-channel hydraulics, McGraw Hill Publications (1959, 1973).

Reference books:

- H Chaudhury, Open channel flow, Second Edition. Springer (2008).
- Rajesh Srivastava, Flow through open channels, Oxford University Press (2008).

CE544 | SITE REMEDIATION | 3-0-0-6 | Pre-requisites: Nil

The course site remediation will focus on important established and emerging site remediation technologies. The orientation of the course can be divided in three phases, in phase one conceptualization of different process such as multiple-phase equilibrium, phase-partitioning, inter-phase mass transfer and contaminant transport in porous media will be covered. In second phase type, nature and source of contamination as well as site characterization including environmental geochemistry and geophysics will be taught. Finally the available and emerging techniques for site remediation and evaluating the effectiveness of specific techniques for remediation of suitable sites will be discussed.

Text books:

- Thobodaux J., Mackey D., Handbook on Chemical Mass Transport in Environment, CRC Press, 2010.
- Richard J. Watt, Hazardous waste, Sources, Pathways and receptor, John Wiley & Sons Inc, 1998.
- Loller S. B. Environmental Geochemistry. Elsevier, 2005.

Reference books:

- Bedient P. B., Rifai H. S., Newell C. J., Groundwater contamination transport and remediation, Prentice Hall PTR.
- Tian C. Z., Rao, Y. S., Lai K. C. K., Hu Z., Tyagi R. D., Irene M. C. L., Nanotechnology for Water Environment Applications, ASCE-EWRI, 2009.

CE546 | SPECIAL TOPICS IN GEOTECHNICAL ENGINEERING | 3-0-0-6 | Pre-requisites: Nil

Elements of geotechnical earthquake engineering: (seismic loading and its effect on earth structures; dynamic response of single, and multi-degree of freedom systems and continuous systems; behaviour of soil under dynamic loading; pore pressure generation and liquefaction effects; seismicity and seismic design parameters; Engineering Seismology and Seismic Microzonation)

(Offshore geotechnical engineering: (nature of submarine soils; offshore soil investigations; seabed sediments; wave action on seabed; submarine slope stability; seabed anchor systems)

Numerical methods in geotechnical engineering: (application of finite element method to the solution of stress, deformation, seepage, and consolidation problems; numerical solutions for soil dynamics problems; soil-structure interaction).

Tunnels: (Drilling and blasting of rocks; Grouting; Instrumentation and measurements in tunneling, Analysis and Design)

Earth & Rockfill dams: (Analysis and Design, field and laboratory investigations; foundation conditions and treatment; seepage and seepage control; stability analysis; deformation analysis; seismic considerations; instrumentation and monitoring)

Text books:

- J.E. Bowles, "Engineering Properties of Soils and Their Measurement", McGraw-Hill, 1992.

Reference books:

- Kramar S.L, "Geotechnical Earthquake Engineering", Prentice Hall International series, Pearson Education (Singapore) Pvt. Ltd.

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CE548 | THEORY OF PLATES AND SHELLS | 3-0-0-6 | Pre-requisites: Nil

Simple bending of Plates-Assumptions in thin plate theory-Different relationships- Different Boundary Conditions for plates- Plates subjected to lateral loads - Navier's method for simply supported plates - Levy's method for general plates - Example problems with different types of loading.

Circular plates subjected to Axi-symmetrical loads-concentrated load, uniformly distributed load and varying load - Annular circular plate with end moments.

Rayleigh-Ritz method - Application to different problems - Finite difference method - Finite element methodology for plates-Orthotropic Plates - Bending of anisotropic plates with emphasis on orthotropic plates - Material Orthotropy - Structural Orthotropy - Plates on elastic foundation.

Shells- Classification of shells - Membrane and bending theory for singly curved and doubly curved shells - Various approximations - Analysis of folded plates

Text books:

- Szilard, R., Theories and applications of plate analysis: classical, numerical, and engineering methods, Hoboken, NJ : John Wiley, 2003.
- Timoshenko, S., and Krieger, S.W., Theory of Plates and Shells, McGraw-Hill, 1959.

Reference books:

- Ugural, A.C., Stresses in Plates and Shells, 1999.
- Gould, P.L., Analysis of Shells and Plates, 1998.
- Ventsel, E. and Krauthammer, T., Thin Plates and Shells: Theory, Analysis, and Applications, Marcel Dekker, 2001.

CESSO | TRAFFIC ENGINEERING AND HIGHWAY SAFETY | 3_0_0_6 | Pre-requisites: Nil

Fundamentals of traffic flow, traffic flow characteristics, traffic stream models, continuum models, traffic flow models for intersections, network flow models and control, Theory and application of concepts in traffic signal systems control, signal timing design, capacity and delay at signalized intersection; signalized intersection capacity analysis; signal controllers, vehicle detection technologies, communication methods. Highway safety; Driver behavior and crash causality; Elements of highway safety management systems; Safety counter measures; Safety management process; Crash reporting and collision diagrams; Basics of crash statistics; Before-after methods in crash analysis; Highway geometry and safety; Road safety audits; Crash investigation and analysis.

Text Reference books:

- Nicholas Garber, J. and Lester A. Hoel. "Traffic & Highway Engineering", Cengage Learning, 2009.
- Coleman O'Flaherty "Transport Planning and Traffic Engineering", Taylor and Francis, 1996.
- Rune Elvik and Truls Vaa, The Handbook of Road Safety Measures, Elsevier, 2004.
- J. Pline (ed.), Transportation Engineering Handbook, 5th Edition, Institute of Transportation Engineers, Prentice Hall, 1999.

CE566 | PHYSICO-CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT | 3_0_0_6 | Pre-requisites: Nil

Introduction: Environmental systems - natural and engineered, Water quality parameters, Chemical reaction kinetics, Environmental legislations and standards.

Physico-chemical Processes and Unit Operations: Water purification system - natural and engineered processes, Schematic and flow diagram of water and wastewater treatment plants, Preliminary and primary treatment, secondary treatment, tertiary treatment, Physico-chemical unit operations in water and wastewater treatment, Screening and design of screen chamber, Grit removal and design of grit chamber, Sedimentation - Types and analysis of settling, Design of settling tank, Coagulation and flocculation - Stabilization and destabilizations of colloids, Coagulant dose and Jar test, Mixing requirements, Design of flocculators, Filtration - Granular media filtration, Slow and rapid sand filtration, Flow through porous media and filter hydraulics, Mathematical modeling of filtration, Design of slow and rapid sand filters, Disinfection - Rate and kinetics of disinfection, Disinfectants and by-products, Adsorption - Types of adsorption, Adsorption equilibria and isotherm, Rates of adsorption and sorption kinetics, Column adsorption study, Design of adsorption column, Analysis of breakthrough curves.

Advanced Physico-chemical Processes: Advanced physico-chemical processes - theory, practice and design, Ozonation, UV radiation, Ion exchange, Membrane processes.

Text books:

- Nazaroff, W.W. and Alvarez-Cohen, L., Environmental Engineering Science, Wiley, 2000.
- Peavy, H.S., Rowe, D.R., and Tchobanoglous, G., Environmental Engineering, McGraw-Hill International Ed., 1985.

Reference books:

- Benefield, L.D., Judkins, J.F., and Weand, B.L., Process Chemistry for Water and Wastewater Treatment, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.
- Weber, Jr., W.J., Physicochemical Processes for Water Quality Control, Wiley-Interscience, New York, 1983.
- Metcalf & Eddy, Wastewater Engineering - Treatment and Reuse (Revised by Tchobanoglous, G., Burton, F.L. and Stensel, H.D.), Tata McGrawHill, 2004.