

M.Tech Programme in ‘Civil and Infrastructure Engineering (CIE)’
Department of Civil and Environmental Engineering
School of Engineering, IIT Patna

1. Introduction to the programme:

Keeping in mind the infrastructure requirements for improved quality of life in a growing society as well as for industry and economic development, the need of the hour is to focus on Civil and Infrastructure Engineering with interdisciplinary approach. The multi-dimensional approach is perceived to close the socio-techno-economical loop by assessing the infrastructure needs accurately, proper decision-making in allocating resources, relating technological supply to socio-economic needs and most importantly, keeping a balance between economic development and environmental impact.

In order to satisfy the current societal needs and growing industry demands, the M.Tech in Civil and Infrastructure Engineering program under the aegis of Department of Civil and Environmental Engineering at Indian Institute of Technology Patna intends to be the forefront of imparting engineering education by amalgamating traditional Civil Engineering with modern Infrastructure Engineering. The program is designed to provide in-depth knowledge in the fundamentals, design, analysis and implementation of solutions for modern-days Civil Infrastructure problems. Moreover, the program intends to emphasize application-oriented and thesis/project-based learning.

2. Eligibility:

- B.Tech / B.E. or equivalent degree in Civil / Infrastructure / Construction / Mechanical / Electrical Engineering with valid GATE score in above mentioned subjects
- B.Tech from IITs with CPI > 8.0 (as per the institute rule)
- In addition, candidates sponsored by an industry/R&D organization are also considered. Sponsored candidates must have at least 60% marks in the qualifying examination and at least two years of work experience. GATE score is not mandatory for sponsored candidates.
- Intake capacity: 15 + 5 (sponsored)

3. Course structure and Syllabus

3.1 Name of the courses:

- **Core Courses**
 1. CE501 Sustainable Urban Planning
 2. CE503 Construction Technology and Management
 3. CE502 Infrastructure Economics
 4. CE504 Electrical and Mechanical Systems in Infrastructure Engineering
- **Elective Courses (Elective I)**
 1. CE505 Application of Probabilistic Methods in Engineering
 2. CE507 Numerical Analysis in Infrastructure Engineering
 3. SE503 Advanced Engineering Mathematics
- **Elective Courses (Elective II)**
 1. CE509 Applied Finite Element Method for Industries
 2. CE511 Structural Health Monitoring
 3. CE513 Introduction to Green Buildings
 4. CE515 Municipal Rules and By-laws
- **Elective Courses (Elective III)**
 1. CE517 Structural Dynamics
 2. CE519 Theory of Plates and Shells

3. CE521 Pre-stressed Concrete
4. CE523 Soil Exploration
5. CE525 Geotechnical Landfill Design and Maintenance
6. CE527 Advanced Soil Mechanics
7. CE529 Transport System Planning and Management
8. CE531 Highway Geometric Design
9. CE533 Water Transportation
10. CE535 Advanced Water Supply and Wastewater Engineering
11. CE537 Industrial Pollution Control and Prevention
12. CE539 Sanitation Techniques
13. CE541 Modernization of Water Distribution Systems
14. CE543 Hydraulic Machines
15. CE545 GIS in Infrastructure Engineering
16. CE547 Design of Intelligent Buildings and Cities

- **Elective Courses (Elective IV)**

1. CE506 Disaster Mitigation
2. CE508 Reliability Engineering
3. CE510 Environmental Impact Assessment

- **Elective Courses (Elective V)**

1. CE512 Introduction to Earthquake Engineering
2. CE514 Advanced Structural Analysis
3. CE516 Advanced Solid Mechanics
4. CE518 Elastic-Plastic Analysis of Structures
5. CE520 Analysis and Design of Foundations
6. CE522 Soil Dynamics
7. CE524 Special Topics in Geotechnical Engineering
8. CE526 Pavement Design, Maintenance and Management
9. CE528 Railway Engineering
10. CE530 Public Transportation Planning and Management
11. CE532 City Micro-drainage System
12. CE534 Planning and Design of Water Supply and Treatment Facilities
13. CE536 Solid and Hazardous Waste Management
14. CE538 Air Pollution Control Techniques
15. CE540 CFD for Multiphase Gravity flow

- **Elective Courses (Elective VI)**

1. CE542 Concrete Technology
2. CE544 Advanced Structural Design
3. CE546 Stability Analysis of Structures
4. CE548 Active and Passive Control of Structures
5. CE550 Inspection, Maintenance and Retrofitting of Foundation
6. CE552 Earthquake Resistant Design of Foundations
7. CE554 Ground Improvement and Reinforced Earth
8. CE556 Traffic Engineering and Highway Safety
9. CE558 Air Transportation
10. CE560 Auxiliary Water Supply System
11. CE562 Planning and Design of Sewerage and Sewage Treatment Facilities
12. CE564 Hazard Management in Water Distribution System
13. CE566 Physico-chemical Processes for Water and Wastewater Treatment
14. CE568 Water Harvesting, Conservation and Intelligent Control
15. CE570 Infrastructure Informatics

- **Lab Courses**

1. CE591 Infrastructure Engineering Lab-I
2. CE592 Infrastructure Engineering Lab-II

3.2 Course Curriculum:

1ST SEMESTER

Sl. no.	Course Number	Course Title	L	T	P	C
1	CE501	Sustainable Urban Planning	3	0	0	6
2	CE503	Construction Technology and Management	3	0	0	6
3	××5××	Elective-I	3	0	0	6
4	CE5××	Elective-II	3	0	0	6
5	CE5××	Elective-III	3	0	0	6
6	HS513	Technical Communication	2	0	0	4
7	CE591	Infrastructure Engineering Lab-I	0	0	6	6
8	CE593	Seminar-I	0	0	4	4
Sub Total			17	0	10	44

2ND SEMESTER

Sl. no.	Course Number	Course Title	L	T	P	C
1	CE502	Infrastructure Economics	3	0	0	6
2	CE504	Electrical and Mechanical Systems in Infrastructure Engineering	3	0	0	6
3	CE5××	Elective-IV	3	0	0	6
4	CE5××	Elective-V	3	0	0	6
5	CE5××	Elective-VI	3	0	0	6
6	CE592	Infrastructure Engineering Lab-II	0	0	6	6
7	CE594	Seminar-II	0	0	4	4
Sub Total			15	0	10	40

3RD SEMESTER

Sl. no.	Course Number	Course Title	L	T	P	C
1	CE601	Comprehensive Viva-voce				10
2	CE603	Thesis/Industrial Project Phase-I				40
Sub Total						50

4TH SEMESTER

Sl. no.	Course Number	Course Title	L	T	P	C
1	CEE602	Thesis/Industrial Project Phase-II				45
Sub Total						45

TOTAL CREDITS: 44+40+50+45 = 179

3.3 Detailed syllabus:

First Semester:

CE501 Sustainable Urban Planning

3-0-0-6

Concept of town planning with emphasis on the urban design; levels of planning and steps for preparation of a town plan, role of urban design in town planning process; Principles of Urban Conservation; Principles of Streetscape Design; Urban design regulations and control; 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. Analytical techniques in Town Planning and Urban Design; Regional and Metropolitan planning, Urban Design principles and criteria, Urban Scale and Spaces; land subdivision regulations and zoning, Design for the Pedestrians; Waterfront Development;

Texts/References:

- 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
- Peter Hall and M.Tewdwr-Jones, Urban and regional planning, Routledge, Fifth Edition, 2010

CE503 Construction Technology and Management

3-0-0-6

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 projects 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, 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, Introduction to project management software.

Texts / References:

- 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.
- J. Singh, Heavy Constructon-Planning, equipment and methods, Oxford & IBH Publishing Co. Pvt 1993.
- D.S. Berrie and B.c. Paulson, Professional construction management including C.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.
- Peurifoy, Robert L., Schexnayder, Clifford J., Shapira, Aviad & Schmitt, Robert L., (2011), Construction Planning, Equipment, and Methods*, 8th ed., McGraw-Hill.
- Chew, Yit Lin, (2009), Construction Technology for Tall Buildings, 2nd ed., World Scientific.

Probabilistic analysis and determination: i) Forces induced by earthquakes, ii) Forces induced by wind, iii) Forces induced by sea waves, iv) Load on vehicles induced through surface roughness of roads.

Methods of risk Analysis: Composite risk analysis; Direct integration method; Method using safety margin, reliability index and safety factor.

Introduction to reliability analysis: Application of Bayes theorem in real life problem; Reliability analysis of simple systems: serial, parallel and combined systems; First order uncertainty and reliability analysis (FORM), First order second moment (FOSM) and Advanced FOSM methods; Applications of risk and reliability analysis in engineering systems.

Application of probabilistic methods: i) Fluid-structure interaction, ii) Soil-structure interaction iii) Railways iv) Automobile industry, v) Offshore structure, vi) Hydraulic structure.

Texts / References:

- Scheaffer, R. L., Mulekar, M. S. and McClave, J. T., (2011): Probability and statistics for Engineers, Fifth Edition, Brooks / Cole, Cengage Learning.
- Ang, A. H-S., and Tang, W. H., (2006): Probability Concepts in Engineering, Volumes 1. John Wiley and Sons.
- Halder, A and Mahadevan, S., (2000): Probability, Reliability and Statistical Methods in Engineering Design, John Wiley and Sons.
- Rao, S.S., (1992): Reliability-Based Design, McGraw Hill, Inc.
- Harr, M.E., (1987): Reliability-Based Design in Civil Engineering. McGraw Hill, Inc.
- H. S. Ang and W. H. Tang, "Probability Concepts in Engineering Planning and Design", John Wiley, 1975.
- J. R. Benjamin and C. A. Cornell, "Probability Statistics and Decision for Civil Engineers", McGraw Hill, 1975.

CE507 Numerical Analysis in Infrastructure Engineering 3-0-0-6

Introduction, errors in numerical analysis. Solution of nonlinear algebraic equations. Solution of large systems of linear algebraic equations by direct and iterative methods. Introduction to matrix eigenvalue problems. Approximation of functions: interpolation, and least squares curve fitting; orthogonal polynomials. Numerical differentiation and integration. Solution of ordinary and partial differential equations, and integral equations; discrete methods of solution of initial and boundary-value problems. Examples are drawn from structural mechanics, geotechnical engineering, hydrology and hydraulics.

Texts/References:

- J.H. Wilkinson, The Algebraic Eigenvalue Problem, Oxford University Press, 1965.
- K.E. Atkinson, An Introduction to Numerical Analysis, J. Wiley and Sons, 1989.
- G.E. Golub and C.F. Van Loan, Matrix Computations, Johns Hopkins University Press, 1989.

SE 503 Advanced Engineering Mathematics 3-0-0-6

Introduction to Some Special Functions:

Gamma function, Beta function, Bessel function, Error function and complementary Error function, Heaviside's function, pulse unit height and duration function, Sinusoidal Pulse function, Rectangle function, Gate function, Dirac's Delta function, Triangular wave function, Half wave rectified sinusoidal function, Square wave function.

Fourier Series and Fourier integral:

Periodic function, Trigonometric series, Fourier series, Functions of any period, Even and odd functions, Half-range Expansion, Forced oscillations, Fourier integral.

Ordinary Differential Equations and Applications:

First order differential equations: basic concepts, Integrating factor, Linear differential equations, Bernoulli equations, Modeling: Free Oscillations, Euler- Cauchy Equations; Higher order linear differential equations, Higher order homogeneous with constant coefficient, Higher order non homogeneous equations.

Partial Differential Equations and Applications:

Formation PDEs, Solution of Partial Differential equations, Nonlinear PDEs first order, Some standard forms of nonlinear PDE, Linear PDEs with constant coefficients, Equations reducible to Homogeneous linear form, Classification of second order linear PDEs. Separation of variables use of Fourier series, D'Alembert's solution of the wave equation, Heat equation: Solution by Fourier series and Fourier integral.

Laplace Transforms and Applications:

Definition of the Laplace transform, Inverse Laplace transform, Linearity, Shifting theorem, Transforms of derivatives and integrals Differential equations, Unit step function Second shifting theorem, Dirac's delta function, Differentiation and integration of transforms, Convolution and integral equations, Partial fraction differential equations, Systems of differential equations

Texts/References:

- W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005).
- T.M.Apostol, Calculus , Volume-2 (2nd Edition) , Wiley Easter
- Advanced Engineering Mathematics (8th Edition), by E. Kreyszig, Wiley-India (2007).
- Engineering Mathematics Vol 2, by Baburam, Pearson
- R. V. Churchill and J. W. Brown, Fourier series and boundary value problems (7th Edition),McGraw-Hill (2006).

CE509 Applied Finite Element Method for Industries 3-0-0-6

Introduction: Continuum Mechanics, Conservation laws, Riemannian Geometry and stress- strain tensors, Constitutive equation, Potential-, Strain-, and Kinetic energies, Functionals and variational formulation, mathematical programming and weak solutions; Displacement method of FEM analyses.

Field equations: Elasticity, Structural Dynamics, Fluid Mechanics, electromagnetic fields

Alternative approaches: Hybrid FEM, Mixed FEM, Boundary Element Method, Boundary Error Element, Mesh-less methods, Galerkin's approach of error orthogonalization.

Error analyses: Algebraic and Integral inequalities; estimate of error; error bounds; Convergence, super-convergence,

Computer Packaging: Pre-, Post-processing and Turbo C, Analysis Programs in FRORTAN;

Applications (as per request): Rigid-flexible assembly (ME and Bio-Mechanics); Two-phase flow (ME & CE); Electro-magnetic application to wave-guides, MOSFET analyses (ECE); magnetic levitation (electrical), Vibration and control of quartz substrate using smart material; Stochastic FEM, etc.

Text / Reference Books:

- The Finite Element Method: Its Basis and Fundamentals, C. Zienkiewicz, R. L. Taylor, J.Z. Zhu; 6th Edition, 2005.
- Concepts and applications of finite element analysis, Robert Davis Cook.
- Lecture Notes.

CE 511 Structural Health Monitoring 3-0-0-6

Introduction: A systematic approach to planning and executing instrumentation, monitoring and condition assessment programs; strain measurements;

Instrumentation: Types of field measurements; Civil engineering sensors (static, dynamic, optical); environmental measurements; mechatronic sensors; Principles of instrumentation; Settlement gauges, Piezometers, earth pressure cells and inclinometers; Planning of instrumentation; Vibration measurements.

Analysis: Signal conditioning, information measurements and error analysis; business aspects; advanced-measurement systems.

Condition Assessment: Non-destructive testing, repair, rehabilitation, strengthening, high performance plain and fiber reinforced concrete, shotcrete, fiber reinforced polymer laminates, case studies.

Texts/References:

- John Dunnycliff, Geotechnical instrumentation for monitoring field performance, John Wiley, 1993

CE 513 Introduction to Green Buildings**3-0-0-6**

Concept of green building and energy efficient building, Advantages of green building, Components of green building, Design aspects of green building, Green building rating system, Understanding the rating system and accreditation process, Effect on the construction industry, Sustainability and economics of green building.

Texts / References:

- D. Mumovic and M. Santamouris (eds.), A Handbook of Sustainable Building Design and Engineering: An Integrated Approach to Energy, Health and Operational Performance, Earthscan, 2009.
- GRIHA Manual, Vol. I and II, MNRE and TERI, 2010.
- V. Bokalders and M. Block, The Whole Building Handbook: Healthy Buildings, Energy Efficiency, Eco-cycles and Place, Earthscan, 2009.

CE 515 Municipal Rules and By-laws**3-0-0-6**

Rural and urban society; Municipal and panchayet laws; Codes on building, roads, air traffic, railways, energy and electricity, water quality and utilization, sharing of resources, environmental legislations, ISO, Overview of valuation, Valuation techniques, Municipal rules and by-laws implications on valuation, Application of valuation techniques in infrastructure projects – Case studies, Construction laws, Laws of contracts, ADR, Minimum wages act, Workman compensation act, Arbitration.

Texts/References:

- Paul Pignataro, Financial Modeling and Valuation: A Practical Guide to Investment Banking and Private Equity, Wiley, 2013
- S. J. Titman and J. D. Martin, Valuation, Prentice Hall, 2010.
- Various National Codes/Legislations/Standards.

CE517 Structural Dynamics**3-0-0-6**

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

Texts/References:

- Dynamics of Structures: Theory and Applications to Earthquake Engineering, A. Chopra (Prentice Hall, 4th Edition)
- Dynamics of Structures, J. L. Humar (Balkema, 2002)
- Elements of Vibration Analysis, L. Meirovitch (McGraw-Hill, 1986) - Optional
- Dynamics of Structures, R. W. Clough and J. Penzien (McGraw-Hill, 1975) - Optional

CE519 Theory of Plates and Shells**3-0-0-6**

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

Texts/References:

- Szilard, R., Theories and applications of plate analysis : classical, numerical, and engineering methods, Hoboken, NJ : John Wiley, 2003.
- Timoshenko, S., and Kriger, S.W., Theory of Plates and Shells, McGraw-Hill, 1959.
- Ugural,A.C., Stresses in Pates 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. (e-book)

CE521 Pre-stressed Concrete Structures

3-0-0-6

Principles of prestressing - Materials of prestressing - Systems of prestressing - Loss of prestress - Deflection of Prestressed Concrete members.

Slabs - Pre-tensioned and Post-tensioned beams - Design for flexure, bond and shear – IS code provisions Ultimate flexural and shear strength of prestressed concrete sections - Design of end anchorage zones using IS code method.

Composite beams - Analysis and design.Partial prestressing - non-prestressed reinforcements.

Analysis of Continuous beams - Cable layout - Linear transformation - Concordant cables.

Design of compression members and tension members.Circular prestressing - Water tanks - Pipes - Analysis and design - IS Codal provisions.

Texts/References:

- Lin. T.Y., Burns, N.H., Design of Prestressed Concrete Structures, John Wiley & Sons, 1982.
- RajaGopalan N. Prestressed Concrete, Narosa Publishing House, New Delhi, 2002.
- Prestressed Concrete, A Fundamental Approach. Edward G. Nawy. 5th Edition Update ACI, AASHTO, IBC 2009 Codes Version. Prentice Hall
- Prestressed Concrete Analysis and Design, Naaman, 2nd Edition, Techno Press 3000, 2004
- N. Krishna Raju, Prestressed Concrete, Tata Mc Graw Hill Publishing Co. Ltd, New Dehi.
- S K Mallick, A P Gupta, Prestressed concrete, Oxford and IBI Series.
- R. H. Evans, Bennet E W, Prestressed concrete theory and design, Chapman and Hall, London.

CE 523 Soil Exploration

3-0-0-6

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.

Texts/References:

- 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.

CE 525 Geotechnical Landfill Design and Maintenance

3-0-0-6

Regulatory and legal issues, site selection and assessment, geotechnical-subsurface investigation

Clay mineralogy and clay-water-electrolyte system, linear and leachate-control-systems design, stability of landfill slopes, cover design, Construction and operation, final use and remediation design. Long-term care of landfills, Management of wastes generated from landfill, gas movement, control, and uses, leachate control and treatment, Disposal of hazardous and special wastes

Texts/References:

- X. Qian, R. M. Koerner and D. H. Gray, Geotechnical Aspects of Landfill Design and Construction, Prentice Hall, 2001.

CE 527 Advanced Soil Mechanics

3-0-0-6

Introduction: Geotechnical / Geoenvironmental Engineering

BASIC CONCEPTS FROM SOLID MECHANICS: Stress and Stress Transformation, Stress Invariants, Total and effective Stresses in Soils, Equilibrium equation, Strains, Strain Transformation, Strain Compatibility, Constitutive Equation

Nature of Soil: Soil Composition, Index Properties, Soil Classification, Soil Structure: Clay-Water Forces, Intertparticle 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

Texts/References:

- Budhu, M (2002). Soil Mechanics and Foundations, John Wiley & Sons.
- H. Y. Fang and J. L. Daniels, Introductory Geotechnical Engineering, Taylor & Francis, 1st Indian edition, 2011.
- Duncan, J.M. & Wright, S.G (2005). Soil Strength and Slope Instability, John Wiley & Sons.
- Wood, D.M (2004). Geotechnical Modeling, Spon Press.
- Prevost J.H. and R. Popescu, "Constitutive Relations for Soil Materials", Electronic Journal of Geotechnical Engrng., ASCE, 1996.

CE 529 Transportation System Planning and Management

3-0-0-6

Advanced Traffic Management and Traveler Information Issues; Definition of intelligent transport system (ITS), The historical context of ITS from both public policy and market economic perspectives; Elements of Vehicle Location and Route Navigation and Guidance concepts; Traffic signal control; traffic management and surveillance (e.g., ramp metering); incident management; electronic toll collection; traveller information; transit management; commercial vehicle operations; vehicle control technologies; Planning and human factor issues for ITS; ITS Models and Evaluation Methods.

Texts / References

- Joseph S. Sussman, Perspectives on Intelligent Transportation Systems (ITS), Springer, 2005.
- Asad J. Khattak, Haitham Al-Deek, Intelligent Transportation Systems: Planning, Operations, and Evaluation, CRC press, 2014.
- Intelligent Transportation Primer, Institute of Transportation Engineering, Washington, D.C., 2000.

CE 531 Highway Geometric Design 3-0-0-6

Introduction and roadway function, Design controls: vehicles and drivers, Design controls: speed, volume and access, Route layout, Design of roadway cross-section, Estimate earthwork volumes. Calculate required sight distances for road segments and intersections, Design of vertical curves and horizontal curve. Environmental considerations, and context sensitive solutions, Sight distance, horizontal and vertical alignment, Intersection design considerations Earthwork Supplemental, Safety assessment tools.

Texts / References

- American Association of State Highway and Transportation Officials (AASHTO), *A Policy on Geometric Design of Highways and Streets*, 5th Edition, 2004.
- Federal Highway Administration (FHWA), U.S. Department of Transportation, *Flexibility in Highway Design*, Publication Number FHWA-PD-97-062, 1997

CE 533 Water Transportation 3-0-0-6

Water Transportation: Basic elements of water transport, Water Transport Operations, Major and Minor Ports of India, Functions of Port Trust, Classes of harbours, desirable features of harbour site, planning and design of port facilities; Water Traffic, Inland water Transport, Commercial and Economic aspects of Water Transport. Role of Water Transport in Industry, trade and commerce, Pipeline transportation systems: need and planning.

Texts / References

- Mary Richardson. *The Water Transportation Career Guide*, 2011

CE 535 Advanced Water Supply and Wastewater Engineering 3-0-0-6

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.

Texts:

- H. S. Peavy, D. R. Rowe and George Tchobanoglous, *Environmental Engineering*, McGraw-Hill International Ed., 1985.
- T. J. McGhee, *Water Supply and Sewerage*, McGraw-Hill Inc., 1991.

References:

- M. L. Davis and D. A. Cornwell, *Introduction to Environmental Engineering*, McGraw-Hill, Inc., 1991.
- Metcalf & Eddy, *Wastewater Engineering- Treatment and Reuse* (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill, 4th Edn., 2004.
- C. N. Sawyer, P. L. McCarty and G. F. Parkin, *Chemistry for Environmental Engineers*, McGraw- Hill, 1994.
- APHA, *Standard Methods Examination of Water and Wastewater*, American Public Health Association, Washington DC, 1995.

- *Manual for Sewer and Sewerage*, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1993.
- *Manual for Water Supply and Treatment*, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1999.

CE 537 Industrial Pollution Control and Prevention 3-0-0-6

Types of industries and industrial pollution, Introduction to industrial waste, Types of industrial wastes, Hazardous waste, Environmental standards and legislations; Pollution prevention and cleaner production, Source reduction, recycling, and treatment, Pollution prevention assessments; Waste treatment techniques, Physico-chemical techniques, Biological treatment techniques, Concept of ETP and CETP, Concept of zero discharge; Industrial products and materials; Energy efficiency and clean energy; Industry environmental programs and performance; Environmental audit, Environmental management plan, Introduction to ISO and ISO 14000, Communicating pollution prevention and reporting; Case studies - Sugar, Distillery, Dairy, Tannery, Textile, Fertilizer, Pulp and paper, Refinery, Iron and steel, Metal plating, Thermal power plants, etc.

Text/References:

- Eckenfelder Jr., W.W., *Industrial Water Pollution Control*, 3rd Edition, McGraw-Hill, 2000.
- 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 McGrawHill, 2004.
- Wise, D.L. and Trantolo, D.J. (eds.), *Process Engineering for Pollution Control and Waste Minimization*, 1st Edition, Marcel Dekker, 1994.

CE 539 Sanitation Techniques 3-0-0-6

Building drainage system, Conventional water-borne sanitation – merits and demerits, Sanitary/sewage discharge standards and regulations, Sanitation in isolated unsewered areas, Septic tanks, Imhoff tanks and their effluent disposal, Design of septic tank and Imhoff tank, Ecological sanitation (EcoSan), Dry toilet, Vacuum toilet, Zero discharge toilet, Rural sanitation, Public sanitation infrastructures.

Texts/References:

- D.D. Porto and C. Steinfeld, *The Composting Toilet System Book: A Practical Guide to Choosing, Planning and Maintaining Composting Toilet Systems*, Ecowaters Books, 2000.
- J.A. Salvato, *Environmental Sanitation*, Wiley, 1958.
- A. Rosemarin, Jennifer R. McConville, Amparo E. Flores, and Zhu Qiang, *The Challenges of Urban Ecological Sanitation: Lessons from the Erdos Eco-Town Project, China*, Practical Action, 2012.

CE 541 Modernization of Water Distribution System 3-0-0-6

Conventional city water distribution system – merits and demerits, Risk and hazard assessment of Conventional water distribution system, Building and managing an Intelligent City – Overview, Intelligent city infrastructures and services, Requirements of intelligent water distribution system, Innovative techniques for collection of large-scale and continuous smart meter data, Integration of data for real-time analysis and decision making, Integrated pumping strategies for minimal pumping costs and carbon emissions, Deployment sensing system for informed decision making in intelligent urban water systems, Smart solutions of retrofitting and modernization of existing distribution system for intelligent city, Socio-economic considerations, Case studies.

Texts/References:

- C. J. Lim, and Ed Liu, *Smart cities and Eco-Warriors*, Routledge, 1st ed., 2010.
- Lecture Slides and/or Handouts.

CE543 Hydraulic Machines**3-0-0-6**

Water intake wells—Estimate of power-- Analysis of distribution system—power required for driving the network—location of booster pumps—maintenance and replacement theory.

Texts/References:

- G. I. Krivchenko, Hydraulic machines: turbines and pumps, Lewis Publishers,1994
- D. Rama Durgaiyah Fluid Mechanics and Machinery, New Age International, 2007
- Banga & Sharma, Hydraulic Machines, Khanna Publishers, 1983

CE545 GIS in Infrastructure Engineering**3-0-0-6**

Elementary concepts of GIS; Introduction to GIS; History and Early developments of GIS; Benefits of GIS; Georeferencing and Projection; Data Models and Data Structures; Urban applications of GIS; applications of GIS in the planning and management of urban transportation systems; fleet management-Automatic Vehicle Location (AVL); Application of GIS in Analytical Modelling-Simulation- and Spatial Decision-Support Systems; Applications of RS and GIS in optimal routing of solid wastes collection system of an urban area, zoning atlas development and impact of land use and land cover change on environment; Re-modelling of water distribution and sewer network systems using GIS; GIS for sustainable land use urban development planning, rivers, lakes and coastal areas; Groundwater vulnerability modelling using GIS, environmental degradation and soil erosion of catchment, reservoir capacity and sedimentation.

Texts / References:

- Heywood I, Cornelius S.,and Carver,S. (1998) An Introduction to Geographical Information Systems, Longman pub., 279 pp.
- Aronoff, S. (1991) Geographic Information Systems: A management Perspective, WDL Publications, Canada.
- Longley, P.A., Goodchild,M.F., Maguire,D.J. and Rhind,D.W (eds) (1999) Geographic Information Systems, Volumes 1 & 2, Wiley pub.

CE 547 Design of Intelligent Buildings and Cities**3-0-0-6**

Components of urban forms and their planning. Concepts of neighbourhood unit. Street system and layout in a neighbourhood. Functional planning of buildings, optimization of space: Spatial Synthesis graphical techniques, heuristic procedures, formulation of linear and non-linear optimization problem. Space requirements and relationships for typical buildings, like residential offices, hospitals, etc. Standard fire, fire list, fire resistance, classification of buildings, means of escape, alarms, etc. Engineering services in a building as a systems. Lifts, escalators, cold and hot water systems, wastewater systems, and electrical systems. Building Maintenance: Scheduled and contingency maintenance planning. M.I.S. for building maintenance. Maintenance standards. Economic maintenance decisions.

Texts/References:

- S. Wang, Intelligent Buildings and Building Automation, Taylor & Francis, Spon Press, 1st ed., 2010.
- Albert Ting-Pat So, and W. L. Chan, Intelligent Building Systems, Springer, Kluwer Academic Publishers group, 1999.

Second Semester:

CE 502 Infrastructure Economics

3-0-0-6

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.

Texts/References:

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

CE504 Electrical and Mechanical Systems in Infrastructure Engineering

3-0-0-6

General overview of electricity demand and supply: Energy requirement and consumption in building, Electrical load calculations for home appliances, AC and DC Supply, Electrical wiring – single phase and three phase.

Structure and Operation of Modern Power Systems: Introduction to generation, transmission and distribution systems, Technical and commercial aspects, Power System Components: Generators, Transmission lines, Transformers, Laying of underground distribution system.

Load Flow Studies: Nonlinear numerical techniques, Gauss-Seidel method, Newton's method, Convergence criteria, Classification of buses, Load flow studies.

Voltage stability. Introduction to FACTS Controllers: Development and application, Shunt, Series and Shunt-Series controllers.

Heavy machineries: Excavators, shovels, Earth movers, compactors, trucks and dumpers; Batching plants, Concrete pumps, Cranes, Tower cranes, winches and ropeways; Lifts, escalators, vibrators; Pile rigs, rock drills, ell and caisson shuttering, Scaffolding; Pumps, Blowers, Pre-stressing jacks, grouting and pressure grouting pumps;

HVAC System, Basics of air-conditioning and central air-conditioning system, Duct Design: Design considerations and procedures.

Energy requirement and consumption, load calculation for heavy machineries.

Texts / References:

- N. Jenkins, J.B. Ekanayake, G. Strbac, Distributed Generation, IET, Renewable Energy Series, 2010
- Gilbert M. Masters, Renewable and Efficient Electric Power Systems, Wiley, 2004.
- J. J. Grainger and W.D. Stevenson Jr., Power System Analysis, Tata McGraw-Hill, (1994)
- D. P. Kothari and I.J. Nagrath, Modern Power System Analysis, Tata McGraw-Hill, Third Edition, (2003)
- A. J. Wood and B.F. Wollenberg, Power Generation Operation and Control, Wiley India Edition, Second Edition, (2003)
- M. A. Pai, Computer Techniques in Power System Analysis, Tata McGraw-Hill, Second Edition, (2006)
- Frank Harris, Modern construction and ground engineering equipment and methods, Longman Scientific & Technical, 1994.
- R.J.Dossat, Principles of Refrigeration, Pearson Education (Singapore) Pte. Ltd. , 2008.
- A. Ameen, Refrigeration and Air Conditioning, Prentice Hall of India Private Limited, New Delhi. 2006.

CE 592 Infrastructure Engineering Laboratory-II

0-0-6-6

Concrete mix design, casting and testing of cubes and cylinders, Experiments to illustrate buckling of structural members; load-deformation behaviour of beams, columns, joints, and frames under various loads, mode shapes, natural frequency, damping factors from free and forced vibrations, shake table tests.

California bearing ratio; Dynamic cone penetration test; Evaluation of Bitumen for various properties, Bitumen ductility test; Viscosity of bitumen; LA abrasion testing; direct shear testing of soils; Plate load test; Triaxial Test, Compaction Properties of soil.

Texts/References:

- Salient Indian Standard Codes
- David, Troxell, Inspection and Testing of Engineering Materials, Wskocil.
- S. K. Khanna and C. E. G. Justo, Highway Engineering, Nem Chand Bros., 2002.
- D. Fratta, J. Aguetant, and L. R. Smith, Soil Mechanics Laboratory Testing, Boca Raton, CRC Press, USA, 2007.

CE 506 Disaster Mitigation

3-0-0-6

Definitions, types of hazards, natural and manmade disasters, impact, causes and effects, damages, coping mechanism and relief assistance, disaster continuum, preparedness, prevention, mitigation, warning and management, vulnerability assessment, rehabilitation and reconstruction after disasters, pre disaster planning (for earthquakes, cyclones, floods, draught and famine), disaster resistant constructions, nonstructural and structural mitigation measures, guiding principles of mitigation, education and training for disasters, disaster case studies, computer use in disaster scenario development.

Texts / References:

- R.B. Singh (Ed) Disaster Management, Rawat Publication, New Delhi, 2000
- P. Sahni, A. Dhameja, U. Medury. Disaster Mitigation: Experiences And Reflections. PHI Learning Private Limited, 2013.
- R. Anand, N. C. Jana and S. Singh.. Disaster Management And Sustainable Development. Pentagon Press, 2009.
- H.K. Gupta (Ed) Disaster Management, Universiters Press, India, 2003
- R.K. Bhandani An overview on Natural & Manmade Disaster & their Reduction, CSIR, New Delhi
- M. C. Gupta Manuals on Natural Disaster management in India, National Centre for Disaster Management, IIPA, New Delhi, 2001.

CE508 Reliability Engineering

3-0-0-6

Concepts of structural safety; Basic statics and probability; Resistance parameters and distributions; Probabilistic analysis of loads, live load and wind load; Determination of reliability; Monte Carlo study of structural safety; Level 2 reliability methods including advanced level 2 method; Reliability analysis of components; Reliability based design-determination of partial safety factors, code calibration; Reliability of structural systems; Applications to steel and concrete structures

Texts/References:

- Palle Thoft Christensen and M.J. Baker, Structural Reliability Theory and its Application, Springer-Verlag, Berlin Haidelberg, New York, 1982.
- R.E. Melchers, Structural Reliability Analysis and Prediction, Ellis Horwood, Chisester, England, 1987.
- A.H.S. Ang and W.H. Tang, Probability Concepts in Engineering Planning and Design, Vol. II, John Wiley, New York, 1984.
- Palle Thoft Cristensen and Y. Murotsu, Applications of Structural Systems Reliability Theory, Springer-Verlag, Berlin, 1986.

CE510 Environmental Impact Assessment

3-0-0-6

Evolution of EIA: Concepts of EIA, EIA methodologies, Screening and scoping, Rapid EIA and Comprehensive EIA, General Framework for Environmental Impact Assessment, Characterization and site assessment. Environmental Risk Analysis, Definition of Risk, Matrix Method. Checklist method, Fault free analysis, Consequence Analysis, Socio-economic aspects, measures of effectiveness of pollution control activities, Environmental Legislation, Introduction to Environmental Management Systems, Initial environmental examination (IEE), environmental impact statement

(EIS), Environmental statement procedures, environmental appraisal, Environmental Audit: Cost Benefit Analysis, Life cycle Assessment, Resource Balance, Energy Balance & Management Review, Operational Control, Case studies on EIA.

Texts/References:

- 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.
- Larry Canter, Environmental Impact Assessment, McGraw-Hill, 1995.
- Various EIA Reports

CE512 Introduction to Earthquake Engineering

3-0-0-6

Causes of earthquakes and seismic waves, Magnitude, intensity and energy release, Characteristics of earthquakes, Liquefaction; Seismic risk; EQ response of structures, Single-degree-of freedom dynamics, Concept of response spectra and 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

Texts/References:

- 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.
- Wiegel R.L., 'Earthquake Engg.', Prentice Hall, 1970.
- Blume J.A., Newmark N.M., Corning L.H., 'Design of Multi-storied Buildings for Earthquake ground motions', Portland Cement Association, Chicago, 1961.
- Proc. World Conferences on Earthquake Engg., 1956-1992.
- I.S. Codes No. 1893, 4326, 13920 etc.

CE514 Advanced Structural Analysis

3-0-0-6

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- Δ effect, buckling of frames, tension structures; Material nonlinear analysis of frames: basics of plasticity, distributed plasticity & lumped plasticity, incremental nonlinear analysis.

Texts/References:

- Matrix Structural Analysis. William McGuire, Richard H. Gallagher and Ronald D. Ziemian by Wiley

CE516 Advanced Solid Mechanics

3-0-0-6

Linear elasticity; Stress, strain, constitutive relations; Boundary conditions; Description of an Elasticity problem as a boundary value problem; Plane stress, strain, axi-symmetric problems; Large displacements and large strains; Cartesian, cylindrical and spherical coordinates; Introduction to curvilinear coordinates; Thermal strains.

Introduction to plasticity; Yield condition; Ideal elasto-plastic material; Complete formulation for an elasto-plastic problem.

Texts/References:

- N. Filonenko-Borodich, 'Theory of Elasticity, Mir Publishers, Moscow, 1965.
- S.P. Timoshenko and J. N. Goodier, 'Theory of Elasticity', 3rd ed., McGraw-Hill, Singapore, 1970.
- C.R. Calladine, 'Plasticity for Engineers', Ellis Herwood, Chichester, U.K., 1985

CE518 Elastic-Plastic Analysis of Structures

3-0-0-6

Introduction, Elastic and Plastic Behaviour, Yield condition and concepts of simple plastic collapse idealization, collapse criteria, virtual work in the elastic-plastic state; Theorems of plastic collapse; Methods of analysis and design; Applications to planar and simple space structures; Deflection at collapse; Minimum weight analysis; Variable repeated loads; Combined stress problems; Introduction to stability.

Texts/References

- J.F. Baker, M.R. Home and J. Heyman, Steel Skeleton, Vol. II, Cambridge Univ. Press., London.
- B.G. Neal, Plastic Methods of Structural Analysis, Chapman and Hall.
- P.G. Hodge (Jr.), Plastic Analysis of Structures, McGraw-Hill, 1959.

CE520 Analysis and Design of Foundations

3-0-0-6

Evaluation and interpretation of soil properties, engineering properties of soil, geophysical and seismic methods, Stress in soil mass due to applied load, various methods of settlement analysis, 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, static and dynamic earth pressure theories, stability analysis of retaining walls, reinforced earth wall design, 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

Texts/References:

- J.E. Bowles, Foundation Analysis and Design, McGraw-Hill, 2001.
- 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.
- Gopal Ranjan, and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International Publishers, 2nd Edition 2000.

CE522 Soil Dynamics

3-0-0-6

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.

Texts / References:

- S. Prakesh & V. K. Puri, Foundation for machines, McGraw-Hill 1993
- B. M. Das and G. V. Ramana, Principles of Soil Dynamics, 2nd edition, Cengage Learning, 2011
- Srinivasulu, P & Vaidyanathan, Hand book of Machine Foundations, McGraw-Hill, 1996
- Swami Saran, "Soil Dynamics and Machine Foundations", Galgotia Publications Pvt. Ltd, 1999
- Kramar S.L, "Geotechnical Earthquake Engineering", Prentice Hall International series, Pearson Education (Singapore) Pvt. Ltd.
- Kameswara Rao, "Dynamics Soil Tests and Applications", Wheeler Publishing, New Delhi, 2003
- Kameswara Rao, "Vibration Analysis and Foundation Dynamics", Wheeler Publishing, New Delhi, 1998.
- IS code of Practice for Design and Construction of Machine Foundations, McGraw-Hill, 1996
- Moore P.J., "Analysis and Design of Foundation for Vibration", Oxford and IBH, 1995.

CE 524 Special Topics in Geotechnical Engineering

3-0-0-6

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)

Texts / References:

- J.E. Bowles, Foundation Analysis and Design, McGraw-Hill, 2001.
- J.E. Bowles, "Engineering Properties of Soils and Their Measurement", McGraw-Hill, 1992.
- Campanella, R.G., Field methods for dynamic geotechnical testing: An overview of capabilities and needs. Symp. on Dynamic Geotech. Testing II, pg. 3-23, San Francisco, CA, 1994.
- D.P. Conduto, "Geotechnical Engineering - Principles and Practice", Prentice Hall, 1999.
- B.M. Das, "Principles of Geotechnical Engineering",.
- B.M. Das, "Principles of Foundation Engineering",.
- Das, B.M., Fundamentals of Soil Dynamics. Elsevier, 1996.
- R.D. Holtz and W.D. Kovacz, "An Introduction to Geotechnical Engineering", Prentice Hall, 1981.
- Ishihara, K., Liquefaction and flow failure during earthquakes, Geotechnique, 43(3):351-415, 1993.
- Lambe, T.W and Whitman, R.V., Soil mechanics, SI version, 1979.

CE 526 Pavement Design, Maintenance and Management

3-0-0-6

Pavement types: Flexible Rigid and Composite pavements;

Design factors: wheel loads, environment, materials, failure criteria, reliability; Pavement performance and serviceability; Surface friction; Pavement distresses; Characterization of roadbed

design considerations for pumps, Hydraulics of treatment plant, hydraulic profile through the treatment plant, Planning and design of city water supply system.

Texts/References:

- J. M. Montgomery, *Water Treatment Principles and Design*, John Wiley & Sons, 1985
- H. S. Peavy, D. R. Rowe and G. Tchobanoglous, *Environmental Engineering*, McGraw-Hill International Ed., 1985.
- T. J. McGhee, *Water Supply and Sewerage*, McGraw-Hill, Inc, 1991.
- *Manual for Water Supply and Treatment*, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1999.

CE 536 Solid and Hazardous Waste Management

3-0-0-6

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.

Texts/References:

- P. A. Vesilind, W. A. Worrel and D. R. Reinhart, *Solid Waste Engineering*, Thomson Brooks/Cole, First Edition, 2002.
- G. Tchobanoglous, H. Theisen, and S.A. Vigil, *Integrated Solid Waste Management: Principles and Management Issues*, McGraw Hill Book Company, Singapore, 1993.
- M. LaGrega, P. Buckingham, and J. Evans, *Hazardous Waste Management*, McGraw Hill, 2000.
- Charles A. Wentz, *Hazardous Waste Management*, McGraw-Hill, 1995.

CE 538 Air Pollution Control Techniques

3-0-0-6

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.

Texts/References:

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

CE540 CFD for Multiphase Gravity Flow

3-0-0-6

Introduction to Computational Fluid Dynamics and Principles of Conservation: Continuity Equation, Navier Stokes Equation, Energy Equation and General Structure of Conservation Equations, Classification of Partial Differential Equations and Physical Behaviour, Approximate Solutions of Differential Equations: Error Minimization Principles, Variational Principles and Weighted Residual Approach, Fundamentals of Discretization: Finite Element Method, Finite Difference and Finite Volume Method, Finite Volume Method: Some Conceptual Basics and Illustrations; Construction of geometry and discretization using Gambit-Fluent's manuals; Commercial CFD solvers; Turbulence modeling; Implementation of boundary conditions; Introduction to multiphase flow; Customizing commercial CFD solver; Unsteady state simulations.

Review of conservation laws for mass, momentum, energy— Pipe flow network-- Open channel hydraulics—sediment transportation models—shallow channel flow—flow through open conduits—critical flow—Navier Stokes-equation for multiphase flow

Texts/References:

- Anderson, J.D., “Computational Fluid Dynamics: The Basics with Application” McGraw-Hill Co. Inc.
- Ferziger, J.H. and Peric, M., “Computational Methods for Fluid Dynamics”, Springer.
- Versteeg, H.K. and Malalasekera, W., “ An Introduction to Computational Fluid Dynamics: The Finite Volume Method”, Prentice-Hall Inc.
- S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill.
- T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
- H. K. Versteeg & W. Malalasekera, An Introduction to Computational Fluid Dynamics, Longman Scientific & Technical.
- J. H. Ferziger and M. Peric, Computational Methods for Fluid Dynamics, Springer.
- John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis.
- John D. Anderson Jr, Computational Fluid Dynamics, McGraw Hill Book Company.
- J. Blazek, Computational Fluid Dynamics:Principles and Applications, Elsevier.
- Dale A. Anderson, John C. Tannehill and Richard H. Platcher.. Computational Fluid Mechanics and Heat Transfer; McGraw Hill Book Company.
- K. Muralidhar and T. Sundarajan.. Computational Fluid Flow and Heat Transfer, Narosa Publishing House.
- W.F.Ames.. Numerical Method for Partial Differential Equation, Academic Press.
- C.A.J. Fletcher.. Computational Techniques for Fluid dynamics: Vol – I & II, Springer-Verlag, Berlin.

CE542 Concrete Technology

3-0-0-6

Fundamental of concrete - constituents, proportioning, mixing, transportation, placing and curing; Properties of fresh and hardened concrete.

Concrete and the environment: interaction; Mechanisms of degradation of concrete structures. Damage identification and prevention strategies. Codal provisions for durability; Nondestructive testing; repair/rehabilitation of structures.

Texts/References:

- Concrete - Microstructure, Properties And Materials, Pk Mehta And Pjm Monteiro, McGraw-Hill Book Company.
- Properties Of Concrete, Am Neville, Elbs Longman.
- Neville, A.M., "Properties Of Concrete", Pitman. 1983.
- Brandt, A.M., "Cement Based Composites: Materials, Mechanical Properties And Performance", E & Fn Spon. 1995.
- Mehta, P.K., "Concrete Structure, Material And Properties" Prantice Hall Inc.1986.
- Newman, John & Choo, Ban Sang. "Advanced Concrete Technology - Constituent Materials" Elsevier 2003.

CE544 Advanced Structural Design

3-0-0-6

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; Strengthening of masonry buildings

Design of reinforced concrete structures: methods of design - WSD, LSD, ULD, LRFD, review of LSD - flexure, axial-flexure, shear, torsion; 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 - slenderness ratio of columns, local buckling of

flanges and web bracing of column about weak axis. Method of design - allowable stress design, plastic design, load and resistance factor design; 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

Texts/References:

- S.U. Pillai and D. Menon, "Reinforced Concrete Design", Tata McGraw Hill, 3rd Edition.
- M.L. Gambhir, "Fundamentals of Reinforced Concrete Design", Prentice Hall of India Private Limited, 2006.
- MacGregor, J.G., and Wight, J.K., (2005), Reinforced Concrete Mechanics and Design, Pearson Prentice Hall, New Jersey.
- T. Paulay and M.J.N. 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.

CE546 Stability Analysis of Structures

3-0-0-6

Criteria for design of structures: stability, strength, and stiffness; Classical concept of stability; Stability of discrete systems: linear and nonlinear behaviour; Stability of continuous systems: stability of columns: axial–flexural buckling, lateral bracing of columns, combined axial-flexural-torsion buckling; Stability of frames: member buckling versus global buckling, slenderness ratio of frame members; Stability of beams: lateral-torsion buckling; Stability of plates: axial flexural buckling, shear flexural buckling, buckling under combined loads; Introduction to inelastic buckling and dynamic stability

Texts/References:

- Don O., Brush and B.O. Almorh, Buckling of Bars, Plates and Shells, McGraw-Hill, 1975.
- S.P. Timoshenko and J.M. Gere, Theory of Elastic Stability, 2nd Ed., McGraw-Hill, 1961.
- Chajes, Principles of Structural Stability Theory, Prentice Hall, 1974.

CE548 Active and Passive Control of Structures

3-0-0-6

Basics of vibration, Overview of Vibration Control, Factors affecting vibration level, Dynamic Properties and Selection of Materials, Dynamic Vibration Absorbers, Vibration isolation of single degree of freedom systems, Principles of Passive Vibration Control, Principles of Active Vibration Control

Texts/References:

- Principles of Vibration Control, A. K. Mallik, Affiliated East-West Press, 1990
- Vibration Control of Active Structures, A Premount, Springer; 2011

CE 550 Inspections, Maintenance and Retrofitting of Foundation

3-0-0-6

Assessment of damage and deterioration of structures by NDT and other techniques, Cause of deterioration; Environmental aspects and loading aspects, Repair and strengthening of superstructure – structural components, Load bearing wall, Panel walls, Strengthening of foundation, Grouting, Shotcreting, Under pinning, Monuments and historical structures, Prevention of water leakage in structure, Underwater repair, Retrofitting of buildings by seismic base isolation and supplemental damping; Retrofitting of heritage structures; Retrofitting of bridges

Texts/References:

- Pankaj Agrawal & Manish Shrikhande, Earthquake Resistant Design of Structures, Prentice Hall India.
- Duggal S. K., Earthquake Resistant Design of Structures, Oxford University Press 2007

CE 552 Earthquake Resistant Design of Foundations 3-0-0-6

Seismic hazard, Engineering seismology, Wave propagation, Dynamic Soil Properties, Dynamic bearing capacity, Seismic design of foundation, Seismic slope stability, Dynamic earth pressure, Seismic design of retaining structure, Liquefaction, Design of machine foundation, Soil improvement techniques, Seismic design codes for foundation design.

Texts / References:

- S.L. Kramer, Geotechnical Earthquake Engineering, Prentice Hall, 1996.
- V. N. S. Murthy, Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, CRC Press, Taylor & Francis Group, First Indian Reprint, 2010.
- H. G. Poulos, and E. H. Davis, Pile Foundation Analysis and Design, Krieger Pub Co., 1990.
- Gopal Ranjan, and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International Publishers, 2nd Edition 2000.
- R. F. Craig, Craig's Soil Mechanics, Taylor & Francis Group, 7th Edition, 2004.
- K. Terzaghi, R. B. Peck and G. Mesri, Soil Mechanics in Engineering Practice, John Wiley & Sons, 1996.
- J.E. Bowles, Foundation Analysis and Design, McGraw-Hill, 2003.

CE 554 Ground Improvement and Reinforced Earth 3-0-0-6

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

Geo-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, LDPE and HDPE strips, as reinforcing material.

Texts/References:

- Nihar R Patra, "Ground improvement Techniques", Vikas Publishing House pvt Ltd., First Edition 2012.
- Koerner, R.M. "Designing with Geosynthetics", Prentice Hall, New Jersey, USA, 4th edition, 1999.
- Jewell, R.A., "Soil Reinforcement with Geotextiles", Special Publication No. 123, CIRIA, Thomas Telford. London, UK, 1996.
- Geosynthetics - New Horizons, Eds. G.V. Rao, PK Banerjee, J.T. Shahu, G.V. Ramana, Asian Books Private Ltd., New Delhi, 2004.

CE 556 Traffic Engineering and Highway Safety 3-0-0-6

Fundamentals of traffic flow, traffic flow characteristics, statistical distributions of traffic flow parameter, traffic stream models, car following models, continuum follow models, traffic flow models for intersections, network flow models and control, traffic simulation. Theory and application of concepts in traffic signal systems control, signal timing design, signal cabinet components, signal controllers, traffic signal theory and control, vehicle detection technologies, communication methods. Highway safety; Driver behaviour and crash causality; Elements of highway safety management systems; Safety countermeasures; 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.

Traffic Stream Characteristics; Capacity Analysis - Basic Freeway Segment; Capacity Analysis - Ramps and Weaving Areas; Shockwave Analysis; Capacity and Delay at Signalized Intersection; Signalized Intersection Capacity Analysis; Isolated Traffic Signal Optimization Approaches; Coordinated Traffic Signal Optimization -Manual Calculation

Texts / References:

- 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.

CE558 Air Transportation 3-0-0-6

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.

Texts/References:

- S.C. Rangwala. "Airport Engineering",. 13th edition, Charotar Publishing house, 2013.
- Priyani Vb and Priyani Vb. "Highway and Airport Engineering", Charotar Publishing house, 1979.

CE 560 Auxiliary Water Supply System 3-0-0-6

Major water supply system- auxiliary system: volume estimate for fire fighting, treated sewage, solar heater, gardening—mass balance.

Texts/References:

- Essentials of Fire Fighting IFSTA; 6th edition (2013)
- James Angle, Occupational Safety and Health in the Emergency Services Cengage Learning; 3 edition, 2012

CE 562 Planning and Design of Sewerage and Sewage Treatment Facilities 3-0-0-6

Wastewater source and characteristics, Effluent discharge standards, Wastewater treatment concept, Fundamentals of process kinetics, Zero order, First order, Second order reactions, Enzyme reactions, Reactor analysis, Completely mixed batch reactor, Continuous flow stirred tank reactor, Plug flow reactor, Design of sewer and sewerage systems; Design of preliminary and primary unit operations, Design of secondary and biological unit operations, Design of advanced unit operations, Design of wastewater pumping facility, Design of sludge handling units, Hydraulics of wastewater treatment plant, Complete design of city sewage treatment plant (STP).

Texts/References:

- Manual for Sewer and Sewerage, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1993.
- Metcalf & Eddy, *Wastewater Engineering- Treatment and Reuse* (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill, 4th Edn., 2004.
- S. J. Arceivala and S. R. Asolekar, *Wastewater Treatment for Pollution Control and Reuse*, Tata McGraw Hill, 2006.

CE 564 Hazard Management in Water Distribution System 3-0-0-6

Concept of water distribution system, Distribution system design and analysis, Optimization of pipe network systems, Distribution reservoirs and service storage, Vulnerability of water distribution system – Risk, hazards, vulnerability and mitigation measures, Risk and uncertainty assessment of urban water distribution system, Possible ways of threat mitigation, Case studies.

Texts / References:

- P. Hlavinek, C. Popovska, I. Mahrikova, and T. Kukharchyk (eds.), Risk Management of Water Supply and Sanitation Systems, Springer, 2009.
- S. Pollard, Risk Management for Water and Wastewater Utilities, IWA Publishing, 2008.

CE 566 Physico-chemical Processes for Water and Wastewater Treatment 3-0-0-6

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, Aeration and gas transfer, Design of aerators;

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

Case Studies on Physico-chemical Processes in Water and Wastewater Treatment: Selected case studies on physico-chemical processes – Water treatment, Municipal and industrial wastewater treatment.

Text:

- 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.
- Weber, Jr., W.J., Physicochemical Processes for Water Quality Control, Wiley-Interscience, New York, 1983.

Reference:

- Benefield, L.D., Judkins, J.F., and Weand, B.L., Process Chemistry for Water and Wastewater Treatment, Prentice-Hall, Englewood Cliffs, New Jersey, 1982.
- Metcalf & Eddy, Wastewater Engineering - Treatment and Reuse (Revised by Tchobanoglous, G., Burton, F.L. and Stensel, H.D.), Tata McGrawHill, 2004.

CE 568 Water Harvesting, Conservation and Intelligent Control 3-0-0-6

Basis of water harvesting and conservation: History and perspectives, Need for water harvesting and conservation, Basic categories of water harvesting systems, Micro-catchments and External catchment systems for rainwater harvesting, Floodwater farming and harvesting, Water harvesting techniques, Smart water harvesting solutions, Examples of innovative low-cost technologies for rain, fog, runoff water and groundwater, Planning for effective water harvesting in rural and urban areas, Rain water tanks for houses and other buildings, Water harvesting legislations and guidelines, Intelligent control in water harvesting and smart solutions, Case studies on water harvesting and conservation with intelligent control.

Texts/References:

- B. Lancaster and J. Marshall, Rainwater Harvesting for Drylands and Beyond (Vol. I & II), Rainsource Press, 2nd ed., 2007.
- Netherlands Water Partnership, Smart Water Harvesting Solutions: Examples of Innovative Low-Cost Technologies for Rain, Fog, Runoff Water and Groundwater, KIT Publishers, 1st ed., 2009.

CE 570 Infrastructure Informatics 3-0-0-6

Introduction to informatics, Information pertaining to infrastructure engineering, Application of GIS in information transfer, Mapping of building floor plan, Information transfer and tracking for: traffic movement and road accident, city water supply and distribution, sewage transfer and treatment, health

center and facility, Institute campus. Evacuation planning and management in a disaster: earthquake, flood, fire, terrorism, etc.

Visual surveillance: Types of CCTV camera- IR (Infrared) camera, IP (Internet Protocol) camera, wireless security camera, PTZ (pan-tilt zoom) camera, Introduction to image processing methods, Image transforms and compression, Implementation of algorithms for visual surveillance using C/MATLAB, Security and privacy of visual surveillance information.

Texts/References:

- Q. Huihuan, X. Wu, Y. Xu, “*Intelligent Surveillance Systems*”, Springer Publication, 2011.
- Richard Szeliski, “*Computer Vision: Algorithms and Applications*”, Springer Publication, 2010.
- H. Aghajan and A. Cavallaro (Ed.), “*Multi-Camera Network: Principles and Applications*”, Elsevier, 2009.
- Y. Ma and G. Qian (Ed.), “*Intelligent Video Surveillance: Systems and Technology*”, CRC Press, 2009.
- Murat A. Tekalp, “*Digital Video Processing*”, Prentice Hall, 1995.