CIVIL ENGINEERING

Scheme of Instruction for M Tech Civil Engineering (2026-27)

1 Major Courses

a) To complete the M Tech degree students shall complete 42 credits of coursework, with fulfilling the requirement of one Major, and 22 credits of project.
b) To fulfill Major requirement in an Area, students shall complete minimum 21 course credits (15 core + 6 elective on offer) and 22 Dissertation project credits in the said Area.
c) For optional Minor in one of the other four Areas, a student must complete minimum of 12 credits in the said Area. A course can be counted only once for determining the major or minor. For a minor in Dam Engineering, only the marked courses qualify.

1.1 Semester 1: Common Core for all students

Core: 15 Credits

CE 201 3:0 Basic Geomechanics

CE 263 3:0 Modelling Transport and Traffic

CE 217 3:0 Fluid Mechanics

CE 204 3:0 Solid Mechanics

CE 211 3:0 Mathematics for Engineers

1.2 Major in Dam Engineering

Core: 15 Credits

CE 285 3:0 Disaster Management for Dams

CE 201A 3:0 Dam Safety Surveillance, Instrumentation and Monitoring

CE 260 3:0 Rock mechanics

CE 202A 2:1 Integrated Investigation of Dams

CE 211A 3:0 Concrete Durability and Repair

CE 299 0:22 Dissertation Project

1.3 Major in Geotechnical Engineering

Core: 12 Credits (+ 3 credits from term 1)

CE 202 3:0 Foundation Engineering

CE 295 3:0 Earth Retaining Structures and Earthen Dams

CE 208 3:0 Ground Improvement and Geosynthetics

CE 260 3:0 Rock mechanics

CE 299 0:22 Dissertation Project

1.4 Major in Structural Engineering

Core: 12 Credits (+ 3 credits from term 1)

CE 205 3:0 Finite Element Method

CE 209 3:0 Mechanics of Structural Concrete

CE 210 3:0 Structural Dynamics

CE 228 3:0 Continuum Plasticity

CE 299 0:22 Dissertation Project

1.5 Major in Water Resources Engineering

Core: 12 Credits (+ 3 credits from term 1)

CE 203 3:0 Surface Water Hydrology

CE 277 3:0 Remote Sensing in Ecohydrology

CE 214 3:0 Ground Water Hydrology

CE 215 3:0 Stochastic Hydrology

CE 299 0:22 Dissertation Project

1.6 Major in Transportation Systems Engineering

Core: 12 Credits (+ 3 credits from term 1)

CE 204A 3:0 Pavement Engineering

CE 235 3:0 Optimization Methods

CE 207A 3:0 Characterization of Bituminous Materials

CE 262 3:0 Public Transportation Systems Planning

CE 299 0:22 Dissertation Project

2 Electives for Each Major

2.1 Electives in Dam Engineering

CE 203A 3:0 Hydrologic Safety Evaluation of Dams

CE 295 3:0 Earth Retaining Structures and Earthen Dams

CE 208 3:0 Ground Improvement and Geosynthetics

CE 221 3:0 Earthquake Geotechnical Engineering

CE 227 3:0 Engineering Seismology

CE 279 3:0 Computational Geotechnics

CE 208A 3:0 Flood Resilient Transport System

CE 240 3:0 Uncertainty Modeling and Analysis

2.2 Electives in Geotechnical Engineering

CE 220 3:0 Design of Substructures

CE 221 3:0 Earthquake Geotechnical Engineering

CE 227 3:0 Engineering Seismology

CE 279 3:0 Computational Geotechnics

CE 202A 2:1 Integrated Investigation of Dams

2.3 Electives in Structural Engineering

CE 229 3:0 Non-Destructive Evaluation Methods for Concrete Structures

CE 235 3:0 Optimization Methods

CE 236 3:0 Fracture Mechanics

CE 243 3:0 Bridge Engineering

CE 250 3:0 Stability and Design of Steel Structures

CE 210A 3:0 Thermodynamic Modelling of Cementitious Systems

CE 211A 3:0 Concrete Durability and Repair

CE 240 3:0 Uncertainty Modeling and Analysis

CE 212A 3:0 Stochastic Dynamics, Optimal Transport, and Neural Algorithms

CE 213A 3:0 Design for Dynamic and Fatigue Loading

CE 284 3:0 Plates, Shells, and Geometric Elasticity

2.4 Electives in Water Resources Engineering

CE 213 3:0 Systems Techniques in Water Resources Engineering

CE 247 3:0 Remote Sensing and GIS for Water Resources Engineering

CE 249 3:0 Water Quality Modelling

CE 203A 3:0 Hydrologic Safety Evaluation of Dams

WR201 3:0 Watershed Modeling

AS 216 3:0 Introduction to Climate Systems

2.5 Electives in Transportation Systems Engineering

CE 269 3:0 Traffic Engineering

CE 208A 3:0 Flood Resilient Transport System

CE 202 3:0 Foundation Engineering

DS 290 3:0 Modelling and Simulation

ST 203 3:0 Technology and Sustainability

MG 219 3:0 Introductory Probability

MG220 3:0 Introductory Statistics

CP 318 2:1 Data Science for Smart City Applications

CP 218 2:1 Theory and Applications of Bayesian Learning

3 SOI of Courses

CE 201 (AUG) 3:0 Basic Geo-mechanics

Introduction to genesis of soils, basic clay mineralogy; Principle of effective stress, permeability and flow; Fundamentals of Tensors, Introduction to stresses and deformation measures; Mohr-Coulomb failure criteria, soil laboratory tests; Critical state and stress paths. Shear Strength and Stiffness of Sands; Consolidation, shear strength and stiffness of clays

Swetha Veeraraghavan

Wood, D.M., Soil Behaviour and Critical State Soil Mechanics, Cambridge University Press, 1991.

Bolton, M.D. A Guide to Soil Mechanics, Cambridge University Press, 1991.

Salgado, R., The Engineering of Foundations, McGraw Hill, 2008.

CE 217 (AUG) 3:0 Fluid Mechanics

Vectors and tensors, divergence theorem, pressure, Archimedes principle, fluid mass conservation, heat and contaminant conservation, momentum conservation and Cauchy equation, stress tensor, constitutive relation for Newtonian fluids, Navier-Stokes equations, vorticity, laminar plane couette and open channel flow, Euler equations, potential flow approximation, simple solutions of potential flows, laminar flow in pipes and channels, transition to turbulence Reynolds stress and fluxes, laminar boundary layer, laminar bottom dense flows.

Debsunder Dutta

Kundu, Cohen and Dowling Fluid Mechanics, Sixth Ed., Academic Press, 2016.White, F.M. Fluid Mechanics, F.M., Eighth Edition, McGraw Hill, 2016.

CE 204 (AUG) 3:0 Solid Mechanics

Introduction to tensor algebra and calculus, indicial notation, matrices of tensor components, change of basis formulae, eigenvalues, Divergence theorem. Elementary measures of strain. Lagrangian and Eulerian description of deformation. Deformation gradient, Polar decomposition theorem, Cauchy-Green and Lagrangian strain tensors. Deformation of lines, areas and volumes. Infinitesimal strains. Infinitesimal strain-displacement relations in cylindrical and spherical coordinates. Compatibility. Tractions, body forces, stress at a point, Cauchy's theorem. Piola-Kirchhoff stress tensors. Momentum balance. Symmetry of the Cauchy stress tensor. St. Venant's Principle. Virtual Work. Green's solids, elastic strain energy, generalized Hooke's Law, material symmetry, isotropic linear elasticity in Cartesian, cylindrical and spherical coordinates, elastic moduli, plane stress, plane strain,. Navier's formulation. Airy stress functions. Selected problems in elasticity. Kirchhoff's uniqueness theorem, Betti-Maxwell reciprocal theorem, Principle of stationary potential energy, Torsion in circular and non-circular shafts and thin-walled tubes, warping.

Ananth Ramaswamy

Fung, Y. C. and Pin Tong, Classical and Computational Solid Mechanics, World Scientific, 2001

Boresi, A.P., and Lynn P.P., Elasticity in Engineering Mechanics, Prentice Hall 1974.

Malvern L., Introduction to the Mechanics of a Continuous Medium, Prentice Hall, 1969

CE 205 (JAN) 3:0 Finite Element Method

Calculus of variations; Variational principles: Principle of virtual work; PSPE; Cycle of FE using 1D elements: Rod elements; Lagrange interpolation and shape functions; stiffness matrix; assembly; boundary conditions; singularities; Coordinate transformations; Plane truss elements; Beam elements; Symmetry; Consistent nodal loads; plane frame elements; Constraints in FE; Lagrange multipliers; penalty method FE formulation for planar elasticity and 2D Continuum Elements; Constant Strain Triangle and Q4 bilinear rectangle; Isoparametric formulation; mapped domain; element stiffnesses; Higher-order (LST, serendipity Q8, Q9) elements; compatibility; Gauss quadrature and reduced integration. Element pathologies: parasitic shear, locking, hour-glassing; Error estimates, convergence. Superconvergence and Barlow points; a posteriori (Zienkiewicz-Zhu) error estimates; Foundations of FE: Sobolev and Hilbert spaces; weak derivatives; weak and strong forms; abstract form; Riesz representation theorem; Lax-Milgram theorem; Ritz-Galerkin approximation; Galerkin orthogonality; Computational aspects: Sparse linear systems, ill-conditioning; other topics as time permits

Narayan K Sundaram

Zienkiewicz, O.C. and Taylor, R.L., The Finite Element Method: Vol. 1 (The Basis), Butterworth-Heinemann, 2000.

Cook R.D.. Malkus, D. S., Plesha and Witt, R.J., Concepts and Applications of Finite Element Analysis, Fourth edition, John

Wiley and Sons.

J N Reddy, An Introduction to the Finite Element Method, Second Edition, McGraw Hill Inc, 1993.

CE 211 (AUG) 3:0 Mathematics for Engineers

Revision of ordinary linear ODEs, Formal operators, Adjoint operator, Sturm-Liouville theory, eigenvalue problems, Classification of PDEs, Characteristics / first order PDEs, Laplace equation / potential theory, Separation of variables (cartesian, polar), Eigenfunction expansions, Green's functions, Introduction to boundary value problems. Probability space and axioms of probability. Conditional probability. Total probability and Bayes theorems. Scalar and vector random variables. Probability distribution and density functions. Expectation operator. Functions of random variables. Vector spaces and subspaces, solution of linear systems, Linear independence, basis, and dimension, The four fundamental subspaces, Linear transformations, Orthogonal vectors and subspaces, Cosines and projections onto lines, Projections and least squares, The fast Fourier transform, Eigenvalues and eigenvectors, Diagonalization of a matrix, Difference equations and powers of matrices, Similarity transformations.

Debraj Ghosh, J M Chandra Kishen

Michael Stone, Paul Goldbart, 2009, Mathematics for Physics: A Guided Tour for Graduate Students, Cambridge University Press

Papoulis A and Pillai, S U., 2002, Probability, random variables and stochastic processes, Mc Graw-Hill, Boston

Strang Gilbert, 2013, Linear Algebra and Its Applications, India Edition (4th), CENGAGE LEARNING

CE 285 (JAN) 3:0 Disaster Management for Dams

Overview of disaster management and flood mapping, Flood risk associated with various types of dams, Dam hazard classification systems, Dam failure modes and assessment of consequences, Dam breach modelling, Hydrologic, Hydraulic and breach outflow routing, Remote Sensing and Geographic Information Systems (GIS) applications for emergency preparedness and flood mapping, Dam hazard classification framework in India, Emergency action plans preparation and implementation.

D Nagesh Kumar, V V Srinivas

Guidelines for Developing Emergency Action Plans for Dams, Dam Safety Rehabilitation Directorate (DSRD), Central Water Commission (CWC), 2016.

Guidelines for Mapping Flood Risks Associated with Dams, DSRD, CWC, 2018.

Heywood, I., Cornelius, S., and Carver, S. An Introduction to Geographical Information Systems, Pearson Education, 1998.

Lillesand T.M. and Kiefer R.W. Remote Sensing and Image Interpretation, John Wiley & Sons, 2000.

Singh, V. P. Dam Breach Modeling Technology, Springer Science & Business Media, 2013.

CE 201A (AUG) 3:0 Dam Safety Surveillance, Instrumentation and Monitoring

Dam safety: Overview of dam inspection for dam safety; Dam safety inspection program; Inspecting embankment dams, concrete & masonry dams; Inspecting spillways, outlets and mechanical equipment; Inspection using ROVs. Instrumentation & Monitoring: Instrument types and their uses; Instrumentation system planning-Embankment, concrete and masonry dams, seismic monitoring; Hydrometeorological instrumentation – data collection and management, data organization & analysis, automation

J M Chandra Kishen, Debsunder Dutta, Souradeep Gupta

Guide to Hydrological Practices, Volume I, Hydrology – From Measurement to Hydrological Information, WMO-No. 168.

Technical Specifications of Hydro-meteorological, Geodetic, Geotechnical and Seismic Instruments, Dam Safety Rehabilitation Directorate, Central Water Commission,2018.

Guidelines for Safety Inspection of Dams (2018), DRIP, Central Water Commission, Government of India, New Delhi.

Guidelines for Instrumentation of Large Dams (2018), DRIP, Central Water Commission, Government of India, New Delhi.

CE 260 (AUG) 3:0 Rock Mechanics

Physical properties of intact rocks, stresses and strains, engineering properties of rocks and rock masses, theory of elasticity, rock discontinuities, in situ stresses, structural geology, strike, dip, bedding plane, types of fractures: joints, faults, folds, unconformity, formation and classification of joints, faults and folds, effects of joints, faulting, folding, geological exploration - bore holes, methods of drilling, rock strength and rock mass strength, rock failure criteria, rock mass classification: rock mass rating, geophysical methods, geology of dam sites and reservoirs, Importance of geology in dam construction, rock slope stability. numerical and computer methods in rock mechanics and under-ground excavations.

Jyant Kumar, Tejas G Murthy

John A. Hudson and John P. Harrison. Engineering Rock Mechanics

John Jaeger, N. G. Cook, and Robert Zimmerman. Fundamentals of Rock Mechanics

Goodman, R. E. Introduction to Rock Mechanics. John Wiley & Sons.

Ömer Aydan. Rock Mechanics and Rock Engineering.

CE 202A (JAN) 2:1 Integrated Investigation of Dams – Laboratory Course

Introductions to Geotechnical field investigations, laboratory experiments and relevant IS codes; Geotechnical and Geophysical investigation of Dams; Theory and demonstration of Ground Penetrating Radar testing: Multichannel Analysis of Surface Testing: Seismic borehole tests, Down/Up and Cross hole testing; Electric Resistivity testing; Planning of Integrated Investigation. Field experimental case studies of Dam investigations.

P Anbazhagan & P Raghuveer Rao

An-Bin Huang, Paul W Mayne, Geotechnical and Geophysical Site Characterization, CRC Press, 2008.

Head, K.H., Manual of Soil Laboratory Testing. Vols. 1 to 3, 1981.

Compendium of Indian Standards on Soil Engineering Parts 1 and II, 1987 - 1988.

CE 202 (JAN) 3:0 Foundation Engineering

Subsurface investigations, Bearing capacity of shallow foundations, penetration tests, plate load tests. Settlement of shallow foundations, elastic and consolidation settlements; settlement, estimates from penetration tests, settlement tolerance. Allowable bearing pressure. Foundations on problematic soils. Principles of foundation design. Introduction of deep foundations. Bearing capacity and settlement of piles and pile groups in soils. Machine foundations. Reinforced soil beds.

Tejas G Murthy

Bowles, J.W., Foundation Analysis and Design, 5th Ed., McGraw-Hill, 1996.

Das, M. B., Principles of Foundation Engineering, Brooks/Cale Engineering Division, 1984.

CE 295 (JAN) 3:0 Earth Retaining Structures and Earthen Dams

Earth retaining structures, lateral earth pressure coefficients, Rankine and Coulomb theories, passive earth pressure computation with curved rupture surfaces, stability of gravity and cantilever retaining walls, stability of vertical cuts, braced excavations, cantilever and anchored sheet piles, stability of infinite slopes and finite slopes, different methods of slices for the analysis of finite slopes and embankments, stability analysis of earth and rock dams, forces/loads to be considered, different load cases, factors of safety in different conditions, filters for earthen dams, seepage analysis, software application.

Jyant Kumar

Terzaghi, K., Theoretical Soil Mechanics, John Wiley, 1965.

Taylor, D.W., Fundamentals of Soil Mechanics, John Wiley, 1948.

Bowles, J.W., Analysis and Design of Foundations, 4th and 5th Ed., McGraw-Hill, 1988 & 1996.

Lambe, T.W. and Whitman, R.V., Soil Mechanics, Wiley Eastern Limited, 1976.

Earth and earth-rock dams: Engineering problems of design and construction. James L. Sherard, Wiley, 1963.

CE 208 (JAN) 3:0 Ground Improvement and Geosynthetics

Principles of ground improvement, mechanical modification. Properties of compacted soil. Hydraulic modification, dewatering systems, preloading and vertical drains, electro-kinetic dewatering, chemical modification, modification by admixtures, stabilization using industrial wastes, grouting, cutoff walls, underpinning, soil nailing, soil reinforcement principles, properties of geo-synthetics, applications of geo-synthetics in bearing capacity improvement, slope stability, retaining walls, embankments on soft soils and dams, filtration, drainage and seepage control with geo-synthetics, landfills and other applications of geo-synthetics, case studies.

G Madhavi Latha

Hausmann, M.R., Engineering Principles of Ground Modification, McGraw-Hill, 1990.

Jones, C.J.E.P., Reinforcement and Soil Structures, Butterworth Publications, 1996.

Koerner, R. M., Designing with Geosynthetics, Prentice Hall Inc. 1998.

CE 209 (JAN) 3:0 Mechanics of Structural Concrete

Introduction, Limit state design philosophy of reinforced concrete, Stress-strain behavior in multi-axial loading, failure theories, plasticity and fracture, ductility, deflections, creep and shrinkage, Strength of RC elements in axial, flexure, shear and torsion, RC columns under axial and eccentric loading, Beam-column joints, Strut and Tie modelling, Yield line theory of slabs, Seismic resistant design, Methods for predicting the behavior of pre-stressed concrete members and structures.

Keshav Bharadwaj Ravi

Nilson, A. H., Darwin, D. and Dolan, C. W., Design of concrete structures, McGraw Hill, 2004

Lin and Burns, Design of Prestressed concrete structures, John Wiley and Sons, 2006

Agarwal and Shrikhande- Earthquake resistant design of structures, Prentice-Hall of India Pvt. Ltd. New Delhi, 2006.

CE 210 (JAN) 3:0 Structural Dynamics

Equations of motion. Degrees of freedom. D' Alembert principle. SDOF approximation to vibrating systems. Energy storage elements: mass, stiffness and damper. Undamped free vibration. Natural frequency. Damped free vibration. Critical damping. Forced response under periodic and aperiodic excitations. Support motions. Resonance. Impulse response and complex frequency response functions. Duhamel integral. Vibration isolation: FTR and DTR. Multi-DOF systems. Normal modes and natural frequencies. Orthogonality of normal modes. Natural coordinates. Uncoupling of equations of motion. Repeated natural frequencies. Proportional and non proportional damping. Damped normal modes. Principle of vibration absorber. Continuous systems. Vibration of beams. Forced response analysis by eigenfunction expansion. Moving loads and support motions. Effect of axial loads. Approximate methods for vibration analysis. Rayleigh's quotient. Rayleigh-Ritz method. Method of weighted residual. Method of collocation. Galerkin's method.

J M Chandra Kishen

Meirovich, L., 1984, Elements of vibration analysis, McGraw-Hill, NY

Clough R W and J Penzien, 1993, Dynamics of structures, McGraw-Hill, NY

Rao,S S 2004, Mechanical Vibrations, 4th Edition, Pearson Education, New Delhi.

CE 213A (AUG) 3:0 Design for Dynamic and Fatigue Loading

Introduction to dynamic loading, fatigue loading, vibration concepts, and engineering applications in civil structures; Dynamic response of structures under earthquake, machinery vibration; Principles of dynamic structural design including vibration control, dynamic amplification, response spectrum concepts; Earthquake resistant design concepts of buildings, code-based procedures for analysis and design; Fundamentals of fatigue; stress cycles, S–N curves, fracture mechanics based crack propagation theories, cumulative damage theories. Life predictions and structural integrity.

J M Chandra Kishen

Chopra A K, Dynamics of Structures: Theory and Applications to Earthquake Engineering, Pearson Education, 2017.

Agarwal and Shrikhande, Earthquake Resistant Design of Structures, PHI Learning Private Limited, New Delhi, 2006

Suresh S., Fatigue of Materials, Second Edition, Cambridge University Press, UK.

Broek, D., The Practical Use of Fracture Mechanics, Kluwer Academic Publishers, 1989.

Current literature

CE 228 (JAN) 3:0 Continuum Plasticity

Prerequisite: This is a graduate-level course designed for masters and doctoral students with a fair background in solid mechanics. The pre-requisite is a graduate level course in solid mechanics or continuum mechanics. We essentially assume the definition of strain and equations of mechanical equilibrium.

Brief reviews of finite deformation kinematics and constitutive closure; introduction to rational thermodynamics and formulation of constitutive theories; internal variables; dissipation inequality; physics of yielding; plastic flow and hardening; notion of yield surface; classical models for yielding; plastic flow and hardening; additive and multiplicative splitting of kinematic quantities; solutions of simple BVPs; FEM for small deformation plasticity; yield free plasticity models; linearization and computational schemes; introduction to damage mechanics

Debasish Roy

A S Khan, S Huang, 1995, Continuum Theory of Plasticity, John Wiley, NY

J Lubliner, 2008. Plasticity theory. Courier Corporation.

M E Gurtin, L Anand, 2012, The Mechanics and Thermodynamics of Continua, Cambridge University Press, UK

Simo, J. C., & Hughes, T. J., 2006, Computational inelasticity, Springer Science & Business Media.

CE 212A (AUG) 3:0 Stochastic Dynamics, Optimal Transport, and Neural Algorithm

This course introduces the mathematical foundations of diffusive stochastic processes and their modern algorithmic extensions. The first part covers Brownian motion, sample-path regularity, stochastic continuity, and the basic structure of Itô processes. It then develops Itô and Stratonovich calculus, with illustrative examples including Langevin dynamics, Ornstein-Uhlenbeck processes, and geometric Brownian motion. The course next treats the Fokker-Planck and Kolmogorov backward equations, together with Feynman-Kac representations, killed diffusions, and boundary-conditioned stochastic processes. A further module is devoted to change of measure for diffusions, including Girsanov's theorem and Doob's h-transform, with applications to controlled Brownian motion and related probabilistic constructions. The second part of the course introduces KL-divergence-based variational formulations and then develops the stochastic optimal transport viewpoint, emphasizing diffusive transport and entropic interpolation rather than deterministic Monge transport. The course concludes with selected neural methods built on these ideas, including neural stochastic control, neural filtering, and OT-inspired stochastic optimization schemes for learning systems.

Debasish Roy

B. Øksendal, 2003, Stochastic Differential Equations: An Introduction with Applications, Springer.

C. Villani, 2010, Optimal Transport: Old and New, Springer.

CE 203 (JAN) 3:0 Surface Water Hydrology

Review of basic hydrology, hydrometeorology, infiltration, evapotranspiration, runoff and hydrograph analysis. Flood routing – lumped, distributed and dynamic approaches, `hydrologic statistics, frequency analysis and probability, introduction to environmental hydrology, urban hydrology. Design issues in hydrology.

V V Srinivas

Bedient, P. B., and Huber, W. C., Hydrology and Floodplain Analysis, Prentice Hall, 2002.

Chow, V.T., Maidment, D.R. and Mays, L.W,. Applied Hydrology, McGraw-Hill 1988.

Linsley, R.K., Kohler, M.A. and Paulhus, J.L.H., Hydrology for Engineers, McGraw Hill, 1985.

CE 214 (JAN) 3:0 Ground Water Hydrology

Ground water and hydrological cycle. Ground water movement and balance. Ground water monitoring. Equations of flow. Well hydraulics - analysis of aquifer tests and models. Regional groundwater resource evaluation and numerical modeling. Groundwater recharge estimation. Base flow analysis and models. Ground water quality. Mass transport in ground water. Tracer tests and scale effects of dispersion. Solute transport modeling.

M Sekhar

Freeze, A. R. And Cherry, J. A. Groundwater, Prentice Hall, 1979.

Fetter, C. W. Applied Hydrogeology, Prentice Hall, 1988.

Domenico, P. A., and Schwartz, F. W. Physical and Chemical Hydrogeology, John Wiley, 1990.

Fetter, C. W. Contaminant Hydrogeology, Prentice Hall, 1993.

CE 215 (JAN) 3:0 Stochastic Hydrology

Introduction to random variables, statistical properties of random variables. Commonly used probability distributions in hydrology. Fitting probability distributions to hydrologic data. Probability plotting and frequency analysis. Data generation. Modeling of hydrologic uncertainty - purely stochastic models, first order Markov processes. Analysis of hydrologic time series – linear and nonlinear correlations, Fourier analysis and spectral density functions, Wavelets. Applications to hydrologic forecasting.

Rajarshi Das Bhowmik

Bras, R.L. and Rodriguez-Iturbe, Random Functions and Hydrology, Dover Publications, New York, USA, 1993.

Hann, C.T., Statistical Methods in Hydrology, First East-West Press Edition, New Delhi, 1995.

Ang, A.H.S. and Tang, W.H., Probabilistic concepts in Engineering Planning Design, Vol. 1, Wiley, New York, 1975.

Clarke, R.T., Statistical Models in Hydrology, John Wiley, Chinchester, 1994

CE 277 (JAN) 3:0 Remote Sensing in Ecohydrology

Introduction to ecohydrology, fundamentals of exchange of energy and water in terrestrial ecosystems, soil temperature and moisture, surface energy fluxes, modeling leaf photosynthesis and stomatal conductance, introduction to plant canopies and radiation regime, soil, plant atmosphere continuum, fundamentals of optical remote sensing, remote sensing of vegetation composition, structure and function, applications of remote sensing to coupled water and carbon cycles in terrestrial ecosystems.

Debsunder Dutta

Ecological Climatology, 3rd Edition, Gordon Bonan, Cambridge University Press. An Introduction to Environmental Biophysics, 1998, G.S. Campbell, J. Norman, Springer. Remote Sensing and Image Interpretation, 2015, Lilliesand, Thomas and Chipman, John Wiley & Sons. Some current and previous literature on remote sensing and modeling.

CE 262 (JAN) 3:0 Public Transportation Systems Planning

Modes of public transportation and application of each to urban travel needs; comparison of transit modes and selection of technology for transit service; transit planning, estimating demand in transit planning studies, demand modeling, development of generalized cost, RP & SP data and analysis techniques; functional design and costing of transit routes, models for planning of transit routes, scheduling; management and operations of transit systems; integrated public transport planning; operational, institutional, and physical integration; models for integrated planning; case studies.

Ashish Verma

A. Verma and T. V. Ramanayya, Public Transport Planning and Management in Developing Countries, CRC Press, 2014

VuchicVukan R., Urban Transit: Operations, Planning and Economics, Prentice Hall, 2005.

Gray G. E., and Hoel L. A., Public Transportation, Prentice Hall, 1992.

CE 204A (AUG) 3:0 Pavement Engineering

Introduction to pavement engineering; design of flexible and rigid pavements: selection of pavement design input parameters, traffic loading, material characterization, failure criteria; non-destructive tests for pavements; IRC, AASHTO design codes.

Satyavati Komaragiri

Rajib B Mallick and Tahar El-Korchi, Pavement Engineering, Principles and Practice, CRC Press, 2009.

Y.H. Huang, Pavement Analysis and Design, Prentice-Hall, New Jersey, 1993.

E. J. Yoder, M. W. Witczak, Principles of Pavement Design, Wiley New York, 1975. C. E. G. Justo, S.K. Khanna, and A.

Veeraragavan, Highway engineering, Nem Chand & Bros, 2017.

CE 235 (JAN) 3:0 Optimization Methods

Basic concepts, Kuhn-Tucker conditions, linear and nonlinear programming, treatment of discrete variables, stochastic programming, Genetic algorithm, simulated annealing, Ant Colony and Particle Swarm Optimization, Evolutionary algorithms, Applications to various engineering problems.

Ananth Ramaswamy

Arora, J.S. Introduction to Optimization, McGraw-Hill (Int. edition)1989.

Rao, S.S., Optimization: Theory and Applications. Wiley Eastern, 1992

Current Literature.

CE 203A (AUG) 3:0 Hydrologic Safety Evaluation of Dams

Significance of hydrologic safety evaluation and modeling uncertainty in hydro-meteorological processes; Standard project storm and Probable maximum precipitation (PMP); Design flood estimation - Hydro-meteorological approach: unit hydrograph construction, design storm depth estimation from PMP Atlas, storm transposition and adjustment, estimation of loss rate, base flow and time distribution coefficients, HEC-HMS model; Flood frequency analysis approach: At-site and regional frequency analysis using commonly used probability distributions in hydrology, Probability plotting and Goodness of fit tests; Reservoir sedimentation, Reservoir rule curve.

V V Srinivas

Chow, V.T., Maidment, D.R. and Mays, L.W., Applied Hydrology, McGraw-Hill, 1988.

Handbook for Assessing and Managing Reservoir Sedimentation, Dam Safety Rehabilitation Directorate, Central Water Commission, 2019.

Hosking, J. R. M., and Wallis, J. R., Regional Frequency Analysis: An Approach Based on L-Moments, Cambridge University Press, 1997.

Manual on Estimation of Probable Maximum Precipitation (PMP), World Meteorological Organization, 2009.

CE 220 (AUG) 3:0 Design of Substructures

Design considerations, field tests for bearing capacity and settlement estimates, selection of design parameters. Structural design considerations. Codes of practice. Design of spread footings, combined footings, strap footings, ring footings, rafts, piles and pile caps and piers.

P Raghuveer Rao

Bowles, J.E. Foundation analysis and design. 5th Edn., McGraw Hill, 1996

Indian Standard Codes

CE 221 (AUG) 3:0 Earthquake Geotechnical Engineering

Introduction to engineering seismology, Plate tectonics, Seismic wave propagation, Earthquake magnitude, Ground motion, Seismic hazard analysis, Ground response analysis, Soil-structure interaction, Local site effects, Dynamic properties of soils, Liquefaction phenomena, analysis of pore pressure development. Laboratory and in-situ testing for seismic loading, analysis and design of slopes, foundations, earth retaining structures and dams for seismic loading, Case histories, Earthquake hazard mitigation techniques.

G Madhavi Latha

Geotechnical Earthquake Engineering By Steven L. Kramer, Pearson Education, 2003. Geotechnical Earthquake Engineering Handbook, Robert W. Day, McGraw-Hill, 2002.

CE 227 (JAN) 3:0 Engineering Seismology

Introduction to earthquake hazards. Strong ground motions, tsunamis, landslides, liquefaction. Overview of plate tectonics and earthquake source mechanisms. Theory of wave propagation. Body waves and surface waves. Concepts of seismic magnitudes and intensity. Seismic station. Sensors and data loggers, mechanical and digital sensors. Interpretation of seismic records – acceleration, velocity and displacement. Regional seismicity and earthquakes in India. Seismic zonation – scales, macro and micro, attenuation, recurrence relation. Seismic hazard analysis - deterministic and probabilistic. Site characterization – different methods and experiments. Local site effects, ground motion amplifications. Development of response/design spectrum. Liquefaction hazard assessments. Integration of hazards using GIS. risk and vulnerability Studies.

P Anbazhagan

Earthquake Engineering – From Engineering Seismology to Performance Based Engineering, Edited by Bozorgnia, Y. and Bertero, V.V., CRC Press Washington 2004.

Leon Reiter, Earthquake hazard Analysis – Issues and Insights, Columbia University Press New York 1990.

Steven L Kramer, Geotechnical Earthquake Engineering, Pearson Education, 2003.

CE 279 (JAN) 3:0 Computational Geotechnics

Introduction to numerical modelling with focus on geotechnical aspects, basics of continuum mechanics, introduction to finite difference and finite element methods, constitutive modelling of linear elastic and elasto-plastic behaviour of soils, static & dynamic loads and boundary conditions applicable to dams and other structures, coding of finite element and finite difference problems using MATLAB, examples of solving for dam's response using the commercial Geotech software FLAC.

Swetha Veeraraghavan

Bathe, K.J., Finite Element Procedures in Engineering Analysis, Prentice-Hall,

Englewood Cliffs, NJ, 1982.

Wood, D.M., Soil Behavior and Critical State Soil Mechanics, Cambridge University

Press, New York, 1990.

Hai-Sui Yu, Plasticity and Geotechnics, Springer, 2006

Desai, C.S. and Christian, J.T. Eds. Numerical Methods in Geotechnical Engineering,

McGraw-Hill, 1977.

CE 284 (AUG) 3:0 Plates, Shells, and Geometric Elasticity

Prerequisites: A background grad-level solid mechanics course (CE 204 or ME 242) is strongly recommended

Calculus of variations and variational principles of mechanics; Kirchhoff plate theory: Kinematics and elements of plate deformation; plate resultants; formulation of Kirchhoff theory for plates of general shape; corner forces; Thomson-Tait analogy; pure bending of thin circular and rectangular plates under various boundary conditions; Navier and Lévy solutions; problems in combined lateral and membrane loading in thin rectangular plates; plates on an elastic foundation; circular and annular plates; problems in plates of general shape; linear stability and plate buckling analysis; Other plate theories: Introduction to Reissner-Vasil'ev shear plates; stream functions and governing equations; large deflection of thin plates and the Fóppl-von Kármán equations; Galerkin analysis of flexible plates. Differential geometry of surfaces in R^3: Metric tensor / first fundamental form; Directional derivative and Gauss Map; Shape operator ; second fundamental form; normal curvature; normal sections; principal curvatures; Euler's formula; Gauss and mean curvatures; Flat and minimal surfaces; Monge patches; Surfaces of revolution; Christoffel symbols; Derivation of Codazzi-Gauss equations; Theorema Egregium; Isometry; Fundamental theorem of surfaces. Shells: Thin shells and load-carrying mechanisms in shells; structure of general shell theories; axisymmetric shells and their specialization; examples and applications. Additional topics as time permits.

Narayan K Sundaram

CE 229 (JAN) 3:0 Non-Destructive Evaluation Methods for Concrete Structures

Planning and interpretation of in-situ testing of concrete structures; Surface hardness methods; Fundamental bases and methodologies of non-destructive evaluation (NDE) techniques related to concrete structures; NDE methods for concrete testing based on sounding: Acoustic emission (AE) testing of concrete structures; NDE methods for concrete testing based on sounding: Ultrasonic pulse velocity (UPV) methods; Partially destructive strength tests related to concrete; cores; Examples of UPV corrections for reinforcement; examples of evaluation of core results

R Vidya Sagar

J. H. Bungey and S. G. Millard (1996) Testing of concrete in structures. Blackie Academic & Professional, 1996, chapman & Hall publishers.

V. M. Malhotra and N. J. Carino (2005) Handbook on Nondestructive Testing of Concrete Ed. by V.M. Malhotra and N.J. Carino., CRC publishers.

C. V. Subramanian (2016) Practical Ultrasonics., Narosa publishers

C. U. Gross and M. Ohtsu (2008) Acoustic Emission Testing., Springer-Verlag Berlin Heidelberg

JSNDI (2016) Practical Acoustic Emission testing. Springer Japan 2016.

CE 235 (JAN) 3:0 Optimization Methods

Basic concepts, Kuhn-Tucker conditions, linear and nonlinear programming, treatment of discrete variables, stochastic programming, Genetic algorithm, simulated annealing, Ant Colony and Particle Swarm Optimization, Evolutionary algorithms, Applications to various engineering problems.

Ananth Ramaswamy

Arora, J.S. Introduction to Optimization, McGraw-Hill (Int. edition)1989.

Rao, S.S., Optimization: Theory and Applications. Wiley Eastern, 1992

Current Literature.

CE 236 (AUG) 3:0 Fracture Mechanics

Introduction; Linear Elastic Fracture Mechanics; Design based on LEFM; Elasto-Plastic Fracture Mechanics; Mixed Mode Crack Propagation; Fatigue Crack Propagation; Finite Elements in Fracture Mechanics.

R Vidya Sagar

T. L. Anderson, Fracture Mechanics, CRC press, Fourth Edition, 2017, Boca Raton, Florida

David Broek, Elementary Fracture Mechanics, Sijthoff and Noordhoff, The Netherlands.

Prashanth Kumar, Elements of Fracture Mechanics, Wheeler Publishing, New Delhi.

J. F. Knott, Fundamentals of Fracture Mechanics, Butterworths, London.

CE 243 (JAN) 3:0 Bridge Engineering

Bridge types, aesthetics, general design considerations and preliminary design, IRC / AASHTO design loads, concrete bridge design - reinforced and prestressed girder bridges, steel bridge design Composite bridges, design of bridge bearings, Pier, Abutment and foundation; seismic and wind load analysis, analysis of cable supported bridge systems, bridge inspection and maintenance.

Ananth Ramaswamy

Barker and Puckett Design of Highway Bridges, John Wiley and Sons 2007

CE 250 (Jan) 3:0 Stability and Design of Steel Structures

Concepts and principles of stability of beam-columns- Differential equations for beam-columns, effects of concentrated lateral loads, effects of different end conditions such as built-in or elastic supports; continuous beams and columns with axial loads, torsion in Thin walled sections, Lateral buckling of beams, elastic buckling of rigid frames, arches; influence of material inelasticity and imperfections in the structural stability of member ; application of energy and numerical methods in critical buckling load assessments; design of structural steel thin walled members and built up sections.

Ananth Ramaswamy

Timoshenko, S. and Gere, J., "Theory of Elastic Stability" McGraw Hill.

Wai-Fa Chen and Lui, E.M., "Structural Stability: Theory and Implementation" Elsevier.

Bazant , Z.P.,and Cedolin, Luigi "Stability of Structures:. Elastic, Inelastic, Fracture and Damage Theories", Dover Publications.

CE 216N (Aug) 3:0 Seismic Design of Reinforced Concrete Structures.

J M Chandra Kishen

CE 210A (AUG) 3:0 Thermodynamic Modelling of Cementitious Systems

Prerequisites: Basic knowledge of cement and concrete at the undergraduate level Registration will only be permitted after an initial discussion with the instructor.

A brief recap of cement chemistry, cement hydration and concrete technology (influence of binder chemistry on reaction products, concrete microstructure, mineral and chemical admixtures, microstructure and pore structure; concrete mechanics and durability); A brief recap of thermodynamics (zeroth law, first law, second law, activity); Law of mass action; Mass Balance calculations; Determination of Reactivity; Fundamentals of thermodynamic modelling; Predicting reaction products; Predicting pore solution compositions; Predicting pore volumes; Kinetic modelling; Structure-property relations in concrete.

Keshav Bharadwaj Ravi

“Concrete: Microstructure, Properties, and Materials” by P.K. Mehta and Paulo J. M. Monteiro, 4th Edition (2014), McGraw Hill Education (India), New Delhi, India.

“Introduction to the Thermodynamics of Materials” by David R. Gaskell and David E. Laughlin, 6th Edition (2018), CRC Press, Boca Raton, FL, USA

Online tutorials

Recent and Historical Literature

CE 211A (JAN) 3:0 Concrete Durability and Repair

Introduction to concrete; Concrete constituents and manufacture; Introduction to cement and concrete microstructure; Transport through concrete - physics and measurement; Dimensional Changes in Concrete - shrinkage and creep; Corrosion of steel and repair, role of chlorides; Carbonation; Aggregates and durability of concrete; Freeze-thaw and salt-scaling; Sulphate attack and delayed ettringite formation, physical salt attack; Effect of fire, acid attack, abrasion and cavitation; Concrete quality control, workmanship and choice of materials; Biological processes and mic; Non-destructive and laboratory test-methods; Inspection, repair and protection of structures; Durability based design of structures.

Keshav Bharadwaj Ravi

Mehta P.K. and Monteiro P.J.M., Concrete Microstructure Properties and Materials, Fourth Edition, Tata McGraw Hill, 2014

Wilson M., Paul D. Tennis, Design and Control of Concrete Mixtures, Seventeenth Edition, Portland Cement Association, 2021

Bertolini, L., Bernhard, E., Pedeferri, P., Redaelli, E., Polder R., Corrosion of Steel in Concrete, Wiley-VCH Verlag GmbH & Co. KGaA, 2013

Recent and Historical Literature and Case Studies

CE 213 (JAN) 3:0 Systems Techniques in Water Resources Engineering

Optimization Techniques - constrained and unconstrained optimization, Kuhn-Tucker conditions, Linear Programming (LP), Dynamic Programming (DP), Multi-objective optimization, applications in water resources, water allocation, reservoir sizing, multipurpose reservoir operation for hydropower, flood control and irrigation. Review of probability theory, stochastic optimization. Chance constrained LP, stochastic DP. Surface water quality control. Simulation - reliability, resiliency and vulnerability of water resources systems.

D Nagesh Kumar

Loucks, D.P., Stedinger, J.R. and Haith, D.A., Water Resources Systems Planning and Analysis, Prentice Hall, Englewood Cliffs, N.J, 1981.

Vedula, S. and Mujumdar, P. P., Water Resources Systems: Modelling Techniques

Tata-McGraw Hill, 2005.

Srinivasa Raju, K and Nagesh Kumar, D., Multicriterion Analysis in Engineering and Management, PHI Ltd., New Delhi, 2010.

CE 240 (JAN) 3:0 Uncertainty Modeling and Analysis

Prerequisite: Familiarity with Probability and Statistics, Computer programming

Deterministic vs nondeterministic perspectives. Sources of uncertainty. Epistemic vs. aleatoric uncertainty. Data driven vs. physics driven uncertainty modelling. Introductory probability and statistics, point estimation, hypothesis testing, time series. Modelling: connecting data to the probabilistic models. Discretization of random fields. Tools for uncertainty propagation. Computational aspects of uncertainty propagation.

Debraj Ghosh

References will be given during the course

CE 247 (AUG) 3:0 Remote Sensing and GIS for Water Resources Engineering

Basic concepts of remote sensing. Airborne and space borne sensors. Digital image processing. Geographic Information System. Applications to rainfall - runoff modeling. Watershed management. Irrigation management. Vegetation monitoring. Drought and flood monitoring. Environment and ecology. Introduction to digital elevation modeling and Global Positioning System (GPS). Use of relevant software for remote sensing and GIS applications.

D Nagesh Kumar

Lillesand T.M. and Kiefer R.W. Remote Sensing and Image Interpretation, John Wiley & Sons, 2000.

Sabins, F.F. Remote Sensing - Principles and Interpretation, Freeman & Co., New York, 1986.

Heywood, I., Cornelius, S., and Carver, S. An Introduction to Geographical Information Systems, Pearson Education, 1998.

CE 249 (AUG) 3:0 Water Quality Modeling

Basic characteristics of water quality, stoichiometry and reaction kinetics. Mathematical models of physical systems, completely and incompletely mixed systems. Movement of contaminants in the environment. Water quality modeling in rivers and estuaries - dissolved oxygen and pathogens. Water quality modeling in lakes and ground water systems.

M Sekhar

Chapra, S.C., Surface Water Quality Modeling, McGraw Hill, 1997.

Tchobanoglous, G., and Schroeder, E.D., Water Quality, Addison Wesley, 1987.

CE 269 (AUG) 3:0 Traffic Engineering

Traffic flow elements and its characterization: vehicle characteristics, human factors, infrastructure elements, capacity and LoS concepts, Highway Capacity Manual (HCM) methods. Uninterrupted Traffic Flow: speed-flow-density relationships, multi-regime models, car-following, lane-changing, simulation framework. Interrupted Traffic Flow: signal design, shock-wave theory, gap-acceptance behavior, delay and queue analysis. Design of traffic facilities: expressways, signalized and un-signalized intersections, interchanges, parking, signs and markings.

Vijay Gopal Kovvali and Ashish Verma

Roess, R.P., Prassas E.S. & McShane, W.R. (2010), Traffic Engineering, Prentice Hall, USA.

May, A. D. (1990), Traffic Flow Fundamentals, Prentice Hall, USA.

Highway Capacity Manual (2010), Transportation Research Board, USA.

Kadiyali, L. R. (2000), Traffic Engineering and Transport Planning, Khanna Publishers, India.

Salter, R J. & Hounsell, N. B. (1996), Highway Traffic Analysis and Design, Macmillan Education, UK.

CE 207A (AUG) 3:0 Characterization of Bituminous Materials

Introduction and overview of mixture design; chemical, physical, and rheological properties of asphalt binder; behavior, testing, and selection of aggregates; design of asphalt mixtures, compaction and properties; common distresses and characterization of distresses; additives and surface properties; engineered materials, warm mixtures, RAP, and other special mixtures.

Satyavati Komaragiri

F.L. Roberts, P. S. Kandhal, E.R. Brown, D-Y. Lee and T. W. Kennedy, 2nd Edition, NAPA Research and Education Foundation, 1996.
Dallas N. Little, David H. Allen, and Amit Bhasin. Modeling and design of flexible pavements and materials, Springer, 2018.
C. E. G. Justo, S.K. Khanna, and A. Veeraragavan, Highway engineering, Nem Chand & Bros, 2017.

CE 208A (JAN) 3:0 Flood Resilient Transport System

Prerequisite: Transportation Systems Modeling (CE 275)

Introduction to principles of resilient transport system and development of resilient plans; Transport network planning and design; Measures/policies for adaptation of transport system to flooding situation; Modelling, simulation, and geospatial analysis methods to design resilient transport system and plans; Integrated macro and micro traffic simulation models for scenario analysis and development of resiliency plans.

Ashish Verma

1. M A P Taylor, Climate Change Adaptation for Transportation Systems (1st Edition), Elsevier, 2020.

2. Vajjarapu, H., Verma, A., & Hemanthini AR., Evaluating climate change adaptation policies for urban transportation in India, International Journal of Disaster Risk Reduction, 47, 101528. https://doi.org/10.1016/j.ijdrr.2020.101528, 2020.