CIVIL ENGINEERING

M.E. Programmes

Geotechnical Engineering

Hard Core: 24 Credits (All courses are mandatory)

CE 201	3:0	Basic Geomechanics
CE 202	3:0	Earthquake Geotechnical Engineering
CE 203	3:0	Earth and Earth Retaining Structures
CE 204	3:0	Foundation Engineering
CE 205	3:0	Geoenvironmental Engineering
CE 206	3:0	Ground Improvement and Geosynthetics

One 3:0 core course from either the Structural Engineering or the Water Resources and Environmental Engineering streams

A suitable 3:0 mathematics course will be identified by the department at the beginning of the term.

Project: 22 Credits

CE299	0:22	Dissertation Project

Electives: 18 Credits, of which at least 9 credits must be from among the group electives listed below.

CE 231	2:0	Soil Stabilization by Admixtures
CE 232	2:0	Fundamentals of Soil Behaviour
CE 234	2:0	Soil Dynamics
CE 236	2:1	Behaviour and Testing of Unsaturated Soils
CE 237	2:0	Rock Mechanics
CE 239	3:0	Computational Geotechnics
CE 240	3:0	Engineering Seismology
CE 241	3:0	Introduction to the theory of Plasticity
CE 242	3:0	Probabilistic Methods in Civil Engineering
CE 266	3:0	Pavement Engineering

Water Resources and Environmental Engineering

Hard Core: 24 Credits (All courses are mandatory)

CE 207	3:0	Computational Fluid Dynamics in Water Resources Engineering
CE 208	3:0	Surface Water Hydrology
CE 209	3:0	Ground Water and Contaminant Hydrology
CE 210	3:0	Systems Techniques in Water Resources & Environmental Engineering.
CE 211	3:0	Water Quality Modeling
CE 212	3:0	Design of Water Supply and Sewerage Systems

One 3:0 core course from either the Geotechnical Engineering or the Structural Engineering streams

A suitable 3:0 mathematics course will be identified by the department at the beginning of the term.

Project: 22 Credits

CE299	0:22	Dissertation Project

Electives: 18 Credits, of which at least 9 credits must be from among the group electives listed below.

CE 255	3:0	Urban Hydrology
CE 256	3:0	Stochastic Hydrology
CE 258	3:0	Remote Sensing and GIS for Water Resources and Environmental Engineering
CE 259	3:0	Regionalization in Hydrology and Water Resources Engineering.
ME 201	3:0	Fluid Mechanics
AS216	3:0	Introduction to Climate Systems

Structural Engineering

Hard Core: 24 Credits (All courses are mandatory)

CE 214	3:0	Solid Mechanics
CE 215	3:0	Mechanics of Structural Concrete
CE 216	3:0	An Introduction to Finite Elements in Solid Mechanics
CE 217	3:0	Linear Structural Dynamics
CE 218	3:0	Optimization Methods
CE 219	3:0	Stability of Structures

One 3:0 core course from either the Geotechnical Engineering or the Water Resources and Environmental Engineering streams

A suitable 3:0 mathematics course will be identified by the department at the beginning of the term.

Project: 22 Credits

CE 299 0:22 Dissertation Project

Electives: 18 Credits of which at least 9 credits must be from among the group electives listed below.

CE 273 3:0 Fracture Mechanics
CE 275 3:0 Nonlinear FEM in Structural Engineering
CE 276 3:0 Structural Masonry
CE 287 3:0 Stochastic Structural Dynamics
CE 291 3.0 Uncertainty Modelling and Analysis
CE 294 3:0 Monte Carlo Simulations in Structural Mechanics

M Tech Programme in Transportation and Infrastructure Engineering

Hard Core: 25 Credits (All courses are mandatory)

CE 266 3:0 Pavement Engineering
CE 212 3:0 Design of Water Supply and Sewerage Systems
CE 263 3:0 Modelling Transport and Traffic
CE 218 3:0 Optimization Methods
MG 223 3:0 Applied Operations Research
ST 210 3:1 Principles and Applications of GIS and Remote Sensing
MA 261 3:0 Probability Models
MG 221 2:1 Applied Statistics

Project: 22 credits

CE 299 0:22 Dissertation Project

Electives: 18 Credits of which at least 9 credits should be from among the electives listed below.

CE 204 3:0 Foundation Engineering
CE 206 3:0 Ground Improvement and Geosynthetics
CE 267 3:0 Transportation Statistics and Micro-simulation
CE 215 3:0 Mechanics of Structural Concrete
CE 216 3:0 Introduction to Finite Elements in Solid Mechanics
ST 202 3:0 Renewable Energy – Technology, Economics and Environment
ST 203 3:0 Technology and Sustainable Development

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

Introduction to genesis of soils, basic clay mineralogy; Principle of effective stress, permeability and flow; Stresses and Strains; Mohr circles, failure criteria, soil laboratory tests; Critical state and stress paths. Shear Strength and Stiffness of Sands; Consolidation, shear strength and stiffness of clays

Tejas. G Murthy

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 202 (AUG) 3:0
Earthquake Geotechnical Engineering

Introduction to engineering seismology. Plate tectonics. Earthquake magnitude. Ground motion. Effect of local soil conditions on ground motion. Dynamic behaviour of soils. Analysis of seismic site response. Liquefaction phenomena and analysis of pore pressure development. Laboratory and in-situ testing for seismic loading. Analysis and design of slopes, embankments, foundations and earth retaining structures for seismic loading. Case histories. Mitigation techniques and computer-aided analysis

G Madhavi Latha

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

CE 203 (AUG) 3:0
Earth and Earth Retaining Structures

Lateral earth pressure coefficients, Rankine and Coulomb theories. Graphical constructions, passive earth pressure with curved rupture surfaces, arching, stability of retaining walls, stability of vertical cuts. Braced excavations, anchored sheet piles, stability of infinite slopes, stability of finite slopes. Methods of slices - Swedish, Morgenstern and Price methods. Stability analysis of earth and rock-fill dams.

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.

CE 204 (AUG) 3:0
Foundation Engineering

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.

T G Sitharam

Bowles, J.W., Foundation Analysis and Design, 5th Edn., McGraw-Hill, 1996.
Das, M. B., Principles of Foundation Engineering, Brooks/Cale Engineering Division, 1984.

CE 205 (JAN) 3:0
Geo-environmental Engineering

Source, production and classification of wastes. Soil pollution processes. Physical, chemical and biological interactions in soil. Effects on geotechnical properties and case studies. Waste disposal facilities such as landfills and impoundments, slurry walls, etc. Barrier systems- basic concepts, design and construction, stability, compatibility and performance. Transport in subsurface; reuse of waste materials. Contaminated site remediation.

P V Sivapullaiah

Daniel, D. E., Geotechnical Practice for Waste Disposal, Chapman and Hall, London, 1993.
Reddi, L. N., and Inyang, H. F. Geoenvironmental Engineering- Principles and Applications Marcel Dekker, Inc., 2000.
Sharma, H. D., and Lewis, S.P. Waste Containment Systems, Waste Stabilization and Landfills: Design and Evaluation, John Wiley & Sons, Inc. New York, 1994.

CE 206 (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, soil reinforcement principles, properties of geo-synthetics, applications of geo-synthetics in bearing capacity improvement, slope stability, retaining walls, embankments on soft soil, and pavements, filtration, drainage and seepage control with geo-synthetics, geo-synthetics in landfills, soil nailing and other applications of geo-synthetics.

G L Sivakumar Babu and G. Madhavi Latha

Manfred R. Hausmann, Engineering Principles of Ground Modification, McGraw-Hill Pub, Co., 1990.
Jones, C.J.E.P., Reinforcement and Soil Structures, Butterworth Publications, 1996.
Koerner, R. M., Designing with Geosynthetics, Prentice Hall Inc. 1998.

CE 207 (Aug) 3:0
Computational Fluid Dynamics in Water Resources Engineering

Governing equations of fluid dynamics, numerical solution of ODEs, Classification of Quasi-Linear PDEs, classification of PDEs, Solution methods for Parabolic, Elliptic and Hyperbolic PDEs and their analysis. Curvilinear co-ordinates and grid generation. Introduction to finite difference, finite volume and finite elements method, Application of CFD to open channel flow, pipe flow, porous media and contaminant transport problems.

M. S. Mohan Kumar

Computational Fluid Dynamics: Applications in Environmental Hydraulics, edited by Paul D. Bates, Stuart N. Lane, Robert I. Ferguson, Wiley; 1st edition, 2007.
Computational Fluid Dynamics: A Practical Approach, by Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu, Elsevier, 2013.
Computational Fluid Dynamics in Drinking Water Treatment, by Bas Wols, IWA Publishing, 2011.
Computational Fluid Dynamics for Engineers, By Andersson et al, Cambridge University Press, New York, 2012.
Fundamentals of Computational Fluid Dynamics, by Tapan K Sinha, University Press, 2004.
Applied Numerical Analysis, by Curtis F. Gerald and Patrick O. Wheatley, Addison and Wesley, 1994

CE 208 (AUG) 3:0
Surface Water Hydrology

Review of basic hydrology, hydrometeorology, infiltration, evapotranspiration, run-off 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 Poulhus, J.L.H., Hydrology for Engineers, McGraw-Hill, 1985.

CE 209 (Aug) 3:0
Ground Water and Contaminant Hydrology

Groundwater movement and balance, equations of flow. Well hydraulics: Models and methods, pumping tests, slug tests, aquifer tests - porous and fractured media, regional groundwater resources evaluation, groundwater recharge, groundwater monitoring, groundwater quality, mass transport in groundwater. Tracer tests. Scale effects of dispersion. Solute transport modeling. Transport in fractured media.

M Sekhar

Freeze, A.R., and Cherry, J.A., Ground Water, Prentice Hall, 1979.
Domenico, P.A., and Schwartz, F.W., Physical and Chemical Hydrogeology, John Wiley, 1990.
Batu, V., Aquifer Hydraulics, John Wiley, 1998.
Lerner, D.N., Issar, A.S., and Simmers, I., Groundwater Recharge, International Contributions to Hydrogeology, Vol.8, Verlag Heinz Heise, 1990.
Nielsen, D.M., Practical Handbook of Groundwater Monitoring, Lewis Publishers, 1991.

CE 210 (AUG) 3:0
Systems Techniques in Water Resources and Environmental 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 and Analysis', Tata-McGraw Hill, New Delhi, 2005.
Mays, L.W. and Tung, Y-K,'Hydrosystems Engineering and Management', McGraw Hill, 1992.

CE 211 (JAN) 3:0
Water Quality Modelling

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 212 (JAN) 3:0
Design of Water Supply and Sewerage Systems

Basics of hydraulics and hydrology. Introductory chemistry and biology. Water distribution systems, water processing, operation of networks. Design of water supply units, wastewater flows and collection systems, wastewater processing. Advanced wastewater treatment and water reuse.

M S Mohan Kumar

Mark J Hammer & Mark J Hammer Jr., Water and Wastewater Technology, Fifth Edition, Pearson Prentice Hall, Columbus, USA, 2004.

CE 213 (JAN) 0:1j
Experimental Methods in Environmental Engineering

Water quality measurement – chemical and instrument methods, Contaminant transport through water and soil-water medium. Experiments on aeration. Experiments on water conveyance systems – pipes and open channels.

M Sekhar and M S Mohan Kumar

Current literature/ Laboratory manuals

CE 214 (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. Pure bending of thin rectangular and circular plates, small deflection problems in laterally loaded thin rectangular and circular plates. Outline of Mindlin plate theory. Introduction to yield and plasticity.

Narayan K. Sundaram

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.
Theoretical Elasticity, A.E. Green and W. Zerna, 1968, Dover Publications

CE 215 (AUG) 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.

J.M. Chandra Kishen

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 216 (AUG) 3:0
An Introduction to Finite Elements in Solid Mechanics

Concepts of the stiffness method. Energy principles. Continuum BVP and their integral formulation. Variational methods: Raleigh-Ritz, weighted residual methods, virtual work and weak formulations. Finite element formulation of one, two and three dimensional problems, Isoparametric formulation. Computational aspects and applications

Debraj Ghosh

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.

CE 217 (AUG) 3:0
Linear Structural Dynamics

An overview of continuous dynamical systems; principle of virtual work; Hamilton's principle; Lagrangian equations of motion; equations of motion by Reynolds transport theorem; PDEs of motion for taut strings; Euler-Bernoulli beams and Kirchhoff plates; solutions of governing PDEs through separation of

variables; orthonormal bases and eigenfunction expansions; Rayleigh-Ritz and weighted residual methods; finite element semi-discretizations of continuous dynamical systems; semi-discrete MDOF systems and eigenvalue problems; modal dynamics and the notion of an SDOF model; free and forced vibration responses; damped MDOF systems; structures under support excitations; a brief overview of eigensolution techniques; direct integration techniques including Euler and Newmark-beta methods.

D Roy

D Roy and G V Rao, 2012, Elements of Structural Dynamics: A New Perspective, John Wiley, New York.
L Meirovitch, 1984, Elements of Vibration Analysis, McGraw-Hill, New York.

CE 218 (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.
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CE 219 (JAN) 3:0
Stability of Structures

Analysis of beam columns. Stability functions. Behavior of ideal columns. Bifurcation buckling and limit point instability. Mechanical models of stability. Static and dynamic formulations. Energy methods. Finite element formulation. Lateral torsional buckling of beams. Buckling of frames. Imperfection sensitivity and post critical behavior. Buckling of beams on elastic foundations, arches and plates. Thermal buckling. Inelastic buckling. Dynamic analysis of stability. Parametric instabilities and stability under nonconservative forces. Divergence and flutter.

C S Manohar

S P Timoshenko and J M Gere, 1963, Theory of elastic stability, McGraw Hill, London.
G J Simtses and D H Hodges, 2005, Fundamentals of structural stability, Elsevier, Amsterdam.
J M T Thompson and G W Hunt, 1973, A general theory of elastic stability, John Wiley, London

CE 231 (AUG) 2:0
Soil Stabilization by Admixtures

Principles of soil stabilization. Role of admixtures. Purpose-based classification of soils. Methods of stabilization - lime, cement, bitumen and special chemicals; mechanisms, uses and limitations. Use of fly ash and other waste materials. Methods and applications of grouting; Application to embankments, excavations, foundations and sensitive soils.

P V Sivapullaiah

Ingles, O.G. and Metcalf, J.B., Soil Stabilization, Principles and Practice, Butterworths, 1972.
Bowen, R., Grouting in Engineering Practice, Allied Science Publishers Ltd., 1975.

CE 232 (AUG) 2:0
Fundamentals of Soil Behaviour

Origin of soils, identification of clay minerals, soil structure, soil classification, soil - water interactions in the environment. Effective stress concepts, role of mineralogy in hydraulic conductivity. Consolidation and shear strength of fine-grained soils. Problematic soils

M Sudhakar Rao & P Raghuveer Rao

J. K. Mitchell, Fundamentals of Soil Behaviour, John Wiley, 1993.
R. N. Yong & B. P. Warkentin, Soil Properties and Behaviour, Elsevier, 1975,
H. Y. Fang & J. L. Daniels, Introductory Geotechnical Engineering-An Environmental Perspective, Taylor and Francis, 2006

CE 234 (JAN) 2:0
Soil Dynamics

Fundamental of vibrations; analysis of free and forced vibrations using spring dashpot model; block vibration test for determining stiffness and damping coefficient of soil mass; formulation of the problem for the multi-degree freedom system; theories for foundations on elastic half space; effect of different pressure distribution; comparison with spring-dashpot

model; wave propagation in bar and elastic media; different types of waves; resonant column test for determination of elastic and shear modulus; geophysical survey using reflection, refraction, steady state vibration and cross hole shear tests, liquefaction analysis; cyclic shear test; seismic bearing capacity of foundations and seismic earth pressures, vibration isolations.

Jyant Kumar

Richart, F.E., Woods, R.D. and Hall, J.R., Vibrations of soils and foundations. Prentice-Hall, 1970.
Major. A., Vibration Analysis and Design of Foundations for Machines and Turbines. Collets, 1962.
Robert W. Day., Geotechnical Earthquake Engineering Handbook, McGraw-Hill, 2002

CE 236 (JAN) 2:1
Behaviour and Testing of Unsaturated Soils

Identification and classification of expansive and collapsing soils, effective stress concepts, matric and osmotic suction, collapse, heave and strength characteristics of unsaturated soils, flow through unsaturated soils. Laboratory evaluation of swell pressure and swell potential, tests to evaluate collapse potential. Measurements of soil suction.

M Sudhakar Rao & P Raghuveer Rao

Blight, G.E. Mechanics of Residual Soils, Taylor & Francis Pub. 1997
Fredlund, D.G. and Rahardjo, H. Soil Mechanics for Unsaturated Soils, Wiley-Interscience Publications,1993
Nelson, J.D. and Miller, D.J. Expansive soils-Problems and Practice in Foundation and Pavement Engineering. Wiley-Interscience Pub. (1992)

CE 237 (JAN) 2:0
Rock Mechanics

Classification of inferential testing. Transitional materials engineering property evaluation. Laboratory methods and in-situ tests. Friction in rocks; elasticity and strength of rocks in situ stress determination. Application of rock mechanics in engineering, and underground opening. Slope stability and foundation problems.

T G Sitharam

Goodman, R.E., Rock Mechanics (2nd Edn.), John Wiley and Sons, 1982.
John. A. Franklin and Maurice B. Dusseault, Rock Engineering, McGraw-Hill Publishing Company, New York, 1989.

CE 239 (JAN) 3:0
Computational Geotechnics

Introduction to numerical modeling in geotechnical engineering. Review of basic concepts. Solution of nonlinear systems of equations. Finite difference method. Finite element method. Discrete element method. Measured soil response. Constitutive modeling of soil response. Artificial Neural Networks. Using finite difference, finite element and discrete element computer codes. Application for solving geotechnical engineering problems.

G Madhavi Latha

Desai, C.S. and Christian, J.T. Eds. Numerical Methods in Geotechnical Engineering, McGraw-Hill, 1977.
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.

CE 240 (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 241 (JAN) 3.0
Introduction to the Theory of Plasticity

1D plasticity and viscoplasticity; physical basis of plasticity; uniaxial tensile test & Bauschinger effect; phenomenological basis of assumptions in plasticity; Levy-Mises equations; yield criteria (Tresca, von Mises, Mohr-Coulomb, Drucker-Prager); geometry of yield surfaces; flow rules and hardening ; plastic / viscoplastic potentials; Drucker's postulate;convexity; normality; Illyushin's principle; shakedown; problems in rigid-perfectly plastic solids; slipline fields; introduction to upper and lower bounds; selected rigid-perfectly plastic and elastic-plastic boundary value problems; advanced hardening models; introduction to computational plasticity; radial return and other integration algorithms

Tejas G Murthy & Narayan K Sundaram

Chakrabarty, J. Theory of Plasticity, Butterworth, 2006
Calladine, C.R., Plasticity for Engineers, Woodhead, 2000
Lubliner J., Plasticity Theory, Dover, 2008

CE 242 (Aug) 3:0
PROBABILISTIC METHODS IN CIVIL ENGINEERING (3:0)

Randomness, uncertainty, modeling uncertainty, engineering judgment, introduction to probability, measures of variability, probability theory, random variables, probability mass and density functions, moments of distribution, Bayes theorem, Stationary processes, autocovariance functions, functions of random fields, sampling techniques, concepts of sampling, sampling plans, decisions based on samplings. levels of reliability, loads and resistances, reliability methods, first order second moment, (FOSM) method, Hasofer-Lind approach, comparative discussion, simulation methods, random number generation, decision making, branching, use of fault tree and event tree analysis and examples in civil engineering.

G L Sivakumar Babu

Ang, A.H.-S. and Tang, W.H. (1975 and 1984). Probability Concepts in Engineering Planning and Design, Vol. 1 and Vol.2 , Basic Principles, John Wiley, New York.
Nathabandu T. Kottegoda and Renzo Rosso (1998) Statistics, Probability, and Reliability for Civil and Environmental Engineers, McGraw-Hill International edition.
Baecher, G.B. and Christian, J.T. (2003). Reliability and Statistics in Geotechnical Engineering, John Wiley and Sons, London and New York

CE 255 (AUG) 3:0
Urban Hydrology

Review of basic hydrology. Storm water runoff generation; return period; hydrologic risk; frequency analysis – IDF relationships; open channel flow in urban watersheds; interception storage, infiltration, depression storage; combined loss models; estimation of runoff rates from urban watersheds; flow routing; storm water drainage structures; storm water detention; structural and non-structural control measures; Source control techniques; urban storm water models. Introduction to urban ground water systems.

P P Mujumdar

Butler, D. & Davies, J.W., Urban Drainage, Spon Press, 2nd Edn., 2004.
Akan A.O and Hioughtalen R.J., Urban Hydrology, Hydraulics and Storm Water Quality – Engineering Applications and Computer Modeling, John Wiley & Sons 2003.
Hall, M.J., Urban Hydrology. Elsevier, 1984.
Shaw, E.M., Hydrology in Practice, 3rd Edn., Chapman & Hall, 1994.

CE 256 (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 - auto correlation and spectral density functions. Applications to hydrologic forecasting.

P P Mujumdar

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 258 (JAN) 3:0
Remote Sensing and GIS for Water Resources & Environmental Engg

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 259 (JAN) 3:0
Regionalization in Hydrology and Water Resources Engineering

Prediction in ungauged basins. Regional frequency analysis- probability weighted moments and its variations, stationary and non-stationary distributions, regional goodness-of-fit test. Approaches to regionalization of hydrometeorological variables and extreme events. Regional homogeneity tests. Prediction of hydrometeorological variables in gauged and ungauged basins, Estimation of probable maximum precipitation and probable maximum flood, and their use in hydrologic design.

V V Srinivas

Prerequisite: CE 208

Diekkrüger, B., Schröder, U., Kirkby, M. J., Regionalization in Hydrology, IAHS Publication no. 254, 1999.
Hosking, J. R. M., and Wallis, J. R., Regional Frequency Analysis: An Approach Based on L-Moments, Cambridge University Press, 1997.
Rao, A.R. and Srinivas, V.V., Regionalization of Watersheds - An Approach Based on Cluster Analysis, Series: Water Science and Technology Library, Vol. 58, Springer Publishers, 2008.

CE263 (AUG) 3:0
Modelling Transport and Traffic

Approaches to travel demand modelling; trip-based modelling approach, activity based travel demand modelling, land use-transport models; traffic flow theory; deterministic and stochastic models of traffic flows; delay and saturation flow models; pedestrian flow modeling; optimization of public transport system

Ashish verma

J. de D. Ortuzar and L.G. Willumsen, Modelling Transport, John Wiley and Sons, 2001.
A. D. May, *Traffic Flow Fundamentals*, Prentice–Hall, 1990
Vuchic Vukan R., Urban Transit: Operations, Planning and Economics, Prentice Hall, 2005.

CE 266 (AUG) 3:0

Pavement Engineering

Introduction to pavement engineering: Design of flexible and rigid pavements; selection of pavement design input parameters, traffic loading and volume, material characterization, drainage, failure criteria: pavement design of overlays and drainage system: pavement performance evaluation: non-destructive tests for pavement: IRC, AASHTO design codes: maintenance and rehabilitation of pavements

P Anbazhagan

Rajib B Mallick and Tahar El-Korchi, Pavement Engineering, Principles and Practice, CRC Press, 2009
Huang, Y.H, Pavement Analysis and Design, Prentice-Hall, New Jersey, 1993.
E. J. Yoder, M. W. Witczak, Principles of Pavement Design, Wiley New York, 1975.

CE267 (JAN) 3:0
Transportation Statistics and Micro-simulation

Role of statistics in transportation engineering; graphical methods for displaying transportation data; numerical summary measures; random variables in transportation; common probability distributions in transportation; use of sampling and hypothesis testing in transportation; use of ANOVA; regression models for transportation; Bayesian approaches to transportation data analysis; traffic micro-simulation models, analysing micro-simulation outputs, performance measures.

Ashish Verma

C. H. Spiegelman, E. S. Park, and L.R. Rilett, Transportation Statistics and Microsimulation, CRC Press, 2011.
J. R. Benjamin and C. A. Cornell, Probability, Statistics, and Decisions for Civil Engineers, McGraw-Hill Book Company, 1970.

CE 273 (JAN) 3:0
Fracture Mechanics

Definition of stress intensity factor. Fracture toughness. Energy release rate, critical energy release rate. Crack mouth opening displacement, R-curve. Elasto-plastic fracture mechanics and J-integral. Mixed-mode crack propagation, fatigue crack propagation. Computational fracture mechanics. Introduction to fracture of quasi-brittle materials like concrete, Non-linear fracture models with softening, Size effect in fracture of concrete.

J M Chandra Kishen

David Broek, Elementary Engineering Fracture Mechanics, Sijthoff and Noordhaff, Alphen Aan Den Rijn, The Netherlands.
Anderson, T. L., Fracture Mechanics: Fundamentals and Applications, CRC Press, USA, Second Edition.
Shah, S. P., Swartz, S. E. and Ouyang, C., Fracture Mechanics of Concrete: Applications of Fracture Mechanics to Concrete, Rock and Other Quasi-Brittle Materials, John Wiley and Sons, USA

CE 275 (JAN) 2:0
Nonlinear FEM in Structural Engineering

Concept of material, geometric, and contact nonlinearities. Review of continuum mechanics: stress and strain measures; balance laws. Review of continuum plasticity: rules for yield, flow, and hardening. Total Lagrangian and updated Lagrangian formulations for geometrically nonlinear solid continua. FE formulations for inelastic solids with linear/nonlinear strain-displacement relations. Thermo-mechanical analysis. Problems of structural dynamics. General solution techniques

C S Manohar
Pre-requisite:: Background in FEM and solid mechanics
T Belytschko, W K Liu, B Moran, and K I Elkhodary, 2014, Nonlinear finite elements for continua and structures, 2nd Edition, Wiley, Chichester.
J N Reddy, 2004, An introduction to nonlinear finite element analysis, Oxford University Press, New Delhi.
W F Chen and D J Han, 2008, Plasticity for structural engineers, J .Ross publishing / Cengage Learning, New Delhi.
J Bonet, and R D Wood, 2008, Non-linear continuum mechanics for finite element analysis, Cambridge University Press, Cambridge.

CE276 (JAN) 3:0
Structural Masonry

Masonry materials, Masonry characteristics, Compression failure theories, masonry in tension, shear and biaxial stress, Laterally loaded un-reinforced walls, Strength of masonry arches, Design of reinforced and un-reinforced masonry structures.

B V VENKATARAMA REDDY

Hendry, A. W., Structural Masonry, MacMillan Press, 1998
Current literature

CE 287 (JAN) 3:0
Stochastic Structural Dynamics

Introduction to random variables and processes: probability, random variables. Transformations of random variables. Stationary, ergodic and non-stationary stochastic processes. Linear transformation of stationary-ergodic stochastic processes. Normal Gaussian Stochastic processes. PSD functions. Wiener processes and an introduction to Ito calculus. Response of SDOF and MDOF oscillators under random inputs. Oscillators subject to white noise excitations. Input-output relations in time and frequency domains under the assumption of response stationarity. Handling non-stationarity in the response. level crossing and first passage problems. Nonlinear oscillators under random inputs: sources of non-linearity. Equivalent

linearization and perturbation methods. Numerical integration and Monte Carlo simulations: Ito-Taylor expansions. Stochastic Euler and Heun methods. Higher order implicit and explicit methods. Errors in Monte-Carlo simulations. Variance reduction techniques.

D Roy

Lin, Y K, Probabilistic Structural Dynamics, McGraw-Hill
Kloeden, P.E. and Platen, E., Numerical Solutions of Stochastic Differential Equations, Springer
Ghanem, R.G and Spanos, P D, Stochastic Finite Elements: A Spectral Approach, Springer-Verlag.

CE 291 (JAN) 3:0
Uncertainty modelling and analysis

Deterministic vs. nondeterministic perspectives. Sources of uncertainty. Epistemic vs. aleatoric uncertainty. Data driven vs. physics driven uncertainty modelling. Different approaches such as probabilistic, interval, fuzzy. 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

Applied Statistics and Probability for Engineers by Douglas C. Montgomery & George C. Runger, John Wiley and Sons, 2010
Selected works from the current literature will be given by the instructor

CE 294 (AUG) 3:0
Monte Carlo Simulations in Structural Mechanics

Review of probability and statistics. Pseudo-random numbers; tests for randomness; generation of scalar and vector random variables; transformation techniques; accept-reject method; Markov Chain, Monte Carlo, Review of random processes. Simulation of scalar and vector random processes; Fourier and Karhunen-Loeve expansions; filtered white noise models and SDE-s. Applications to structural reliability estimation. Variance reduction techniques; subset simulations; Girsanov transformation; Sequential Monte Carlo.

C S Manohar

Prerequisites: Background in theories of probability and random processes.
J.S. Liu, Monte Carlo strategies in scientific computing, Springer, New York, 2006.
P.E. Kloeden and E.Platen, Numerical solution of stochastic differential equations, Springer-Verlag, Berlin, 1992.
A.Papoulis,, Probability, random variables and stochastic processes, 3rd Edition, McGraw-Hill, New York. 1991.

CE 299 0: 22 Dissertation Project

The project work is aimed at training the students to analyze independently problems in geotechnical engineering, water resources and environmental engineering, structural engineering and transportation and infrastructural engineering. The nature of the project could be analytical, computational, experimental, or a combination of the three. The project report is expected to show clarity of thought and expression, critical appreciation of the existing literature, and analytical, computational, experimental aptitudes of the student.

Faculty