CIVIL ENGINEERING

Syllabus for Revised M.E. Program (from August 2015)

Semester 1 Common to all students

Core: 18 Credits

CE 201N 3:0 Basic Geomechanics
CE 202N 3:0 Foundation Engineering
CE 203N 3:0 Hydrological Processes
CE 204N 3:0 Solid Mechanics
CE 205N 3:0 An Introduction to Finite Elements in Solid Mechanics
MA------- 3:0 Math course

a) The 3:0 credits mathematics course will be identified by the Department at the beginning of the semester.
b) **To fulfill Major requirement in an Area,** students shall complete minimum 21 course credits (15 core + 6 elective) and 22 Dissertation project credits in the said Area.
c) **For optional Minor in one of the other two Areas**, a student must complete minimum of 12 credits in the said Area.

Major in Geotechnical Engineering

Core: 9 Credits

CE 206N 3:0 Earth and Earth Retaining Structures
CE 207N 3:0 Geoenvironmental Engineering
CE 208N 3:0 Ground Improvement and Geosynthetics
CE299N 0:22 Dissertation Project

Major in Structural Engineering

Core: 9 Credits

CE 209N 3:0 Mechanics of Structural Concrete
CE 210N 3:0 Linear Structural Dynamics
CE 211N 3:0 Stability of Structures

CE299N 0:22 Dissertation Project

Major in Water Resources and Environmental Engineering

Core: 12 Credits

CE 212N 3:0 Computational Fluid Dynamics in Water Resources Engineering
CE 213N 3:0 Systems Techniques in Water Resources & Environmental Engineering
CE 214N 3:0 Water Quality Modeling
CE 215N 3:0 Stochastic Hydrology
CE299N 0:22 Dissertation Project

Electives in Geotechnical Engineering

CE 220N 3:0 Pozzolanic Stabilization of Soils
CE 221N 3:0 Earthquake Geotechnical Engineering
CE 222N 3:0 Fundamentals of Soil Behaviour
CE 223N 3:0 Soil Dynamics
CE 224N 2:1 Behaviour and Testing of Unsaturated Soils
CE 225N 3:0 Engineering Rock Mechanics
CE 226N 3:0 Computational Geotechnics
CE 227N 3:0 Engineering Seismology
CE 228N 3:0 Introduction to the Theory of Plasticity
CE 229N 3:0 Probabilistic Methods in Civil Engineering
CE 230N 3:0 Pavement Engineering

Electives in Structural Engineering

CE 235N 3:0 Optimization Methods
CE 236N 3:0 Fracture Mechanics
CE 237N 3:0 Nonlinear FEM in Structural Engineering
CE 238N 3:0 Structural Masonry
CE 239N 3:0 Stochastic Structural Dynamics
CE 240N 3.0 Uncertainty Modeling and Analysis
CE 241N 3:0 Monte Carlo Simulations in Structural Mechanics

Electives in Water Resources and Environmental Engineering

CE 245N 3:0 Design of Water Supply and Sewerage Systems
CE 246N 3:0 Urban Hydrology
CE 247N 3:0 Remote Sensing and GIS for Water Resources and Environmental Engineering
CE 248N 3:0 Regionalization in Hydrology and Water Resources Engineering
ME 201 3:0 Fluid Mechanics
AS216 3:0 Introduction to Climate Systems

Semester 1 (mandatory for all students)

CE 201N (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 202N (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 203N (AUG) 3:0 Hydrological Processes

Introduction to hydrological processes, Reynolds transport theorem, Energy & momentum principles, Hydrograph analysis, Flood routing, Hydrologic statistics and frequency analysis, Hydrologic design, Groundwater movement and balance, Equations of flow, Well hydraulics, Groundwater recharge estimation, Groundwater modeling.

V V Srinivas & M Sekhar

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.
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

CE 204N (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 205N (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.

Major in Geotechnical Engineering

CE 206N (Jan) 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 207N (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 208N (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.

Major in Structural Engineering

CE 209N (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.

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 210N (Jan) 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 211N (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

Major in Water Resources and Environmental Engineering

CE 212N (Jan) 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 213N (Jan) 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 Tata-McGraw Hill, 2005.
Srinivasa Raju, K and Nagesh Kumar, D., Multicriterion Analysis in Engineering and Management, PHI Ltd., New Delhi, 2010.

CE 214N (JAN) 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 215N (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

Electives in Geotechnical Engineering

CE 220N (AUG) 3:0
Pozzolanic Stabilization of Soils

Need for stabilization, Principles of soil stabilization, Different methods of stabilization, Pozzolanic stabilizations, Classification of soils for stabilisation, Different methods of stabilization. Mechanism of lime, cement stabilization, stabilization of soils with different solid waste materials such as fly ash, rice husk ash, ground granulated blast furnace slag etc. Design and Application of stabilizing agents, Stabilisation for different applications such as Embankments, excavations, Roads, problematic soils etc. Deep mixing and Grouting methods, Containment of Hazardous materials.

P V Sivapullaiah

Ingels O. G. and Metcalf, J. B. Soil stabilization, Principles and Practice, Butterworths, 1973.
Bowen , R. Grouting in Engineering Practice, Allied Publishers Ltd. 1975.
Broms, B. B. Stabilisation of soils with Lime Columns, Foundations Engineering Hand Book. Fang, H. Y. 1991. (ebook).
Karol R. H., Chemical Grouting and Soil Stabilisation, CRC Press, 2003.

CE 221N (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 222N (Jan) 3:0
Fundamentals of Soil Behaviour

Origin of soils. Identification and classification of clay minerals. Inter-particle forces. Soil structure. Soil - water interactions in the environment. Effective stress concepts and inter-particle forces. Role of clay mineralogy in engineering properties; hydraulic conductivity. consolidation, shear strength. Problematic soils-soft soils, swelling soils, collapsing 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 223N (JAN) 3:0
Soil Dynamics

Fundamental of vibrations; analysis of free and forced vibrations using spring dashpot model; equations' formulation and solution; 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; dynamic tests 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; assessment of zone of liquefaction. 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.

CE 224N (Aug) 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 225N (JAN) 3:0
Engineering Rock Mechanics

Rock as an engineering material, Geological factors affecting rocks, Stress, Strain and Strength of rocks, Insitu stresses in rock, Intact Rock - Elastic Deformation, Discontinuities and deformability and strength of rock masses, permeability, anisotropy and in homogeneity in rocks, Stereonet Analysis, testing techniques, rock mass classification, Failure criteria for rock and rock masses, Rock mechanics interactions and rock engineering systems, Excavation and stabilization principles, rock slope stability, foundations on rock, rock blasting support and reinforcement, Underground excavation and stability, Urban tunnels, Problematic Rocks - Rock

Engineering, Modern modelling techniques & analyses in rocks.

T G Sitharam

Engineering Rock Mechanics: an Introduction to the Principles, 1997. Hudson J.A. and J.P. Harrison. Elsevier, Oxford
Introduction to Rock Mechanics by R.E.Goodman, John Wiley & Sons.
Engineering in Rocks for Slopes, Foundation and Tunnels, Editor T.Ramamurthy, Prentice Hall India Pvt. Ltd.
Additional Readings:
Additional literature, Related codes and manuals from International Society of Rock Mechanics, ASTM and Bureau of Indian Standards

CE 226N (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 227N (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 228N (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 229N (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 230N Pavement Engineering (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.

Electives in Structural Engineering

CE 235N (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 236N (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 237N (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.

CE238N (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 239N (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 240N (JAN) 3:0
Uncertainty Modeling 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 241N (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.

Electives in Water Resources and Environmental Engineering

CE 245N (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 246N (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 247N (AUG) 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 248N (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 203N

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.

CE 299N 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