CIVIL ENGINEERING
Syllabus for M Tech Civil Engineering and
M Tech Transportation and Infrastructure Engineering program (2019-20)

M Tech Program in Civil Engineering

Semester 1 Common to all students
Core: 18 Credits
CE 201 3:0 Basic Geomechanics
CE 202 3:0 Foundation Engineering
CE 203 3:0 Surface Water Hydrology
CE 204 3:0 Solid Mechanics
CE 205 3:0 Finite Element Method
CE 211 3:0 Mathematics for Engineers

Electives in Structural Engineering
CE 216 3:0 Random Vibration and Reliability Analyses
CE 218 3:0 Fire 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 239 3:0 Stochastic Structural Dynamics
CE 243 3:0 Bridge Engineering
CE 297 3:0 Problems in the Mathematical Theory of Elasticity
CE 298 3:0 Parallel computing in mechanics problems

Electives in Water Resources Engineering
CE 226 3:0 Open-channel Flow
CE 245 3:0 Design of Water Supply and Sewerage Systems
CE 247 3:0 Remote Sensing and GIS for Water Resources Engineering
CE 248 3:0 Regionalization in Hydrology and Water Resources Engineering
CE 249 3:0 Water Quality Modelling
ME 201 3:0 Fluid Mechanics
AS 216 3:0 Introduction to Climate Systems

Major in Geotechnical Engineering
Core: 9 Credits
CE 206 3:0 Earth and Earth Retaining Structures
CE 207 3:0 Geoenvironmental Engineering
CE 208 3:0 Ground Improvement and Geosynthetics
CE 299 0:22 Dissertation Project

Electives in Geotechnical Engineering
CE 220 3:0 Design of Substructures
CE 221 3:0 Earthquake Geotechnical Engineering
CE 222 3:0 Fundamentals of Soil Behaviour
CE 227 3:0 Engineering Seismology
CE 231 3:0 Forensic Geotechnical Engineering

Major in Structural Engineering
Core: 9 Credits
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

Electives in Structural Engineering
CE 216 3:0 Random Vibration and Reliability Analyses
CE 218 3:0 Fire 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 239 3:0 Stochastic Structural Dynamics
CE 243 3:0 Bridge Engineering
CE 297 3:0 Problems in the Mathematical Theory of Elasticity
CE 298 3:0 Parallel computing in mechanics problems

 majors in Structural Engineering

Electives in Water Resources Engineering
CE 226 3:0 Open-channel Flow
CE 245 3:0 Design of Water Supply and Sewerage Systems
CE 247 3:0 Remote Sensing and GIS for Water Resources Engineering
CE 248 3:0 Regionalization in Hydrology and Water Resources Engineering
CE 249 3:0 Water Quality Modelling
ME 201 3:0 Fluid Mechanics
AS 216 3:0 Introduction to Climate Systems

Major in Water Resources Engineering
Core: 12 Credits
CE 212 3:0 Computational Fluid Dynamics in Water Resources Engineering
CE 213 3:0 Systems Techniques in Water Resources Engineering
CE 214 3:0 Ground Water Hydrology
CE 215 3:0 Stochastic Hydrology
CE 299 0:22 Dissertation Project

Electives in Water Resources Engineering
CE 226 3:0 Open-channel Flow
CE 245 3:0 Design of Water Supply and Sewerage Systems
CE 247 3:0 Remote Sensing and GIS for Water Resources Engineering
CE 248 3:0 Regionalization in Hydrology and Water Resources Engineering
CE 249 3:0 Water Quality Modelling
ME 201 3:0 Fluid Mechanics
AS 216 3:0 Introduction to Climate Systems

M Tech Program in Transportation and Infrastructure Engineering

Core: 24 Credits
CE 235 3:0 Optimization Methods
CE 262 3:0 Public Transport System Planning
CE 269 3:0 Traffic Engineering
CE 270 3:0 Travel Demand Modeling
CE 272 3:0 Traffic Network Equilibrium
CE 274 3:0 Sustainable Urban Transportation Planning
CE 211 3:0 Mathematics for Engineers

One 3:0 credit core course from either Geotechnical Engineering/ Structural Engineering/ Water Resources Engineering

CE 299 0:22 Dissertation Project

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

Tejas G Murthy


CE 202 (AUG) 3:0
Foundation Engineering


P Anbazhagan


CE 203 (AUG) 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


CE 204 (AUG) 3:0
Solid Mechanics

and circular plates. Outline of Mindlin plate theory.

**Narayan K. Sundaram**


**CE 205 (AUG) 3:0**

**Finite Element Method**


**J M Chandra Kishen**


**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


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 & Tarun Rambha**

Mathematics for Physics: A Guided Tour for Graduate Students, Cambridge University Press


**Major in Geotechnical Engineering**

**CE 206 (JAN) 3:0**

**Earth and Earth Retaining Structures**


**Jyant Kumar**


**CE 207 (JAN) 3:0**

**Geo-environmental Engineering**

Sources, production and classification of wastes, Environmental laws and regulations, physico-chemical properties of soil, ground water flow and contaminant transport,
contaminated site characterization, estimation of landfill quantities, landfill site location, design of various landfill components such as liners, covers, leachate collection and removal, gas generation and management, ground water monitoring, end uses of landfill sites, slurry walls and barrier systems, design and construction, stability, compatibility and performance, remediation technologies, stabilization of contaminated soils and risk assessment approaches.

G L Sivakumar Babu


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, 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 Madhavi Latha


Major in Structural Engineering

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.

Ananth Ramaswamy


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


CE 210 (JAN) 3:0

Structural Dynamics


C S Manohar

Meirovich, L., 1984, Elements of vibration analysis, McGraw-Hill, NY
Clough R W and J Penzien, 1993, Dynamics of structures, McGraw-Hill, NY

**CE 228 (JAN) 3.0**

**Continuum Plasticity**

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.

**Prerequisites:** A graduate level course in solid mechanics or continuum mechanics.

**Debasish Roy**

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

**Major in Water Resources Engineering**

**CE 212 (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 in Drinking Water Treatment, by Bas Wols, IWA Publishing, 2011.
Applied Numerical Analysis, by Curtis F. Gerald and Patrick O. Wheatley, Addison and Wesley, 1994

**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**

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

**CE 214 (JAN) 3:0**

**Ground Water Hydrology**

water. Tracer tests and scale effects of dispersion. Solute transport modeling.

M Sekhar


CE 215 (JAN) 3:0
Stochastic Hydrology


P P Mujumdar

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

Electives in Geotechnical Engineering

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 Raghuvender Rao

Indian Standard Codes

CE 221 (Aug) 3:0
Earthquake Geotechnical Engineering


G Madhavi Latha


CE 222 (JAN) 3:0
Fundamentals of Soil Behaviour

Identification and classification of clay minerals, expansive and collapsing soils; Concepts and measurements of matric and osmotic suction, Role of inter-particle forces and suction in effective stress, Role of clay mineralogy, inter-particle forces and suction in volume change, hydraulic conductivity and shear strength of soils

M Sudhakar Rao and P Raghuvender Rao


CE 227 (JAN) 3:0
Engineering Seismology

Introduction to earthquake hazards. Strong ground motions, tsunamis, landslides,

P Anbazhagan


CE 231 (Aug) 3:0
Forensic Geotechnical Engineering

Introduction, Definition of a Forensic Engineer, Types of Damage, Planning the Investigation, investigation methodology, Collection of Data, Distress Characterization, Development of Failure, Hypothesis, Diagnostic Tests, Back Analysis, Technical Shortcomings, Legal Issues Reliability Aspects, Observation Method of Performance Evaluation, Case Histories related to settlement of Structures, lateral movement, backfill settlements, causes due to soil types such as collapsible soil, expansive soil, soluble soils, slope Failures and landslides, debris flow, slope softening and creep, trench collapses, dam failures, foundation due to earthquakes, erosion, deterioration, tree roots, groundwater and moisture problems, groundwater problems, retaining failures problems, pavement failures and issues, failures in soil reinforcement and geosynthetics, development of codal provisions and performance based analysis procedures.

G L Sivakumar Babu


Electives in Structural Engineering

CE 216 (Aug) 3:0
Random Vibration and Reliability Analyses


C S Manohar

Prerequisites: Background in structural dynamics and theory of probability


CE 218 (AUG) 3:0
Fire Structural Engineering


C S Manohar
Prerequisites: Background in structural dynamics and theory of probability

B Karlsson, and J Quintiere. 1999, Enclosure fire dynamics. CRC press, Boca Raton

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

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

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

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


CE 239 (JAN) 3:0
Stochastic Structural Dynamics

Debasish Roy
Lin, Y K, Probabilistic Structural Dynamics, McGraw-Hill
Kloeden, P.E. and Platen, E., Numerical Solutions of Stochastic Differential Equations, Springer

CE 243 (AUG) 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 297 (JAN) 3:0
Problems in the Mathematical Theory of Elasticity


Prerequisites: Graduate-level solid mechanics (CE-204 / ME-242 or equivalent) with a grade of B or higher, or instructor consent.

Narayan K Sundaram
Current and historic literature

CE 298 (JAN) 3:0
Parallel computing in mechanics problems

Introduction to parallel computing. Parallelization using MPI. Parallel operations on vectors and matrices; linear systems solving and eigenvalue problems. Substructuring and domain decomposition. Parallelization in statistical simulation.

Prerequisites: Programming experience using one of the languages among C/C++/Fortran. Familiarity with Linux/Unix.

Debraj Ghosh

Electives in Water Resources Engineering

CE 226 (AUG) 3:0
Open-channel Flow


P P Mujumdar

Page 9
CE 245 (AUG) 3:0
Design of Water Supply and Sewerage Systems


M S Mohan Kumar


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


D Nagesh Kumar


CE 248 (JAN) 3:0
Regionalization in Hydrology and Water Resources Engineering


V V Srinivas

Prerequisites: CE 203


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


M Tech Program in Transportation and Infrastructure Engineering

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


CE 269 (AUG) 3:0
Traffic Engineering


Tarun Rambha


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

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


CE 270 (AUG) 3:0
Travel Demand Modeling

Individual travel behavior and aggregate-level travel demand analysis; Alternative approaches to modeling travel demand (aggregate, trip-based approaches and disaggregate, activity-based approaches); Econometric methods for modeling travel demand (development, estimation, and application of statistical models for travel behavior analysis); Linear regression for activity and trip generation (specification, interpretation, estimation, hypothesis testing, market segmentation, non-linear specification, tests on assumptions); Mode choice and destination choice using discrete choice methods (introduction to binary logit and multinomial logit models, contrast with gravity methods); Traffic assignment/route choice (network equilibrium, system optimum); Model transferability; Microsimulation for activity-based models; Recent advances.

Abdul R. Pinjari


CE 271 (Jan) 3:0
Choice Modeling

Individual choice theories: Binary choice models; Unordered multinomial choice models (multinomial logit and multinomial probit); Ordered response models (ordered logit, ordered probit, generalized ordered response; rank-ordered data models); Maximum likelihood estimation; Sampling based estimation (choice-based samples and sampling of alternatives); Multivariate extreme value models (nested logit, cross-nested logit); Mixture models (mixed logit and latent class models); Mixed multinomial probit; Integrated choice and latent variable models; Discrete-continuous choice models with corner solutions; Alternative estimation methods (EM, analytic approximations, simulation); Applications to travel demand analysis.

Abdul R. Pinjari


CE 272 (JAN) 3:0
Traffic Network Equilibrium

Traffic assignment; Fixed points and Variational inequalities; Fundamentals of convex optimization; Shortest path algorithms; Wardrop user equilibrium; System optimum and Price of Anarchy; Link-based algorithms (Method of successive averages, Frank-Wolfe); Potential games; Variants of the traffic assignment problem (Multiple-classes, Elastic demand); Path-based algorithms; Origin-based methods; Sensitivity analysis.

Tarun Rambha


CE 273 (Aug) 3:0
Markov Decision Processes

Discrete time Markov chains; Transient and limiting behavior; Finite horizon MDPs; Backward induction; Infinite horizon models; Discounted, average, and total cost MDPs; Value and policy iteration; Linear programming methods; Approximate dynamic programming; Reinforcement learning; Dynamic discrete choice models; Applications to shortest paths, airline ticketing, dynamic pricing, adaptive signal control, and demand estimation.

Tarun Rambha


CE 274 (AUG) 3:0
Sustainable Urban Transportation Planning

Concept of sustainability and its relevance to urban transport; Introduction to Sustainable Transport; Indicators of Sustainable Transport; modelling and analytical techniques to measure and analyze sustainability of transportation projects and policies; Urban and Land use planning for Sustainable Transport; Modelling and Planning for Public transport, and Non-Motorized Transport; impact of factors related to perception/aspirations, travel behaviour, on development and promotion of sustainable transport.

Ashish Verma


CE 299 0:22 Dissertation Project

The project work is aimed at training the students to analyze independently problems in geotechnical engineering, water resources 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.