Detailed Contents of Courses for the M.Engg Programme in Civil Engineering

Structural Engineering

CE-501 Advanced Structural Analysis

Matrix algebra, solution of equations, review of energy principles, virtual work; degree of redundancy, choice of redundants, flexibility method, kinematic indeterminacy, development of element stiffness matrices, stiffness method of analysis of structures, computer applications and software development, axial force effects and eigenvalue analysis, introduction to finite element method, introduction to structural stability.

CE-502 Advanced Mechanics of Solids

Introduction to Cartesian tensors; stress tensor and tensorial transformation of stress; Mohr's circle for 3-D stress transformation; dyadic and indicial symbols; finite and infinitesimal strain tensors; Mohr's circle for 3-D strain; constitutive equations for anisotropic material; composite laminates; two dimensional theories of yield; Airy's stress function in plane elasticity; generalized Fourier series solution to biharmonic equation; elasticity in polar coordinates; thermoelasticity; numerical methods in elasticity.

CE-503 Advanced Reinforced Concrete

Constituent materials and their properties. Material behaviour and common models in various loading regimes and application for concrete, steel and reinforced cement concrete. Analysis in flexure; known methods and theories, pre-cracking, post cracking and behavior at ultimate load, analysis at discrete point on M-ø curve, moment-curvature relationships and ductility, non-linear analysis in flexure, effect of tension in concrete and tension stiffening load-deflection diagram, plastic rotation capacity and curvature ductility, deflection and crack control mechanism, recent researches in cracking and crack width, idealization and idealized models for analysis in flexure, analysis of prismatic non-prismatic sections in flexure. Shear in reinforced concrete; theories regarding diagonal tension problem, shear-flexure interaction, idealization, assumptions, assumptions, prevailing methods, their limitations and scope, ACI adaptation, Torsion as applied to concrete sections, strength of section in torsion for plain and reinforced concrete; review of theories, adaptation by code committee strength of section in combined shear and torsion.

CE-504 Advanced Engineering Mathematics

Numerical solutions of linear algebraic equations. Solutions of non-linear using first and second order iterative methods. Numerical differentiation and integration. Partial differential equations and finite difference methods. Eigen Value problems such as plates. Laplace equations. Applications of Legendre., Chebyshev, Hankal and Bessel Functions to Structural Problems. Application of Taylor Series, Runge Kutta Method. Calculus of Variation, Euler-Lagrange equations, Raleigh-Ritz & Galerkin techniques.

CE-505 Prestressed Concrete Design

Basic concepts of prestressed concrete, Systems of prestressing, materials. Partial prestressing, prestress losses. Use of high strength concrete. Structural behaviour of Beams for Elastic and Ultimate ranges for Bending and Shear. Moment curvature relationship, Camber and deflections. Detailed design of simple and continuous beams for Service and Ultimate loads. Design of End Anchorages. Determination of Cable layout. Construction techniques. Precast and in-situ pre-stressed concrete members. Applications to special structures.

CE-506 Finite Element Method

Basic equations of elasticity; virtual work; stiffness properties of structural elements; variational and weighted residual methods, applications to trusses, beams, plane frames, two-dimensional, axi-symmetric and three-dimensional solids; higher order and isoparametric elements; field and time-dependent problems of fluid and heat flow; computational modelling.

CE-507 Advanced Concrete Technology

Raw materials, manufacturing, composition physical properties of Ordinary Portland Cement. Effect and implication of variation in composition and various blends of cement. Hydration process and product of hydration, volume changes upon hydration. Structure of the hardened cement paste, its deformational characteristic and mechanisms, strength of hardened cement paste and factors affecting the strength of hardened cement paste. Properties of rock and mineral aggregates used in concrete and its influence on strength and durability of concrete. Properties of fresh and hardened concrete, factors affecting the properties and its correlation with performance, and test and measurement of these properties. Hot and cold weather concrete, fiber concrete, mass concrete, recycled concrete and Ferracment. Deterioration, causes and mechanism of deterioration of concrete with emphasis on some well known causes.

CE-508 Computer Methods in Structural Analysis

Introduction to finite difference calculus; applications in computing bending moments, shear force and deflection of beams, critical loads for columns and analysis of beams on elastic foundations; plate bending by finite difference; finite difference software development; introduction to finite element method; application to problems of Timoshenko beam and Mindlin plate bending with emphasis on software development.

CE-509 Theory of Plates and Shells

Equation of equilibrium and deformation. Cylindrical bending of Plates of Rectangular, Circular and other non-standard shapes. Classical methods of solutions. Navier, Levy Galerkin and Raleigh-Ritz methods. Strain Energy methods. Grillage and Orthotropic Plate theory. Applications of Finite difference and Finite Element methods. Large deflection of Plates. Geometric and material non-linearity. Theory of Shells. Membrane and bending theories. Shells of revolution, Symmetric and non-symmetric loads

applied to Cylindrical, Spherical and Conical Shells. Study of existing experimental results for Shells with complex boundary conditions. Simplified design of Cylindrical shells. Domes and Folded Plates.

CE-510 Structural Stability

Introduction to common areas of stability problems in structures, conservative and non-conservative loads, elastic and inelastic buckling of columns; stability of members under combined bending and axial loads; buckling of frames; torsional buckling of open sections; lateral stability of beams and buckling of thin plates and shells; design considerations for stability.

CE-511 Structural Dynamics

Single Degree of Freedom Systems: Formulation of the equation of motion and its methods of formulation, Free vibration response; undamped free vibration and damped free vibration; Response to different types of dynamic loadings and different methods of analysis of nonlinear structural response. Multi Degree of Freedom Systems: Formulation of equation of motion and evaluation of structural property matrix, undamped free vibration, Vibration frequencies; mode shapes, orthogonality conditions, methods of practical vibration analysis and analysis of nonlinear systems, introduction to random vibration, Application of structural dynamics to earthquake engineering and methods of determinstic analysis, soil frame interaction.

CE-512 Bridge Analysis and Design

Bridge loadings and bridge systems; types of deck structures and idealization; orthotropic plate theory and its application to multi-girder deck systems; use of finite difference and finite strip methods; composite steel girder-slab bridges, pseudo slab, girder-slab and multi- beam type prestressed concrete bridges, design consideration for substructures; analysis of horizontally curved bridge decks.

CE-513 Seismic Analysis & Design

Introduction to wave propagation in solid media, body and surface waves, reflection and refraction. Causes of earthquake,review of the seismicity of earth with special reference to Pakistan; computation of response to lateral forces. Review of structural vibration theory and response spectrum. Methods for analysis of multi-storeyed buildings and others subjected to earthquake motions. Design of reinforced concrete structures to resist earthquake forces, concepts of ductility and energy absorption. Reliability Analysis.

CE-514 Design of Tall Structures

Wind loads, Gust factors & Karman Vortices. Design for strength and stability, thermal loads, fatigue and corrosion. Behaviour of tall structures under static and dynamic loads. Design for buckling. Criteria for design of Chimneys, TV towers, Transmission towers and Tubular Scaffolding.

CE-515 Design of Steel Structures

Review of elastic-plastic concepts of structural behaviour; plastic design of beams and frames; design of plate girders, compression member with large width-thickness ratio, stiffened plate, composite design and behaviour, behaviour of rigid and semi-rigid connections; design considerations for fracture and fatigue; design of rigid frames; behaviour of multistory frames and second-order analysis.

CE-516 Repair Maintenance And Strengthening of Reinforced Concrete Structures

Review of engineering properties of conventional and prestressed reinforced concrete materials. Review of design theories and its implications. Review of deterioration and causes of deterioration of concrete structures and its implication on structures. Implication of debonding of reinforcing steel and analytical modelling of sections with unbounded reinforcement. Need of strengthening are re-strengthening. Prevailing strengthening techniques and their comparison. Recent researches in strengthening in flexure and shear, methodologies, analysis, design and execution. Strengthening techniques related to columns and foundations. Case studies of strengthened and re-strengthened structures.

CE-517 Performance-based Seismic Design

Mechanics of earthquakes and strong ground motion characteristics, response spectra and seismic response of elastic and inelastic systems, mechanical behaviour of structural members under earthquake excitations, seismic design philosophies, philosophy of seismic design for reinforced concrete structures, building code procedures for seismic design, advantages of performance-based seismic design, seismic performance levels, measures of seismic performance, seismic hazard, performance objectives, general approaches for estimating deformation capacity of the structures, response spectra, fundamental consideration of direct displacement-based design, analysis tools for direct displacement-based design, framed buildings, dual wall-frame buildings, masonry buildings, structures with isolation and added damping, pushover analysis.

EQ-521 Displacement Based Seismic Design

Philosophy and need for displacement based design (DBD), review of conventional force based design (FBD) methods with particular reference to seismic design codes, review for DBD methods, advantages of DBD over FBD with illustrative examples, seismic input for DBD method such as displacement spectrum; concept of hysteretic damping and displacement ductility; influence of displacement and ductility on spectral displacement response; attenuation model for displacement spectrum, fundamental considerations of DBD, design limit states and performance levels, single degree of freedom (SDF) structures, multi-degree of freedom (MDF) structures, p-delta effects, combination of seismic and gravity loadings, considerations for torsional response, capacity design of members, nonlinear analysis tools, force-displacement response for reinforced concrete members, force-displacement response for steel members, analysis related to capacity design philosophy, application of DBD in buildings, bridges and structures with base isolation and added damping.

EQ-523 Seismic Design of Steel and Composite Structures

Elastic and inelastic behaviour of steel subjected to static and dynamic loading, mechanical behaviour of steel beams, types of connection, behaviour of connections, methods of global analysis, seismic design of steel structures using seismic design provisions, concepts of ductility, inter-storey drift; behaviour factors/force reduction factors and damage, capacity design principles, typology of steel structures, effect of global instability, effects of diaphragms, semi-rigid connections and axial forces, seismic design of moment resisting steel frames; braced steel frames and composite structures, introduction to performance and displacement based design, hybrid force and displacement based design and use of advanced methods of analysis.

EQ-524 Seismic Design and Assessment of Masonry Structures

An introduction to masonry and non-engineered construction, mechanical properties of clay brick, cellular concrete block, autoclave aerated concrete (AAC) block, adobe and stone masonry units, categories of masonry walls for seismic resistance, in-plane and out-of-plane behaviour of masonry assemblages and walls, analytical methods for masonry walls, seismic design of masonry moment resisting wall frames and masonry-infilled frames, assessment of unreinforced masonry structures, design principles and code specifications for masonry construction, repair and strengthening techniques for damaged masonry buildings after earthquakes, displacement based design of masonry structures.

EQ-525 Loss Estimation and Hazard Mitigation

Modelling parameters, geometric nonlinearity and material inelasticity, concentrated vs. distributed plasticity modelling approach, nonlinear dynamic analysis, selection, scaling and matching of accelerograms, nonlinear static analysis, conventional pushover analysis, multi-modal pushover analysis and adaptive pushover analysis, nonlinear static procedures, capacity spectrum method (CSM), adaptive capacity spectrum method (ACSM), N2 method, modal pushover analysis (MPA) method and displacement based earthquake loss assessment (DBELA) method, seismic vulnerability assessment of single structures using nonlinear static and dynamic procedures with special reference to (FEMA) and Applied Technology Council (ATC) provisions, seismic vulnerability assessment of groups of structures (empirical and analytical methods), hazard, exposure, human/economic losses, remote sensing and global earthquake model (GEM) initiative.