

EQ-521 Displacement Based Seismic Design (3)

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-522 Performance Based Seismic Design (3)

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-523 Seismic Design of Steel and Composite Structures (3)

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 (3)

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 (3)

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.

EQ-526 Fundamentals of Fire Dynamics (3)

Fire and its ingredients, chemistry and physics of fires, smouldering, fuels and materials, combustion process, fire combustion products and toxicity, forms of heat transfer, heat flux as an indication of damage, radiation from fires, piloted and auto-ignition, ignition time, diffusion and premixed flames, flame spread, flame spread rate, burning rate, fire development, fire growth rate, fully developed fires, fire plumes, compartment fires, fire spread, smoke movement, smoke spread, smoke hazard management

EQ-527 Seismic Vulnerability Assessment of Bridges (3)

Bridge Typologies and Bridge components; Classification of Road Bridges; functional and operational requirements; Bridge planning and selection of Bridge site; Collection of bridge design data; Standard loading for bridge design and design process for highway bridges; Bridge management systems (process, characteristics and practice); Bridge management cycle; Bridge inventory data; Bridge inspection methods; Collection of bridge condition information; Bridge condition assessment (historical & recent perspective); Bridge assessment models and assessing a bridge in terms of damage and defects; Aging and deterioration processes; Performance problems and threats; Identifying functional deficiencies; Recognizing reduced redundancy; Bridge condition ratings; Bridge condition index; Challenges associated with various bridge component rating methods; Seismic vulnerability and assessment of damage; Systematic evaluations of bridges based on failure modes; Fragility curves; Repair and retrofitting, Prioritization; Optimization of retrofit methods

EQ-528 Finite Element Method (3)

Basic equations of elasticity; virtual work; stiffness; properties of structural elements; variational and weighted residual methods; application 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

EQ-529 FRP Reinforced Concrete (3)

Basic equations of elasticity; virtual work; stiffness; properties of structural elements; variational and weighted Overview of FRP reinforcement; constituent materials for FRP; properties of FRP composites; design issues such as cover delamination, FRP debonding; design basis for FRP reinforcement and strengthening; flexure and shear design; serviceability design of FRP RC beams; FRP reinforcement detailing; flexure strengthening of beams and slabs; shear strengthening of RC members; FRP confining for columns; fire resistance and endurance of FRP reinforced structures

EQ-530 Fracture Mechanics of Concrete (3)

Introduction to fracture mechanics; applications of fracture mechanics to concrete; principles of linear-elastic fracture mechanics; principles of nonlinear fracture mechanics; dynamic fracture mechanics; nonlinear fracture models; structure and fracture process of concrete; nonlinear fracture mechanics for mode I quasi-brittle fracture; test methods to determine mode I fracture properties for concrete; fracture resistance curves (R-curves) for quasi-brittle materials; tension softening response of concrete; applications of fracture mechanics to plain and reinforced concrete structures under static and temperature load

EQ-531 Structural Fire Engineering (3)

Fire safety in buildings; fundamentals of fire behaviour in buildings; room fires and post-flashover fires; estimating the temperatures in building compartments and individual structural members; fire severity and the concept of equivalent fire severity; standard test results and calculation methods for fire resistance; fundamentals of the behaviour of common construction materials under fire; application of structural analysis principles to the fire problem; design of structures exposed to fire; fire resistance design of steel structures; fire resistance design of concrete structures; fire resistance design of lightweight frame structures

EQ-532 Fire Safety and Management (3)

Fire safety concepts; design fires; flame spread, modelling of flame spread and fire growth; external fire spread and heat radiation; smoke movement; buoyancy; principles of smoke hazard management; smoke spread; smoke hazard management subsystems; fire safety measures; fire safety system design principles, occupant evacuation; fire department response; qualitative and quantitative risk assessment; fire safety risk management; logic trees

CE 5022 Forensic Engineering (3)

Introduction to Forensic Engineering; Competencies and Qualifications of Forensic Engineers: qualifications, attributes competencies, technical skills, legal knowledge, detective skills, communication skills, personality characteristics etc. The Standard of Care: expert testimony, methods, validity, reliability, Delphi process of expert consensus; Civil Engineering Investigations: activities in investigation, site investigation, sampling and collection of evidence, preliminary findings, equipment and its selection, recording observations, photography, sample removal, eyewitness account, field tests, document collection and review, theoretical analysis, laboratory tests and investigation, office investigations determination of procedural responsibilities, reports; Ethics of Forensic Engineering: code of ethics, solicitation of work, contract process, testimony ethics, damage caused by unethical conduct, ethical standards for publication, interaction with media; The Legal Forum: role of forensic engineer as a witness in mediation and litigation, admissibility of testimony by forensic engineers, rules of evidence and

Drainage on Walls. Pile-supported Retaining Wall. Behaviour of Flexible Earth-Retaining structures. Design Criteria and Pressure Analysis of Anchored Bulk Heads, Braced Out and Tie-Back Bracing system, Design criteria for cellular cofferdams. Behaviour of Retaining Walls during earthquakes.

CE 541 Computer Applications in Geo-technical Engineering (3)

Numerical solutions of partial differential equations, Finite difference Approximation solutions to two-dimensional flow field and one-dimensional consolidation Soil Layer. Finite Element Method application to stress analysis of Linearly elastic systems of Geotechnical Engineering problems. Soil-foundation Dynamics Interaction problems.

CE 542 Geoenvironmental Engineering (3)

Introduction: Emergence of Geoenvironmental Engineering, Types of Geoenvironmental Problems. Chemical Background And Geochemistry: Toxic Chemicals, Inorganic Chemistry, Organic Chemistry, Nuclear Chemistry, Chemical Analysis Methods. Contaminant Transport Mechanism: Introduction, Sources of Contamination, Types of Contaminants, Transport Processes, Chemical Mass Transfer Processes , Biological Process (Biodegradation), Contaminant Transport and Fate Modeling, Applications. Contaminated Site Characterization And Risk Assessment: Preliminary Site Assessment, Exploratory Site Investigation, Detailed Site Investigation, Risk Assessment Procedures, Remedial Strategy. Waste Management And Landfill Design: Sources of Wastes, Classification of Wastes, Waste Characterization, Environmental Concerns with Wastes, Waste Management Strategies, Landfill Configurations, Waste containment liner systems, Containment System Liner Design, Leachate collection and removal system, Final cover systems, Gas generation and management, End uses of closed landfills..

CE 543 Transportation Geotechnics (3)

Properties of geomaterials for design and construction of highways, airfield and port pavements. Embankments for highways and high-speed trains, Behavior of compacted geomaterials using stabilization technique. Geosynthetics and reinforcement of constructed layers and interlayers. Compaction technology, compaction management, maintenance technology. Underwater geotechnics for construction of breakwater, jetties, wharves and other coastal infrastructure purposes. Modeling of multi-layered structures and supporting ground under dynamic and repeated loads. Case studies.

CE 5022 Forensic Engineering (3)

Introduction to Forensic Engineering; Competencies and Qualifications of Forensic Engineers: qualifications, attributes competencies, technical skills, legal knowledge, detective skills, communication skills, personality characteristics etc. The Standard of Care: expert testimony, methods, validity, reliability, Delphi process of expert consensus; Civil Engineering Investigations: activities in investigation, site investigation, sampling and collection of evidence, preliminary findings, equipment and its selection, recording observations, photography, sample removal, eyewitness account, field tests, document collection and review, theoretical analysis, laboratory tests and investigation, office investigations determination of procedural responsibilities, reports; Ethics of Forensic Engineering: code of ethics, solicitation of work, contract process, testimony ethics, damage caused by unethical conduct, ethical standards for publication, interaction with media; The Legal Forum: role of forensic engineer as a

Distribution of traffic variables, Head-way, speed distributions, traffic flow & different Queuing theory as applied to traffic flow, Traffic dynamics, Microscopic & Macroscopic models.

CE 566 Highway Materials & Construction (3)

Properties & Usage of soil, sand & rock as highway materials. Modification & evaluation of their properties, Criteria for use & acceptance, testing, variability & Quality Control, requirements of crushed rock for surfacing, use of non standard material, material resources, in-service conditions & their effect on material performance.

Properties & use of bitumens, asphalts, tars & concrete as pavement materials, Rheology of bitumens, bituminous coating of aggregates, optimization of bituminous mixtures, Asphalt concrete mix design. Quality Control & performance of bituminous & concrete pavement materials.

CE 567 Public Mass Transportation (3)

The development of public transportation, Urban passenger modes, Comparative analysis and selection of transport modes, perspective of transport & highway planning, managing and operating public transportation system, policy considerations, Unconventional systems. Mass and Rapid Transit Systems.

CE 568 Airport Planning & Design (3)

Air Transportation, classification & size of airports, Air craft characteristics, Airport Planning i/c necessary surveys, Ground transportation facilities, Airport capacity & delays, Air traffic control, layout & design of runways, taxiways & aprons, layout & design of terminals & service facilities, Passenger, Baggage & Cargo handling systems, lighting, visual aids, Maintenance equipment & operations, Airport drainage.

CE 569 Pavement Analysis & Design (3)

Pavement type, stress distribution in pavements; theoretical and actual subgrade conditions & traffic loading, design principles, methods & criteria for flexible pavements, rigid & semi-rigid pavements. Design of special duty & temporary pavements. Environmental influences & effects, pavement overlays, Mechanistic Design of Pavements. Pavement Subdrainage.

CE 570 Transportation Economics (3)

Economic function of Transportation; Economic Significance of Improved Transportation; Freight Rates and Locations of Industries and Markets; Technical and economic characteristics of different modes of transport; Development of transportation system in Pakistan including pricing, and regulation, railroads, highways, pipeline, water and air transportation; and the roles that these modes of transportation play in economic development; Economic efficiency of various modes of Transport; Explanation of travel or shipping behaviour within the paradigm of microeconomic demand and supply theory. Transport project appraisal.

examination etc.), codes and guidelines (local and international) for professionals engaged as experts; The Business of Forensic Engineering: readiness, marketing, decisions, liability, insurance individual and group practice; National and International Case Studies.

Water Resources Engineering

CE-518 Mathematical Methods for Engineers (3)

Ordinary Differential Equations: Bessel's equation, Legendre's equation, Hermite equations, Laguerre's equation, Sturm-liouville problem, Eigen function and Eigen values, Ordinary differential equation from a geometric point of view, Involving significant use of phaseplane diagrams and associated concepts, Including equilibrium points, Orbits, limit cycles and domain of attraction, Simple application. Partial Differential Equation: Partial differential equation (vibrating string problem), Classification of partial differential equation, Partial differential equation with constant coefficients, Method of separation of variables, D'Alembert's method, General solution of wave equation, Initial value problem in general, Partial differential equation with variable coefficients, Solution of linear hyperbolic equation, Vibrating modes of a finite string, Simple application.

CE-577 Irrigation System Design and Management (3)

Introduction/overview of irrigation and its purpose: horticulture, urban landscaping, agriculture, soilwater- plant relationships, irrigation water requirements, computation of evapotranspiration by various methods, performance evaluation of irrigation systems, surface irrigation system-design principles, Design of basin, border and furrow irrigation, Trickle irrigation and sprinkler irrigation – design and operation, irrigation management, irrigation and drainage interactions, environmental consideration.

CE-579 Water Quality Management (3)

Water quality parameters-Indicators, sources, causes and effects; Nature of water systems; Objectives and case studies of water quality management; Water quality monitoring, modeling and forecasting in water systems; Management practices and methodologies for reuse, recycling and treatment of contaminated water; A system approach to water quality management: Institutional, environmental, and ethical aspects.

CE-580 Applied Hydrology (3)

Hydrologic Components: Hydrologic Cycle, Intensity-Duration-Frequency curve, Stream flow, Unit and Synthetic Hydrograph Analysis. Stream Gauging: Methods of Measuring Stream Flow; Stage-Discharge- Rating Curve, Storage. Statistical Analysis: Probability Analysis, Recurrence Interval, Annual Maxima using Hydrological Data. Sediment Transport: Weathering, Erosion and Sediment Processes, Factors Affecting Erosion, Sediment Yield e.g., RUSLE, Sediment Transport processes, Erosion and Pollution, Reservoir Sedimentation: Reduction in Reservoir Capacity, Reservoir Sedimentation Control. Probability concept, Flow Duration Curve, Risk and Reliability. Application of Hydrologic Models. Water Quality: background, Important Concepts, Best Management Practices, Biological Impaired Water

CE-583 Groundwater Engineering

(3)

Groundwater origin and Occurrence: Geologic formation and groundwater distribution, Global distribution of groundwater levels. Hydrologic Budget: Surface water, soil water and groundwater budget. Aquifer characteristics: Homogeneous and non homogeneous aquifers, Isotropic and anisotropic aquifers, storage coefficient and specific yield, hydraulic conductivity, transmissivity and their determination. Steady Well Hydraulics: Dupuit_Forchheimer assumptions, Boussinesq equation, differential equations for confined flow, flow equations with vertical accretion, one dimensional flow radial flow, aquifer boundaries, leaky aquifers, one dimensional flow and radial flow in leaky aquifers. Unsteady well hydraulic: Unsteady radial flow towards a fully penetrating well, radial flow in leaky aquifer, drawdown with variable pumping rater, one dimensional flow with distributed recharge. Superposition of wells: Principle of superposition, drawdown due to a well field, pinging near hydrologic boundaries, fully penetrating and partially penetrating well considerations. Pumping test data analysis: Methods, data collection, data analysis, methods of determining aquifer, characteristics using test data. Groundwater quality: Water analysis, irrigation water quality criteria, groundwater pollution. Introduction to Groundwater Modeling. USGS MODFLOW, MT3D, etc.

CE-556 Water Resources Planning and Management

(3)

Introduction, History of water resources planning and development, Importance of water resources planning, Planning objectives, Protocols employed at local, provincial, federal, regional and international levels, Investigation data and analysis, Demand projection, Water productivity parasites and constraints, Land-Water-Human resources interaction, Plan formulation, evaluation and approval, Comprehensive regional planning, Stakeholder involvement in water resources planning, Social and environmental impact assessment, Institutional arrangements for planning and implementation, Engineering economy in water resources planning, Introduction to surface water / groundwater / conjunctive water management.

CE-557 Legal & Financial Aspects of Water Resources

(3)

Sources of Water, Uses of Water, General concepts of water governance, International Laws (riparian and prior appropriation doctrines), Legal schemes for securing and allocating water rights in surface water and groundwater for private and public uses in Pakistan, Water Treatise and Accords (Indus Waters Treaty, Water Apportionment Accord, similar case studies), Institutional Framework, Groundwater management regimes, Issues and national water sector strategy, Evolving role of science, economics, and policy in water allocation law, Major paradigm shifts in water governance through integrated water resource management. Legislation on harmful effects of water.

CE-558 Sustainable Water Resources Management

(3)

Historical perspective of water use and development, Water facts and trends, Introduction to sustainable development and its importance, Related terminologies, SWRM strategies, Sustaining healthy freshwater ecosystems, Hydrologic aspects of water sustainability, Human

impacts on hydrologic ecosystem and mitigation, Water resources – agriculture, environment, and society, Flood control management strategies, Economics of water; value of water, water affordability and marketing. Emerging water management issues and resolutions.

CE-559 Remote Sensing In Water Resources (3)

History and scope of remote sensing, Concepts of remote sensing, Photogrammetry, Satellite characteristics, Remote sensing imagery types, Remote sensing satellites, Image resolution, Preprocessing, Image rectification, enhancement and classification, Accuracy assessment, Applications of satellite remote sensing in water resources i.e., for identifying drainage basin networks, for watershed dynamics analysis, flood inundation modeling and mapping, Evaluation of surface and ground water resources, Image processing software exercises, Introduction to Geographical Information Systems (GIS).

CE-560 Reservoir Operations (3)

Introduction on the functions of reservoirs and possible problems, Operation purposes, Storage-yield concepts; flow-duration curve development, mass-curve analysis and sequent-peak analysis; Flood management and reservoir operation; formation and process of floods, Techniques for flood prevention in reservoirs, Relationship between flood management and reservoir operation, Reservoir simulation for flood control, urban water supply, hydropower and multipurpose operation, Automatic reservoir operation system; Sedimentation in reservoirs, Preventative methods for the sedimentation in reservoirs, Impacts of sedimentation on the function of reservoirs, Management for sedimentation in reservoirs and techniques for capacity restoration, Ecological environment in water reservoirs and protection & restoration techniques.

CE-578 Groundwater Resource Management (Prerequisite EM-505 Operations Research) (3)

Introduction to groundwater resources engineering and management, groundwater resources protection and water supply; Technical aspects as well as the legal, regulatory and policy aspects of groundwater resources management; Development of groundwater resource; simulation/optimisation models for GWM; embedding and response matrix approaches, Conjunctive use of groundwater and surface water and planning of groundwater resources projects.

CE-581 Hydroclimatology (3)

Hydroclimatic Systems; Hydrologic Cycle: Applications, Components of hydrologic cycles and estimation Surface Water Hydrology: Methods of measuring surface runoff, stream flow, base flow etc. Climate and Stream flow forecasting, Verification measures, Watershed Geomorphology: Basin characteristics, Soil characteristics, Landuse Routing Methods: Muskingham etc. Continuous and event based Modeling Climate Change Impact and Modeling: Water Resources System Effect, Case Studies Climate Change, Floods (Types Analysis, Prediction); Droughts (Climatic, Hydrologic, Agriculture) ; Risk Assessment

CE-582 Water Resources Modelling

(3)

Interpretation of hydrologic/hydraulic principles and underlying procedures for surface water modeling; Quantification of water quantity (e.g. floods, droughts, climate change impacts etc.) and quality (e.g. contamination of groundwater, lakes and river due to point and non-point sources) problems using computer models. Classify and evaluate the methodology for hydrological process and preparation of input data files for different models (e.g. HEC-HMS, SWAT, HSPF, RUSLE, etc.) to actual watersheds. Model Evaluation: Uncertainty and Sensitivity Analysis, Calibration, and Validation Model Applications: Impact estimation of drought, flood, erosion, contaminant, climate change etc. Water Quality Assessment: Different process representations of contaminant and sediment transport

CE-584 Drainage Engineering

(3)

Drainage Concepts: Need and benefits of drainage, sources of excess water, surface and subsurface drainage. Drainage Investigations: Purpose and scope of drainage investigations, based data collection (Topography, slope, soil profile, soil characteristics, salinity, water table, crops, climate, surface runoff, hydraulic conductivity, infiltration rate), diagnosis and nature of drainage problem, drainage coefficient, stage of project preparation-Identification, reconnaissance, feasibility and final Stage. Field Drainage System and Methods: Surface drainage, vertical drainage, pipe drainage, layout patterns for groundwater drainage; organic, natural and synthetic drainage envelop materials, drain pipes, construction equipment, design, construction and operational problems. Storm water management: Design of storm sewers and detention, Highway drainage and culverts. Design Methods: Pipe drainage flow patterns, components of head loss, Homogenous and non Homogenous soils, Hooghoudt formula, Earnst formula and Glover-Dumm formulae. Application of drainage design methods to selected problems: Use of nomographs for drainage design. Surface drainage factors affecting, design formula, safe velocity and grades. Performance Assessment of drainage systems: Need, performance parameters and criteria. System Problems: Back filling, installation below water table, blocking and clogging, sediment outflow and performance efficiency.

CE-585 Hydraulic Structure Engineering

(3)

Water conveying channels and structures, Non uniform flow; longitudinal water surface backwater curve computation for irregular channels, backwater curve computation for regular channels, discharge problems. Unsteady flow: Introduction, equation of motion, method of characteristics, positive and negative waves, surge formation, dam break problem. Flood routing: Storage routing, kinematic routing, diffusion analogy, dynamic routing. Wind generated waves, Shallow and deep water waves, Storm surges, Harbour resonance, Hydraulic loading on structures – static and dynamic effects, Codes of practice, Design and construction of offshore structures, Dams and barrages, Design of weirs and barrages, Dams in general – types and selection, Designing of reservoir capacity with capacity elevation and area-elevation curves of a reservoir site, Design and construction of gravity dams, Water for hydroelectric generation, Tidal power – Principle, Components, Ebb-cycle, Tide-cycle, Estimate of energy and power, etc. Penstocks, Water hammer and surge tanks, Gates in hydraulic installations, Spillways, River training and control works.

EN-528 Urban Water Supply and Sewer System Design

(3)

Water requirement, Sources of water supply, Water transmission, Hydraulics, Water distribution Components, Methods of analysis, Water conservation, Wastewater and storm water collection, Hydraulics of sewer systems, Design of sewer systems, Materials and appurtenances, Pumps and pumping stations.

CE 5022 Forensic Engineering (3)

Introduction to Forensic Engineering; Competencies and Qualifications of Forensic Engineers: qualifications, attributes competencies, technical skills, legal knowledge, detective skills, communication skills, personality characteristics etc. The Standard of Care: expert testimony, methods, validity, reliability, Delphi process of expert consensus; Civil Engineering Investigations: activities in investigation, site investigation, sampling and collection of evidence, preliminary findings, equipment and its selection, recording observations, photography, sample removal, eyewitness account, field tests, document collection and review, theoretical analysis, laboratory tests and investigation, office investigations determination of procedural responsibilities, reports; Ethics of Forensic Engineering: code of ethics, solicitation of work, contract process, testimony ethics, damage caused by unethical conduct, ethical standards for publication, interaction with media; The Legal Forum: role of forensic engineer as a witness in mediation and litigation, admissibility of testimony by forensic engineers, rules of evidence and testimony, testimony in courts and at deposition (preparation, demeanor, speech, direct examination, cross examination etc.), codes and guidelines (local and international) for professionals engaged as experts; The Business of Forensic Engineering: readiness, marketing, decisions, liability, insurance individual and group practice; National and International Case Studies.

Coastal and Harbour Engineering

CE-521 Introduction to Ocean and Coastal Engineering (3)

Incompressible fluid mechanics and applications to analysis of wave motions, circulation, and other free surface flows in coastal and offshore regions; wave spectra, water-level fluctuations, tides, tsunamis, oscillations, and storm surges; wind-generated waves, beaches, sediment transport, wave forces on coastal and offshore structures. Introduction to state-of-the-art Instrumentation with reference to measuring various aspects of Oceanic parameters.

CE-522 Port Planning and Design (3)

Sea Transportation system, facilities and growth, Port and Harbour functions, classification, components and features, Harbour Planning, size, shape, Dimensional characteristics of entrance, approach channel; Site investigations considering hydrographic, topographic and geotechnical factors. Harbour siting considerations. Hydraulic models. Port buildings. Navigation facilities. Master planning of ports, Planning of Bulk Terminals, Port Administration, Port Management, Port Structures, Port planning for Developing Countries UNCTAD Hand Book, Marine Transport, Merchant Shipping.

CE-523 Coastal Processes (3)

Coastal sediment properties and analysis, long-shore transport processes and rates; sediment budget; response of beaches to wave action and structures; tidal inlets, mechanical bypassing; beach nourishment; wind transport in sand dune stabilisation, sediment tracing.

CE-524 Coastal Management (3)

Introduction of key processes operating in the coastal zone and to management techniques appropriate to these processes and environments. Emphasis on policy, regulatory and intergovernmental complexities that characterize coastal zone management in coastal nations.

CE-525 Soil Mechanics in Coastal Engineering (3)

Physical and mechanical properties of weak compressible and loose marine subsoils; Stability analysis of shallow foundations and embankments resting on weak soils. Use of geotextile fabrics for stability of weak soils; Design criteria and pressure analysis of deep water anchored bulk heads, containers berths and marine cofferdams; Reclamation of large coastal areas using fill materials; Principles and methods for ground stabilisation, compaction equipment and their optimum utilisation; Soil liquefaction due to earthquakes; procedures of determination soil liquefaction and remedial measures.

CE-551 Marine Geology (3)

Major Physiographic division of sea floor, Classification of marine environment; the origin, form and resources of the ocean basin and continental margins, including discussion of seafloor spreading, trenches and island arcs, mountain building; coral reefs and atolls; sedimentation; coastal morphology and the impact of wave action and human activities on beaches, coasts, continental shelves, and submarine canyons. Natural resource potential of oceans.

CE-552 Marine Dredging (3)

Dredge pumps selection, Pumps and system characteristics, cavitations, type of dredging, head loss in horizontal and vertical pipes for two and three phase flow, design of disposal method for dredged material, environment effect of dredging.

CE-553 Off-shore Engineering Analysis (3)

Design and analysis requirements of offshore facilities; Derivation of hydrodynamic loads on rigid bodies; Load on long rigid and flexible cylinders; Viscous forces on cylinders; experimental data; Morison's equation; stroke wave theories; shallow water waves; Selection of appropriate wave theory; Diffraction of waves by currents; Hydrodynamic loads on risers, cables and pipelines.

CE-554 Computational Hydraulics (3)

Review of Basic Fluid Mechanics: Introduction; One, two, three dimensional flows; Steady versus unsteady flow; uniform versus non-uniform flow, Prismatic versus non-prismatic channels; sub-critical, critical, and supercritical flows; turbulent versus laminar flow, Physical properties of fluid and their effects; conservation of mass or continuity equation; Energy and its Dissipation in Open Channels, The Momentum Principle Applied to Open Channel Flows

CE 5012 Intellectual Property (IP) Protection and Professional Ethics (3)

Overview of Intellectual Property Law; The Use of Intellectual Property in Business; Introduction to Patents; Obtaining Information from a Patent; Patentable Subject Matter and Utility; Requirement of Non-Obviousness for Patentability; The Patenting Process and Patent Application; Design Patents; Protection of information and communication related patents; Business method protection; Trademark; Ethical Reasoning and ethics for engineer ethics, norms and codes of professional conduct; Workplace rights and responsibilities; Ethics and research misconduct, authorship credits etc.

CE 5013 Construction Contracts and Procurement Law (3)

Principles of construction contracts (basics, doctrines, and elements of contract.); Review of types of construction contract (DB, DBB, CMAA, CM@Risk); Overview of Standard forms of Contracts (PEC, AIA, FIDIC etc.); Design liability of engineers and contractors; Finance and management of contracts; Contractual obligations of employer, architect/engineer, and contractors; Concepts and processes in construction law including procurement; Right to payment, time, completion and liquidated damages; Public works procurement and tendering procedures; PPRA regulations, SPPRA regulations; New and emerging options including, integrated project delivery, public private partnerships, concessions and joint ventures, early and collaborative working, frameworks and alliances; Subcontracting and supply contracts; overview of international perspective of contracts and procurement.

CE 5014 Construction Claims Preparation and Analysis (3)

Contract Administration for Claims and Claims Avoidance; Types of Claims; Construction contract errors; Unforeseen and changed conditions; Delays, disruptions, acceleration, termination, and proving of claims; Extension of time claims; Methods of Delay Analysis (Use of CPM techniques, Forensic Schedule analysis, window analysis, etc.); Claim for Additional Payments and its calculations; Construction claims related documentation; Claims preparation and presentation; Essential Elements of a Successful Claim; International perspective of construction claims.

CE 5015 Construction Disputes (3)

Introduction to Construction Disputes; Starting point, causes and reasons of arise of disputes; Role of the Engineer in dispute avoidance; Dispute avoidance; Negotiation; Mediation; Arbitration ; Expert determination ; Early neutral evaluation ; Procedures of dispute resolution as per PEC rules, FIDIC, AIA and comparison among the requirements.; Overview of Arbitration law in Pakistan and Arbitration Act of 1940; Dispute review and resolution boards; Litigation ; Multi-party Dispute Resolution.

CE 5016 Fundamentals of Environmental Laws of Construction Industry (3)

An Overview of Environmental Law and its Development; Legal and Administrative; Structures for their Implementation from the International, Regional and National Perspectives; Regulations and laws in Pakistan and the Laws of Selected Countries; Project Planning Applications, Permissions and Other Consents; Planning and Pollution Control; Site Hazards, nuisance and waste management; Environmental Impact Assessment; Environmental Crisis Management ; Application of Policy Issues in Environmental Management ; Political Economy of Environmental Regulations; Case studies.

CE 5017 Construction Specifications Writing and Documentation (3)

The role of specifications and construction project documents; Relationship between drawings and specifications; Types of specifications; Organization and formatting of specifications; Specification writing principles. Bidding documents, general conditions, special conditions; Bonds, guarantees and warranties writing; Specification resources and writing procedures; Modifications to bidding and contract documents; Computer Aided; Specifications writing; Specifications and plan interpretation; Case studies.

CE 5018 Construction Law Case Studies (3)

Case study and analysis of reported appellate decisions on common construction law issues on topics such as tort or negligence; Quantum merit; privity of contract, flow down clauses; suspension and termination; cases related to funding, penalty clauses; design liability; concurrent delays; insurance and bonding; landmark cases that lead to development of new legal doctrines (eg: Severin; Spearin doctrines); licensing; bid disputes; contract issues; construction lien law; surety problems; and unresolved claims; international construction project related case studies

CE 5019 Building Codes and Regulations (3)

Study of building codes required at city, provincial, and federal levels and their relation to quality control. These may include (but not limited to): Conduct and Consulting Byelaws; Construction and Operations Engineering Works Byelaws; Code of Ethics and Conduct; Building Code of Pakistan; Building Code of Pakistan-Energy Provisions; Building Code of Pakistan Fire Safety Provisions; Building Control and Town Planning Regulations; Land Regulations; Different Development Authorities and their regulations; Overview of Regional Codes; Overview of International Codes; Comparative assessment of national vs. international codes and regulations.

CE 5020 Construction Law and Risk Management (3)

Risk Management Essentials; Risk and legal aspects during project inception, feasibility and financing, procurement model selection; Risk identification and mitigation strategies employed during the delivery phase and their role in avoiding unnecessary disputation; Allocation of Risks through Contracts; Philosophies and commercial drivers affecting risk allocation in contracts and consultancy agreements; Security for performance mechanisms and instruments; Risk Insurance mechanisms in Construction; Insurance products available to the construction industry and related laws; International best practices in Risk insurance; Managing sub-contract/suppliers risk; Need for documentation, written procedures and maintenance of risk records; Construction Law & Risk Management Cases Studies

CE 5021 International Perspective of Construction Law (3)

International Construction Projects; Typical Hazards in International Construction Business; Civil law vs. Common Law; Common delivery methods and international construction; Unification and standardization in International Construction Projects; Aspects of Price, time variations, and claims; FIDIC Contracts; AIA Contracts; Overview of Construction terms in different languages, such as; Chinese, Czech, English, French, German, Hungarian, Polish, Portuguese, Russian, Spanish; The influence of national culture on the preparation, evaluation and negotiation of time and money claims on international construction projects; International Projects Dispute Resolution; Projects funded by International Funding Agencies (World Bank, ADB, AIDB); Case studies

CE 5022 Forensic Engineering (3)

Introduction to Forensic Engineering; Competencies and Qualifications of Forensic Engineers: qualifications, attributes competencies, technical skills, legal knowledge, detective skills, communication skills, personality characteristics etc. The Standard of Care: expert testimony, methods, validity, reliability, Delphi process of expert consensus; Civil Engineering Investigations: activities in investigation, site investigation, sampling and collection of evidence, preliminary findings, equipment and its selection, recording observations, photography, sample removal, eyewitness account, field tests, document collection and review, theoretical analysis, laboratory tests and investigation, office investigations determination of procedural responsibilities, reports; Ethics of Forensic Engineering: code of ethics, solicitation of work, contract process, testimony ethics, damage caused by unethical conduct, ethical standards for publication, interaction with media; The Legal Forum: role of forensic engineer as a witness in mediation and litigation, admissibility of testimony by forensic engineers, rules of evidence and testimony, testimony in courts and at deposition (preparation, demeanor, speech, direct examination, cross

examination etc.), codes and guidelines (local and international) for professionals engaged as experts; The Business of Forensic Engineering: readiness, marketing, decisions, liability, insurance individual and group practice; National and International Case Studies.

Water Resources Management

EM-501 Organisational Systems (3)

Definitions of management; Evolution of management thought, classical, quantitative and behavioral schools; interactions between organisations and their environments. The planning process; strategic and tactical planning, developing planning premises, nature of managerial decision making, quantitative aids, management by objectives. Organisational structures; behavior of the individual, work group, and organisation; coordination and spans of control, the informal organisation; authority delegation and decentralisation, groups and committees, managing organisational change and conflict. Motivation, performance and satisfaction; building a high-performance team; leadership, interpersonal and organisational communication, staffing and personal function. The control process; budgetary and nonbudgetary methods of control; team performance measurement and improvement strategies. Use of management information systems.

EM-502 Accounting and Financial Management (3)

Foundations of finance with applications in corporate finance and investment management. Major financial decisions made by corporate managers and investors with focus on process valuation. Criteria for investment decisions, valuation of financial assets and liabilities, relationships between risks and return, market efficiency, and the valuation of derivative securities. Major corporate financial instruments including debt, equity and convertible securities. Analysis and projection of financial statements, cost elements in pricing, cost control and design of accounting systems.

EM-503 Strategic Planning and Decision Making (3)

Critical issues in shaping the competitive strategy for engineering-driven companies in a turbulent business environment; corporate mission; key result areas and situational analysis including strengths, weaknesses, opportunities and threats; identifying planning assumptions, critical issues, setting objectives, formulating strategy. Managing technology as a strategic resource of the firm; understanding of the process, roles and rewards of technological innovation; integrating the strategic relationship of technology with strategic planning, marketing, finance, engineering and manufacturing; government, societal and international issues; issues pertaining to cultural diversity and ethical concerns. Subjective, judgmental and expert decisions; conflict resolution in strategic decisions involving technological alternatives; hierarchical decision modeling; individual and aggregate decisions; decision discrepancies and evaluation of group disagreements.

EM-504 Project Management Framework and Tools (3)

Role of projects in organisation's competitive strategy; Standard methodologies for managing projects; Project life cycle; Design-implementation interface; Estimating: preliminary and detailed; Contractual risk allocation; Scheduling: PBS; WBS; Integration of scope, time, resource and cost dimensions of a project; Evaluation of labor, material, equipment, and subcontract resources; Scheduling techniques including CPM/ PERT, GERT, critical chain; Solving real-world project schedules; Monte Carlo simulation; Cost budgeting; Cost baseline; Cash flow analysis; Earned value analysis; Cost control; Proposal presentation; Application of software for project management (MS Project, Primavera Project Planner - P3).

EM-505 Operations Research (3)

Deterministic modeling: Linear programming; The Simplex method; Multiple objective linear optimisation; Duality and sensitivity analysis; Post optimality analysis from the viewpoint of technology management; Transportation, transshipment, and assignment problems; Problem formulation; Goal programming; Network analysis; Dynamic programming; Integer programming and nonlinear programming. Probabilistic modeling: Markov chains; Queuing theory and applications; Inventory theory; Forecasting; Design analysis and simulation; Pareto optimality and tradeoff curves.

EM-511 Total Quality Management (3)

Critical principles and procedures of quality management in a competitive global environment; contemporary definitions of quality; construction quality; Product quality; Process quality; Quality economics; Quality philosophies; Planning, organising and controlling for quality; Human resource strategies; QA and QC tools.

EM-512 Project Evaluation and Feasibility Analysis (3)

Evaluation of engineering projects from the engineering management perspective; Techniques for capital investment for decision-making; Time value of money and the concept of equivalence; Present worth, annual and rate of return analysis; Multiple alternatives; Replacement criteria; Tax considerations; Breakeven sensitivity analysis; Project evaluations under uncertainty; Risk sharing; Capital budgeting; Cost of capital depreciation; Multicriteria decisions. Project feasibility analysis; Organisational impacts; societal impacts; Environmental impacts.

EM-513 Research Methods in Engineering Management (3)

Research methods in engineering and technology management; Statistical techniques including proper selection; Use and interpretation of parametric and non-parametric tests along with factor and discriminate analysis; Design of experiments and model misspecification; Simulation in engineering and management research and practice.

CE-556 Water Resources Planning and Management (3)

Introduction, History of water resources planning and development, Importance of water resources planning, Planning objectives, Protocols employed at local, provincial, federal,

regional and international levels, Investigation data and analysis, Demand projection, Water productivity parasites and constraints, Land-Water-Human resources interaction, Plan formulation, evaluation and approval, Comprehensive regional planning, Stakeholder involvement in water resources planning, Social and environmental impact assessment, Institutional arrangements for planning and implementation, Engineering economy in water resources planning, Introduction to surface water / groundwater / conjunctive water management.

CE-557 Legal & Financial Aspects of Water Resources (3)

Sources of Water, Uses of Water, General concepts of water governance, International Laws (riparian and prior appropriation doctrines), Legal schemes for securing and allocating water rights in surface water and groundwater for private and public uses in Pakistan, Water Treatise and Accords (Indus Waters Treaty, Water Apportionment Accord, similar case studies), Institutional Framework, Groundwater management regimes, Issues and national water sector strategy, Evolving role of science, economics, and policy in water allocation law, Major paradigm shifts in water governance through integrated water resource management. Legislation on harmful effects of water.

CE-558 Sustainable Water Resources Management (3)

Historical perspective of water use and development, Water facts and trends, Introduction to sustainable development and its importance, Related terminologies, SWRM strategies, Sustaining healthy freshwater ecosystems, Hydrologic aspects of water sustainability, Human impacts on hydrologic ecosystem and mitigation, Water resources – agriculture, environment, and society, Flood control management strategies, Economics of water; value of water, water affordability and marketing. Emerging water management issues and resolutions.

CE-559 Remote Sensing In Water Resources (3)

History and scope of remote sensing, Concepts of remote sensing, Photogrammetry, Satellite characteristics, Remote sensing imagery types, Remote sensing satellites, Image resolution, Preprocessing, Image rectification, enhancement and classification, Accuracy assessment, Applications of satellite remote sensing in water resources i.e., for identifying drainage basin networks, for watershed dynamics analysis, flood inundation modeling and mapping, Evaluation of surface and ground water resources, Image processing software exercises, Introduction to Geographical Information Systems (GIS).

CE-560 Reservoir Operations (3)

Introduction on the functions of reservoirs and possible problems, Operation purposes, Storage-yield concepts; flow-duration curve development, mass-curve analysis and sequent-peak analysis; Flood management and reservoir operation; formation and process of floods, Techniques for flood prevention in reservoirs, Relationship between flood management and reservoir operation, Reservoir simulation for flood control, urban water supply, hydropower and multipurpose operation, Automatic reservoir operation system; Sedimentation in reservoirs, Preventative methods for the sedimentation in reservoirs, Impacts of sedimentation on the function of reservoirs, Management for sedimentation in reservoirs and techniques for

capacity restoration, Ecological environment in water reservoirs and protection & restoration techniques.

CE-576 Water Services Management (3)

Water Supply and Sanitation Systems; options, standards and developments with sustainable performance and technical reliability. Water Supply Systems; raw water quality (surface and groundwater) and abstraction, pre-treatment and storage, water treatment processes and plants, water transport and distribution, Sanitation Systems; on-site and off-site sanitation systems, ecological sanitation concepts, sewerage and drainage systems wastewater treatment processes and plants, sludge management (treatment, disposal and reuse), Institutional arrangements and management options for providing water services. Finance issues at utility level; financing water organisations and undertaking cost-recovery.

CE-577 Irrigation System Design and Management (3)

Introduction/overview of irrigation and its purpose: horticulture, urban landscaping, agriculture, soilwater- plant relationships, irrigation water requirements, computation of evapotranspiration by various methods, performance evaluation of irrigation systems, surface irrigation system-design principles, Design of basin, border and furrow irrigation, Trickle irrigation and sprinkler irrigation – design and operation, irrigation management, irrigation and drainage interactions, environmental consideration.

CE-578 Groundwater Resource Management (Prerequisite EM-505 Operations Research) (3)

Introduction to groundwater resources engineering and management, groundwater resources protection and water supply; Technical aspects as well as the legal, regulatory and policy aspects of groundwater resources management; Development of groundwater resource; simulation/optimisation models for GWM; embedding and response matrix approaches, Conjunctive use of groundwater and surface water and planning of groundwater resources projects.

CE-579 Water Quality Management (3)

Water quality parameters-Indicators, sources, causes and effects; Nature of water systems; Objectives and case studies of water quality management; Water quality monitoring, modeling and forecasting in water systems; Management practices and methodologies for reuse, recycling and treatment of contaminated water; A system approach to water quality management: Institutional, environmental, and ethical aspects.

CE 5022 Forensic Engineering (3)

Introduction to Forensic Engineering; Competencies and Qualifications of Forensic Engineers: qualifications, attributes competencies, technical skills, legal knowledge, detective skills, communication skills, personality characteristics etc. The Standard of Care: expert testimony, methods, validity, reliability, Delphi process of expert consensus; Civil Engineering Investigations: activities in investigation, site investigation, sampling and collection of evidence, preliminary findings, equipment and its selection, recording observations, photography, sample removal, eyewitness account, field tests, document collection and review, theoretical analysis, laboratory tests

and investigation, office investigations determination of procedural responsibilities, reports; Ethics of Forensic Engineering: code of ethics, solicitation of work, contract process, testimony ethics, damage caused by unethical conduct, ethical standards for publication, interaction with media; The Legal Forum: role of forensic engineer as a witness in mediation and litigation, admissibility of testimony by forensic engineers, rules of evidence and testimony, testimony in courts and at deposition (preparation, demeanor, speech, direct examination, cross examination etc.), codes and guidelines (local and international) for professionals engaged as experts; The Business of Forensic Engineering: readiness, marketing, decisions, liability, insurance individual and group practice; National and International Case Studies.

Master of Engineering Management Programme

EM 501 Organizational Systems

(3)

Definitions of management; Evolution of management thought, classical, quantitative and behavioural schools; Interactions between organizations and their environments. The planning process; Strategic and tactical planning, developing planning premises, nature of managerial decision making, quantitative aids, management by objectives. Organizational structures; Behaviour of the individual, work group, and organization; Coordination and spans of control, the informal organization; authority delegation and decentralization, groups and committees, managing organizational change and conflict. Motivation, performance and satisfaction; Building a high-performance team; Leadership, interpersonal and organizational communication, staffing and personal function. The control process; Budgetary and non-budgetary methods of control; Team performance measurement and improvement strategies. Use of management information systems.

EM 502 Accounting and Financial Management

(3)

Foundations of finance with applications in corporate finance and investment management. Major financial decisions made by corporate managers and investors with focus on process valuation. Criteria for investment decisions, valuation of financial assets and liabilities, relationships between risks and return, market efficiency, and the valuation of derivative securities. Major corporate financial instruments including debt, equity and convertible securities. Analysis and projection of financial statements, cost elements in pricing, cost control and design of accounting systems.

EM 503 Strategic Planning and Decision Making

(3)

Critical issues in shaping the competitive strategy for engineering-driven companies in a turbulent business environment; Corporate mission; Key Result Areas and situational analysis including strengths, weaknesses, opportunities and threats; Identifying planning assumptions, critical issues, setting objectives, formulating strategy. Managing technology as a strategic resource of the firm; Understanding of the process, roles and rewards of technological innovation; Integrating the strategic relationship of technology with strategic planning, marketing, finance, engineering and manufacturing; Government, societal and international issues; Issues pertaining to cultural diversity and ethical concerns. Subjective, judgmental and expert decisions; Conflict resolution in strategic decisions involving technological alternatives;

Hierarchical decision modeling; Individual and aggregate decisions; Decision discrepancies and evaluation of group disagreements.

EM 504 Project Management Framework and Tools (3)

Role of projects in organization's competitive strategy; Standard methodologies for managing projects; Project life cycle; Design-implementation interface; Estimating: preliminary and detailed; Contractual risk allocation; Scheduling: PBS; WBS; Integration of scope, time, resource and cost dimensions of a project; Evaluation of labor, material, equipment, and subcontract resources; Scheduling techniques including CPM/ PERT, GERT, critical chain; Solving real-world project schedules; Monte Carlo simulation; Cost budgeting; Cost baseline; Cash flow analysis; Earned value analysis; Cost control; Proposal presentation; Application of software for project management (MS Project, P3).

EM-505 Operations Research (3)

Deterministic modeling: Linear programming; The simplex method; Multiple objective linear optimization; Duality and sensitivity analysis; Post optimality analysis from the viewpoint of technology management; Transportation, transshipment, and assignment problems; Problem. formulation; Goal programming; Network analysis; Dynamic programming; Integer programming and nonlinear programming. Probabilistic modeling: Markov chains; Queuing theory and applications; Inventory theory; Forecasting; Design analysis and simulation; Pareto optimality and tradeoff curves.

CI 511 Total Quality Management (3)

Critical principles and procedures of quality management in a competitive global environment; contemporary definitions of quality; construction quality; Product quality; Process quality; Quality economics; Quality philosophies; Planning, organizing and controlling for quality; Human resource strategies; QA and QC tools.

EM 512 Project Evaluation and Feasibility Analysis (3)

Evaluation of engineering projects from the engineering management perspective; Techniques for capital investment for decision-making; Time value of money and the concept of equivalence; Present worth, annual and rate of return analysis; Multiple alternatives; Replacement criteria; Tax considerations; Breakeven sensitivity analysis; Project evaluations under uncertainty; Risk sharing; Capital budgeting; Cost of capital depreciation; Multicriteria decisions. Project feasibility analysis; Organizational impacts; Societal impacts; Environmental impacts.

CI 513 Research Methods in Engineering Management (3)

Research methods in engineering and technology management; Statistical techniques including proper selection; Use and interpretation of parametric and non-parametric tests along with factor and discriminate analysis; Design of experiments and model misspecification; Simulation in engineering and management research and practice.

CE-544 Quantitative Tools for Engineering Management (3)

Descriptive measures and review of probability concepts. Demand estimation and Time Series Forecasting and Index number. Linear Programming for decision making, Optimization techniques and management tools, Decision making under risk, Multivariate and constrained Optimization, Economics Order Quantity (EOQ) model for inventory, Networks, Hypothesis testing for decisions, Analysis of Variance (ANOVA) techniques, Multiple regression and correlation analysis.

(Course to be supplemented by Case Studies)

CE 545 Construction Claim Management (3)

Construction claims administration and avoidance. Covers the importance of construction contract errors, unforeseen and changed conditions, disruptions, acceleration, termination, and proving of claims; Dispute Resolution in Pakistan - Case study and analysis of reported appellate decisions on common construction law issues; licensing; bid disputes; contract issues; construction lien law; surety problems; unresolved claims. Construction related documentation requirements for avoidance of litigation before, during, and after completion of construction projects; dispute resolution processes for construction operations.

CE 546 Vulnerability Analysis and Hazard Mitigation (3)

Assessment of risk and potential for damage to a community or facility from the impact of natural or anthropogenic hazards. Physical and construction related issues. Reducing potential damage to the built environment from natural hazards, including hurricanes, floods, earthquakes, explosions. Benefit-cost analysis. Regulatory problems.

CE 547 Housing for Developing Countries (3)

Problems faced by developing countries in housing their population. Political, economic, social, and technical considerations in decision process. Recognition and definition of those factors which affect the planning, financing, and construction of housing projects. The operations and responsibilities of a multidisciplinary team dealing with decision process; housing delivery system including how the housing industry operates, various technologies prevalent in housing construction, and constraints to housing; Future assessment and examination of problems and forces that will shape opportunities.

CE 548 Occupational Health and Safety in Construction Project Management (3)

Introduce the graduate student in Construction Management to the important elements essential in managing the health and safety function of a construction company. Principles of safety engineering applied to construction industry, job safety analysis, reduction of accident rates, protective equipment, safety rules and regulations; Health and Environmental Management Issues in construction; Health hazards; Environmental hazards; OSHA and Construction Health and Safety; Discussion of the common hazardous materials and waste regulations found in construction activities.

CE 549 Value Engineering in Construction (3)

The Value Concept; Developments in Value Thinking; Relationship of costs to time and life cycle of construction projects, and methods to improve the economic value of construction projects; Function Analysis; Teams, Team Dynamics and Facilitation; Current Study Styles and the Value Process; Value Framework; Value Engineering Job Plan; Project Value Chain; Client Value Systems; Application of Value Engineering Job Plan to Construction Projects; Professionalism and Ethics within Value Engineering; Value Engineering Organization in the Construction Industry; Future of Value Engineering.

CE 550 Construction Productivity Management

(3)

Construction Productivity: Definition and Importance; Failing Productivity Diagnosis; Method Improvement in Construction Operations; Productivity Improvement by Work Measurement; Productivity Analysis using Tested Scientific Models and Methods; Production Planning and Control; Construction Workforce Motivation; Computer Applications in Improving Productivity; Managing Construction Projects for Improved Productivity.

CE-587 Human Resource Management in Construction Industry

(3)

The challenges of managing people in construction industry, Modern organizational and management theories, strategic concepts and operational implications of human resource management in construction industry strategic approaches to managing human resource in the construction industry The mechanics of human resource in construction resourcing development and rewards approaches to managing employee relations Employee participation involvement and empowerment in construction industry Workforce diversity equal opportunities and work life balance in construction industry Employee health safety and welfare in construction industry strategic human resource development in construction industry issues and trends of human resource management in 21st century strategic human resource management as a route to improved business performance in construction industry Training motivation and performance of HR in construction projects Training Needs Assessment, Effective Training Provision, Evaluating Training Managers as Trainers and Trainees, Workforce Literacy improving learning inhibitors, performance Appraisal best practices of project HR planning in the construction industry best practices of project HR development in the construction industry Assessing the impacts on performance improvement of construction projects with improved HR planning and development.

CE-588 Leadership in Construction Management

(3)

What is leadership introduction to construction leadership Qualities of an effective construction leader leadership styles in modern construction project management building and Maintaining a Following leadership vs. Management leadership and change in construction projects history of leadership research and theory leadership potential Profile of a construction leader Myths and Realities of construction leadership Teambuilding and Teamwork Developing firm foundation to become a construction leader respect trust influence by-in Ethics stress management improving personal productivity social network building motivational drivers of construction leaders and their followers vision planning leading by example intuition momentum elements of winning developing construction leaders leading from the top empowerment legacy leading the close-out process of a construction project learning from lessons learned leadership challenges in changing world taking up the role of leadership the

transition process innovation culture for sustainable development motivating people in construction organizing people and resources in construction transforming people leading people with authority leading people without authority leading geeks developing a sustainable construction work environment to gain organizational objectives overcoming

CE-589 Supply Chain Management in Construction (3)

Logistics and supply chain management basics logistics and supply chain management in construction factory and construction physics variability and buffering in production management of inventory in the supply chain re-engineering of supply chain relational contracting and other contractual issues in the construction supply chain assuring the quality of procurement system for construction contractors strategic SCM Customer focus in SCM analytical approaches to deal with logistics issues in construction reliable commitment model buffer management and negotiation with third parties information technology in construction logistics and supply chain management construction logistics simulation Aligning supply chain with business strategy high performance supply chain organization performance measurement system for managing supply chain best practices and benchmarking for supply chain green supply chain sustainable logistic and supply chain management.

CE 590 Advanced Topics in Project Management (3)

Enterprise project management; Project Management Office; PM maturity models; PM integrated advanced techniques; PM Monitoring, Evaluation, Reporting and Control Framework; Application of software for project monitoring, evaluation and control (MS Project/ P3); Project Audit and Closure; Design integration management in construction; Communication and Conflict Management in Construction; Professional Responsibility and Ethics; Learning Curves; Leadership; Managing Project Teams; Partnering; Negotiating; Managing Customer Relations; International Construction Project Management: Introduction to procurement, financing and management of international construction projects with emphasis on international economics, contracts, trade agreements and specifications; Maintenance Management of construction projects; Construction/ Project Management Proposal Presentation.

CE-591 Cost Engineering and Control (3)

Introduction to Cost Engineering; Cost Estimating: Estimate Accuracy; Estimate Approaches/ Classes; Estimating Methods; Computerized Estimating; Labor Productivity Analysis; Equipment Unit Cost Estimation; Indirect Costs; Data Collection and Management; Activity Unit Price Estimation based on Field Data; Estimate Coding and Documentations; Predicting Future Escalation; Contingency; Application of computer software to rigorous exercises in construction estimating. Cost Control: Introduction to Cost Control; Role of Cost Control Engineer; Cost Control during Various Project Phases; Project Changes; Subcontract Development, Administration and Control; Cost Control during Construction; Monthly Cost Report and Cost Control Meetings; Computer Applications; The Cost of Cost Control; Control of Bulk Materials; Case Studies.

CE 592 Decision Making and Risk Management in Construction (3)

Sources of hazards; Definition of risk; System analysis; Functional modeling and analysis techniques; Techniques of analysis of engineering systems for risk management decisions involving trade-offs (technical, humans, environmental aspects); Risk assessment, communication and management; Elements of decision analysis; Probabilistic risk analysis (fault trees, event trees); Analytical Hierarchy Process; EMV and EUV Criteria; Inventory Modeling; Monte Carlo Simulation; Risk acceptance; Consequence assessment; Risk benefit assessment; Economic analysis of failure consequences (issues of human safety and long-term economic discounting); Uncertainty sources and types; Uncertainty modeling; Human factors engineering; Quantitative and qualitative risk analyses and management strategies employed in proactive, reactive, and interactive modes; Emphasis on risk management issues in public and private sector.

CE 593 Construction Operations and Development of Technologies (3)

Construction methods and practice; Design and construction technologies; Construction operations management: Integrated approach to planning, scheduling, modeling, analysis and design of construction processes and operations; Use of simulation models and other analytical tools; Constructability; Subcontractor and supplier management; Equipment selection; Material selection, procurement and control; Construction facilities and site development; Lean construction mechanisms for identifying and eliminating wastage and unnecessary cost by examining the construction process with a TQM framework. Artificial Intelligence Applications in Construction Management. A study of the concepts, techniques, and applications of AI technology in the construction management domain; Study of advanced field techniques and emerging uses worldwide. Information flow and creativity are highlighted as crucial elements which stimulate new developments. This course prepares the students to understand and deal with concepts of change.

CE 594 Bidding Strategy and the Legal Construction Environment (3)

Contract types and their implications on estimation and bidding procedures; general office operations, and bidding procedures; Bid Package Preparation; Tender Negotiations; Development of Working Methodologies. Legal and business aspects of engineering contracts and specifications in the construction industry. Legal principles as framework of interaction of project stakeholders; Contracts for civil engineering services; Contract risk allocation and reciprocal liabilities; Issues of contract formation, breach, and remedy; Analysis, study of precedents, and application of contract clauses, including changes, changed conditions, termination, disputes, payments, risk and insurance, inspection, liquidated damages, and technical requirements.

CE 595 Technical Entrepreneurship and the Management and Marketing of Construction Services (3)

Managerial, financial, legal, ethical and organizational aspects of starting and growing a construction organization; Setting up a virtual company and carrying it through the entrepreneurship process; Marketing aspects of entrepreneurship including market research (Guest lectures from practicing entrepreneurs, financiers and professionals associated with the entrepreneurship process should play a key role in the course). Management of a construction company: company organization, incorporation structures, policies and procedures, finance,

accounting, information modeling, bidding strategies, and operation; Human effectiveness in marketing construction services in the public and private sectors.

CE 596 Public Infrastructure Management (3)

Complexities, expanding pressures and demands on infrastructure management; Issues, identification of indigenous needs and managing provisions of required infrastructure facilities; Maintaining public infrastructure inventories; Assets management models. Methods and integrative approaches for balanced infrastructure management policies and practices; Roles of civic agencies/ essential services organizations; Disaster mitigation and management scenarios. Strategies for interaction between government and informal sectors; Infrastructure sustainability under economic constraints; Procuring funding for public infrastructure projects through non-conventional alternatives; Contemporary tools and instruments such as GIS/ LIS in public infrastructure management; Global trends and case studies.

CE 597 Real Estate Management (3)

Real Estate fundamentals; Real Estate Finance; Urban economic development and Real Estate market analysis; Real Estate development; Housing Economics and Finance; Real Estate investment decisions; Legal issues in Real Estate.

CE 598 Construction Failure Analysis (3)

Develop an understanding of the integration process of technical, human, capital, social and institutional aspects that drive the life cycle of a construction project. Study of failures to provide a vehicle to find ways for the improvement of planning, design and construction of facilities; Investigation of failure including technical analysis and also a comprehensive analysis of the organizational, contractual and regulatory aspects of the process that lead to the failure. (This course should use case studies to illustrate different types of failure in the planning, design, construction and operation of constructed facilities).

CE 5023 Building Information Modelling (BIM) for Construction Industry (3)

BIM Overview; Common BIM Terminologies; BIM as a Communication and Collaboration Tool; BIM Implementation Needs, Challenges and Guidelines for various Stakeholders in Construction Industry; Discussion of BIM Application on Project Life Cycle; BIM Maturity Levels; Develop understanding of how BIM models are applicable to: Reduction of Design Errors, Clash Detection, Quantity Takeoff and Cost Estimation, Construction Analysis and Planning, Energy Analysis, Construction Management, Facilities Management and other aspects of Construction Project Management; Application of nD BIM Technology on a Real Time Project of Challenging Scope; Performing Walkthroughs/ Flythroughs/ Animation, Presentation/ Rendering; Overview of BIM application in allied areas of Construction Industry (such as MEP).

Following software may be used; Revit, Tekla, Navisworks, CostX, Primavera, Microsoft Project, Lumion, EnergyPlus etc..

CE 5022 Forensic Engineering (3)

Introduction to Forensic Engineering; Competencies and Qualifications of Forensic Engineers: qualifications, attributes competencies, technical skills, legal knowledge, detective skills, communication skills, personality characteristics etc. The Standard of Care: expert testimony, methods, validity, reliability, Delphi process of expert consensus; Civil Engineering Investigations: activities in investigation, site investigation, sampling and collection of evidence, preliminary findings, equipment and its selection, recording observations, photography, sample removal, eyewitness account, field tests, document collection and review, theoretical analysis, laboratory tests and investigation, office investigations determination of procedural responsibilities, reports; Ethics of Forensic Engineering: code of ethics, solicitation of work, contract process, testimony ethics, damage caused by unethical conduct, ethical standards for publication, interaction with media; The Legal Forum: role of forensic engineer as a witness in mediation and litigation, admissibility of testimony by forensic engineers, rules of evidence and testimony, testimony in courts and at deposition (preparation, demeanor, speech, direct examination, cross examination etc.), codes and guidelines (local and international) for professionals engaged as experts; The Business of Forensic Engineering: readiness, marketing, decisions, liability, insurance individual and group practice; National and International Case Studies.

EQ-532 Fire Safety and Management (3)

. Fire safety concepts; design fires; flame spread, modelling of flame spread and fire growth; external fire spread and heat radiation; smoke movement; buoyancy; principles of smoke hazard management; smoke spread; smoke hazard management subsystems; fire safety measures; fire safety system design principles, occupant evacuation; fire department response; qualitative and quantitative risk assessment; fire safety risk management; logic trees