

# Dhaka University of Engineering & Technology, Gazipur



## Information Booklet for Postgraduate Program

## Department of Civil Engineering

# Courses and Syllabus for Postgraduate Programs

## List of Courses

| Course No.                         | Course Title                                         | Credit |
|------------------------------------|------------------------------------------------------|--------|
| CE 6000                            | Thesis                                               |        |
| CE 6001                            | Project                                              |        |
| <b>A. Structural Engineering</b>   |                                                      | 18     |
| CE 6101                            | Theory of Elasticity                                 | 6      |
| CE 6102                            | Theory of Plates                                     |        |
| CE 6103                            | Plastic Design of Structures                         | 3      |
| CE 6104                            | Elastic Stability of Structures                      | 3      |
| CE 6105                            | Analysis and Design of Shells                        | 3      |
| CE 6106                            | Finite Element Methods I                             | 3      |
| CE 6107                            | Finite Element Methods II                            | 3      |
| CE 6108                            | Advanced Concrete Technology                         |        |
| CE 6109                            | Advanced Design of Concrete Structures               | 3      |
| CE 6110                            | Analysis and Design of Tall Buildings                | 3      |
| CE 6111                            | Bridge Engineering                                   | 3      |
| CE 6112                            | Structural Dynamics and Vibration Control            | 3      |
| CE 6113                            | Seismic Resistant Concrete Structures                | 3      |
| CE 6114                            | Structural Brickwork                                 | 3      |
| CE 6115                            | Advanced Theory and Design of Steel Structures       |        |
| CE 6116                            | Theory and Design of Structural Concrete             | 3      |
| CE 6117                            | Structural Reliability                               | 3      |
| CE 6118                            | Properties and Application of High Strength Concrete | 3      |
| CE 6119                            | Boundary Element Method                              | 3      |
| CE 6120                            | Computer Methods in Civil Engineering                | 3      |
| CE 6121                            | Disaster Management                                  | 3      |
| CE 6122                            | Retrofitting and Its Application to Urban Structures | 3      |
| <b>B. Geotechnical Engineering</b> |                                                      | 3      |
| CE 6201                            | Soil Mechanics I                                     | 3      |
| CE 6202                            | Soil Mechanics II                                    | 3      |
| CE 6203                            | Foundation Analysis Methods                          | 3      |
| CE 6204                            | Earth Pressure and Retaining Structures              | 3      |
| CE 6205                            | Earth Dams and Stability of Slopes                   | 3      |
| CE 6206                            | Rock Mechanics                                       | 3      |
| CE 6207                            | Soil Dynamics                                        |        |

| Course No.                            | Course Title                                  | Credit |
|---------------------------------------|-----------------------------------------------|--------|
| CE 6208                               | Advanced Engineering Geology                  | 3      |
| CE 6209                               | Reinforced Earth                              | 3      |
| CE 6210                               | Constitutive Modeling in Soil Mechanics       | 3      |
| CE 6211                               | Geotechnical Earthquake Engineering           | 3      |
| CE 6212                               | Continuum Mechanics                           | 3      |
| CE 6213                               | Shallow and Deep Foundations                  | 3      |
| CE 6214                               | Geo-Environmental Engineering                 | 3      |
| CE 6215                               | Offshore Geotechnical Engineering             | 3      |
| CE 6216                               | Underground Excavation and Tunneling          | 3      |
| CE 6217                               | Advanced Soil Testing                         | 3      |
| CE 6218                               | Unsaturated Soil Mechanics                    | 3      |
| <b>C. Environmental Engineering</b>   |                                               |        |
| CE 6301                               | Theory of Water Treatment                     | 3      |
| CE 6302                               | Theory of Sewage Treatment                    | 3      |
| CE 6303                               | Environmental Impact Assessment               | 3      |
| CE 6304                               | Environmental Management                      | 3      |
| CE 6305                               | Solid and Hazardous Waste Management          | 3      |
| CE 6306                               | Industrial Wastewater Treatment               | 3      |
| CE 6307                               | Air and Noise Pollution Control               | 3      |
| CE 6308                               | Environmental Chemistry and Microbiology      | 3      |
| CE 6309                               | Environmental Sanitation                      | 3      |
| CE 6310                               | Water Pollution and Control                   | 3      |
| CE 6311                               | Surface Water Quality Modeling                | 3      |
| CE 6312                               | Aquatic Chemistry for Environmental Engineers | 3      |
| CE 6313                               | Environmental Fluid Dynamics                  | 3      |
| CE 6314                               | Design of Water and Wastewater Facilities     | 3      |
| CE 6315                               | Environmental Risk Assessment                 | 3      |
| CE 6316                               | Ecology and Ecosystem Dynamics                | 3      |
| CE 6317                               | Environmental Modeling and GIS Application    | 3      |
| <b>D. Water Resources Engineering</b> |                                               |        |
| CE 6401                               | Advanced Fluid Mechanics                      | 3      |
| CE 6402                               | Free-Surface Flow                             | 3      |
| CE 6403                               | Advanced Hydrology                            | 3      |
| CE 6404                               | Irrigation and Drainage Engineering           | 3      |
| CE 6405                               | Hydraulic Structures                          | 3      |
| CE 6406                               | Fluvial Hydraulics                            |        |



| Course No. | Course Title                                 | Credit |
|------------|----------------------------------------------|--------|
| CE 6407    | River Engineering                            |        |
| CE 6408    | GroundWater Engineering                      | 3      |
| CE 6409    | Water Resources Systems                      | 3      |
| CE 6410    | Flood Modeling and Management                | 3      |
| CE 6411    | Design of River Training and Bank Protection | 3      |
| CE 6412    | Hazard and Risk Analysis                     | 3      |
| CE 6413    | Water Resources System Analysis              | 3      |
| CE 6414    | Integrated Water Resources Management        | 3      |
| CE 6415    | Coastal Zone Management                      | 3      |
| CE 6416    | River and Floodplain Management              | 3      |
| CE 6417    | Computational Fluid Dynamics                 | 3      |
| CE 6418    | River Ecosystem                              | 3      |

### E. Transportation Engineering

|         |                                               |   |
|---------|-----------------------------------------------|---|
| CE 6501 | Transportation Engineering                    | 3 |
| CE 6502 | Geometric Design of Highways                  | 3 |
| CE 6503 | Highway Materials                             | 3 |
| CE 6504 | Structural Design of Pavements                | 3 |
| CE 6505 | Traffic Engineering                           | 3 |
| CE 6506 | Railway Engineering                           | 3 |
| CE 6507 | Planning and Design of Airports               | 3 |
| CE 6508 | Transportation Planning                       | 3 |
| CE 6509 | Water Transportation and Waterways            | 3 |
| CE 6510 | Intelligent Transport Systems                 | 3 |
| CE 6511 | Road Safety Engineering and Injury Prevention | 3 |
| CE 6512 | Transportation Engineering Economics          | 3 |
| CE 6513 | Traffic Simulation                            | 3 |
| CE 6514 | GIS and Remote Sensing in Transportation      | 3 |

### F. Climate Change (Water and Environment)

|         |                                                                    |   |
|---------|--------------------------------------------------------------------|---|
| CE 6601 | Understanding Climate Change Implications of Water and Environment | 3 |
| CE 6602 | Climate Change Adaptation                                          | 3 |
| CE 6603 | Gender, Climate Change and Health                                  | 3 |
| CE 6604 | Disaster Management                                                | 3 |
| CE 6605 | Climate Change and GIS                                             | 3 |
| CE 6606 | Building with Nature                                               | 3 |
| CE 6607 | Adaptive Water Management                                          | 3 |

## Detailed Syllabus

### A. Structural Engineering

**CE 6101 Theory of Elasticity** **3 Credits**  
 Stress-strain relationship; Plane-stress and Plane-strain; Stress functions; Two dimensional problems in rectangular and polar coordinates; Torsion; Energy principles; Stress and strain in three dimensions; General theorems; Three dimensional problems; Theories of failure; Computer solutions of elasticity problems.

**CE 6102 Theory of Plates** **3 Credits**  
 Rectangular plates with various edge conditions; Circular plates; Energy methods; Approximate methods; Orthotropic plates; Buckling of thin plates; Numerical methods in the solution of plate problems; Non-linear analyses of plates.

**CE 6103 Plastic Design of Structures** **3 Credits**  
 Review of fundamental concepts-plastic hinges, collapse of beams and frames; Effects of axial load and shear force; Investigation of plastic collapse mechanisms and calculation of collapse loads; Upper and lower bounds; Plastic analyses and design of beams, frames and grillages; Plastic collapse of reinforced concrete and masonry structures; Elastic plastic analysis; Repeated loading; Shakedown theorems; Minimum weight design, numerical analysis; Design of multistory frames.

**CE 6104 Elastic Stability of Structures** **3 Credits**  
 Stability of struts and beam-columns; Initial imperfections; Inelastic buckling; Stability functions; Stiffness matrix; Fixed end moments; Energy method; Elastic instability of plane frames Critical load; Buckling modes. Failure load analysis. Tensional buckling under various conditions of end loads; Buckling by combined torsion and flexure. Lateral buckling of beams; Local buckling phenomenon. Buckling of thin plates and membrane shells. Buckling of built-up sections.



**CE 6105 Analysis and Design of Shells**

Introduction to shells; Membrane theory, bending theory, and theory of cylindrical shells; Design of cylindrical shells; Surfaces of revolution; Shells of double curvature other than shells of revolution; Synclastic shells; Anticlastic shells.

**3 Credits****CE 6106 Finite Element Methods I**

Introduction to finite element concepts, basic techniques, shape functions, Finite element formulation of various elastic problems-plane stress, plane strain, axis-symmetric and three dimensional cases. Isoperimetric elements, the elastic membrane, thick shell and plate elements, body of revolution with pressure and sinusoidal loading. Local loads from shape functions routines. Bending of plates, axis-symmetric shells. Developing and implementing elements. Convergence the patch test. Solution techniques: Front and band solutions, element assembly and equation solving, round off errors. Variational principles in finite element analysis.

**3 Credits****CE 6107 Finite Element Methods II**

General sources of nonlinearity in structures. Solution of nonlinear equations-incremental. Iterative- Newton-Raphson and Modified Newton Raphson solution procedures. Geometric Nonlinearity- Large displacement and structural instability, Lagrangian approach-both total and updated, Eulerian approach, Material Nonlinearity- Material modeling. Yield criteria, plasticity, creep, elasto-plasticity, viscoplasticity, elastoviscoplasticity, modeling of reinforced concrete. Combined geometric and material nonlinearity. Modeling of dynamic problems and solution procedure.

**3 Credits****CE 6108 Advanced Concrete Technology**

Concrete and its ingredients; Production of concrete; Fresh concrete; Quality control of concrete; Strength of concrete; Elasticity, creep, and shrinkage of concrete; Durability of concrete; Testing of hardened concrete; Concrete mix design; Formworks for concreting; Deterioration of concrete and its prevention; Inspection and testing of concrete; Special concrete-lightweight concrete, fiber reinforced concrete and high density concrete.

**3 Credits**

**CE 6109 Advanced Design of Concrete Structures** **3 Credits**  
Review of principles of designing concrete structures: beams, slabs and columns; Design of columns: short columns and long columns; Design of slabs: two way slab systems, grids, waffle slabs, ribbed slab; Deep beams, curved beams, shear walls, building frames. Design for torsion. Bulk storage structures, creep and temperature effects. Details of reinforced concrete members, Advanced problems in foundations of structures, Codes and specifications and their influence in design. Prestressed concrete structures.

**CE 6110 Analysis and Design of Tall Buildings** **3 Credits**  
Structural forms of tall buildings-floor system Vertical load resisting systems, lateral load resisting systems. Choice of systems-optimum design; Coupled shear walls -continuous medium, wide-column analogy, and finite element solutions. Interaction of walls and frames-approximate methods. Tubular structures Methods. Tubular Structures approximate methods, computer analysis. Masonry high-rise buildings. The future of high-rise buildings.

**CE 6111 Bridge Engineering** **3 Credits**  
Planning concepts. Various types of bridges and their suitability for different span ranges. Bridge loadings. Orthotropic plate decks. Grillage. Space frames, finite element and finite strip methods of bridge deck analysis. Long span bridges-cable stayed bridge, suspension bridge. Substructures; Design and construction.

**CE 6112 Structural Dynamics and Vibration Control** **3 Credits**  
Fundamental of structural dynamics, single degree of freedom systems, free vibration response to harmonic, periodic, base excitation and general dynamic loading, multi degree of freedom systems, numerical evaluation dynamic response, linear and nonlinear of structures and evaluation, vibration control of structure: Active control, passive control, and semi-active controls; Application of different vibration control in high-rise buildings and long span bridges.



### CE 6113 Seismic Resistant Concrete Structures

Introduction to earthquake resistant design, Current design method for reinforced concrete structures, setup of design earthquake load, behaviors of reinforced concrete structures under seismic load, restoring forces of reinforced concrete member, response analysis, design of section under seismic load, reinforcement detail for earthquake resistance.

3 Credits

### CE 6114 Structural Brick work

Introduction of load-bearing masonry structures; Bricks, blocks, and mortars; Properties of masonry; Codes of practice for structural masonry; Design for compressive loading; Lateral load analysis of masonry panels; Design for wind loading; Composite action between walls and other elements; Reinforced masonry; Prestressed masonry.

3 Credits

### CE 6115 Advanced Theory and Design of Steel Structures

Introduction of steel structures; Prospect of steel structures in Bangladesh. Application of design codes Tension members - Design criteria; Compression members - Buckling of Column; Residual Stress; Column Strength curves; AISC design formulas for working stress design and Load and Resistance Factored (LRFD) design; Buckling of plates; Design of column as affected by local buckling. Design of laterally supported beam; Shear on beams; Biaxial bending; Stresses due to torsions; Analogy between torsion and plane bending; Design for combined procedures for laterally unsupported beams. Beam column; AISC working stress design and LRFD design criteria for combined bending and axial load; Connections.

3 Credits

### CE 6116 Theory and Design of Structural Concrete

Introduction to the limit state design concept. Ultimate limit state design of sections in bending, shear, torsion and combination of axial load and bending. Comparison of design recommendations of different codes (viz. American, British, Canadian etc). Evaluation of the impact of traditional concepts describing structural concrete behavior on its analysis and design. Introduction to compressive field theory, strut-and-tie model and compressive-force path concept. Design in compliance with these concepts. Prospects and problems of applying finite element method in the analysis and design of structural concrete.

3 Credits

### CE 6117 Structural Reliability

Introduction of Structural Reliability; Fundamental concepts of statistical learning, uncertainty in building process, random variables, functions of random variables, structural safety, structural reliability methods, simulation techniques, structural load models, models of resistance, design codes, system reliability.

3 Credits

### CE 6118 Properties and Application of High Strength Concrete

3 Credits

Historical development of high strength concrete (HSC); HSC versus normal strength concrete; Advantages and limitations of using HSC; Considerations in achieving HSC; Production and properties of HSC; Structural use of HSC; HSC for prestressed concrete members; Code provision for the design of HSC members.

### CE 6119 Boundary Element Method

3 Credits

Introduction; One-dimensional problems: potential flow, beam bending; Two-dimensional problems of potential flow; Two-dimensional problems of elastostatics; Axisymmetric analysis; Three-dimensional formulations; Parametric representations of functions and geometry; Time dependent analysis: elastodynamics, transient groundwater flow; Non-linear analysis: problems of elastoplasticity; Combination of Boundary Element Method with other numerical methods.

### CE 6120 Computer Methods in Civil Engineering

3 Credits

Advanced programming techniques related to civil engineering problems; Program optimization; Computational pitfalls; Management of files and data bases; File structures; Direct access backing storage; Computational aspects of matrix algebra relaxation methods, various reduction and elimination schemes; Eigenvalue problems, storage of and computation with large and space matrices; Numerical differentiation and integration; Interpolation and curve fitting; Linear and non-linear programming algorithms; Software packages; Computer graphics; Interactive analysis and design; Programming for civil engineering problems on microcomputers.



**CE 6121 Disaster Management****3 Credits**

Introduction to Disasters, Principles/Components of Disaster Management, Organizational Structure for Disaster Management, Disaster Management Schemes, Natural Disasters and Mitigation Efforts, Earthquake, Flood Control, Drought Management, Cyclones, Landslides, Forest fire, Risk Assessment and Disaster Response, Quantification Techniques, Role of Financial Institutions in Mitigation Effort, Group Dynamics, Concept of Team Building, Motivation Theories and Applications, School Awareness and Safety Programmes, Psychological and Social Dimensions in Disasters, Trauma and Stress, Emotional Intelligence, Electronic Warning Systems, Recent Trends in Disaster Information Provider, Geo Informatics in Disaster Studies, Remote Sensing & GIS Technology, Laser Scanning Applications in Disaster Management, Statistical Seismology, Quick Reconstruction Technologies, Role of Media in Disasters, Management of Epidemics, Bio-Terrorism, Forecasting / Management of Casualties.

**CE 6122 Retrofitting and Its Application to Urban Structures****3 Credits**

Retrofitting, Conventional and non-conventional methods of retrofitting, Comparative study of various methods and case studies. Recent Problems in Urban Infrastructures; Classification and Causes of Deterioration of Infrastructures; Strategy of Damage Assessment of Existing Structures; Inspection and Measurements; Application and Recent Problems of Nondestructive Evaluations; Health Monitoring Systems with Sensors for Damage Detection; Evaluation of Actual Strengths of Existing Structures; Ultimate Strengths of Deteriorated Structural Elements; Retrofitting of Corroded Structural Elements; Seismic Retrofitting of Deteriorated Structural Elements; Fatigue Retrofitting of Deteriorated Structural Elements; Strengths of Repaired Structural Elements and Structures; Discussion: Case Studies.

**B. Geotechnical Engineering****CE 6201 Soil Mechanics I****3 Credits**

Identifying characteristics of soils, clay minerals, clay water relation, fabric, Compression. One and three dimensional consolidation, swelling, collapse and theological properties. Soils shear strength, concept of cohesion and internal friction. Failure theories. Bearing capacity equations and factors. Subsoil exploration programme, interpretation of topographic, geological and agricultural soil maps. Laboratory testing of soils sand their interpretation for engineering purposes.

**CE 6202 Soil Mechanics II****3 Credits**

Soil porosity and moisture effects relative to effective stress principles, capillarity, permeability and frost action. Hydraulic fracturing. Principles governing flow of water through soils, Soil Seepage analysis for isotropic and anisotropic conditions. Numerical techniques for vertical and radial drainage. Description, design procedure and usage of current site improvement techniques, preloading, earth reinforcements, dynamic consolidation, and vibro compaction, blasting densification, lime treatment, drains and geotechnical fabrics.

**CE 6203 Foundation Analysis Methods****3 Credits**

Elastic foundations, loads on infinite slabs, sub grade coefficient, settlement on non-homogeneous half spade, linearly elastic pile and soil, laterally loaded pile, soil foundation interaction for footing and mat designs. Analysis of pile and pile group foundations. Exact and numerical solutions to above problems.

**CE 6204 Earth Pressure and Retaining Structures****3 Credits**

Earth Pressure: Types - at rest, active, passive; Rankine's theory; Backfill features - soil type, surface inclination, loads on surface, soil layers, water level; Coulomb's theory; Effects due to wall friction and wall inclination; Graphical methods; Earthquake effects.

Rigid Retaining Structures: Types; Empirical methods; Stability analysis.

Flexible Retaining Structures: Types; Material; Cantilever sheet piles; Anchored bulkheads - free earth method, fixed earth method, moment reduction factors, anchorage.



Braced Excavation: Types; Construction methods; Pressure distribution in sands and clays; Stability - bottom heave, seepage, ground deformation.

Cofferdams: Types; Construction methods; Stability analysis and design.

Reinforced Soil Walls: Elements; Construction methods; External stability; Internal stability.

Laterally Loaded Piles: Short and long piles; Free head and fixed head piles; Lateral load capacity of single piles; Lateral deflection; Elastic analysis; Group effect; Lateral load test; Codal provisions.

Underground Structures in Soils: Pipes; Conduits; Trenchless technology; Tunneling techniques - cut-and-cover method, shield tunneling.

### CE 6205 Earth Dams and Stability of Slopes

3 Credits

Slope Stability: Short term and long term stabilities; Limit equilibrium methods; Infinite slopes; Finite height slopes - Swedish method, Bishop's simplified method, other methods; Stability charts; Conditions of analysis - steady state, end of construction, sudden draw down conditions; Factor of safety; Codal provisions; Earthquake effects. Seepage Analysis: Types of flow; Laplace equation; Flow net in isotropic, anisotropic and layered media; Entrance-exit conditions; Theoretical solutions; Determination of phreatic line. Earth Dams: Introduction; Factors influencing design; Design of components; Construction; Instrumentation - piezometer, settlement gauge, inclinometer; Road and rail embankments. Reinforced Slopes: Steep slopes; Embankments on soft soils; Reinforcement design. Landslides: Remedial measures for unstable slopes - soil nailing, gabions, drainage.

### CE 6206 Rock Mechanics

3 Credits

Classification and engineering properties of intact rocks, stress-strain relationship, brittle fracture theory. Characterization and properties of rock discontinuities criteria of rock failure, In-situ stresses in earth crust. Engineering problems associated with construction in rocks; Stabilization, anchoring and rock bolting; Rock slope stability and reinforcement; Design of underground opening and structures; Moisture sensitive behavior of weak rocks (swelling and slaking). Geotechnical aspects of open pit and underground mining; soft and hard rock; Material handling, waste disposal.

### CE 6207 Soil Dynamics

3 Credits

Sources and types of dynamic loading. Vibration of elementary systems. Wave propagation in soils. Dynamic soil properties and methods of their determination, liquefaction, shear modulus and damping effects. Vibrations of foundations on elastic media, machine foundations, earthquake response, blast effects including nuclear weapon effects.

### CE 6208 Advanced Engineering Geology

3 Credits

Advanced physical geology concerning transported and residual soils, Erosion and deposition. Geomorphology. Study of the formation of delta. Engineering geology of soft clays. Engineering properties of rocks. Geologic structures. Historical geology. Geology of Bengal Basin. Earthquake zones of Bangladesh. Geological considerations for engineering designs.

### CE 6209 Reinforced Earth

3 Credits

Materials used in reinforced earth; constitutive laws; Design parameters and testing techniques; Conceptual performance of reinforced soil; Analysis, design and construction of reinforced earth retaining structures, reinforced earth walls and Reinforced slopes and codal provisions; Design and construction of reinforced paved and unpaved roads, railways, AASHTO and other relevant guidelines; Analysis, design and construction of granular in-situ stabilized columns; Soil nailing, root or micropiles. Random (non-oriented) fibre reinforced soil. Liners for ponds and canals; covers and liners for landfills - material aspects and stability considerations; Landslides - occurrences and methods of mitigation; Erosion - causes and techniques for control.

### CE 6210 Constitutive Modeling in Soil Mechanics

3 Credits

Elasto-plastic modeling of soils; Model development process; Models for different types of soils; Monotonic, cyclic and repetitive loading models; Modern approach of constitutive modeling in soil mechanics; Thermodynamic approach of modeling; Application of soil models with small and large strain theories; Application of soil models in Finite Element Method, Distinct Element Method and Finite Difference Method.

**CE 6211 Geotechnical Earthquake Engineering****3 Credits**

Historical background; Plate tectonics; Various types of earthquakes and faulting; Wave types and their characteristics; Characteristics of seismometers and micro tremor instruments; Characteristics of magnitude and intensity scales; Earthquake time histories; Fourier and response spectra; Historical seismicity and earthquake catalogues: data acquisition, sources, magnitude rescaling, application to hazard analysis; Site characterization: amplification and responses; Experimental simulation and shaking tables. Introduction to lifeline engineering: electricity, water, natural gas, telecommunication and transportation systems; Post earthquake damage survey; Mitigation strategies; Case studies of major earthquakes.

**CE 6212 Continuum Mechanics****3 Credits**

Basic concepts of the theory of continuous media, introduction to tensor algebra, theory of stresses, infinitesimal and finite strains, strain-displacement relationships, compatibility, stress-strain relationships, boundary value problem in elasticity, plane stress and plane strain case, stress function approaches, plane problems in Cartesian and polar coordinates, elements of plasticity: yield criteria, flow rule and hardening. Plastic stress-strain relationships, Variational methods, Rayleigh-Ritz and Weighted residual methods, Introduction to Hamilton's principles.

**CE 6213 Shallow and Deep Foundations****3 Credits*****Types of foundations.***

Shallow Foundations: Design considerations - factors of safety (including limit state), allowable settlements, location and depth of foundations, codal provisions. Presumptive bearing capacity. Bearing capacity theories. Layered soils. Choice of shear strength parameters. Bearing capacity from N-values, static cone tests, plate load tests. Shallow foundations: Total and differential settlement. Stress distribution. Consolidation settlement in clays (with correction factors). Immediate settlement. Settlement in sands from N-values, elastic solutions. Static cone tests, plate load tests. Deep foundations: Types of piles. Construction methods. Axial capacity of single piles - dynamic formulae, soil mechanics approach. Skin friction and end bearing in sands and clays. Axial capacity of groups. Settlement of single piles and groups. Uplift capacity (including under-reamed piles). Negative skin friction. Pile load tests. Pile integrity tests. Codal provisions.

**Caissons.** Foundations in difficult soils: expansive soils, chemically aggressive environment, soft soils, fill regions of subsidence.

**CE 6214 Geo-Environmental Engineering****3 Credits**

Sources and effects of subsurface contamination; Physical, Chemical and biological characteristics of solid wastes; Soil-waste interaction; Contaminant transport; Laboratory and field evaluation of permeability; Factors affecting permeability; Waste disposal on land. Types of landfills; Siting criteria; waste containment principles; Types of barrier materials; Planning and design aspects relating to waste disposal in landfills, in ash ponds and tailing ponds, and in rocks. Environmental monitoring around landfills; Detection, control and remediation of subsurface contamination; Engineering properties and geotechnical reuse of waste, demolition waste dumps; Regulations; Case studies.

**CE 6215 Offshore Geotechnical Engineering****3 Credits**

Submarine soils: Origin, nature and distribution. Terrigenous and pelagic soils. Submarine soils of Bangladesh. Engineering behavior of submarine soils: under-consolidated soils, calcareous soils, cemented soils, corals. Offshore site investigations: sampling and sampling disturbance, in-situ testing, wire line technology. Offshore pile foundations for jacket type structures. Foundations of gravity structures. Foundations for jack-up rigs. Anchors and breakout forces; anchor systems for floating structures. Stability of submarine slopes. Installation and stability of submarine pipelines.

**CE 6216 Underground Excavation and Tunneling****3 Credits**

Introduction: History, type, stability and influencing factors, related problems.

***Underground Excavations in Rocks:***

Stresses and displacements around underground excavations: In situ stresses, Thick-walled cylinder solution, stresses and displacements around a circular opening, uniform stress field & non-uniform stress field (elastic, elasto-plastic), ground reaction curves (characteristic lines). Displacements around advancing tunnel face. Elastic stresses and displacements around non-circular openings and caverns; around multiple excavations, Design considerations for underground rock excavation on



the basis of stress criteria; pressure tunnels. Tunnel responses and relation to ground properties and geology: Standup time and free span, Type of tunnel grounds: rock and soft ground. Major ground responses: rock burst, loosening, squeezing. Methods of excavation and support, Geotechnical investigations for design and construction, Determination of rock loads on tunnel support requirements, Instrumentations, purposes, types of measurements and interpretation.

#### **Soft Ground Tunneling:**

Types of ground responses and influencing factors, Face stability in clay and granular soils, Shield tunneling, Ground movement prediction (empirical & numerical analyses), Response of structures to ground movement from tunneling, shallow foundation, piled foundation, damage criteria, risk assessment, Control of stability and ground movements: compressed air; ground treatment (grouting, dewatering, freezing, etc.). Lining design: lining load, ground-lining interaction, segmented lining, analysis methods. Instrumentation and Monitoring.

#### **CE 6217 Advanced Soil Testing**

**3 Credits**

Field Testing Equipment and Data Interpretation: Sampling, Standard Penetration Test, Field Vane, Cone Penetration & Dissipation Tests, Pressure meter, Dilatometer. Field Monitoring Equipment: Piezometer, Inclinator, Settlement Measurements Advanced Laboratory Equipment: Consolidation, Constant rate of strain/displacement, Rowe Cell & Radial flow, K0 consolidated Tri-axial, Measurement of K0-value, Strength testing, K0-consolidated Tri-axial (Compression & Extension), Direct Shear and Simple Shear, True Tri-axial & Plane Strain, Torsional Shear Hollow Cylinder, Directional Shear Cell.

#### **CE 6218 Unsaturated Soil Mechanics**

**3 Credits**

Introduction to unsaturated soil mechanics; Phase, properties and relations: Stress state variables; Flow laws; Measurement of permeability; Steady state flow; Pore pressure parameters; Shear strength theory; Measurement of shear strength parameters; Plastic and limit equilibrium; Volume change theory; Measurement of volume change indices; Volume change predictions; One-dimensional consolidation and swelling; Two and three dimensional unsteady-state flow; Non-isothermal analysis.

### **C. Environmental Engineering**

#### **CE 6301 Theory of Water Treatment**

**3 Credits**

Water and its impurities; criteria of water quality; physical, chemical and biological treatment processes; Desalinization and demineralization processes, Controls of aquatic growth; Control of taste and odor.

#### **CE 6302 Theory of Sewage Treatment**

**3 Credits**

Composition, properties and analysis of sewage; Biology and biochemistry of sewage treatment; principles of physical, chemical and biological treatment processes; Tertiary treatment of effluents; Sludge digestion; Sludge dewatering and disposal.

#### **CE 6303 Environmental Impact Assessment**

**3 Credits**

Historical development; Definition, aims and objectives of Environmental Impact Assessment(EIA); Environmental issues related to development projects; Project screening, Initial Environmental Examination (IEE); Impact identification, prediction analysis and evaluation; EIA methodologies, Environmental Impact Statement (EIS); Impact mitigation plan; Environmental monitoring and post-development audits; Organization of EIA: Scope, Work plan, resource requirements and costs of EIA, TOR for EIA; EIA in developing countries; Case studies. Current environmental rules and legislation in Bangladesh.

#### **CE 6304 Environmental Management**

**3 Credits**

Environment and sustainable development; Global and regional approach to environmental management; Environmental implications of sectoral development: Infrastructure, water resources, industry, agriculture, transport and communication, energy, health and population, mineral resources, tourism, land use and urbanization; Environmental management at project level; Environmental resource management and conservation strategies; Environmental policy and legislation; Environmental Quality Standards (EQS); Economics of Environmental Management



**CE 6305 Solid and Hazardous Waste Management** 3 Credits  
Solid waste management: Sources and types of solid wastes; Physical and chemical properties of solid wastes; Solid wastes generation; On-site handling, storage and processing, collection of solid wastes, transfer stations and transport; Ultimate disposal methods; resources and energy recovery, soil pollution. Industrial solid waste collection and disposal; Hazardous waste management.

**CE 6306 Industrial Wastewater Treatment** 3 Credits  
Characteristics and volume of industrial waste; Problems associated with industrial wastes; Physical, chemical and biological methods of treatment; Industrial waste problems of major industries and their methods of treatment and disposal.

**CE 6307 Air and Noise Pollution Control** 3 Credits  
Air Pollution: Sources and classification of air pollutants; Effects of air pollution; Air pollution regulations, air quality standards, emission standards, pollution indices; Sources of pollution in combustion process; Air pollution and meteorology: properties of atmosphere, atmospheric lapse rates and atmospheric stability, atmospheric diffusion theories, Gaussian plume models; Air quality management and control measures: atmospheric removal processes, engineered systems for air pollution control; Global atmospheric change: global warming, stratospheric ozone layer depletion; Indoor air quality; Air pollution measurements. Noise Pollution: Concept, measurement, frequency analysis, sources of noise, impact of noise, control of noise pollution.

**CE 6308 Environmental Chemistry and Microbiology** 3 Credits  
Chemistry of air and water pollution; Chemistry of aqueous metal; Industrial chemistry related to environmental pollution; Ecology and Ecosystem; Geo-biochemical cycle, Bio-geochemical cycle; Toxic substances and substances of life; Agriculture and energy; Catastrophic dioxygen depletion, lipids. Bioamplification and detoxification of toxic materials, Molecular mechanisms of mutagenesis, carcinogenesis and teratogenesis, Control of toxic substances in environment; Biological species for environmental pollution and control.

**CE 6309 Environmental Sanitation** 3 Credits  
Application of engineering principles to the control of communicable diseases; Vector control; Insecticides and bactericides; Collection and disposal of municipal refuse; Housing; Milk and food sanitation; Industrial and personal hygiene; Air pollution; Plumbing; Ventilation, air-conditioning; Hospital sanitation; Camp sanitation.

**CE 6310 Water Pollution and Control** 3 Credits  
Water pollution: Source and types of pollutants; Waste assimilation capacity of streams; Dissolved oxygen modeling; Ecological balance of streams; Industrial pollution: Heavy metal contamination; Detergent pollution; Eutrophication; Ground water pollution; Marine pollution; Pollution control measures; Water quality monitoring and management; Water pollution problems in Bangladesh.

**CE 6311 Surface Water Quality Modeling** 3 Credits  
Principal components of dissolved oxygen (DO) analysis, sources and sinks of DO kinetics. DO analysis for water bodies, engineering control of DO; Basic mechanisms of eutrophication, significance of N/P ratio, sources and sinks of N and P, phytoplankton and nutrient interactions, phytoplankton-D relationships, simplified river-stream eutrophication analysis for phytoplankton and rooted aquatic plants; Objectives of modeling, applications; Mass loading rate estimations: point source, tributary and intermittent sources, Low flow estimates, travel time and velocity estimates; Steady state stream equations; Estuarine hydrology: Distribution of water quality in rivers and estuaries, dispersion coefficients, hydraulic transport processes, mathematical formulations, water quality parameters, solution techniques, multi-dimensional models; Physical and hydrologic characteristics of lakes, lake side response to inputs, finite segment steady state lake models, model calibration and verification, sensitivity analysis parameter estimation; Case studies.



**CE 6312 Aquatic Chemistry for Environmental Engineers****3 Credits**

Review of some fundamentals of Chemistry; Approaches to equilibrium problem solving; numerical solution, graphical solution. Equilibrium problem solving; numerical solution graphical solution, the 'tableau' method. Natural weak acids and bases, alkalinity and pH in natural waters, buffer capacity; Dissolved carbonate equilibria (closed system), dissolution of  $\text{CO}_2$  (open system); Solubility of solids, coexistence of phases in equilibrium; Metal ions and ligands in natural waters, aqueous complexes, ion association among major aquatic constituents, inorganic and organic complexation of trace elements; Redox equilibria and electron activity, pe-pH diagrams, redox conditions in natural waters; Aquatic particles and coordinative properties of surfaces, adsorption of metals and ligands on aquatic particles, surfaces complexation models; Fate of organic compounds in natural environment: volatilization, sorption/partitioning, transformation reactions, structure-activity and property -activity relationships.

**CE 6313 Environmental Fluid Dynamics****3 Credits**

Governing laws of motion for a viscous fluid: Review of laminar and turbulent flows; Fickian diffusion; Turbulent diffusion, Mass transport equation; Shear flow dispersion; Mixing in rivers and estuaries; Jets and buoyant jets; Reservoir dynamics; Pollutant movement in porous media; Computation of environmental flows.

**CE 6314 Design of Water and Wastewater Facilities****3 Credits**

Design and analysis of water distribution system, Design and analysis of wastewater conveyance system. Water treatment: Source selection process, selection of treatment chain, plant siting, Treatability studies. Design of physicochemical unit operations: screening, flow measurement and pumping, grit removal, equalization, sedimentation, floatation, coagulation-flocculation, filtration, disinfection. Wastewater Treatment: Design of pre-treatment, secondary treatment, and tertiary treatment, disposal systems. Design of processes for nitrogen and phosphorus removal. Sludge stabilization, treatment, sludge thickening, sludge drying, aerobic and anaerobic digestion of sludges. Hydraulics of treatment plants: flow measurement and hydraulic control points, hydraulic profile through the treatment plant.

**CE 6315 Environmental Risk Assessment****3 Credits**

Basic concepts of environmental risk and definitions; Hazard identification procedures; Environmental risk zonation; Consequence analysis and modeling (discharge models, dispersion models, fire and explosion models, effect models etc). Estimation of incident frequencies; estimation of incident frequencies from historical data, frequency modeling techniques e.g., Fault Tree Analysis (FTA) and Event Tree analysis (ETA). Case studies. Human factors in risk analysis; Calculation and presentation of risk (individual risk, societal risk); Risk management. Rules, regulations and conventions.

**CE 6316 Ecology and Ecosystem Dynamics****3 Credits**

Concepts of diversity. Diversity in ecosystems and habitat classification, important types of ecosystems in Bangladesh (e.g. Wetland eco-system including estuaries, tidal marsh lands, swamps, lakes etc.), Forest ecosystem (including tropical forests, Himalayan and sub-Himalayan forest eco-system etc.), Desert eco-system, Coastal shelf ecosystem, Temperature and Tundra eco-system, Grasslands etc. Ecology and diversity. Abiotic factors affecting the distribution and productivity of various terrestrial life forms. Leibig's law of minimum. Census techniques, random sampling, various indices of species dominance, richness and abundance, species evenness and diversity. Statistical models, cluster and principal component analysis for similarity studies. Concepts of stability, equilibrium and on-equilibrium in eco-system dynamics. Links between diversity and stability. Concept of succession and its use in reclamation. Facilitation, enablement, Trophic structure, food webs, energy flow diagram, nutrient cycles. Restoration, Reclamation, and Regeneration of Degraded or Destroyed Ecosystems.

**CE 6317 Environmental Modeling and GIS Application****3 Credits**

Introduction to environmental modeling; introductory concepts of GIS; need for integrating GIS with environmental modeling; application of GIS to environmental problem solving. Application of GIS to cartographic modeling, broad-category environmental modeling, atmospheric modeling, hydrological modeling, land surface and subsurface modeling, bio-ecological systems modeling, integrated modeling. GIS and risk analysis; spatial analysis in GIS for hazard assessment; role of modeling in policy formulation. Spatial information analyses: sources of and issues related to spatial database; sample databases; statistical analyses of spatial data related to environmental and ecological systems; geostatistics.



## D. Water Resources Engineering

### CE 6401 Advanced Fluid Mechanics

3 Credits

Kinematics of Flow: Equation of continuity in Cartesian, polar and cylindrical coordinates. Standard two Dimensional Flow Patterns: Source, sink, doublet and their combinations. Solution of Laplace equation by graphical method; relaxation method, conformal mapping. Laminar Flow: Derivation of N.S. Equations, exact solution for flow between parallel plates, Couette flow, flow near a suddenly accelerated plate and an oscillating plate. Boundary layers: Similarity solutions of boundary layer equations. Falkner-Skan wedge flows. Karman's momentum integral equation, Kármán-Pohlhausen's approximate solution, Separation in boundary layer under adverse pressure gradient, Turbulent boundary layer. Turbulent flow: Reynolds equations of motion, semi-empirical theories of turbulence-velocity profiles for inner, outer and overlap layers, equilibrium boundary layer, measurement of turbulence. Statistical theories of Turbulence: Isotropic and Homogeneous turbulence, probability density function, correlation coefficients, decay of isotropic turbulence.

### CE 6402 Free-Surface Flow

3 Credits

Energy and momentum principles; Flow resistance; Boundary layer theory; Non-uniform flow computation; Channel controls; Channel transitions; Hydraulic jump and surges; Unsteady flow; Hydraulic method of flow routing; Overland flow; Mathematical models of open channel flow; Practical problems.

### CE 6403 Advanced Hydrology

3 Credits

Precipitation -its temporal and spatial variability; Evapotranspiration; Runoff and its time-space distribution; Conceptual models; Hydraulics of overland flow; Flood in stream channel and flood flow estimation; Flood forecasting; Hydrology of urban, agricultural and forest lands; Computer simulation of hydrologic techniques; Watershed models.

### CE 6404 Irrigation and Drainage Engineering

3 Credits

Moisture-crop relationship, irrigation requirements, irrigation efficiencies; Design of conventional and modern methods of irrigation; Irrigation of arid lands; Drainage of irrigated land; Salinity of soil, salinity control; Quality of irrigation water, contaminants and their effects on various crop types; Rain water management; Planning and operation of irrigation systems; Conjunctive use of water, participatory irrigation management; Water management policy during droughts, predicting effect of water shortage on crops.

### CE 6405 Hydraulic Structures

3 Credits

Design principles of hydraulic structures; Dams; Barrages; Channels and flumes; Spillways; Stilling basins; Transitions and control structures; Locks; Use of model in hydraulic design.

### CE 6406 Fluvial Hydraulics

3 Credits

Properties of sediment; Incipient motion; Bed load; Suspended load; Total load; Sediment measurements; Regime concept; Bed form mechanics; Plan form and stream bed variations of rivers; Reservoir sedimentation; Erosion and deposition; Sediment control; Sediment transport in pipes.

### CE 6407 River Engineering

3 Credits

River hydraulics and morphology; Bed forms in alluvial channels; River channel patterns; Flood plain and their formation; Fluvial process in geomorphology; River training and bank protection works; River restoration; Rivers in Bangladesh.

### CE 6408 Ground Water Engineering

3 Credits

Definition of ground water; Aquifers; Vertical distribution of subsurface water; Properties of water bearing strata; Ground-water hydraulics; Ground-water exploration; Types of wells; Design and construction of wells; screens, perforations and gravel packs; Pumping equipments; Maintenance of wells; Sea-water intrusion in coastal aquifers; Ground-water quality; Ground-water pollution; Ground-water conservation; Ground-water models; Sand tanks; Heleshaw models and idealized mathematical models.

**CE 6409 Water Resources Systems**

Systems concepts and its application in irrigation, flood control, hydro-power generation, water supply and drainage; Storage-yield analysis; Rule curves; Reservoir sizing; Multi-reservoir systems; Real time operation; Water conflicts; River basin planning; Systems reliability; Case studies.

**3 Credits****CE 6410 Flood Modeling and Management**

Flood hydrology and flood characteristics: Cause of floods and flood inundation, Flood hydrology and hydraulics, Classification of floods, Flood control and mitigation, Flood modeling and model classification; Physically-based models, Lumped conceptual models, Black box models, Flood routing methods: Hydrodynamic routing, Diffusion routing, Muskingum routing, Kinematic routing, Flood forecasting models: Deterministic models, Stochastic models, Combined deterministic-stochastic models, Model output updating process, Flood control and management: Comprehensive flood disaster prevention and management, Structural and non-structural flood control measures, Flood risk analysis and Mapping, Flood-plain development and management, Flood damage categories, Feasibility of flood control projects.

**3 Credits****CE 6411 Design of River Training and Bank Protection**

Introduction; River bank erosion management; River training structures; Design of various river training and bank protection works; Design considerations, hydraulic loads(wave and current); Geotechnical aspects; Planning, monitoring and quality control of bank protection works; River bank protection works in Bangladesh with examples.

**3 Credits****CE 6412 Hazard and Risk Analysis**

Natural hazards: Climate, Riverine and coastal; Man made hazards: Presentation of hazards data; Hazards assessment; Expected damage; Risk analysis; Risk reduction measures: Structural and non structural; Operation and maintenance of mitigation facilities; Reliability analysis; Risk-based zoning; Forecasting and warning; Hazard management planning; Case studies.

**3 Credits****CE 6413 Water Resources System Analysis**

Characteristics of water resources systems; Concept of systems analysis; Systems techniques: Linear, Nonlinear, Dynamic and multi-objective programming; Analytical and computational frameworks for decision making; Applications in water resources management.

**3 Credits****CE 6414 Integrated Water Resources Management**

IWRM concepts and principles; Planning fundamentals and processes; Multi-criteria analysis; Functions of water resources system; Water management and sustainable development; National development and water policy; Basin-wide management and water sharing; Multiple users, water rights and conflicts; Sectoral demands and resource allocation; Water use efficiency and productivity; Management of water demand and use; Institutional aspects and peoples participation.

**3 Credits****CE 6415 Coastal Zone Management**

Definition and delineation of the coastal zone; Coastal zone management: concepts, issues, prospects; Coastal, estuarine and delta processes; Coastal hazards: storm surge, sea level rise, tsunami; Linkages among coastal systems; Coastal ecosystem and environment; Socio-economic, political and institutional considerations; Coastal infrastructure: erosion protection, embankment, polder, cyclone shelter, cross-dam, port and waterway; Coastal population and livelihood; Marine and coastal resources; Coastal zone policy and strategy; Case studies on Integrated Coastal Zone Management.

**3 Credits****CE 6416 River and Floodplain Management**

Resources, functions and ecology of river-floodplain system; Flood flow and low flow analysis; Flood damage mitigation: structural and non-structural measures; Waterways; Instream flow requirement; River pollution; River and floodplain restoration; Land and water use conflicts.

**3 Credits****CE 6417 Computational Fluid Dynamics**

Introduction to Fluid Dynamics; Finite difference methods for solving fluid flow problems; Classification of partial differential equations and formulation of well-posed problems; Discrete approximation of partial differential equations: stability, consistency, and convergence; Finitevolume formulations; Survey of methods for solving hyperbolic, elliptic, and parabolic problems; Formulation of discrete boundary conditions. Application of methods to one- and two-dimensional flow problems.

**3 Credits**

**CE 6418 River Ecosystem****3 Credits**

Functions of Rivers; River Basin Development Planning and Management; A Critical Review; River Ecology: An Introduction; River Geomorphology; Stream Classification, Land-water Linkages; Aquatic Insect, Biodiversity and Biological Classification of Rivers; Fish Community Dynamics, Role of Decomposition, Benthic Organic Matter and Trophic Dynamics; Suspended Organic Matter (SOM); Biogeochemical/Microbial Processes; Role of Animals; Stream Ecosystem Theory; Rivers of the Future.

**E. Transportation Engineering****CE 6501 Transportation Engineering****3 Credits**

Historical development, systems of transportation, technical and operating characteristics of highways, railways, waterways, airways and pipe lines, Transportation planning and development.

**CE 6502 Geometric Design of Highways****3 Credits**

Highway classification; Design controls and criteria; Traffic vehicle characteristics, speed capacity; Elements of design; Sight distance, horizontal and vertical alignment; Cross-section elements; Road intersections; grade separation and interchanges; Highway drainage.

**CE 6503 Highway Materials****3 Credits**

Origin, production, specifications, properties and uses of bituminous materials, binder mixtures, design and analysis of bituminous paving mixes, field operations, surface treatments stabilization methods aggregates, base, sub-base and sub-grade, cement concrete in pavement constructions.

**CE 6504 Structural Design of Pavements****3 Credits**

Pavement types, wheel loads stresses in flexible pavements, stresses in rigid pavements pavement performance, evaluation of subgrade and base support, design theories and practices, construction methods and maintenance, pavement rehabilitation.

**CE 6505 Traffic Engineering****3 Credits**

Characteristics of vehicles and driver, traffic stream characteristics, traffic control and operation, traffic surveys, accidents and road safety, parking, roadway lighting, traffic management and administration.

**CE 6506 Railway Engineering****3 Credits**

General requirements, permanent way, alignments, gradient and curves, points and crossings, signaling and interlocking tunneling, construction and maintenance.

**CE 6507 Planning and Design of Airports****3 Credits**

Growth and demand of air transport, airport site selection and configuration, geometric design for runways and taxiways, terminal areas, Capacity analysis, lighting and marking, air traffic control systems, structural design, construction and maintenance of airport pavements, airport drainage.

**CE 6508 Transportation Planning****3 Credits**

Techniques and processes used in solving transportation problems, relationship between trip generation and land use, collection and characteristics of base year data, formulation of mathematical models to simulate existing travel patterns, forecast on procedures and evaluation of transportation systems.

**CE 6509 Water Transportation and Waterways****3 Credits**

Historical development of navigation, navigational channels, survey of waterways, classification of waterways, traffic, vessels, ports and harbours, navigational aids, maintenance of waterways.

**CE 6510 Intelligent Transport Systems****3 Credits**

History of ITS: History of ITS and highway operation, ITS timeline, ITS technological element, ITS Legislation and Financing: Legal issues, Financial and economic issues, User Service: ITS user services, User service bundles, ITS Components: Advanced traffic management systems (ATMS), Advanced traveler information systems (ATIS), Commercial vehicle operations (CVO), Advanced rural transportation systems (ARTS), Advanced vehicle control systems (AVCS), ITS Standard: ITS architecture and standards, Development process, ITS Technologies and Future of ITS: Systems integration and upgrade Future of ITS.



**CE 6511 Road Safety Engineering and Injury Prevention****3 Credits**

Overview of traffic crashes- The Need for safety; issues involved in transportation safety, traffic crashes and the need for safety; Safety Systems Approach: Road safety analysis, road safety policy and programs, The road traffic system; Diagnosis of Road Accident Problems: Progress of diagnosis, Data analysis and presentation, Site investigations, Problem analysis; Development of countermeasures; Principle of countermeasure development, Countermeasure selection, Effectiveness and cost-effectiveness; Road safety audit: Application of road safety audit, Safety audit process; Monitoring and Program Evaluation: The need for monitoring, Monitoring techniques, Analysis of accident statistics; WHO guidelines for injury prevention.

**CE 6512 Transportation Engineering Economics****3 Credits**

Introduction to basic economic theories; principles and methodologies appropriate to transportation engineering; identification and measurement of transportation costs and benefits; Road user charges and principles of road pricing; Evaluation of transportation proposals in terms of their economic, social and environmental consequences; Techniques of cost benefit analysis; Selected case studies - application of economic principles to one or more current issues in transportation policy and planning.

**CE 6513 Traffic Simulation****3 Credits**

Introduction to simulation techniques; Review of Monte Carlo simulation, macroscopic and microscopic simulation, deterministic and stochastic simulation; Simulation in traffic engineering, review of traffic simulation models, lane-based and non-lane-based mixed traffic simulation; Simulation system components, introduction to statistical distributions, sampling from distributions, random number generation techniques, vehicle representation and processing techniques, simulation warm up and update procedures; Development of traffic simulation model, logical aspects of modeling traffic flow components, elements of systems analysis and synthesis; Model verification, refinements and parameter estimation, calibration and validation; Application of simulation models.

**CE 6514 GIS and Remote Sensing in Transportation****3 Credits**

Concepts of Geographic Information Systems (GIS): definition, data structure, data processing and management, spatial analysis; GIS software;

Basic principles of remote sensing (RS) and global positioning systems (GPS): definition, data acquisition, spectral characteristics of land cover, multi-spectral analysis, image interpretation, geometric corrections, classification techniques; Integration of RS and GPS with GIS; GIS applications in the field of transportation planning and traffic engineering: digitized mapping of land use and transport network, transport infrastructure development and management, analysis and prediction of impacts, strategy planning, monitoring and evaluation of transport systems and environment, route selection, traffic management and accident analysis, public transport information systems; Integration of GIS packages with transport modeling software.

**F. Climate Change (Water and Environment)****CE 6601 Understanding Climate Change Implications of Water and Environment****3 Credits**

Understanding Climate Change; Climate science; Trend analysis (present, future); Scenarios, future climate change, global implications; Impacts (salinity, sea level rise, storms/cyclones, droughts, floods); Mitigation, socio-economic implications; IPCC.

**CE 6602 Climate Change Adaptation****3 Credits**

Introduction to climate change adaptation; How to use climate change knowledge; Multi criteria analysis; Urban adaption; international, national, Local levels; Community/local knowledge; Link with livelihoods; Role of women; Change theory; Drought; Livelihood adaptation; Embankments; Pond sand filters; Changing agricultural water demand; Ecodesign; Engineering (solutions); Design aspects; Technologies; design.

**CE 6603 Gender, Climate Change and Health****3 Credits**

Understanding different gender roles and impacts; Knowledge and awareness on pressing gender issues; Incorporate gender in the concept of climate change and health; Gender mainstreaming and equality; Climate change vulnerability and resilience; Disability adjusted life years; Key epidemiological measure; Gender analysis; Adverse climate impacts on human health; Design gender-responsive health adaptation measures; Assignment on report writing.



**CE 6604 Disaster Management**

**3 Credits**

Identify, analyse and critically reflect on disaster risk reduction, vulnerability, local coping mechanisms and capacities, and social resilience; Competing and complementary approaches to disaster management; Relations between environmental, technological, and human factors; identify strong and weak points; Consequences of natural hazards and disasters for society; Impacts for different groups within society; Examples/case studies of disaster management.

**CE 6605 Climate Change and GIS**

**3 Credits**

Geo-Information Science; Practical application of GIS in relation to climate change; ArcGIS; Geo-Information Cycle; Geo-visualisation; data handling classes; Applying projections to Bangladesh; Remote Sensing; Evaluate important geo data; Geographical data attributes; Modelling; Digital Image Processing; Related opensource software (e.g. OpenEarth, qGIS).

**CE 6606 Building with Nature**

**3 Credits**

Understand basic principles and philosophy of building with Nature; System analysis; applying GIS; Applying hydrology; applying hydraulic modelling; DPSIR; Practical cases (e.g. Sand Motor/Engine; Tidal River Management; Ecobas; Balance Islands; Char Development and Settlement Project); Testing assumptions; Calculating; Social aspects; technical designs; Multi-criteria analysis; Mind mapping; Stakeholder analysis; Time-lines; reporting; Systems-thinking; Reporting; data collection; Case study; Design assignments.

**CE 6607 Adaptive Water Management**

**3 Credits**

Integrated water management; Adaptive water management; Theoretical concepts of IWM; Discourse analysis; Systems thinking; Socio-ecological systems; Governance; Valuing of water; Multi scale and multi stakeholder analysis; Catchments; Reporting; Data collection; role of science in integrated water management and adaptive water management issues; Case study.

**Address for Correspondence:**

Head

Department of Civil Engineering

Dhaka University of Engineering & Technology, Gazipur

Gazipur-1707

Phone : +88-02- 49274008, +88-02-49274034-53, Ext. 2011 (Off.)

Fax : +88-02-49274008

E-mail: head\_ce@duet.ac.bd

Web : www.duet.ac.bd/ce

