A: Table of the main and required Specialized courses of the Structure Engineering

<table>
<thead>
<tr>
<th>Prerequisite or time of offering Lesson</th>
<th>Time</th>
<th>Number of Units</th>
<th>Name of Course</th>
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<tr>
<td></td>
<td>Practical</td>
<td>Theoretical</td>
<td>Sum</td>
<td>Higher Engineering Mathematics</td>
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<td>51</td>
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<td>3</td>
<td>Dynamics of Structures</td>
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<td>51</td>
<td>3</td>
<td>Theory of Elasticity and Plasticity</td>
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<td>finite element method</td>
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<td>One of the following courses *</td>
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<td>A: Stability of Structures</td>
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<td>B: Advanced Steel Structures</td>
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<td>C: Advanced reinforced concrete structures</td>
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*: Planning and decision of these courses is the responsibility of the Committee on Graduate Studies Group training (comprehensive universities) and school (technical college), and the student is required to adapt himself with this program.
B: Table of the optional specialized courses of the Structure Engineering

<table>
<thead>
<tr>
<th>Prerequisite or time of offering Lesson</th>
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<th>Number of Units</th>
<th>Name of Course</th>
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<td>Design Principles of Offshore structures</td>
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<td>Plastic design of structures</td>
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<td>Prestressed concrete</td>
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<td>Design buildings against earthquakes</td>
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<td>Effects of earthquakes on special structures</td>
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<td>Maintenance and repair of structures</td>
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<td>Concrete dams</td>
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<td>Theory of Plasticity</td>
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<td>Higher Concrete Technology</td>
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<td>Design of Hydraulic Structures</td>
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<td>Advanced Foundation Engineering</td>
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<td>Structure and Water Interaction</td>
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<td>Soil and structure interaction</td>
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<td>Rehabilitation of damaged structures in earthquake</td>
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Higher Engineering Mathematics

Number of Units: 3

Course outline:

1. Reminders of ordinary differential equations, Solving equations by helping extended power and overview of the concepts of extension in terms of orthogonal functions (Fourier, Bessel, Legendre), Application in solving Sturm-Liouville Equation
2. Application of the method of separation of variables for solving differential equations with partial derivatives in the orthogonal coordinate system of the curved line
3. Introduction to the concepts of the integral transforms and it’s application in solving differential equations with partial derivatives and using the residuals theorem(The theory of complex functions ) in estimating integral inverse transform
4. Application of Z Transform in solving harmonic and non-harmonic equations by using conformal mapping application
5. Tensor analysis and its application in engineering problems
6. Introduction to the calculus of variations, including the concept of Functional, Euler-Lagrange equation, application of weight Residuals theorem and Raylh- Ritz method for solving differential equations are converted into algebraic equations in scope or boundary
Dynamics of Structures

Number of Units: 3

Course outline:

1. Difference of static and dynamic analysis
2. Types of Dynamic Loads
3. Degrees of freedom and structures modeling approach
4. Equations of motion in one degree of freedom systems
5. Free vibration of one degree of freedom systems
6. Dynamic Analysis of one degree of freedom systems Against types of loads (harmonic, shock ...)
7. Duhamel integral and systems analysis to the above method
8. Nonlinear behavior of one degree of freedom systems in dynamic mode
9. Determine of equations of Multi-degree of freedom systems
10. Free vibration of multi-degree of freedom systems and determine the eigenvalues and vibrational modes
11. The modal analysis method for analysis of multi-degree of freedom systems
12. Direct integration method for the analysis of single and multi degree of freedom systems
13. Fransyl method for analysis of multi-degree of freedom systems
14. Dynamic analysis of simple continuous systems
Theory of Elasticity and Plasticity

Number of Units: 3

Purpose: Introduce the students with the Rules governing the behavior of elastic and plastic deformable objects

Course outline:

1. Stress: define stress on a surface, equilibrium equations, Principal Stresses, shear stress, maximum, Some special states of stress, equilibrium equations in cylindrical and spherical coordinate systems
2. Strain, strain at a point, Strain and displacement relations, principle strains, compatibility conditions, Some special states of the strain, Strain and displacement relations in cylindrical and spherical coordinate systems
3. General relations of stress and strain in the elastic state, express compatibility conditions in terms of stress
4. Solving the three-dimensional theory of elasticity by using potential functions, Kelvin issues, Sarut
5. Stress and strain general relations for perfectly plastic solids, hardening solids, Terms of flow rules system
6. plane stress and plane strain in elastic state, its application in solving problems, solving two-dimensional axial axisymmetric problems by using the stress functions
7. plane stress and plane strain in plastic state, equilibrium equations
8. Pure bending of shaft in elastic state
9. Torsion of shaft in elastic state, Torsion of shaft with different sections
10. Torsion of cylindrical shaft in plastic state
11. Energy methods, strain energy, virtual work principle, the principle of minimum work, the principle of oneness - castigliano theorems, solving problems
12. Thermal stresses
Finite element method

Number of Units: 3

Purpose: Introduction to numerical analysis of finite element methods for solving differential equations governing the continuous environments and getting analytical skills particularly in the area of solid mechanics and structures

Course outline:

1. Introduction to continuous environments and their mathematical models Includes continuous and discrete models
2. Finite element method for the analysis of elastic continuous environments in the solid mechanics
3. Plane stress and strain analysis
4. Three-dimensional stress analysis
5. Two and three dimensions types of Functions
6. Isoparametric elements and numerical integration
7. Generalized Finite Element Method- Galerkin weighted residual method
8. Computer programming of the finite element method
9. Introduction to plates bending and Finite Element related to it
Stability of Structures

Number of Units: 3
Prerequisite: Theory of Elasticity and Plasticity

Purpose: introduction to students with the principles of components and structures sustainability and its application in the design of structures

Course outline:

1. Elastic and elastic-plastic buckling of columns: Euler load, effective length, tangential and dual-modulus theory, shanli theory, columns with initial imperfection, The use of these principles in the codification of Provisions
2. Approximation method and its application in solving stability problems, Critical load using the approximation deformation curve, Static potential energy, Riley-Ritz method and Galerkin method
4. Torsional buckling and Members lateral torsion, Lateral buckling of beams with rectangular cross section in Pure bending, Z-shaped lateral buckling of beams, The use of these principles in the codification of Provisions
Advanced Steel Structures

Number of Units: 3

Purpose: introduction to students with design of steel structures in various types

Course outline:

1. Stability principles of compressive components in the elastic limit and beyond elastic limit, The effect of residual stresses, The design compression members in trusses and frames, Instability of frames, Effective length of compression members, the Investigation of basics of provisions criteria
2. Stability principles of plates, in the elastic limit and beyond elastic limit, the Investigation of basics of provisions criteria
3. Torsion in beams, torsion at different sections and profiles, Combine bending and torsion, torsional buckling, beams without lateral support, the Investigation of properties of different sections, the Investigation of lateral supports, the Investigation of basics of provisions criteria
4. Beam–columns design: Stability analysis methods of beam-columns under axial load and lateral loads and moments, the Investigation of basics of provisions criteria
5. Design beams with variable cross-section, dual beam-plates, the Investigation of basics of provisions criteria
6. Design composite steel and concrete beams, applying beam theory, The effect of the methods, construction methods, shear connections, the Investigation of basics of provisions criteria
7. Design thin-walled members, flexural members, compression members, beams-columns and their connections
8. Design and analysis of various types of connections
9. Design frames, rigid frames, braced frames and frame without brace
10. Design Due to fatigue, Members designing, connections

Important Note: In addition to the above-mentioned headings notes about industrial structures is required as follows:

Heavy industrial halls, Bunkers and silos, Sustained elevated Reservoirs, Reservoirs under Pressure, chimneys
Advanced concrete Structures

Number of Units: 3

Purpose: introduction to students to advanced topics of reinforced concrete and design of special structure and other things on reinforced concrete structures topics 1 and 2 undergraduate is presented.

Course outline:

1. The theory of rupture lines and Their application in the design methodology
2. analysis the Pleated and mesh roof and investigate their design details
3. Analysis continuous and pinned arches, and investigate their design details
4. Design concrete components with high quality
5. Specific problems of reinforced concrete tall structures and Load bearing wall systems
6. The air and land water resources and investigate their design details
7. Design Silos and investigate their details
Earthquake Engineering

Number of Units: 3

Prerequisite: Dynamics of Structures

Course outline:

1. Mechanisms of earthquakes and region seismicity
2. Phenomena associated with the earthquake and the damage due to that
3. Scales for measuring earthquakes
4. Waves due to earthquakes and related phenomena (reflection and refraction of waves)
5. Determination of design earthquake in important projects
6. Analysis method of Iran provisions
7. Dynamic Analysis method against Earthquake
8. Spectral analysis method against earthquake
9. Vibrations of Structures and determine the period of the vibration modes by the available methods
10. Criteria for design earthquake resistant structures
Design Principles of Offshore structures

Number of Units: 3

Purpose: Introduction to design notifications of different offshore structures

Course outline:
1. General Introduction to the types of offshore structures
2. Investigate to Locating Offshore structures Issues and provide detailed design
3. Initial Investigation of all the forces acting on the offshore structures and study geotechnical and foundation problems
4. Design Types of wharf (caissons - pile- deck- floating ...)
5. Design of breakwaters (gravel, concrete, floating, mixed ...)
6. Design Types of platforms (fixed metal, concrete weighted, floating, mixed)
7. Design tanks and pipes under the sea
8. Design Small offshore structures (different buoy lanterns, etc.)
9. Introduction to floating design
10. Investigate the problem of fatigue of the offshore structures and attention to that in design
11. Maintenance and repair of offshore structures
12. Type of Consumable materials and Select them
plastic design of structures

Number of Units: 3

Course outline:

1. The relation between stress and strain, section resistant moment, ideally the relation between stress and strain (elastic-perfectly-plastic material), Plastic Elastic Full Computing
2. Perfect plastic moment, simple theory of perfect plastic
3. Plastic theoretical propositions, upper limit theorems, the lower limit theorem, uniqueness theorem
4. Analysis and design of beams by perfect plastic method
5. Analysis of Plastic column - the design of column
6. Analysis and design of sway multi-storey frames
7. Calculate the displacement in at the begin of collapse
8. Design non-sway frames
9. Principles of method
10. reinforced concrete and plastic Design
11. yield lines Theory
Prestressed concrete

Number of Units: 2

Course outline:

1. Consumable materials properties
   - Concrete, mechanical properties and ductility, immediate and long-term deformation, shrinkage and increase concrete, concrete with high quality
   - Steel, types of steel, high strength steel, decreasing mechanical properties of steel – Fatigue
   - The types of standard steel (single wire and group wire)
2. The calculation of the loss of prestressing force, loss of short-term and long-term
3. The Bending Calculation of determined beams in Ultimate limit states and Operation, Route cables, Control the stresses in different bending states
4. Shear strength: determine Shear capacity of beams, calculate the shear steel (steel or Prestressed steel)
5. Indeterminate beams bending calculations, Optimal Route cables with the effect of prestressing force
6. Prestressed Systems, methods of implementation, bending calculations, determine the prestressing force and control the stresses
7. Spin circle: Theoretical Foundations, calculate the prestressing force in different states, Modes of action: resources and silos
8. Special case of The use of Prestressed systems: foundations and repair works
Design buildings against earthquakes

Number of Units: 3
Prerequisite: Dynamics of Structures

Course outline:

1. Investigate behavior of types of the buildings against earthquake
2. Model various buildings to analysis
3. Types of earthquake resistant structural systems (for buildings)
4. Analysis of various buildings against earthquakes
5. Comparison of provisions methods, spectral and dynamical to analysis Buildings
6. Investigate engineering issues of buildings foundation in earthquake
7. Implementation issues in the construction of earthquake resistant buildings
8. Tips of design concrete buildings against earthquakes
9. Tips of design steel buildings against earthquakes
10. Investigate design of tall buildings and related issues in earthquake
effects of earthquakes on Special structures

Number of Units: 3
Prerequisite: Earthquake Engineering - Computation of buildings against earthquakes

Course outline:

1. Local familiarity with the behavior of Special structures and their importance
2. Behavioral difference between Special structures and usual buildings
3. Analysis and design of earthquake resistant dams (earth-fill, gravity, arch)
4. Analysis and design of earthquake resistant water air tower
5. Analysis and design of earthquake resistant ground and underground tanks
6. Analysis and design of earthquake resistant grid tower of power transmission
7. Analysis and design of earthquake resistant telecommunication tower (sway and non-sway)
8. Analysis and design of earthquake resistant chimneys
9. Analysis and design of earthquake resistant types of Bridges
10. Analysis and design of earthquake resistant buried pipes
11. Analysis and design of earthquake resistant retaining walls
12. Analysis and design of earthquake resistant offshore structures (breakwater-wharf)
13. Analysis and design of earthquake resistant Silos
14. Analysis and design of earthquake resistant industrial structures and Refineries equipment
Theory of plates and shells

Number of Units: 3

Prerequisite: Theory of elasticity and plasticity, or simultaneously

Purpose: introduction to students with the principles governing the behavior of plates and shells and their application in solving some of the structures

Course outline:

1. General equations of plates bending
2. Methods for solving general equations of bending of rectangular plates, circular and parallelogram with different loading and end conditions
3. Energy methods: strain energy, Ritz and Galerkin methods
4. Buckling of plates: Critical load of rectangular plates
5. Numerical methods for solving Plates problems
6. Membrane theory of shells: general equilibrium equations, solving equations for shells with axial symmetry, the deformation
7. Bending theory of shells: general equilibrium equations, solving these equations for shells with axial symmetry
8. Mention to the stability of cylindrical shells
9. Mention to plates and shells dynamic
Number of Units: 2

Prerequisite: Finite Element Method

Course outline:

1. Introduction
   1-1: The problem of optimizing structure and effective parameters on that
   1-2: History and general method for solving the optimization problem
   1-3: Important applications of optimization

2. Scheduling optimization problems
   2-1: Methods for solving linear Optimized problem
   2-2: Method for solving Optimized problem without constraint
   2-3: Method for solving constrained problem by linear constraints
   2-4: Transformation and alternative methods and solving Consecutive problems
   2-5: Advanced methods for solving linear Optimized problem

3. Optimal design of steel, concrete and prestressed
4. Formulation of appropriate analysis to design optimal method by hardness and softness method
5. Sensitivity analysis of elastic structures
6. Analysis and design ultimate limit of reinforced concrete or steel moment frame
7. formulation of the optimal design of truss structures
8. The formulation of the optimal design of three-dimensional structures, masts and shells
9. Appropriate Programming project
Optimization in civil Engineering

Number of Units: 2

purpose: introduction to damage and materials evaluation methods and repair and Strengthening of Structures methods

Course outline:

1. introduction to the concepts of repair, Strengthening and service life of structures
2. evaluation of existing structures (concrete and steel) against earthquakes:
   - evaluation methods of the Buildings irregularity in plan and elevation and determine the soft story, identify types of earthquake resistant systems such as shear walls, moment frames and bracing ...
   - evaluation methods of the existing resistant systems in structures
3. Methods and strategy of Strengthening of structures, modify irregularity in plan and elevation ,soft story , Strengthening of moment frames, braces, diaphragms, shear walls, foundation and ...  
4. evaluation of damaged concrete structures caused by chemical agents
   - Introduction to nondestructive and semi-destructive tests and methods, such as core measurements, Corrosion potential, chloride profiles, carbanation permeation depth ,Compressive strength and determine the causes of failure such as corrosion of reinforcement, Sulphate of concrete, aggregates alkaline reaction
5. Types of concrete repair materials: Polymeric Systems, resins Such as epoxy and polyester, Adhesives materials for Connect the existing concrete to concrete or repaired mortar-types of crack Repair materials such as cement grout and thermoplastic polymers
7. Repair structures underwater: types of methods Separating damaged concrete and preparing repair surface, types of methods and repaired materials Underwater
8. Various methods of protection against corrosion of steel and reinforced concrete structures
9. planning and Maintenance management Various structures
10. investigation to various models to predict the useful life of structures
Concrete dams

Number of Units: 3

Course outline:

1. Introduction to the History of Concrete Dams
2. The introduction of a variety of concrete dams
3. The dam site selection criteria included: water resources, economics, geology, geometry and geotechnical engineering
4. Concrete Arch Dams
   - Materials, Mechanisms of loading, construction specifications, a variety of possible overflows
   - Criteria of arcs shape, cantilever shape, dam shape, Shape optimization method, Mathematical definition of body shape
   - Stability control of supports, criteria for stress distribution
5. Massive concrete of dams
   - Thermal problems, mix design, Before and after cooling methods for concrete and materials and calculating them
   - RCC dams
   - Deterioration of concrete in concrete dams
6. Loading concrete dams include major and minor loads (water, weight, temperature, earthquake, etc.)
7. Earthquake load and it’s different levels, including the hazard range - base acceleration, Spectra and accelerograms, design Earthquake
8. Hydrodynamic loads induced by earthquake
9. Vulnerability of concrete dams against earthquakes and modify them to reduce the vulnerability
10. Dynamic behavior of arch concrete dam and gravity dam
11. Thermal loading including of internal thermal and control it, the thermal of the environment and set and apply it
12. Mathematical model and methods for analysis of concrete dams, including structures, foundations and lakes - the finite element method
13. Introduction to Analysis method of Load Test
14. Stability Analysis of arch dam supports including two and three dimensional methods
15. Determine the stress safety factors and concrete design
16. Concrete gravity and embankments dams and Special issues in the design, analysis and implementation
17. Multi-arched concrete dams and curved concrete, Arch dam and it’s uses
18. Methods of implementation and monitoring equipment for concrete dams
19. Presentation of film, slides and visit to actual dam site
Bridge Engineering

Number of Units: 3

Prerequisite: Foundations of the theory of plates and shells

Purpose: introduction to students usual bridges design principles in Country

Course outline:

1. Introduction to Various components of bridges, Classification of bridges
2. Choose bridge location with regard to site, choose bridge type with regard to economically, choose the length of the bridge span with regard to economic issues, architecture and Hydrology
3. Types of loads on road and railway bridges - dynamic effects of loads
4. Methods for Theoretical analysis of the bridge deck (network theory) and uses each of them
5. Method of calculating the plate bridge, reinforced concrete bridge with beams and vortex system
6. Calculation of Steel Bridges with lateral and inferior beams and composite bridges
7. Types of bridges pier and choose and calculate them
8. Types of the walls of the embankments and Guide walls on bridges
9. Calculation and design method of variety of the support devices
10. Introduction to container bridges and their computational principles
11. Introduction to Diagonal bridges and arch bridges in plan and facade and their computational principles
12. Introduction to bridges, suspended and their design principles
Structure Laboratory

Number of Units: 1

Purpose: introduction to students with Methods of modeling, measurement testing and results from experiments and investigate structure behavior

Course outline:

Laboratory Training Program by Department of Teaching and regulate According to University facilities, This program can be used to identify the following:

1. Introduction to the different types of loading such as static, dynamic, Pseudo-dynamic and load equipment such as mechanical and hydraulic, gravity, pressure, vacuum
2. Introduction to precision measuring tools and data capture devices, measurement of displacement, strain, curvature, modulus of elasticity, precision and measurement error
3. Investigate structure design methods to help modeling and build various models and carry out the necessary tests
4. Theoretical study of the effect of scale (size) of materials and models.
Space Structures

Number of Units: 2

Purpose: introduction to students with new forms of structures in creating large space especially space structures, The use of any form of space frame structures in architectural design and structural design In order to create realistic models and introduce prototypes in the world Along with use new technology features to create large spaces.

Investigate the above structures components and different form of the components in setting up a space structure, design three-dimensional forms by helping plan Formain

Investigate the performance of these structures against applying load and introduction to specific issues of above systems in analysis and design by using the computer

Course outline:

1. Introduction and investigate three-dimensional structural systems
2. Investigate space structures, segmentation and practical foundations of these structures
3. Space structural components, connections
4. Forms design and analysis space system (investigate Stability)
5. Loading space structures (introduced forms of loading and it’s types)
6. Analysis of small three-dimensional models

In this section, students learn how to define computer models And prepare for the final project.

7. Analysis real and practical models in space structures

In this section, students doing practical model and space structures that can be used to cover a public space, in the early design phase of architectural structures (with considering of stability), then loading, analysis and design of structures at the end.

Students can focus their projects on a space structural components (for example design a practical form Connections between member or support connections with its analysis using the finite element method) and do that.
Plasticity theory

Number of Units: 2

Course outline:
1. Limitations in elasticity theory, concepts of yield and failure criteria. Must the application of the theory of plasticity in metals, soil, and concrete.
2. Relation between the stress component - strain component in nonlinear elasticity theory, application of virtual work, Drucker stability theorems, investigate orthogonality conditions (formalities), Convexity and uniqueness in nonlinear elasticity theory problems.
3. Determine relationship between the stress component - strain component in perfectly plastic modeling.
   3.1- flow rule in multi-dimensional stress state
   3.2- investigate material behavior with associated flow rule and non-associated.
   3.3- investigate limitation of Nonlinear elasticity theory model, and troubleshooting them by theory of plasticity.
   3.4- Determine the material stiffness matrix based on associate with flow rule (Mohr, Kolb, Drucker-Prager, von Mysz).
4. Determine Relation between the stress component - strain component in Work hardening model.
   4.1- different Work hardening materials
   4.2- loading level and hardening rules
   4.3- flow rule and Drucker Stability theorems
   4.4- concept of effective stress and strain
   4.5- Determine Relation between the stress component - strain component in types of Work hardening materials.
5. Limit Analysis
   5.1- Theorems of limit Analysis (upper limit and lower limit)
   5.2- basic methods in upper limit method and applications of plane stress, plane strain and three-dimensional.
   5.3- Application of the limit analysis method in frames
   5.4- Application of the limit analysis method in plates
   5.5- Application of the limit analysis method in shells
Safety of Structures

Number of Units: 2

Course outline:

1. Introduction to Safe Analysis
2. Probabilistic Basics of Safety of Structures
3. extended Safety relations
4. mean value method, first and second moments
5. Advanced Methods first and second moments
6. Monte Carlo simulation methods
7. safety analysis problems

7-1- Safety analysis of a beam

7-2- Safety analysis of a corner Weld in effect of loads combination

7-3- Safety analysis of simple systems

8. system safety analysis based on linear analysis
9. system safety analysis based on Failure mechanisms
10. system safety analysis by using nonlinear finite element method
11. safety analysis methods of static structures
12. safety analysis methods of dynamic structures
13. system safety analysis for Sensitive structures to dynamic loads
14. complexity criteria and coefficients of undetermined of structures
Higher Concrete Technology

Number of Units: 2

Course outline:

1. Chemistry of Cement
   Hydration of the cement, Effect of cement composition in thermal and strength and other

2. Concrete strength
   Strength in compression and tension, effect of various factors on strength, strength equations, the relations between compressive strength and tensile strength, relations between porosity and strength, fatigue strength, impact strength

3. Elasticity, shrinkage, creep
   Static and dynamic elastic modulus, relations between strength and modulus of elasticity, relations between modules and factors affecting modulus, Poisson's ratio, modulus measurements, and factors affecting concrete shrinkage, calculating shrinkage from various Provisions, measurements of shrinkage, creep and factors affecting concrete creep, types of deformation and calculating creep from various Provisions, measurements of creep, creep effects in structures

4. Concrete design
   Key factors in the design of concrete, the relations between the characteristic strength and purpose, concrete design process, volumetric and weight methods of concrete design, concrete design with air bubbles

5. Quality control testing of concrete
   Performance measurement, compressive strength of different samples and compare them with each other, Accelerated strength, non-destructive testing (Schmidt hammer, ultrasonic, ejecting), core test, relations between core strength and real strength, acceptance of concrete, Statistical methods to investigate the results of the tests, investigate the depth of cracks

6. Further material and concrete additives
   Further materials and additive, additives and additives material impact on the properties of concrete, mechanisms of additives, use of pozzolan additives and its role in the properties of concrete

7. Sustainability and durability of the concrete
   Permeability of concrete, factors affecting permeability, measurement of permeability, chemical deterioration of concrete, sulfate attack and prevention techniques, chloride attack and prevention techniques, carbonation and factors affecting on it, preventing carbonation deterioration, mechanism of steel corrosion in concrete, reinforcement corrosion prevention methods, alkali aggregate reaction and methods to prevent concrete cancer, the effects of wear and tear and methods to remove vacuum on concrete, methods to prevent mechanical deterioration, efflorescence and its causes, frost and concrete deterioration caused by freezing and thawing cycles, properties of concrete with bubbles air compared with frost

8. Various methods of application of the concrete
   Concreting in special circumstances, concreting in hot weather, concreting in cold weather, concrete, pumping the concrete, spraying the concrete, concreting underwater

9. New Concretes
   Polymer concrete, concrete with steel and polymer fiber, sulfur concrete, RCC concrete, chemical concrete, lightweight concrete, heavy concrete, high strength concrete, plastic concrete

10. Large concrete
   Thermal problems, calculations of temperature, reduce temperature systems, before and after cooling methods
Design of hydraulic structures

Number of Units: 3

Purpose: introduction to students with Types of hydraulic structures related to dikes, dams and overview involve hydraulic design issues and its structures.

Course outline:

1. introduction to types of hydraulic structures related to dikes, dams and its components and how to coordinate them
2. investigate Various hydrological factors, hydraulic, geological, geotechnical in site selection
   Dams type
3. investigate Spillway and types of them and effect factors in their design
4. sluice, tipper and types of them and effecting factors in design of dams
5. plant hydraulic
6. General introduction to water plants and their various facilities
7. Overview of procedures to construct hydraulic structures

it is recommended Description of This course in addition to having the project, associate by showing Film and slides with visit the facilities hydraulic dams.
Advanced Foundation Engineering

Number of Units: 3

Course outline:

1. Field Laboratores, application this results in design of shallow and deep foundations
2. deep foundations
   • investigate effect of a pile on various soils, group effect
   • Load distribution between the pile group under axial load
   • pile Under lateral pressure, investigate behavior of single pile and pile group
   • load distribution between pile group under Lateral pressure
3. Metal shields
4. dividing walls of concrete in soils, anchors
5. reinforced soil
6. methods of modifying the properties of the soil
7. investigate Specific issues in foundations design
Water-Structure Interaction

Number of Units: 3
Prerequisite: finite element method, dynamic of structures

Course outline:

1. Navier-Stokes equations and it’s different type of boundary conditions in the hydrodynamic
2. Method of Laplace and Helmholtz equations in special circumstances
3. A review of the finite element method in fluid
4. Eulerian and lagrangian element of water
5. Governing equations on dynamic behavior of structures
6. Finite element model of structure
7. Governing Equations of fluid and structure interaction
8. Simple method for dynamical model of Water- structure
9. The exact numerical solution method of involved water-structure system
10. Applications: dams, reservoirs and submerged bodies
11. The introduction of related computer programs
Soil-Structure Interaction

Number of Units: 3
Prerequisite: Soil Dynamics, Finite element methods

Course outline:

1. The purpose of soil-structure interaction analysis and its effects
2. Study the effect of structure on the properties of the ground free movement
3. Mention to the wave spread in soil
4. Dynamic stiffness of soil (soil impedance) and determine that
5. Effect of soil on structure behavior during earthquakes
6. Soil analytical model for study soil-structure interaction (equations of motion)
   A: Focused model of soil properties in the spring and Snubber shapes
   B: Shear beam model
   C: The semi-infinite elastic model
   D: The finite element model
7. Soil-structure interaction analysis methods in time domain
8. Soil-structure interaction analysis methods in frequency domain
9. Soil-structure interaction for rigid and flexible foundations
10. Soil-Structure Interaction for soil and Structures combined models
11. Soil-structure interaction for infrastructure models
12. Soil-structure interaction in nonlinear state
Rehabilitation of damaged structures in earthquake

Number of Units: 3
Prerequisite: Computation of buildings against earthquake

Course outline:
1. Generalities about the rehabilitation of earthquake-damaged structures and it’s features
2. Primary action step (visit, doing some quick and simple tests, geotechnical studies)
3. Diagnosis step (determine the range of damages, classification of damages, apparent damages of concrete and steel, non-structural element damage, deformation and unusual movements, local damage, failure, other damages)
4. Study the causes of damages (pathology): design errors, Implementation and operation, deterioration of materials, Random errors and exceptional parameters, Changes in environmental conditions over the period of design and implementation
5. Evaluation of existing status of structure and residual strength
6. Solution step: determine the type and extent of retrofit, materials selection and retrofit applicable techniques, comparison of methods from a technical and economical viewpoint, evaluate them by cost criterion, result
7. Redesign step: analysis the Structure to redesign and considering foundation status in rehabilitation
8. Rehabilitation operation step: setting executive program, Implementation principle of rehabilitation, substituted materials, tools and equipments, human resources, special criteria for rehabilitation
9. Reinforced concrete structure rehabilitation steps: Remove and destroy defective parts, Prepare surfaces from destroy, modify reinforcement, molding, application of substituted materials, care after use the substituted materials
10. Local retrofitting on-site of steel structures