TEHRAN UNIVERSITY OF TECHNOLOGY
(SHARIF)

Department of Structural Engineering
Announcement of Courses,

1980 - 1982

Department of Strucfural Engineering
Tehran University of Technology
P. O. Box 3406
Telex No. 212882

The Department of Structural Engineering offers a curriculum that provides a balanced program of technical and non-technical courses to meet the needs of students interested in studying civil and structural engineering.

In addition to basic courses in mathematics, chemistry and physics, engineering sciences, and courses in the social sciences offered by other departments in the Tehran University of Technology (Sharif), the student has also the opportunity of learning the fundamentals in civil engineering (including soils, surveying and hydraulics).

Undergratuatesare encouraged to consider the structural engineering Master's program for the fifth year, as a means to incorporate courses on design and analysis into their academic programs.

Civil Engineering Curriculum

Freshman Year-First Semester

General Mathematics I	(22-011)	4 units
General Chemistry I	(23-011)	3 units
General Chemistry Lab I	(23-001)	1 unit
General Physics I	(24-015)	4 units
General Physics Lab I	(24-001)	1 unit
Engineering Workshop I	(33-001)	1 unit
English I	(31-011)	2 units
Sport I	(30-001)	1 unit

Total 17 units

Second Semester

General Mathematics II	(22-012)	4 units
Engineering Graphic I	(35-222)	2 units
Workshop II	(23-002)	1 unit
Static	(20-011)	3 units
General Physics II	(24-016)	4 units
General Physics Lab II	(24-002)	1 unit
English II	(31-012)	2 units
Sport II	(30-002)	1 unit

Total 18 units

Third Semester

Engineering Mathematics I	(22-031)	4 units
Material Properties	(27-512)	2 units
Dynamics	(20-012)	3 units
Solid Mechanics I	(20-111)	3 units
Fundamentals of Electrical Engineering	(25-091)	3 units
English III	(31-013)	2 units
Engineering Graphics II	(35-222)	2 units

Total 19 units

Fourth Semester

Solid Mechanics II	(20-112)	3 units
Theory of Structure I	(20-121)	3 units
Non-Metalic Construction Materials	(20-211)	3 units
Surveying	(20-511)	3 units
Computer Programming	(22-013)	3 units
Fluid Mechanics	(28-491)	3 units

Total 18 units

Fifth Semester

Solid Mechanics Lab I	(20-101)	1 unit
Soil Mechanics	(20-411)	3 units
Theory of Structure II	(20-122)	3 units
Design of Steel Structures I	(20-221)	3 units
Design of Concrete Structures I	(20-231)	3 units
Fluid Mechanics Lab I	(28-401)	1 unit
hydralics	(20-611)	3 units
Social Science	(37-)	2 units

Total 19 units

Sixth Semester

Matrix Analysis of Structures	(20-123)	3 units
Loading	(20-213)	2 units
Design of Steel Structures II	(20-222)	3 units
Design of Concrete Structures II	(20-232)	3 units
Soil Mechanic Lab	(20-401)	1 unit
Highway Engineering	(20-421)	4 units
Social Science	(37-)	2 units

Total 18 units

Seventh Semester

Plastic Theory & Design of Structures	(20-124)	3 units
Foundation Engineering	(20-412)	3 units
Engineering Economics	(21-131)	3 units
Social Science	(37-)	2 units
Electives	(20-)	6 units

Total 17 units

Eighth Semester

Vibration	(20-153)	3 units
Design I	(20-241)	3 units
Construction Methods and Machineries	(20-311)	3 units
Electives		5 units

Total 14 units

Total units required for the B.S. degree in Structural Engineering: 140 units.

Structural Engineering Electives

Eleven units are required. At least three units offered by this department (usually structural projects) must be included in these electives.

Structural Engineering

Statics (20-011) (3 Units)

Pre-requisite: General Physics I (24-015)

Fundametal of mechanics, elements of vector algebra, important vector quantities, equivalent force systems, equation of equilibrium, trusses, beams, cables, frictional forces, properties of surfaces introduction to variational mechanics, virtual work and minimum potential energy, hydrostatics.

Dynamics (20-012) (3 Units)

Pre-requisites: Statics (20-011)*
General Mathematics II (22-012)*

Principles of dynamics, kinematics and kinetics of particles, kinetics of systems of particles, rectilinear, angular and plane curvilinear motion, relative motion in plane and space; Equation of motion, work and energy, impulse and momentum, kinematic and kinetics of rigid bodies, free and forced vibration of single degree of freedom systems.

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* Pass or Fail

Mechanics of Solids Lab I (20-101) (3 Units)

Pre-requisite: Mechanics Solids I(20-111) (Pass or fail)

Experiments on axial loading of bars, bending and torsion of beams, shear center, distribution of stresses in beams, deflection of beams. Impact loading stiffness of springs. etc.

Mechanics of Solids I (20-111) (3 Units)

Pre-requisite: Statics (20-011)

Introduction to mechanics of solids, definition of stress and strain in three dimensional bodies. Equilibrium equation. Generalized Hook's law for Isotrop and Anisotrop materials stress and strain relationships in bars, solid and hollow bars, under axial loading and changes in temperature. Elastic strain energy, application of in axial impact loading. Thin walled pressure vessels, shear stress and strain. Torsion of solid and hollow bars. Plastic torsion elastic strain energy for shearing stress and impact loading, Helical springs. Pure bending of beams. Distribution of flexural and shearing stresses in beams. Plastic hinges in beam strain energy in bending, bending conbined with axial load, biaxial bending, properties of sections, Mohr circle, shear center.

Mechanics of Solids II (20-112) (3 Units)

Pre-requisite : Mechanics of Solids I (20-111)

Biaxial stresses, Mohr Circle, deflection of beams: strain-curvature and moment curvature relations, boundary Conditions, conpatibility, direct integration method, monent area method. Buckling of columns, stability of equilibriums, nature of beam coloumn problem, Euler buckling load for pin-ended columns, elastic buckling columns with different end restraints, eccentricity loaded columns, change of stiffness of columns. Curved beam theories of failure, thick wall cylinders. Rotating discs.

Theory of Structures I (20-121) (3 Units)

Pre-requisites : Mechanics of solids I (20-111)

Introduction to engineering structures; in plane and space trusses, complex trusses, statically determinate beams, influence line for statically determinate structures, elastic deformtion of determinate structures, energy methods, moment area theorem, elastic load and conjugate beam method. Introduction to indeterminate structures and analysis of indeterminate structures by the method of consistent deformation.

Matrix Analysis of Structures (20-123) 3 Units

Prerequisite:

Theory of Structures II (20-122)
Numerical Analysis & Computer Programming (22-013)

Short review of matrix algebra and the Computer-oriented solution techniques of linear system of equations. Introduction to generalized coordinates, flexibility and stiffness characteristics of one-dimensional structural elements. Matrix analysis of two-dimensional skeletal structures based on force method, matrix analysis of two-and three-dimensional skeletal structures based on displacement method. Substructuring techniques, introduction to the finite element method.

Under-graduate Projects (20-810) 3 to 6 Units

Prerequisite: Consent of student and project advisers.

Design and industrial projects as arranged.

Graduate Projects (20-910) 3 to 7 Units

Prerequisite: Graduate Status.

Research projects as arranged.

Theory of Structures II (20-122) (3 Units)

Pre-requisite: Theory of Structure I (20-121)

Analysis of statically indeterminate structures, method of least work, slope-deflection method for beams and frames, moment distribution method for beams and frames with and without joint translation, General discussion on force and displacement methods of analysis of structures, elastic center method, Castiglianos theorems, complementary and potential energy methods, Mohr's integral, Maxwell's and Betti's theorem. Influence lines for indeterminate structures.

Plastic Theory and Design of Structures (20-124) (3 Units)

Pre-requisites: Design of Steel Structures II (20-222)
Design of Concrete Structures II (20-232)
(may be taken concurrently)

Plastic failure; plastic bending of Sections, rigid-plastic failure of determinate and indeterminate structures, theorems of simple plastic theory, methods of plastic analysis and design, plastic moments under shear force and axial load, plastic design of frames and structural members connections, minimum weight design, variable repeated loading, theorems of shakedown.

Non Metalic Construction Materials (20-211) (3 Units)

Pre-requisite: Mechanic of Solids I (20-111) or Concurrent

Concrete making materials, portland cement, aggregates water and admixtures, properties of fresh concrete, proportioning of concrete mixes, strength and durability of concrete, properties of lime and lime products, properties of gypsum and gypsum products, structural properties of timber, structural properties of bricks, structural properties of stones.

This course includes the following experiments:

1. Measurement of concrete consistency C-360 and C-143
2. Grading of aggregates C-29 and C-30
3. Sieve analysis C-136
4. Measurement of moisture content of agg. C-566
5. Compressive and tensile strength of cement mortar C-109 and C-190
6. Abrasion, water absorbtion, flexural and compressive strength of bricks C-67
7. Physical properties of gypsum C-472
8. Physical properties of lime C-110
9. Density, flexural and compressive strength of timber D-198 & D-2395
10. Flexural, compressive and tensile strength of concrete C-139 and C-78 and C-496.

Vibration of Structures (20-153) (3 Units)

Pre-requisites: Dynamics of Structure II (20-012)
Theory of Structure (20-122)

Idealization of structures for vibration analysis-linear plastic systems with single degree of freedom, undamped and damped free vibrations, forced vibration under various forms of excitation, Duhamel's integral, effects of harmonic and transient excitations. Solution of inelastic single degree of freedom system using graphical and numerical methods determination and use response spectrum. Linear elastic systems with finite degrees of freedom, determination of modal shapes and frequencies, modal method of analysis. Introduction to vibration analysis of systems with distributed mass and Lagrange elasticity equation and their applications.

Loading (20-213) (2 Units)

Pre-requisite : Theory of Structures II (20-122)

Introduction to structural loads, static and quasi static methods of design loads live and dead loads on buildings and bridges, crane loading, Impact loading, wind loads, snow loads, earthquake loads, earth-pressure, construction loads, enviromental loads concept of safety and building codes, structural safety requirements in building codes, working load and limit state methods of structural design, load combinations, approximate methods of analysis and design (preliminary design of structures).

Introductions to building codes U.B.C., British standard codes of practice ISIRI NO. 519 (Iranian national code) .

Design of Steel Structures I (20-221) (3 Units)

Pre-requisites: Mechanics of Solids II(20-112) (may be taken concurrently)
Theory of Structures I (20-121)

General principles of elastic and plastic design of steel structures: methods of analysis, economy, safety and efficiency. Design of rolled and built-up members under tension or compression, with or without eccentricities: considering general and local buckling, and the effects of initial imperfections. Design of rolled members under flexure: considering crippling, stability and the effects of axial loading. Design of torsion members. Fasteners, bearing bolts, friction bolts, rivets, fillet and groove welds. Design of hinged and rigid connections. Specifications. Examples of truss and frame analysis and design.

Design of Steel Structures II (20-232) (3 Units)

Pre-requisites: Design of Steel Structures I (20-221)
Theory of Structures II (20-122) (may be taken concurrently)

Plate girder design: flange and web buckling, tension field, stiffeners. Design of compression members with variable cross-sections under distributed loading along the axis, torsional buckling of columns. Effect of shear stress on the buckling of built-up columns. Thin walled sections, design of steel plates for compression, shear and flexure. Tubular sections. Fatigue, brittle failure and corrosion. Steel-concrete composite members. Design examples: multi-storey frames, fuselages, hulls and reservoirs.

Design of Concrete Structures I (20-231) (3 Units)

Pre-requisites: Mechanics of Solids II (20-112) or concurrent
Nonmetallic Materials (20-211) or concurrent
Theory of Structures I (20-121).

Behavior of concrete and reinforcing steel; mechanics and behavior of reinforced concrete, axial compression and tension, bending, shear and diagonal tension, bond; design philosophies based on ultimate strength, working stress, and limit state; analysis and one-way slabs according to the ACI Code; design of web reinforcements, development lengths and bar splices, bar cutoff and bend points, crack and deflection control, design for torsion; behavior of compression members, analysis and design of compression members, slender columns; types of foundations, analysis and design of foundations; reinforced concrete design project.

Design of Concrete Structures II (20-232) (3 Units)

Pre-requisites: Design of Concrete Structures I (20-231),
Theory of Structures II (20-122).

Types of retaining walls, analysis and design of retaining walls, two-way slabs and their behavior, analysis and design of two-way slabs according to the ACI Code, slabs with openings and concentrated loads; yield line theory for analysis and design of slabs, design of concrete stairways, deep beams and shear walls, general design of reinforced-concrete buildings with emphasis on seismic provisions, principles of prestressed concrete and methods of prestressing, reinforced concrete design project.

Soil Mechanics Laboratory (20-401) (1 Unit)

Pre-requisite: Soil Mechanics (20-411)

Water content determination grain-size analysis (Mechanical method) grain size analysis (Hyrometer method), liquid and plastic limits. Shrinkage limit. Specific gravity compaction test C.B.R. Determination consolidation test, unconfined test, direct-shear test, triaxial test, permeability.

Construction methods and machineries (20-311) (3 Units)

Pre-requisite : Junior and Senior Students

Civil engineering and construction management, planning and engineering of construction projects, earthwork, transportation systems and earthwork equipments, soil and earthwork machines interaction, calculation of output and cost, building operations, formwork and concrete mixing plants, transportion of concrete. Cranes, deep drilling and foundation engineering. Predraining, piles and pile driving hammer, method of boring.

Soil Mechanics (20-411) (3 Units)

Pre-requisite : Mechanics of Soilds I (20-111)

Geological origin of the soil formation, soil density grain size distribution, Atterberg limits, soil classification, effective and total stress, pore pressure, ground water, permeability, the flow net in isotropic soil mass, non homogenous soil mass, stratified soil mass. Dewatering wells, single well, well groups drainage. Stress strain relationships according to Terzaghi and Janbu theory. Consolidation theory, primary and secondery consolidation settlement, time prediction. shear strength application of elasticity theory in soil mechanics Coulomb-Mohr's failure concept. The drained shear strength, the consolidated undrianed shear strength, the undrained shear strength. Cohesive and non cohosion soil shear strength. Earth pressure, Rankine active and passive theory.

Foundation Engineering (20-413) (3 Units)

Pre-requisite : Soil Mechanics (20-411)

Shallow foundation, shear strength behaviour in soil Mass, bearing capacity of shallow footing by Buisman-De Beer and Terzaghi theory,stress distribution in soil mass under different type of footing settlements prediction, subgrade reaction of rigid footing, pile foundation, evaluation of positive skin friction for single and pile group, negative friction, point bearing capacity for single and pile group, lateral resistance of single and pile group, negative friction, point bearing capacity for single and pile group, lateral resistance of single and pile group; Settlement prediction, sheet pile wall pressure on the sheet pile and stability analysis retaining wall, slope stability analysis by circle failure theory. Introduction to earthquake problems in building foundation.

Highway Engineering (20-421) (3 Units)

Pre-requisites: Soil Mechanics (20-411)
Surveying (20-511)

Part One: Route location and design, traffic requirements to the geometric design of highways, geometric design, special features of road design, road drainage, intersection and interchanges, choice of route locations, design of profile, the highway technical project.

Part Two: Design of roadbed and pavements, design of subbase and base, design of bituminous surfaces, design of rigid pavements.

Surveying (20-511) (3 Units)

Pre-requisite: (So Phomore, Junior or Senior Students).

Fundamental Concepts, direct and indirect methods of measurement of distance; measurement of vertical and horizontal angles. Application of Theodolite, magnetic compasses; methods of leveling. application of leveling instruments. Errors, sources of error, computation and adjustment of measured quantities; measurement of area and application of planimeter, surveying of straight and curved lines. Introduction to triangulation. Other methods of surveying.

Hydraulic (20-611) (3 Units)

Pre-requisite: Fluid Mechanics (28-411)

Resistance in open channels, hydraulic design of channels, steady, non-uniform flow (backwater curves). Unsteady, non-uniform flows, method of characteristics, numerical solutions for unsteady flows.

Hydraulics of sediment transport: sediment properties, scour criteria, the bed-load, the suspended load, the regime concept, bedform mechanics.

Structural Engineering Electives

Applied Mathematics in Structural Engineering (20-015) (3 Units)

Pre-requisite: Engineering Mathematics (22-031)

Partial differential eouations: examples from continum mechanics, first order equations, second order equations, elliptic, hyperbolic, and parabolic equations, method of characteristics, separation of variables, applications in elasticity, wave propogation and vibration problems stability of ordinary differential equations.

Rest points, Lyapunov's method, test for stability based on first approximation.

Calculus of variations: functionals, Euler's equation, one, two and three dimensional problems, constraint conditions, isoperimetric problems, variations with moving boundaries, second variations, direct methods, applications to structural engineering.

Space Structures (20-125) (3 Units)

Pre-requisite: Matrix Analysis of Structures (20-123); Consent of Instructor

Introduction to three dimensional structural systems, historical review and scope, classical and modern space structures; exact and approximate solutions for double layer trussed grids, braced barrel vaults, braced domes, cable nets and tension structures, plastic design of space grids and related structures; practical considerations of commercial systems.

Theory of Plates (20-131) (3 Units)

Pre-requisites: Engineering Mathematics I (22-031)
Solid Mechanics II (20-112)

Small Deflection Theory; derivation of plate flexural equations, rectangular plates subject to different loadings and edge conditions, circular plates with and without holes, elliptical and skewed plates; Energy methods strain energy of a deformed plate, Ritz method, Galerkin and variational methods, combined action of lateral loads and in-plane forces, critical loads.

Large Deflection Theory; general equations, large deflections of uniformly loaded rectangular and circular plates.

Theory of Shells (20-132) (3 Units)

Pre-requisite: Theory of Plates (20-131)

Membrane Theory; stress systems in shells, stress resultants, membrane forces, differential equation of equilibrium, membrane stresses in shells of revolution subject to axi-symmetric loadings, deformation characteristics, shells of arbitrary shape.

Bending Theory; equilibrium equations, shells of revolution, cylindrical shells subject to axi-symmetric loadings.
Applications of approximate methods (finite elements) to solution of elasto static and dynamic problems of shells.

Theory of Elasticity (20-141) (3 Units)

Pre-requisites: Engineering Mathematics I (22-031) ;
Mechanics of Solids II (20-112)

Concepts of tensor notation, stress and strain tensors, Hooke's law, strain displacement relations, differential equations of equilibrium, boundary conditions, compatibility equations, superposition principle, uniqueness of solutions, plane stress and plane strain problems, Airy's stress function, two dimensional problems in rectangular and polar coordinates , torsion of prismatical bars , deformation of elastic half space subject to concentrated forces; energy principles and variational methods ; wave propagation in elastic solid media.

Theory of Plasticity (20-142) (3 Units)

Pre-requisite : Solid mechanics II (20-112)

Plasticity phenomenon in two and three dimensional deformable bodies. Time dependent and independant inelasticity, Drucker's stability postulate: convexity and normality of yield surface. Tresca and Von Mises yield criteria. Constitutive equations: physical experiments, Levy-Mises relations, Prandtl-Reuss relations, hardening laws, introduction to anisotropy. Problems in torsion and bending of prismatic members. Thick cylinders, spherical shells; numerical solutions of problems for incremental theory: plates and pressure vessels. Some topics such as stretching, drawing, extrusion, forging and cutting.

Experimental Stress Analysis (20-143) (3 Units)

Pre-requisites : Mechanics of Solids 2 (20-112);
Mechanic of Solids Lab. 1 (20-101)

Review of stress and strain analysis, properties of special families of curves, fundamental concepts of strain measurements, statistical methods and their applications to experimental stress analysis, mechanical strain gaging; photoelasticity and photostress methods, grid methods, brittle coating methods.

Continuum Mechanics (20-144) (3 Units)

Pre-requisite: Mechanics of Solids II (20-112) &
Consent of Instructor

Introduction to cartesian tensors. Kinematics of deformation: deformation, deformation gradients, strain measures, vorticity, Cauchy's strain ellipsoid. Principles of conservation of mass, linear mementum and angular momentum, and energy. Surface forces, body forces, stress tensor, principol directions and stresses. Second law of thermodynamics. Invariance principles, constitutive equations. Constitutive equations for Green elasticity. Examples: classical linear elasticity and linear viscous flow.

Energy Methods in Engineering Mechanics (20-145) (3 Units)

Pre-requisites: Mechanics of Solid (20-112)
Engineering Mathematics (22-031)

Basic principles and definitions: energy, potential energy, strain energy, conservative and nonconservative forces, principle of virtual work, principles of potential and complementary energy. Variational methods: the weak variations of one, two and three dimensional problems, natural boundary conditions, forced boundary conditions, constraint conditions and Lagrange multipliers, energy theorems and structural mechanics, approximate methods of solution, Applications: beams, coloumns, plates, small and large deformations, elasticity problems.

Numerical Methods of Structural Analysis (20-148) (3 Units)

Pre-requisite : Analysis of Structures (20-123)

Functional Approximation: differentiation, integration, intepolation, extrapolation, errors.

Functional Equations: ordinary differental equations, application, linear equations, nonlinear equations, initial value problems, boundary value problems, stability of numerical solution, partial differential equations, elliptic, hyperbobic, parabolic, finite defference, structural engineering problems. Applications to static, dynamic and stability of beams and plate problems.

Variational Techniques: Ritz method, Galerkin, finite element method, application to various structural engineering problems.

Stabilitity of Structures (20-151) (3 Units)

Pre-requisites: Theory of Structure II (20-122)
Mechanics of Solids II (20-112)

Introduction to instability, non-linear behaviour of simple link models, types of instability, criteria of stability, purturbation method of analysis, simple and coupled buckling of beams and beam-columms, single and double modulus loads, stability of triangulated and rigid-jointed frames, effect of axial load on stiffness, stability functions, secondary stresses in triangulated frames, elastic-plastic behaviour of frames, Rankine-Merchant load, ultimate loads of structures in strain-harderning material.

Analysis of Structural Safety (20-155) (3 Units)

Pre-requisite: Jonior standing and consent of instructor

Random phenomena and variables, probability distribution and related functions, important expectations and their interpretation using important probability laws.

One and many dimensional normal, lognormal, binomial, Poisson and external distributions, conditional probability-Bayes theorem and its application, prediction of mean, variance and related confidence intervals from data, probability of failure for a given limit state-relationship between factor of safety, measures of variability and failure probability evaluation of safety factors when loads of diferent origins are active and when resistant is a prescribed function of several random variables, hazard and reliability functions for repeated loading determination of upper and lower bounds for system probability if failure and their use in selecting safety factor.

Earthquake Engineering (20-158) (3 Units)

Pre-requisite: Vibration of Structures (20-153)

Wave propagation and dynamic concepts of interest in earthquake engineering earthquake magnitude, intensity and prediction of seismicity-characteristic of earthquake motions-correlation between earthquake magnitude, focal distance, and peak values of ground motion-approximate methods for prediction of earthquake response spectrum on firm and soft ground-random process models for simulating motions and their use-application of response spectrum to predict earthquake effects in linear structures,influence of inelastic action, ductility factor and its use for design of inelastic systems-earthquake resistant design codes and study of special problems in earthquake resistant design. Hydrodynamic concepts of interest in earthquake engineering, pressure for dams and tanks.

Selected Topics in Design of Structures (20-291) (3 Units)

Pre-requisites: Design of Concrete Structures II (20-232)
Design of Steel Structures II (20-222)
Loading (20-213) (Pass or fail)

Case studies is design of several structural systems, supervise by a group of faculty members.

Linear Optimization Methods (20-193) (3 Units)

Pre-requisites: Theory of Structures II (20-122)
Numerical methods of Structural Analysis (20-148)
and Consent of Instructor

Introduction to systems approach; defenitions, objective founction constraint equations, decision and state variables; the different approach to optimization, critical points of a function, different quadratic form, quality of critical point, log rang multipliers linear programming, standard form of, graphical solution of 2-D problems, transportation and transhipment, management of construction projects, CPM and PERT, climbing techniques, gradient search, pattern search.

Non-linear Optimization method, (20-194) (3 Units)

Pre-requisites: Linear Optimization Methods (20-193)
and Consent of Instructor

The differential approach, classical methods, Newton-Raphson method, quality of stationary point, geometric programming-unconstrained, constrained derivatives; inequality constrained, slack variable and slack derivatives, Kuhn-Tucker conditions, differential algorithems, geometric programm, dynamic programming.

Advanced Concrete Technology (20-212) (3 Units)

Pre-requisite: Nonmetallic Materials (20-211)

Portland cement, manufacture of Portland cement, chemical composition of Portland cement, hydration of cement, microscopic structure of clinker, microscopic structure of hydrated cement and the action of gypsum; types of cements, types of admixtures, types of aggregates, properties of aggregate, fresh concrete, workability, factors affecting workability, measurement of workability, mixing of concrete, concreting in hot weather, strength of concrete, factors affecting the strength of concrete, compressive strength, tensile strength, compressive and tensile strength of concrete under biaxial and multiaxial states of stress, fracture, microcracking, failure theories for concrete, failure mechanism of concrete, bond, fatigue strength, impact strength, curing of concrete, elasticity, shrinkage and creep of concrete, mechanism of shrinkage and creep, factors affecting shrinkage and creep, rheological models, durability of concrete, permeability of concrete, chemical attack of concrete, action of frost, concreting in cold weather, thermal, electrical and acoustic properties of concrete, erosion and fire resistance, testing of hardened concrete, lightweight and heavyweight concretes, specialized concretes, mix design, methods of mix design.

Design of Prestressed Concrete Structures (20-233) (3 Units)

Pre-requisite: Design of R/C Structures II (20-232)

Concept of prestressing, methods of prestressing, end anchorages, loss of prestress, friction. Analysis and design of flexural members, shear, bond and bearing, camber and deflections. Partial prestressing, composite beams, continuous beams. " Load balancing " method. Prestressed slabs, tension and compression members, design of piles, design criteria, codes and specifications, connections. Prefabricated prestressed and reinforced concrete elements.

Design of bridges (20-251) (3 Units)

Pre-requisites: Design of Concrete Structures II (20-232)
Design of Steel Structures II (20-222)
Loading (20-213)

Introductions, common systems of sub and super structures; choice of systems based on natural, economical and aestatical conditions loading, exact and approximate analysis of sub and super structures of strainght and curved bridges; design of super structures, slabs, reinforced concrete, prestressed and precast girders;plate girders, rolled beams, box girders, truss bridges, design of sub structures, pier end bent on earthcore, cantilever, counterfort, woll and spill-through abutment.

Design of Dams (20-253) (3 Units)

Pre-requisites: Design of Concrete Structures II (20-232)
Loading (20-213) &
Consent of Instructor

Investigation of dam sites, types of dam, preparation and protection of the foundation, hydraulic model studies, flood flows, spillways, forces acting on dams, design of gravity, arch dams and concrete dams.

Architecture (20-321) (3 Units)

Pre-requisites: Engineering Graphics II(35-222);
Concrete Design I (20-231)(or concurrent);
Steel Design I (20-221)(or concurrent)

Introduction to architecture and different styles of architecture, programming, important elements in design-color, light, climate, location, form, expandability, flexibility, proportions, materials, creation of feeling for space, recognition of function of each space and its relation to other parts, necessary area for each function in a variety of buildings such as residential, commercial, medical, etc.

Study of each part of a building, study of signs, abbreviations, and methods of preparing a plan, schedules, study of safety and legal regulations in planning, use of perspective in presenting ideas.

Rock Mechanics (20-146) (3 Units)

Pre-requisite : Theory of elasticity (20-141)

Marine Structures (20-255) (3 Units)

Pre-requisite : Theory of Structures II (20-122) & Loading (20-213)

Pre-cast Structures (20-234) (2 Units)

Pre-requisite: Design of Concrete Structures II (20-232)

Technical Aspects of Foundations Engineering (20-414) (3 Units)

Pre-requisite: Foundation Engineering (20-413)

The site investigation, methods of drilling and sampling, field testing, S.P.T. tests.

Static penetrometer, seismography apparatus, soil resistivity measurements, piezmeters. Vane test, method of selection of the best type of foundation, preparation the site for shallow foundation, methods of foundation construction in the water, foundation on swelling and collapsing soil. Foundation on plastic and cohesive soils. Dewatering method with regard to the special problems. Different type of pile and method of construction, sheet piling and excavation.

Earth Dams (20-431) (3 Units)

Pre-requisites: Soil Mechanics (20-411)
Engineering Mathematics I (22-031)

Introduction, description of earth dams, seepage, flownet seepage-line equation in general form, mean gradient of the seepage flow in section, the electro-hydrodynamic simulator for the study of seepage through earth dams, application of method of parts to the calculation of seepage through earth dams, earth dams on impervious foundations, homogeneous earth dams with empty tailraces, homogenous earth dams with water in the tailraces, composite dams, seepage through earth dams on previous foundation, dams with facings and aprons, dams with facing and cutoff, slope stability analysis of earth dams.

Soil Dynamic (20-441) (3 Units)

Pre-requisites: Soil Mechanics (20-411)
Engineering Mathematics I (22-031)

Vibration of elementary systems. Systems with different degrees of freedom. Natural frequencies of continuous systems. Wave propagation in an elastic homogeneous isotropic medium. Elastic waves in layered systems. Propegation of waves in saturated media. Behavior of dynamically loaded soils. Theories of vibritions of foundations on elastic media. Isolation of foundations. Isolation materials. Design procedures for dynamically loaded foundations.

Design I (20-241) (3 Units)

Pre-requisites : Loading (20-213) (Pass or fail)

Design of Steel Structures, II (20-222)

Design of Concrete Structures, III (20-232)

Comperhensive design of structural systems special problems and topics.

Design II (20-242) (3 Units)

Pre-requisites Design I (20-291)

Plastic theory and design of structures (20-124)
(Pass or fail)

Comperhensive design of structural systems, special problems and topics.

Selected topics in analysis of structures (20-192) (3 Units)

Pre-reuqisites: Theory of Structures II (20-122)

Mechanics of Solids II (20-112)

Analysis of selected and special structures.

Statics & Strength of Materials (20-915) (3 Units)

Pre-requisite: General Physics (24-011)

Statics, force systems (force, moment, couple, resultant of force systems), determinate & indeterminate structural systems. Trusses, frames & machines. Internal forces: axial force, shear force, beams with concentrated & distributed loads bending moment, flexible cables under distributed loads (symmetrical & unsymmetrical). Strength of materials stress: normal stress shear stress, strain, stress-strain relationship (Hooke's law), Young's Modulus, Poisson's Ratio (biaxial & triaxial deformations), stress-strain diagram thermal stresses, axially statically indeterminate systems, factor of safety, working stress, torsion of circular sections, properties of plane surfaces (centroid, static moment of area, moment of inertia), stresses in strait beams, design of beams, deflection of beams (double integration method), indeterminate beams (double-integration method) & superposition.

Statics and Solid Mechanics (20-917) (3 Units)

(For students in school of Metalugy)

Pre-requisite: General physics (24-011)

Statics; force, moment, couple , resultants, free body diagram static equilibrum, systems of forces.

Solid Mechanics; stress, strain, shear strain, strain stress relationship Hook's law, stress and strain is two and three dimension, generalized Hook's law, Mohr's circle, principle axes and stresses, strain measurment, bending, torsion, compression, etc.