Civil Engineering
Undergraduate Program

Dhahran, Saudi Arabia

March 2019 (Rajab 1440H)
## DEGREE PLAN

### Civil Engineering Curriculum (CE)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>LT</th>
<th>LB</th>
<th>CR</th>
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<td>PYP 004</td>
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<td>Introduction to Differential Equations and Linear Algebra</td>
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<td>XXX xxx</td>
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<td>Engineering Fluid Mechanics</td>
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<td>Engineering Hydrology</td>
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<td>Introduction to Geotechnical Engineering</td>
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<td>CE 315</td>
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<td>GS xxx</td>
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<td>CE Elective III</td>
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Flowchart of CE Program

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<td>IAS 111</td>
<td>ENGL 101</td>
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<tr>
<td>FR2</td>
<td>IAS 101</td>
<td>ENGL 102</td>
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<td>Sci. Elec.</td>
<td>ENGL 214</td>
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<td>IAS 212</td>
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<td>JN1</td>
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<td>GS Else.</td>
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<td>JN2</td>
<td>IAS 301</td>
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<td>CE 395</td>
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<td>SN1</td>
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<tr>
<td>SN2</td>
<td>IAS 322</td>
<td>CE Else.</td>
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Total Credits Required in Degree Program 132

**LEGEND**

- XE xxx: Technical Elective
- ---: Courses should be taken in Sequence
- "": Co-Requisite
- JS: Junior Standing
Requirements for the B.S. Degree in Civil Engineering (CE)

Every student majoring in Civil Engineering (CE) must complete the following curriculum:

(a) General Education Requirements (57 credit hours)

<table>
<thead>
<tr>
<th>Category</th>
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<th>Credit Hours</th>
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<td>English</td>
<td>ENGL 101, 102, 214</td>
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<tr>
<td>Computer Skill</td>
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<tr>
<td>Interdisciplinary Basic Courses</td>
<td>ME 201</td>
<td>3</td>
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<tr>
<td>Mathematics</td>
<td>MATH 101, 102, 201, 208</td>
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<td>Sciences</td>
<td>PHYS 101, 102; CHEM 101, 111</td>
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<td>Islamic and Arabic Studies</td>
<td>IAS 101, 111, 201, 212, 301, 322</td>
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(b) Core Requirements (48 credit hours)

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<tr>
<td>Computer Graphics</td>
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<tr>
<td>Surveying</td>
<td>CE 262</td>
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<tr>
<td>Mechanics and Structures</td>
<td>CE 201, 203, 305, 315</td>
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<td>Materials</td>
<td>CE 204, 206</td>
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<tr>
<td>Geotechnical</td>
<td>CE 354, 356</td>
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<td>Transportation</td>
<td>CE 341, 343</td>
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<tr>
<td>Fluid Mechanics and Environmental Engineering</td>
<td>CE 230, 330, 335, 375</td>
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<td>Senior Design Project</td>
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(c) Electives (27 credit hours)

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<td>CE Electives</td>
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<td>CE Design Electives</td>
<td>Two CE xxx Courses</td>
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<td>Additional Science XXX xxx</td>
<td>GEOL 101 or BIOL 233</td>
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<td>General Studies</td>
<td>GS xxx, GS xxx Courses</td>
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<td>Technical Elective (from approved list)</td>
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(d) Summer Training (0 credit hours)

A minimum of 8-week program to gain experience; submit and present a report.

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The total number of credit hours required is 132
List of Courses as Technical Elective

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<td>Building Economy</td>
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<td>ARE 440</td>
<td>Solar Energy in Buildings</td>
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<tr>
<td>ARE 457</td>
<td>Introduction to Building Maintenance &amp; Management</td>
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<td>ARE 459</td>
<td>Contracts and Specifications</td>
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<td>EE 204</td>
<td>Fundamentals of Electrical Circuits</td>
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<td>ISE 307</td>
<td>Engineering Economics Analysis</td>
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<td>Engineering Mathematics</td>
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<td>MATH 333</td>
<td>Methods of Applied Mathematics I</td>
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<td>MATH 474</td>
<td>Linear &amp; Nonlinear Programming</td>
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<td>Thermodynamics I</td>
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<td>ME 482</td>
<td>Mechanical Vibrations</td>
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<td>STAT 319</td>
<td>Probability and Statistics for Engineers &amp; Scientists</td>
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List of CE Design Electives

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<tr>
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<tr>
<td>CE 441</td>
<td>Design of Pavement</td>
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<tr>
<td>CE 444</td>
<td>Traffic Engineering and Roadway Safety</td>
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<td>CE 455</td>
<td>Foundation and Earth Structure Design</td>
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<td>CE Design Elective II, One from:</td>
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<td>CE 437</td>
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<td>CE 473</td>
<td>Design and Operation of Water and Wastewater Treatment Plants</td>
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</table>
List of Civil Engineering Undergraduate Courses

CE 101 – Engineering Graphics (1-3-2)
CE 201 – Statics (3-0-3)
CE 202 – Statics & Strength of Materials (3-0-3)
CE 203 – Structural Mechanics I (3-0-3)
CE 204 – Civil Engineering Materials (3-0-3)
CE 206 – Civil Engineering Materials Laboratory (0-3-1)
CE 216 – Computer Graphics (1-3-2)
CE 230 – Engineering Fluid Mechanics (3-0-3)
CE 262 – Surveying (2-3-3)
CE 305 – Structural Analysis I (3-0-3)
CE 315 – Reinforced Concrete I (2-3-3)
CE 318 – Numerical & Statistical Methods in Civil Engineering (2-3-3)
CE 330 – Environmental Engineering Principles (3-0-3)
CE 335 – Engineering Hydrology (2-3-3)
CE 341 – Transportation Engineering (3-0-3)
CE 343 – Transportation Engineering Laboratory (0-3-1)
CE 354 – Introduction to Geotechnical Engineering (3-0-3)
CE 356 – Geotechnical Engineering Laboratory (0-3-1)
CE 375 – Environmental Chemistry Laboratory (0-3-1)
CE 399 – Summer Training (0-0-0)
CE 401 – Concrete Technology (2-3-3)
CE 402 – Durability, Evaluation and Repair of Concrete Structures (3-0-3)
CE 405 – Structural Analysis II (3-0-3)
CE 406 – Structural Mechanics II (3-0-3)
CE 408 – Steel Design I (2-3-3)
CE 411 – Senior Design Project (1-6-3)
CE 415 – Reinforced Concrete II (2-3-3)
CE 418 – Steel Design II (3-0-3)
CE 422 – Construction Management and Economy (3-0-3)
CE 433 – Groundwater Engineering (3-0-3)
CE 436 – Open Channel Hydraulics (3-0-3)
CE 437 – Applied Hydraulic Engineering (3-0-3)
CE 439 – Civil Engineering Systems Design (3-0-3)
CE 440 – Highway and Airport Materials (3-0-3)
CE 441 – Design of Pavement (3-0-3)
CE 442 – Construction and Maintenance of Highways and Airports (3-0-3)
CE 444 – Traffic Engineering and Roadway Safety (3-0-3)
CE 454 – Soil Stabilization and Site Improvement (3-0-3)
CE 455 – Foundation and Earth Structure Design (3-0-3)
CE 457 – Advanced Geotechnical Engineering (3-0-3)
CE 464 – Project Surveying (3-0-3)
CE 471 – Water and Wastewater: Treatment and Reuse (2-3-3)
CE 473 – Design and Operation of Water and Wastewater Treatment Plants (3-0-3)
CE 474 – Municipal Solid Waste Management (3-0-3)
CE 476 – Industrial Hazardous Waste Management & Treatment (3-0-3)
CE 491 – Special Topics in Civil Engineering (3-0-3)
CE 497 – Undergraduate Research (1-6-3)
Civil Engineering Course Descriptions

CE 101 Engineering Graphics (1-3-2)  
An introductory course on the “language of engineering” and the use of drafting instruments and machines. Topics include freehand sketching, graphic geometry, orthographic projection, sectional and auxiliary views, dimensioning, intersections, developments, and introduction to working drawings and an overview of computer graphics.  
- This course is for non-CE students only

CE 201 Statics (3-0-3)  
Basic concepts and principles of mechanics; algebraic vector operations on action and reaction vectors; equilibrium of particles in two and three dimensions; definitions of moment and couple; reduction of system of forces; equilibrium of rigid bodies; statically determinate structures including beams, trusses, frames and machines; analysis of internal forces; shear and bending moment diagram for beams; static friction forces and engineering applications; center of gravity of masses, and centroid of lines, areas, and volumes; area moment of inertia and radius of gyration.  
Prerequisite: PHYS 101

CE 202 Statics & Strength of Materials (3-0-3)  
Basic concepts and principles of mechanics; equilibrium of particles in two dimensions; definition of moment and couple; reduction of systems forces; equilibrium of rigid bodies in two dimensions; analysis of truss-type structures and internal forces; geometric properties of cross-section area; centroid and moments of inertia; shear and bending moment diagrams in beams; stress, Stress-strain relationships; stress and deformation of axially loaded members; stress-concentration; thermal stresses; pressure-vessels; torsion-stress and deformation; elastic bending and shear stresses in beams; compound stresses; stress transformation.  
Prerequisite: PHYS 101  
- This course is for non-CE students only  
- Not to be taken for credit with CE 201 or CE 203
CE 203  Structural Mechanics I  (3-0-3)
Concepts of stress, strain, and constitutive relations; stress and deformation of axially loaded members, thermal stresses, pressure vessels, energy concepts, torsion of circular and thin-walled sections, shear and bending moment diagrams in beams, elastic bending, shear stress in beams, compound stresses, stress transformation, deflection of beams, and introduction to the concept of singularity functions.
Prerequisite: CE 201

CE 204  Civil Engineering Materials  (3-0-3)
Introduction; hydraulic cements; water; aggregates for Portland cement and asphalt concrete mixes; admixtures; design of concrete mixtures; production, handling and placement of concrete; properties of fresh concrete; curing of concrete; properties of hardened concrete; asphalt types, physical properties, grading systems and usage of asphalt; asphalt concrete mix design; engineering properties and usage of structural steel. Laboratory sessions on tests of concrete constituents, fresh and hardened concrete, aggregate gradation and mix design; flexure behavior of reinforced concrete beams; physical properties and testing of asphalt binders, asphalt concrete mix design; hardness test, tensile and torsion tests on metals, measurement of Poisson’s ratio and stress concentration and bending tests on steel beams.
Prerequisite: CE 201
Co-Requisite: CE 206

CE 206  Civil Engineering Materials Laboratory  (0-3-1)
Laboratory sessions on tests of concrete constituents using standard procedures generally ASTM standards, fresh and hardened concrete, aggregate gradation and mix design; flexure behavior of reinforced concrete beams; physical properties and testing of asphalt binders, asphalt concrete mix design; hardness test, tensile and torsion tests on metals, measurement of Poisson’s ratio and stress concentration and bending tests on steel beams.
Co-Requisite: CE 204
CE 216  Computer Graphics  (1-3-2)
The course focus on the following topics: Introduction to Computer Aided Design and Drafting, (CADD), 2D Drawings with AutoCAD includes Multiview Projection, Dimensions, Sections, Auxiliary Views, Free Hand Sketching, Mining and Civil Engineering Problems, Metallic Members and their Connections, Bearing and Slope of Lines and Planes, AutoCAD Civil 3d, Contour Map Lines, Cut and Fill, Blue Print Reading, and 3D Drawings.
Prerequisite: None

CE 230  Engineering Fluid Mechanics  (3-0-3)
Properties of fluids, hydrostatics with applications to manometers, forces on plane and curved surfaces, bouncy, equations of continuity, energy and linear momentum with applications, dimensional analysis, dynamic similarity, open channel flow, and conduit flow.
Prerequisite: CE 201, MATH 102

CE 262  Surveying  (2-3-3)
Introduction to basics of surveying, surveying instruments, accuracy and precision, ratios, errors; leveling, types of leveling instruments, techniques of leveling, profile and cross-section leveling; distance measurement techniques, steel tape corrections; angles and directions, azimuth and bearing computations; traverse surveys, latitude and departure computations, traverse adjustments. Area of a closed traverse by coordinate method; satellite positioning systems, Global Positioning System (GPS) codes, signals and frequencies, Receivers, GPS position measurements; topographical hydrographic surveying and mapping. Maps and plans, introduction to contours, cross-section, end areas and volumes, introduction to geographic information systems (GIS).

CE 305  Structural Analysis I  (3-0-3)
Shear force and bending moment diagrams for frames; influence lines for beams and trusses; displacement analysis for beams; Virtual Work Method for beams, frames and trusses; Castigliano's Theorem; analysis of statically indeterminate structures; the Force Method; the Slope-Deflection Method, the Moment Distribution Method; introduction to the Stiffness Method for beams and frames, the use of structural analysis software.
Prerequisite: CE 203
CE 315  **Reinforced Concrete I**  (2-3-3)
Behavior and design of reinforced rectangular and T-sections in flexure; doubly reinforced sections; behavior and design of beams for shear; bond and development length including splices and cut-off points; design of one-way solid and joist floor slabs; design of short columns; design of isolated footings; introduction to prestressing and precast construction; use of appropriate computer software in design; completion of a design project; interpretation of blueprints; site visits.

**Prerequisite:** CE 305

CE 318  **Numerical & Statistical Methods in Civil Engineering**  (2-3-3)
Introduction to numerical methods; error analysis; solution of system of linear and nonlinear equations; numerical integration; numerical solutions of ordinary differential equations; curve fitting and interpolation; statistical methods, descriptive statistics, probability distributions, analysis of variance and regression; introduction to linear programming and optimization problems; development and application of computer programs to case studies derived from civil engineering practices.

**Prerequisite(s):** ICS 103, MATH 208

CE 330  **Environmental Engineering Principles**  (3-0-3)
Introduction to water treatment along with physical operations and chemical processes; Introduction to wastewater treatment and reuse along with preliminary, primary, secondary, and tertiary treatment; municipal solid and hazardous waste management and disposal.

**Prerequisite:** CHEM 111 or CHEM 102

**Co-Requisite:** CE 375

CE 335  **Engineering Hydrology**  (2-3-3)
The hydrologic cycle, precipitation; evaporation and transpiration; infiltration; streamflow; hydrograph analysis including unit hydrograph; hydrologic flood routing; introduction to flood frequency analysis; occurrence of groundwater; fundamentals of groundwater flow including Darcy’s law and its applications; steady and unsteady flow to wells.

**Prerequisite(s):** CE 230
CE 341  Transportation Engineering  (3-0-3)
Transportation system in Saudi Arabia; transportation planning and evaluation; vehicle characteristics; human factors; geometric design of highways and intersections; basis of pavement design; introduction to capacity analysis of highways and intersections; introduction to airport planning and design; application of transportation related softwares.
Prerequisite: PHYS 101
Co-Requisite: CE 343

CE 343  Transportation Engineering Lab  (0-3-1)
Transportation system in Saudi Arabia; transportation planning and evaluation; vehicle characteristics; human factors; geometric design of highways and intersections; basis of pavement design; introduction to capacity analysis of highways and intersections; introduction to airport planning and design; laboratory sessions on Field studies of speed; traffic volume, and delay; capacity analysis; geometric design of highways, intersections, and parking facilities; traffic signal design; pavement material testing and design; flexible pavement design; application of transportation related software; application of transportation related software.
Prerequisite: CE 206
Co-Requisite: CE 341

CE 354  Introduction to Geotechnical Engineering  (3-0-3)
Soil formation and identification; index and classification properties of soils; clay minerals; soil compaction; capillarity, swelling, shrinkage and effective stresses; flow of water in soils; compressibility and consolidation; stress in soils; shear strength of cohesive and cohesionless soils; introduction to lateral earth pressure and shallow foundation.
Co-Requisites: CE 230, CE 356
Prerequisite: CE 203

CE 356  Geotechnical Engineering Laboratory  (0-3-1)
Conduct and report on experiments in geotechnical engineering, including: specific gravity; moisture content; sieve analysis; hydrometer analysis; Atterberg limits; compaction; field density; permeability; consolidation; direct shear; unconfined compression; California bearing ratio; triaxial shear.
Co-Requisite: CE 354
CE 375  Environmental Chemistry Laboratory  (0-3-1)
Introductory environmental chemistry laboratory sessions for water & wastewater treatment;
Standard solutions; Elementary concepts in solution & colloidal chemistry including chemical
equilibrium, kinetics, precipitation; pH measurement; Dissolved-oxygen analysis; Alkalinity
analysis; Water-hardness analysis; Turbidity and solids characterization; Total organic carbon
(TOC) & Chemical oxygen demand (COD) analysis; Biochemical oxygen demand (BOD)
analysis; Total coliforms analysis; Residual chlorine analysis; Jar Test; Adsorption.
Co-Requisite: CE 330

CE 399  Summer Training  (0-0-0)
A continuous period of eight weeks of summer working in the industry to gain exposure and
appreciation of the civil engineering profession. On-the-job training can be acquired in one of
the four specialties of civil engineering. The student is required to write a brief report about his
industrial experience. The report should emphasize duties assigned and completed by the
student.
Prerequisite(s): ENGL 214, Junior Standing, Approval of the Department

CE 401  Concrete Technology  (2-3-3)
In-depth study of cement composition, hydration of cement; structure and properties of hardened
cement paste; volumetric changes in concrete; properties of concrete related to durability such as
water absorption, water permeability, chloride permeability, and chloride diffusion; use of
mineral admixtures; advanced concretes and reinforcing bars; requirements and specifications
for producing durable concretes suiting the local conditions.
Prerequisite:  CE 204

CE 402  Durability, Evaluation and Repair of Concrete Structures  (3-0-3)
Durability problems of concrete structures such as reinforcement corrosion, sulfate attack,
cement-aggregate reactions, salt weathering, efflorescence, acid attack, and environmental
cracking; factors causing severe deterioration problems in the Arabian Gulf; condition survey,
diagnosis and evaluation of deterioration damage in concrete structures; repair materials and
methods; preventive measures such as protective coatings, cathodic protection, de-chlorination,
and re-alkalinization.
Prerequisite:  CE 204
CE 405  Structural Analysis II  (3-0-3)
Review of matrix algebra and solution of simultaneous equations; flexibility (force) method analysis; stiffness (displacement) method of analysis; 2-D trusses, beams and frames; development of computer programs using the stiffness method; use of available computer packages for applications in structural analysis; introduction to the Finite Element Method; introduction to structural stability.

Prerequisite: CE 305

CE 406  Structural Mechanics II  (3-0-3)
Bending of beams of non-symmetrical sections; shear center; energy concepts including Rayleigh-Ritz method; use of classical and energy methods in the analysis of curved beams; torsion of prismatic members; beams on elastic foundations; use of finite element methods in solid mechanics, including introduction to use of FEM software; column buckling and introduction to beam-columns; failure theories and fracture mechanics.

Prerequisite: CE 203

CE 408  Steel Design I  (2-3-3)
Properties of structural steel; steel sections and introduction to Load Resistance Factor Design (LRFD), design of tension members, compression members and capacity calculations; laced columns width-thickness ratios; design of beams with and without lateral supports; design of members under combined axial and bending loads; design and details of simple bolted and welded connections, and an introduction to common building connections; use of software for design of elements and overall design of frames.

Prerequisite: CE 305
CE 411  Senior Design Project  (1-6-3)
Students undertake a civil engineering design project under the supervision of a faculty member with the aim of achieving a comprehensive design experience through a coherent study of all applicable principles, strategies and methodologies of design, including construction operation, and maintenance as and when applicable. The project should also take into consideration other appropriate factors such as alternative designs, economic feasibility and social and environmental impacts. The student chooses the project in the field in which he is most familiar through his co-op work experience or summer training. The student is required to make an oral and written presentation of the design project to an examining committee.

Prerequisite: Senior Standing

CE 415  Reinforced Concrete II  (2-3-3)
Design of two-way slabs using ACI ‘direct design method’; design of continuous beams; behavior and design of columns under axial load and bending moment including slenderness effect; design of beam column joints; design of shear wall and load bearing wall system; simple design of stairs; introduction to various types of foundations; lateral resistivity, design of wall footings and combined footings; design of retaining walls; simple design of prestressed precast elements; appropriate computer software in design; completion of a multistory design project.

Prerequisite: CE 315

CE 418  Steel Design II  (3-0-3)
Introduction to elastic-plastic material behavior, plastic analysis and design of beams and simple frames using Load Resistance Factor Design (LRFD), design of built up beams and plate girders, optimum proportioning of I-beam, design of composite girders, design of rigid connections, design for torsion, computer applications to design rigid frames and steel buildings.

Prerequisite: CE 408
CE 422  Construction Management and Economy (3-0-3)
An overview of construction industry; professional responsibilities, ethics, liabilities and
licensing; contracts and project delivery systems; business ownership; project planning and
scheduling; cost estimation, cost control, resource leveling, introduction to construction
economics, equipment productivity and selection; construction productivity and safety;
construction types, equipment, materials, and foundation; concrete form design;
contemporary issues in Construction Engineering; field projects and life-long learning.
**Prerequisite:** Junior Standing

CE 433  Groundwater Engineering (3-0-3)
Introduction and definitions; Groundwater Aquifers of Saudi Arabia; groundwater storage
and supply; Darcy’s law and its applications; Dupuit approximation; steady and unsteady
flows in confined and unconfined aquifers; radial flow towards wells; storage coefficient and
safe yield in a water-table aquifer; design of wells; methods of drilling and construction;
development of maintenance of wells.
**Prerequisite:** CE 335

CE 436  Open Channel Hydraulics (3-0-3)
Analysis and characteristics of flow in open channels; channel design considerations
including uniform flow; flow measuring devices; gradually varied flow; flood routing;
rapidly varied flow; hydraulic factors for the design of reservoirs, dams, spillways and stilling
basins.
**Prerequisite:** CE 335

CE 437  Applied Hydraulic Engineering (3-0-3)
Application of the basic laws of fluid mechanics to hydraulic problems. Analysis and design
of water supply, sanitary and storm sewer systems and their components; open channel flow
hydraulics; hydraulic structures; computer applications in the design and analysis of
hydraulic systems.
**Prerequisite:** CE 335
CE 439  Civil Engineering Systems Analysis  (3-0-3)
Techniques commonly associated with systems engineering; new techniques applicable to
design and operations of civil engineering systems; linear optimization, linear programming,
transportation and assignment problems, network analysis; simulation techniques; decision
analysis; nonlinear optimization; critical path method.
Prerequisite:  CE 318

CE 440  Highway and Airport Materials  (3-0-3)
Construction materials; asphalt cement; emulsified asphalt; foamed asphalt; Portland cement
asphalts; cement; aggregates and asphalt additives; specifications; material selection and
evaluation; tests of asphalts and aggregates, mix design procedures for hot and cold asphalt
mixes, including Marshall and SuperPave; mix design for Portland cement concrete mixes for
rigid pavements; characterization techniques; modulus of resilience; fatigue and rutting
performance prediction; field quality control procedures; Computer applications in materials
evaluation and design.
Prerequisite:  CE 204

CE 441  Design of Pavement  (3-0-3)
Pavement types and design factors; stresses and strains in flexible and rigid pavements;
traffic analysis and design considerations; material characterization; performance evaluation;
reliability aspects in design and construction; structural thickness design of highway and
airport pavements using different methodologies; pavement evaluation; Computer
application in pavement design.
Co-Requisite:  CE 341

CE 442  Construction and Maintenance of Highways and Airports  (3-0-3)
Selection and processing of construction materials; asphalt concrete mix design; asphalt
plants operation; material placement and compaction methods; quality control; earthwork,
highway drainage and roadside requirements; construction standards; pavement performance
and evaluation; pavement distress identification; surface treatments; techniques; application
and design; overlay design; pavement recycling techniques; computer applications.
Prerequisite:  Junior Standing
CE 444  Traffic Engineering and Roadway Safety  (3-0-3)
Vehicle, roadway and driver characteristics; traffic engineering and safety studies; highway
capacity analysis; traffic control methods and devices; intersection signalization and signal
timing; fundamentals of intersection design; parking facilities; introduction to attenuation
devices; intelligent transportation systems; computer applications.
Prerequisite: CE 341

CE 454  Soil Stabilization and Site Improvement  (3-0-3)
General survey of soil types and their behavior and the available techniques for improvement;
shallow and deep mechanical modifications; modifications by admixtures and grouting;
modifications by inclusions; the use of geosynthetic material in filtration, seepage control,
separation, reinforcement and water retention; hydraulic modifications; and treatment of
marginal soils.
Prerequisite: CE 354

CE 455  Foundation and Earth Structure Design  (3-0-3)
Site investigation, including determination of soil properties for design; bearing capacity
theory of shallow foundation; settlement of building foundations; design and analysis of
retaining walls, sheet piles and braced excavations; design of pile and pier foundations.
Prerequisite: CE 354

CE 457  Advanced Geotechnical Engineering  (3-0-3)
Fundamental relations of elasticity and plasticity in soil masses; unsaturated soils behavior;
deformation properties of cohesionless and cohesive soils; advanced strength concepts in
soils and stress path; slope stability analysis; introduction to soil dynamics.
Prerequisite: CE 354

CE 464  Project Surveying  (3-0-3)
Route survey; horizontal curves; vertical curves; spirals; construction surveys; applications of
Total Stations; topographic surveying and mapping; introduction to Global Positioning
System (GPS) and Geographic Information Systems.
Prerequisite: CE 262
CE 471  Water and Wastewater: Treatment and Reuse  (2-3-3)
Water treatment including pre-design issues, desalination, lime softening, sedimentation, filtration, membrane systems, ion exchange, adsorption, and disinfection technologies; Wastewater treatment including fundamentals of reactor design, activated sludge system, membrane bioreactor, trickling filter, and secondary clarifier; Natural wastewater treatment technologies for smaller and remote communities; Wastewater reuse including water scarcity issues, legal issues, health issues, technical issues & methodologies, areas of application, and case studies.
Prerequisite: CE 330

CE 473  Design and Operation of Water and Wastewater Treatment Plants  (3-0-3)
Theory and practice in sanitary engineering including the concepts of processing, design, economic evaluation and computer analysis; class projects incorporating practical considerations in the design and operation of treatment units and the combining of unit processing in water and wastewater treatment plants; field trips will be organized to visit various types of treatment plants in operation.
Prerequisite: CE 330

CE 474  Municipal Solid Waste Management  (3-0-3)
Problems, regulations, collection, handling, recycling and disposal issues related to municipal solid wastes; Characterization of municipal solid wastes including physical, chemical, and biological characteristics; Integrated municipal solid waste management practices including resource recovery, composting, incineration, and landfill design.
Prerequisite: CE 330

CE 476  Industrial Hazardous Waste Management & Treatment  (3-0-3)
Theory and design of several industrial hazardous waste management and treatment aspects including regulations, environmental audits, pollution prevention, risk assessment, chemical & biological process fundamentals, and industrial hazardous waste separation, handling, treatment, & disposal techniques.
Prerequisite: CE 330
CE 491  Special Topics in Civil Engineering  (3-0-3)
The course covers a special topic with emphasis on recent developments or to explore much deeper into one of the following civil & environmental engineering areas: structural, water resources, transportation, geotechnical and environmental engineering. A detailed syllabus of the course is announced one semester in advance.
**Prerequisite:** Senior Standing and Departmental Approval

CE 497  Undergraduate Research  (1-6-3)
Selection of a research topic, development of research topic, writing a successful proposal, manage and carrying out research tasks, setting up bench scale setup or prototype for lab work or software for modeling based research, communicating the research findings, writing effective reports.
**Prerequisite:** Departmental Approval