



*King Fahd University of Petroleum & Minerals*

Department of Civil & Environmental Engineering

# Applied Civil Engineering Undergraduate Program

**Dhahran, Saudi Arabia**

**March 2019 (Rajab 1440H)**

## DEGREE PLAN (ACE)

COURSE	TITLE	LT	LB	CR	COURSE	TITLE	LT	LB	CR
<b>Preparatory Year</b>									
ENGL 01-xx	Prep. English I (First Quarter)	15	5	4	ENGL 03-xx	Prep. English III (Third Quarter)	15	5	4
ENGL 02-xx	Prep. English II (Second Quarter)			4	ENGL 04-xx	Prep. English IV (Fourth Quarter)			4
MATH 001	Prep. Math I	3	1	4	MATH 002	Prep. Math II	3	1	4
PYP 001	Prep. Physical Science	2	0	2	PYP 002	Prep. Computer Science	0	2	1
PYP 003	University Study Skills	0	2	1	PYP 004	Prep. Engineering Technology	0	2	1
PE 001	Prep. Health and Physical Educ. I	0	2	1	PE 002	Prep. Health and Physical Educ. II	0	2	1
		<b>20</b>	<b>10</b>	<b>16</b>			<b>18</b>	<b>12</b>	<b>15</b>
<b>Total credit hours required in Preparatory Program: 31</b>									
<b>First Year (Freshman)</b>									
CHEM 101	General Chemistry I	3	4	4	PHYS 102	General Physics II	3	3	4
ENGL 101	Intro. to Academic Discourse	3	0	3	MATH 102	Calculus II	4	0	4
MATH 101	Calculus I	4	0	4	ENGL 102	Introduction to Report Writing	3	0	3
PE 101	Health and Physical Educ. I	0	2	1	IAS 101	Practical Grammar	2	0	2
PHYS 101	General Physics I	3	3	4	ICS 103	Computer Programming in C	2	3	3
IAS 111	Belief and its Consequences	2	0	2	CHEM 111	Basics of Environmental Chemistry	2	0	2
		<b>15</b>	<b>9</b>	<b>18</b>			<b>16</b>	<b>6</b>	<b>18</b>
<b>Second Year (Sophomore)</b>									
PE 102	Health and Physical Education II	0	2	1	IAS 201	Writing for Professional Needs	2	0	2
CE 201	Statics	3	0	3	ME 201	Dynamics	3	0	3
MATH 201	Calculus III	3	0	3	CE 203	Structural Mechanics I	3	0	3
ENGL 214	Academic and Professional Communication	3	0	3	CE 204	Civil Engineering Materials	3	0	3
CE 216	Computer Graphics	1	3	2	CE 206	Civil Engineering Materials Lab	0	3	1
CE 262	Surveying	2	3	3	MATH 208	Introduction to Differential Equations and Linear Algebra	3	0	3
IAS 212	Professional Ethics	2	0	2	CE 230	Eng. Fluid Mechanics	3	0	3
		<b>14</b>	<b>8</b>	<b>17</b>			<b>17</b>	<b>3</b>	<b>18</b>
<b>Third Year (Junior)</b>									
CE 305	Structural Analysis I	3	0	3	IAS 301	Oral Communication Skills	2	0	2
IAS 322	Human Rights in Islam	2	0	2	CE 315	Reinforced Concrete I	2	3	3
CE 318	Numerical & Statistical Methods in CE	2	3	3	CE 335	Engineering Hydrology	2	3	3
CE 341	Transportation Engineering	3	0	3	CE 330	Environmental Eng. Principles	3	0	3
CE 343	Transportation Engineering Lab	0	3	1	CE 375	Environmental Chemistry Lab	0	3	1
CE 354	Introduction to Geotechnical Engineering	3	0	3	CE xxx	CE Design Elective I	3	0	3
CE 356	Geotechnical Engineering Lab	0	3	1	GS xxx	GS Elective I	3	0	3
XXX xxx	Science Elective	2	3	3					
		<b>15</b>	<b>12</b>	<b>19</b>			<b>15</b>	<b>9</b>	<b>18</b>
<b>Summer Session</b>					CE 350	Begin Cooperative Work	0	0	0
<b>Fourth Year (Senior)</b>									
CE 351	Cooperative Work	0	0	6	CE xxx	CE Elective I	3	0	3
					GS xxx	GS Elective II	3	0	3
					CE xxx	CE Elective II	3	0	3
					CE xxx	CE Design Elective II	3	0	3
					CE 411	Senior Design Project	1	6	3
					CE 422	Construction Management and Economy	3	0	3
		<b>0</b>	<b>0</b>	<b>6</b>			<b>16</b>	<b>6</b>	<b>18</b>
<b>Total credit hours required in Degree Program : 132</b>									

## Flowchart of ACE Program

Semester	Courses	Credits
FR1	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 5px; text-align: center;">IAS 111</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">ENGL 101</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">PE 101</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">PHYS 101</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">MATH 101</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CHEM 101</div> </div>	18
FR2	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 5px; text-align: center;">IAS 101</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">ENGL 102</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">PHYS 102</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">MATH 102</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">ICS 103</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CHEM 111</div> </div>	18
SO1	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 5px; text-align: center;">IAS 212</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">ENGL 214</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 262</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 216</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">PE 102</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 201</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">MATH 201</div> </div>	17
SO2	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 5px; text-align: center;">IAS 201</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 206</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 204</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">ME 201</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 230</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 203</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">MATH 208</div> </div>	18
JN1	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 5px; text-align: center;">IAS 322</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">Sci. Elec.</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 343</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 341</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 356</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 354</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 305</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 318</div> </div>	19
JN2	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 5px; text-align: center;">IAS 301</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">GS Elec. I</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 375</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 330</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE Des. Elec. I (CE 441/444/455)</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 315</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 335</div> </div>	18
Summer	<div style="border: 1px solid black; padding: 10px; text-align: center;">           CE 350  <b>COOP</b>            CE 351         </div>	0
SN1	<div style="border: 1px solid black; padding: 5px; text-align: center;">           CE 350  <b>COOP</b>            CE 351         </div>	6
SN2	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE Elec. I</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">GS Elec. II</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 411</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE 422</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE Des. Elec. II (CE 437/473)</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">CE Elec. II</div> </div>	18
<b>Total Credits Required in Degree Program</b>		<b>132</b>

### LEGEND

----	Courses should be taken in Sequence	⊗	Co-Requisite
JS	Junior Standing		

## Appendix B.5 – Requirements for the B.S. Degree in Civil Engineering (ACE)

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

<b>(a) General Education Requirements (57 credit hours)</b>		<b>Credit Hours</b>
English	ENGL 101, 102, 214	9
Computer Skill	ICS 103	3
Interdisciplinary Basic Courses	ME 201	3
Mathematics	MATH 101, 102, 201, 208	14
Sciences	PHYS 101, 102, CHEM 101, 111	14
Islamic and Arabic Studies	IAS 101, 111, 201, 212, 301, 322	12
Physical Education	PE 101, 102	2
		57

<b>(b) Core Requirements (54 credit hours)</b>		
Computer Graphics	CE 216	2
Surveying	CE 262	3
Mechanics and Structures	CE 201, 203, 305, 315	12
Materials	CE 204, 206	4
Geotechnical	CE 354, 356	4
Transportation	CE 341, 343	4
Fluid Mechanics and Environmental Engineering	CE 230, 330, 335, 375	10
Numerical and Statistical Methods in CE	CE 318	3
Civil Engineering Cooperative Work	CE 351	6
Senior Design Project	CE 411	3
Construction Management and Economy	CE 422	3
		54

<b>(c) Electives (21 credit hours)</b>		
CE Electives	Two CE xxx Courses	6
CE Design Electives	Two CE xxx Courses	6
Additional Science XXX xxx	GEOL 101 or BIOL 233	3
General Studies	GS xxx, GS xxx Courses	6
		21

**The total number of credit hours required is** 132

## List of CE Design Electives

Course	Title
<b>CE Design Elective I, One from:</b>	
CE 441 (3-0-3)	Design of Pavement
CE 444 (3-0-3)	Traffic Engineering and Roadway Safety
CE 455 (3-0-3)	Foundation and Earth Structure Design
<b>CE Design Elective II, One from:</b>	
CE 437 (3-0-3)	Applied Hydraulic Engineering
CE 473 (3-0-3)	Design and Operation of Water and Wastewater Treatment Plants

## **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 351 – Civil Engineering Cooperative Work (0-0-6)
- 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 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 351 Civil Engineering Cooperative Work****(0-0-6)**

A continuous period of 28 weeks is spent in the industry to acquire practical experience in civil engineering professional practice under the supervision and guidance of the employer and the academic advisor. During this period the student gains an in-depth exposure and appreciation of the civil engineering profession. The student is required to write detailed reports about his training period under regulations of the CE department.

**Prerequisites:** ENGL 214; One CE-Core Course; Junior Standing & Approval of the Department

**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 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 (3-0-3)**

**Treatment Plants**

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