

*University of Tripoli*  
*Faculty of Engineering*

***CIVIL ENGINEERING DEPARTMENT***  
*Graduate Programs*

***Brief history***

Civil Engineering department is the oldest and largest department in the Faculty of Engineering, University of Tripoli. It was established in 1960 with BSc degree in Civil Engineering. It is the first department that started the graduate studies programs (MSc degree) in Libya since 1971. The department, which comprises 9 emeritus professors, 19 professors, 14 associate professors, and 14 assistant professors, is structured into three main divisions: (1) Structural and Geotechnical Engineering; (2) Water and Environmental Engineering; (3) Transportation and Surveying Engineering. The department offers MSc degree in 7 discipline programs. The purpose of graduate programs is to enrich the graduate student's educational preparation as well as to serve the broader community by involving students in scientific inquiry and in outreach activities.

***Vision***

A recognized leader in civil engineering education and learning experiences.

***Mission***

The mission of the department of civil engineering is to offer undergraduate and postgraduate programs according to international standards in all sub-areas of civil engineering. The department also offers other skill development courses that add value to student competencies. The department is dedicated to promote quality education, research and consultancy for industrial and societal needs.

***Programs***

The graduate program in the Civil Engineering Department offers M.Sc. degree in the following

- i. Structural Engineering*
- ii. Geotechnical Engineering*
- iii. Hydraulic and Water Resources Engineering*
- iv. Environmental Engineering*
- v. Highway Engineering*
- vi. Traffic Engineering*
- vii. Surveying*

**Program I**

<b>PROGRAM</b>	<i>Structural Engineering</i>
<b>DEGREE</b>	<i>M.Sc.</i>
<b>OBJECTIVES</b>	The purpose of the program is to equip the engineer with the analytical, experimental and computational expertise necessary to solve structural problems. The program focuses on structural behavior, design and analysis of structures.

<b>Code</b>	<b>Title</b>	<b>Credits</b>	<b>Hours</b>	<b>ECTS</b>
<b>Faculty Requirements (3 credits)</b>				
GE609	Numerical Methods in Engineering	3	4	8
<b>Department Requirements (15 credits)</b>				
CE601	Structural Mechanics and Theory of Elasticity	3	4	8
CE602	Structural Materials and Concrete Technology	3	4	8
CE603	Advanced Structural Analysis	3	4	8
CE604	Behavior and Design of Reinforced and	3	4	8
CE605	Behavior and Design of Steel Structures	3	4	8
<b>Elective courses (7 credits)</b>				
CE606	Finite Element Applications	3	4	8
CE607	Advanced Structural Dynamics	3	4	8
CE608	Theory of Plates and Shells	3	4	8
CE609	Theory of Structural Stability	3	4	8
CE614	Advanced Foundation Engineering	3	4	8
CE697	Special Topics in Structural Engineering	3	4	8
CE698	Graduate Seminar **	1	2	10
<b>Thesis (6 Credits)</b>				
CE699	M. Sc. Thesis	6	0	50
<b>Total</b>		<b>31</b>	<b>0</b>	<b>124</b>

\*\* Mandatory Courses

ECTS: European Credit Transfer and Accumulation System

**Program II**

<b>PROGRAM</b>	<i>Geotechnical Engineering</i>
<b>DEGREE</b>	<i>M.Sc.</i>
<b>OBJECTIVES</b>	The purpose of the program is to equip the engineer with the analytical, experimental and computational expertise necessary to solve geotechnical problems. The program focuses on soil-foundation interaction.

<b>Code</b>	<b>Title</b>	<b>Credits</b>	<b>Hours</b>	<b>ECTS</b>
<b>Faculty Requirements (3 credits)</b>				
GE609	Numerical Methods in Engineering	3	4	8
<b>Department Requirements (15 credits)</b>				
CE610	Engineering Properties of Soils	3	4	8
CE611	Geotechnical Site Investigation	3	4	8
CE612	Advanced Soil Mechanics I	3	4	8
CE613	Advanced Soil Mechanics II	3	4	8
CE614	Advanced Foundation Engineering	3	4	8
<b>Elective courses (7 credits)</b>				
CE615	Engineering Geology for Civil Engineers	3	4	8
CE616	Soil Dynamics	3	4	8
CE617	Rock Mechanics	3	4	8
CE618	Soil Improvement	3	4	8
CE619	Earth-fill Embankments	3	4	8
CE606	Finite Element Applications	3	4	8
CE644	Flow in Porous Media	3	4	8
CE697	Special Topics Geotechnical Engineering	3	4	8
CE698	Graduate Seminar **	1	2	10
<b>Thesis (6 Credits)</b>				
CE699	M. Sc. Thesis	6	0	50
<b>Total</b>		<b>31</b>	<b>0</b>	<b>124</b>

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**Program III**

<b>PROGRAM</b>	<i>Hydraulics &amp; Water Resources Engineering</i>
<b>DEGREE</b>	<i>M.Sc.</i>
<b>OBJECTIVES</b>	The purpose of the program is to equip the engineer with the analytical, experimental and computational expertise necessary to solve hydraulic problems. The program provides training in a modern yet practically oriented multidisciplinary approach to the planning and management of water resources.

<b>Code</b>	<b>Title</b>	<b>Credits</b>	<b>Hours</b>	<b>ECTS</b>
<b>Faculty Requirements (3 credits)</b>				
GE604	Advanced Engineering Mathematics **	3	4	8
<b>Department Requirements (15 credits)</b>				
CE631	Advanced Surface Water Hydrology	3	4	8
CE632	Pipe Conveyance and Network Systems Analysis	3	4	8
CE633	Water Waves Mechanics	3	4	8
CE634	Advanced Fluid Mechanics	3	4	8
CE635	Advanced Groundwater Hydrology	3	4	8
<b>Elective courses (7 credits)</b>				
CE636	Hydrodynamics	3	4	8
CE637	Port Engineering	3	4	8
CE638	Open Channel Flow	3	4	8
CE639	Transient Flow in Closed Conduits	3	4	8
CE640	Advanced Hydraulic Structures	3	4	8
CE641	Statistic and Stochastic Methods in Hydrology	3	4	8
CE642	Water Well Engineering	3	4	8
CE643	Water Resources Management	3	4	8
CE644	Flow in Porous Media	3	4	8
CE698	Graduate Seminar **	1	2	10
<b>Thesis (6 Credits)</b>				
CE699	M. Sc. Thesis	6	0	50
<b>Total</b>		<b>31</b>	<b>0</b>	<b>124</b>

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**Program IV**

<b>PROGRAM</b>	<i>Environmental Engineering</i>
<b>DEGREE</b>	<i>M.Sc.</i>
<b>OBJECTIVES</b>	The purpose of the program is to equip the engineer with the advanced understanding, technical knowledge and practical skills required to provide clean water, treat wastewater, manage solid waste, remediate contaminated land and control air pollution.

<b>Code</b>	<b>Title</b>	<b>Credits</b>	<b>Hours</b>	<b>ECTS</b>
<b>Faculty Requirements ( 3 credits)</b>				
GE609	Numerical Methods in Engineering **	3	4	8
<b>Department Requirements (15 credits)</b>				
CE645	Design of Water & Waste water Conveyance	3	4	8
CE646	Environmental Engineering Laboratory	3	4	8
CE647	Water & Wastewater Treatment Theories	3	4	8
CE648	Water & Wastewater Treatment Technologies	3	4	8
CE649	Solid Waste Engineering & Management	3	4	8
<b>Elective courses (7 credits)</b>				
CE650	Water Reuse Applications	3	4	8
CE651	Environmental & Sustainable Management	3	4	8
CE652	Air Pollution Control	3	4	8
CE653	Water Infrastructures Engineering & Management	3	4	8
CE654	Industrial Wastewater Treatment	3	4	8
CE655	Hazardous Waste Engineering & Management	3	4	8
CE643	Water Resources Managements	3	4	8
CE644	Flow in Porous Media	3	4	8
CE697	Special Topics Environmental Engineering	3	4	8
CE698	Graduate Seminar **	1	2	10
<b>Thesis (6 Credits)</b>				
CE699	M. Sc. Thesis	6	0	50
<b>Total</b>		<b>31</b>	<b>0</b>	<b>124</b>

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**Program V**

<b>PROGRAM</b>	<i>Highway Engineering</i>
<b>DEGREE</b>	<i>M.Sc.</i>
<b>OBJECTIVES</b>	Highway Engineering MSc develops competent and innovative highway engineers by focusing on all aspects of the industry and enabling students to lead design, construction and management of sustainable highways for the future.

<b>Code</b>	<b>Title</b>	<b>Credits</b>	<b>Hours</b>	<b>ECTS</b>
<b>Faculty Requirements (3 credits)</b>				
GE609	Numerical Methods in Engineering **	3	4	8
<b>Department Requirements (15 credits)</b>				
CE661	Advanced Geometric Design	3	4	8
CE662	Advanced Highway Materials	3	4	8
CE663	Advanced Pavement Design	3	4	8
CE664	Highway Construction	3	4	8
CE665	Pavement Maintenance and Rehabilitation	3	4	8
<b>Elective courses (7 credits)</b>				
CE666	Traffic Operation and Flow Theory	3	4	8
CE667	Highway Capacity and Level of Service Analysis	3	4	8
CE668	Traffic Safety and Accident Analysis	3	4	8
CE669	Pavement Management System	3	4	8
CE697	Special Topics in Transportation Engineering	3	4	8
CE698	Graduate Seminar **	1	2	10
<b>Thesis (6 Credits)</b>				
CE699	M. Sc. Thesis	6	0	50
<b>Total</b>		<b>31</b>	<b>0</b>	<b>124</b>

\*\* Mandatory Courses

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**Program VI**

<b>PROGRAM</b>	<i>Traffic Engineering</i>
<b>DEGREE</b>	<i>M.Sc.</i>
<b>OBJECTIVES</b>	Traffic Engineering MSc develops competent and innovative traffic engineers by focusing on all aspects of the industry and enabling students to lead planning, operation and management of sustainable traffic systems.

<b>Code</b>	<b>Title</b>	<b>Credits</b>	<b>Hours</b>	<b>ECTS</b>
<b><i>Faculty Requirements (3 credits)</i></b>				
GE606	Applied Statistics and Computer Applications	3	4	8
<b><i>Department Requirements (15 credits)</i></b>				
CE666	Traffic Operation and Flow Theory	3	4	8
CE667	Highway Level of service and Capacity Analysis	3	4	8
CE668	Traffic Safety and Accident Analysis	3	4	8
CE661	Advanced Geometric Design	3	4	8
CE670	Transportation Planning	3	4	8
<b><i>Elective courses (7 credits)</i></b>				
CE665	Pavement Maintenance and Rehabilitation	3	4	8
CE669	Pavement Management System	3	4	8
CE673	Remote Sensing and Data Acquisition and	3	4	8
CE675	GIS Theory and Practice	3	4	8
CE697	Special Topics in Transportation Engineering	3	4	8
CE698	Graduate Seminar **	1	2	10
<b><i>Thesis (6 Credits)</i></b>				
CE699	M. Sc. Thesis	6	0	50
<b><i>Total</i></b>		<b>31</b>	<b>0</b>	<b>124</b>

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**Program VII**

<b>PROGRAM</b>	<i>Surveying Engineering</i>
<b>DEGREE</b>	<i>M.Sc.</i>
<b>OBJECTIVES</b>	Surveying MSc develops competent and innovative survey engineers by focusing on all aspects of the industry and enabling students to lead planning and operation of survey.

<b>Code</b>	<b>Title</b>	<b>Credits</b>	<b>Hours</b>	<b>ECTS</b>
<b><i>Faculty Requirements (3 credits)</i></b>				
GE606	Applied Statistics and Computer Applications	3	4	8
<b><i>Department Requirements (15 credits)</i></b>				
CE671	Advanced Analytical and Digital Photogrammetry	3	4	8
CE672	Advanced Geodesy and Map Projection	3	4	8
CE673	Advanced Remote Sensing and Data Acquisition	3	4	8
CE674	Advanced GPS Theory and Practice	3	4	8
CE675	GIS Theory and Practice	3	4	8
<b><i>Elective courses (7 credits)</i></b>				
CE676	Advanced Route and Construction Survey	3	4	8
CE677	Geometric Data Adjustment	3	4	8
CE678	Offshore Surveying	3	4	8
CE679	Close Range Photogrammetry	3	4	8
GE604	Advanced Mathematics	3	4	8
CE697	Special Topics in Surveying	3	4	8
CE698	Graduate Seminar **	1	2	10
<b><i>Thesis (6 Credits)</i></b>				
CE699	M. Sc. Thesis	6	0	50
<b><i>Total</i></b>		<b>31</b>	<b>0</b>	<b>124</b>

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## **Description of the Graduate Courses**

- *Faculty General Courses*

### **GE604 Advanced Engineering Mathematics (3 Credits – 4 Hours)**

Review of ordinary differential equations; linear differential equation of the first order; linear differential equations with constant coefficients; particular solutions by variations of parameters. Power series solutions; method of Frobenius; Legendre's equation; Fourier-Legendre Series; Bessel's equation; modified Bessel equation. Fourier methods; Fourier series; Sturm-Liouville theory; Fourier integral; Fourier transformation. Partial differential equations; heat conduction equation; separation of variables; waves and vibrations in strings; wave equation; D'Alembert's solution; longitudinal vibrations in an elastic rod; two dimensional stress systems; solution of Navier's equations by the application of Fourier transforms; Laplace equation.

### **GE606 Applied Statistics and Computer Application (3 Credits – 4 Hours)**

Random variables; common discrete, continuous expectations and their applications; Sampling of the mean, hypothesis testing of the mean and variance, confidence intervals and Chi-Square procedures; Simple linear regression and correlation; precision and straight line fits; Matrix approach; multiple; Linear regression; polynomial and extra sum of squares in linear regression analysis; Transformation, weighted dummy variables and special topics in multiple regression analysis; Selecting the best regression model; Design of experiments; Single-factor and Multi-factor analysis of variance. Application of Statistical software packages such as: MINITAB, SPSS, etc....

### **GE609 Numerical Methods in Engineering (3 Credits – 4 Hours)**

Interpolation; Linear interpolation, Lagrange and Aitkin's interpolating polynomials, Difference calculus, Newton forward and backward difference formula, curve fittings, least square approximations, Fitting nonlinear curves, Cubic spline, Chebyshev polynomials, Approximation with rational function ordinary differential equations, Analytical and computer-aided solutions, Boundary conditions, Taylor series method.

- *Department Courses*

### **CE601 Structural Mechanics and Theory of Elasticity (3 Credits – 4 Hours)**

General equations of elasticity; plane stress and plane strain; stress and strain in three dimensions; principle stresses and strains in three dimensions; constitutive equations; stress displacement relations; energy principles; theories of failure.

**CE602 Advances in Structural Materials and Concrete Technology (3 Credits – 4 Hours)**

Development of structural materials and applications to structural engineering projects; development of concrete technology; mix design; use of admixtures; super plasticizers; high strength concrete; high performance concrete; polymer concrete; steel fiber concrete; roller compacted concrete; creep shrinkage; hot weather concreting; extensive use of laboratory testing.

**CE603 Advanced Structural Analysis (3 Credits – 4 Hours)**

Stiffness matrix method application to frames; second order structural analysis; nonlinear structural analysis; gravity, wind and earthquake loadings on tall buildings; critical load combinations; three dimensional analysis of structures; extensive use of computers software.

**CE604 Behavior and Design of Reinforced and Pre-stressed Concrete Structures (3 Credits – 4 Hours)**

Behavior, analysis and design of reinforced concrete and pre-stressed concrete members and structures; working stress; ultimate strength; limit states; design for strength; serviceability; structural efficiency; yield line methods; comparison between international codes of practice, ACI code, EC , AASHTO and others; introduction to design of reinforced and pre-stressed concrete buildings and bridges; extensive use of computers software.

**CE605 Behavior and Design of Steel Structures (3 Credits – 4 Hours)**

Behavior, analysis and design of rigid space steel structures; design of steel bridges; plastic analysis of steel structures; fatigue and brittle fracture.

**CE606 Finite Element Application to Structural Engineering (3 credits)**

Formulation of differential equations in terms of displacement and stress functions; Rayleigh-Ritz and Galerkin method; finite element formulation of plane stress and plane strain problems; plane element; plane bending elements; assembly of structural matrix; applications to different structural engineering problems; computer applications.

**CE607 Advanced Structural Dynamics (3 Credits – 4 Hours)**

Rigorous analysis of one degree of freedom system; lumped mass multi-degree of freedom systems; structures with distributed mass and load; approximate design methods; earthquake analysis and design; blast resistant design; beams subject to moving loads.

**CE608 Theory of Plates and Shells (3 Credits – 4 Hours)**

Cylindrical bending of plates; pure bending of plates; small deflection theory of plates; rectangular plates with various boundary conditions; shell geometry; membrane theory and bending theories of shells; analysis of cylindrical shell; roofs; domes and folded plates.

**CE609 Theory of Structural Stability** (3 Credits – 4 Hours)

Analysis of beam-column under different boundary and loading conditions; elastic buckling of axially loaded and eccentrically loaded columns; combined stresses and slenderness ratio; elastic buckling of plane frames with and without sideway; lateral buckling of beams; inelastic buckling of columns; inelastic buckling of plates and shells.

**CE610 Engineering Properties of Soils** (3 Credits – 4 Hours)

Determination analysis and application of the index and engineering properties of soils; engineering properties of problematic soils; laboratory testing procedures; reliability of results; evaluation and control methods.

**CE611 Geotechnical Site Investigation** (3 Credits – 4 Hours)

Introduction; types of geotechnical investigations; investigation methods; drilling and boring techniques; soil and rock sampling; field testing, laboratory testing; recording and presentation of data; geotechnical report content and format; responsibilities of geotechnical engineer; introduction to geophysical methods.

**CE612 Advanced Soil Mechanics I** (3 Credits – 4 Hours)

Soil aggregate; clay minerals; consistency of cohesive soils; volume change of soils; effective stress concepts in saturated and unsaturated soils; stresses in soils; two and three dimensional problems; theory of consolidation; numerical solutions; interpretation of one dimension consolidation test; evaluation of soil settlement.

**CE613 Advanced Soil Mechanics II** (3 Credits – 4 Hours)

Stress and strains; elasticity and plasticity; Mohr-Coulomb failure criteria; shearing strength of granular and cohesive soils; applications of drained and undrained shear strength to foundation design; example of interpretation of test results; two dimension field of limiting stress; Coulomb's Rankin's active and passive pressure; stability of rigid retaining walls; flexible retaining walls.

**CE614 Advanced Foundation Engineering** (3 Credits – 4 Hours)

Principles of foundation design; design philosophy; practical considerations; design procedures; foundation types; selection of foundation system; filled site; footings bearing capacity equations; bearing capacity from penetration testing; bearing capacity from field load test; footing with uplift or tension forces; footing in rock; mat design; load tests; group efficiency; pier foundation design; practical cases.

**CE615 Engineering Geology for Civil Engineers** (3 Credits – 4 Hours)

Rock formation processes; slope process and movements; tectonic process; fracture and folds; earthquakes; application of engineering geology in civil engineering construction.

**CE616 Soil Dynamics** (3 Credits – 4 Hours)

Theory of vibrations of massive foundation, design of foundation under reciprocating engines, design of foundations for machines producing impact loading, liquefactions of soils.

**CE617 Rock mechanics** (3 Credits – 4 Hours)

Identification and classification of rocks; physical and mechanical properties; stress strain characteristics; rock failure criteria; laboratory and field testing; rock applications in practice.

**CE618 Soil Improvement** (3 Credits – 4 Hours)

Theory and practice of chemical stabilization of soils and aggregate systems with traditional methods of chemical stabilization including Portland cement, lime, fly ash and by products (kiln dusts, fly ash and slag materials); selected non-traditional methods including polymers, ionic systems, and enzymes; mechanisms and methods to avoid deleterious reactions.

**CE619 Earth-fill Embankments** (3 Credits – 4 Hours)

Earth-fill embankments for roads and airfields: material selection and construction; geotechnical investigations for roads and airfields; compaction methodology; control and monitoring. Earth-fill dams: purpose and function; geotechnical investigation for dam sites; dam materials (rock-fill dams; earth-fill dams; zoned dams); material selection and construction; slope stability analysis; seepage analysis and control; filtering and drains; use of geo-textiles and geo-membranes in dam construction; post construction monitoring.

**CE631 Advanced Surface Water Hydrology** (3 Credits – 4 Hours)

Introduction and elements of hydrologic cycle; Water balance; Precipitation; Evaporation and Evapotranspiration; Initial losses; Infiltration; Stream flow measurements; Runoff; Hydrographs; Unit hydrograph; Floods; Flood routing; Stream-aquifer interactions.

**CE632 Pipe Conveyance and Network Systems Analysis** (3 Credits – 4 Hours)

City planning and system layout; hydraulic analysis of pipe networks; design of long pipe lines; seawater intakes; economic design of pipe networks; pumps and pumping stations; distribution pumping and storage system apparatuses; system evaluation; management and operation of distribution systems; computer solutions of pipe networks.

**CE633 Water Waves Mechanics** (3 Credits – 4 Hours)

Covers theory and numerical modeling of water waves; classical water wave problem and approximate solution techniques; evolution equations and their solutions

for wave systems; viscous damping effects and mass transport; nonlinear shallow-water waves and waves on beaches and structures.

**CE634 Advanced Fluid Mechanics** (3 Credits – 4 Hours)

Applications of the equations of motion to real and ideal fluid flow; Kinematics; Navier-Stokes and Euler equation of motion; Irrotational flow and potential flow theory; Flow superposition; conformal mapping and applications; Airfoil theory; Introduction to turbulence.

**CE635 Advanced Groundwater Hydrology** (3 Credits – 4 Hours)

Organizing pumping tests; Analysis of pumping test data; Recovery tests; Step-drawdown tests; Aquifer parameter estimation without pumping tests; Interferences of wells; Recharging wells; Image of well theory; Groundwater recharge; Subsidence due to groundwater withdrawal; Governing equations of groundwater; Groundwater protection.

**CE636 Hydrodynamics** (3 Credits – 4 Hours)

Theoretical; numerical; and laboratory model approaches to diffusion-dispersion in transport problems of concern to water resources engineers.

**CE637 Port Engineering** (3 Credits – 4 Hours)

Types of harbors; Port Planning; Modeling; Breakwaters; Harbor planning; Berths and Quays; Light house; Wave recorders; Sediment transport and dredging; Off-shore structures; Oil rigs; Submarine pipelines; Design of small harbors.

**CE638 Open Channel Flow** (3 Credits – 4 Hours)

Introduction to open channel flow; Equations of motion; Velocity and momentum coefficient; Energy and momentum principles in open channel flow; Flow regimes; Transition and flow control problems; Flow types; Flow profiles and computations methods; Open channel flow measurements; Channel stability; Flow through bridge piers; Transitions; and culverts; spatially varied and unsteady flow.

**CE639 Transient Flow in Closed Conduits** (3 Credits – 4 Hours)

Pipe flow hydraulics. Rigid and elastic water column theory, Water hammer, Wave reflection, Water hammer for gate operation, Water hammer in pump discharge lines, Water hammer analysis to include hydraulics losses and for compound pipes, Graphical water hammer analysis, Computer methods of water hammer analysis.

**CE640 Advanced Hydraulic Structures** (3 Credits – 4 Hours)

Project planning; Ecological and environmental consideration; Impact statement; Flood study; Dams and dams foundation and construction materials; Spillways types and design; hydraulics of flow and flood control structures; Inlet and outlet works.

**CE641 Statistic and Stochastic Methods in Hydrology** (3 Credits – 4 Hours)

Statistical data; Statistical parameters; Review of probability distributions; Normal distribution and its importance; Probability plotting and frequency analysis; Confidence intervals and hypothesis testing; Fitting regression equations; Multivariate analysis; Data generation; Analysis of hydrologic time series; Case study with application of computer programs; Autoregressive modelling; Autoregressive-moving average modelling.

**CE642 Water Well Engineering** (3 Credits – 4 Hours)

Groundwater resource development; borehole geophysics; Sampling and logging; Well design; Gravel pack design; Economic well design; Methods of well construction; Well completion; Well maintenance; Well rehabilitation; Monitoring wells; Groundwater remediation; Construction dewatering; Artificial recharge; Groundwater pumping and pump technology.

**CE643 Water Resources Management** (3 Credits – 4 Hours)

Part 1: Review of water chemistry and microbiology; Sources and types of water pollution; Statutory and regulatory approaches to water quality management; Water quality standards and criteria; Water supply and wastewater treatment processes; Non-point source pollution control.

Part 2: Water demand forecasting and management; Water resources planning and strategy; Leakage management and control.

**CE644 Flow in Porous Media** (3 Credits – 4 Hours)

Review of vector analysis; Porous media; Fluid properties; Darcy's Law and its extensions; Groundwater flow equations; Dual formulation; Multiphase and unsaturated flow; Solute transport; Stochastic flow and transport.

**CE645 Design of Water and Waste water Conveyance Systems and Storage Facilities** (3 Credits – 4 Hours)

Water supply and sewerage design flow; Analysis of rainfall and runoff; Applications of pipe flow and open channel flow equations to the design of conveyance systems; Pumping and pump systems design; Applications of transient flow in pipelines; Pipe materials; Loads on buried pipes; Valves selection and design of appurtenances such as man holes; storm sewer inlets and storm water over flow structures; Water storage facilities; Software applications in water conveyance.

**CE646 Environmental Engineering Laboratory** (3 Credits – 4 Hours)

Introduction; significance of physical; chemical and microbiological analysis to the environment engineer; analytical chemistry principles; experimental techniques; stoichiometry; sampling techniques; statistical treatment of analytical data; basic laboratory operations and safety; gravimetric techniques in solids analysis; optical methods of analysis; turbidity; color; fluoride; phosphate; nitrogen compounds; acid base reactions; titration; pH; acidity; alkalinity; complexation; chlorine residual;

suspended solids, dissolved solids, dissolved oxygen; biochemical oxygen demand, chemical oxygen demand; total organic carbon; microbiological tests; Laboratory report preparation.

**CE647 Water and Wastewater Treatment Theories (3 Credits – 4 Hours)**

Theory and practice of various unit processes including oxidation; coagulation; flocculation; sedimentation; filtration; processes adsorption; gas transfer; ion exchange; membrane filtration and disinfection; Fundamentals of biological treatment; Applications of microbiology and microbial kinetics in the design of biological unit processes.

**CE648 Water and Wastewater Treatment Technologies ((3 Credits – 4 Hours)**

Design of physical and chemical processes for water and wastewater treatment; Design of biological processes for water and wastewater treatment; and solids handling; Hydraulics of water and wastewater treatment plants; Cost estimates; and a working design team under project managers; Instrumentation and control systems; Case studies of water and wastewater treatment plant designs.

**CE649 Solid Waste Engineering and Management (3 Credits – 4 Hours)**

Regulatory aspects of integrated solid waste management; characterization and properties of MSW including content analysis; municipal wastewater sludge utilization; hazardous waste found in MSW; collection; transfer; and transport of solid waste; separation; processing; combustion; composting; and recycling of waste material; and the landfill method of solid waste disposal, which encompasses guidelines for design; construction; operation; siting; monitoring; remedial actions; and closure of landfills; Permitting and public participation processes; current issues; and innovative approaches.

**CE650 Water Reuse Applications (3 Credits – 4 Hours)**

Overview of wastewater treatment technologies and effluent quality standards; introduction to water reuse; health and environmental concerns in water reuses; regulations and guidelines; water reuse technologies; and treatment systems; water reuse applications (agricultural uses of reclaimed water; landscape irrigation; industrial effluent reuse; groundwater recharge); water reuse planning; selection of water reuse application; application examples; field visits.

**CE651 Environmental and Sustainable Management (3 Credits – 4 Hours)**

Environment and development projects; environment and sustainable development; environmental policies and legislation; environmental implication of sectorial development; environmental quality standards; environmental issues and priorities; environmental impact assessment of development schemes-baseline studies; assessment methodologies; economics of environmental management; contemporary issues; case studies.

**CE652 Air Pollution Control (3 Credits – 4 Hours)**

An overview of air quality issues; sources; measurements; effects; transport and control of potential air contaminants; Impacts of air pollution on human and environmental health and welfare; Current regulations addressing air quality concerns; Estimation of potential pollutants; chemical characterization of gas streams; theory and practice of air pollution control; and design of control technologies to reduce particulate matter emissions; volatile organic compound (VOC) emissions; nitrogen oxide emissions, and sulfur dioxide emissions; Preliminary designs on common types of air pollution control equipment; Contemporary air pollution issues of national and global significance.

**CE653 Water Infrastructures Engineering and Management (3 Credits – 4 Hours)**

Nature and significance of water infrastructures to a nation's economy; global competitiveness and quality of life; Planning; design; execution; operation and maintenance; and financing of water infrastructures projects; Technical; economic; social; and environmental aspects of water infrastructures; Case studies of major infrastructure projects; Industry guest speakers.

**CE654 Industrial Wastewater Treatment (3 Credits – 4 Hours)**

Sources and characteristics of industrial wastes; Unit operations and processes used in the treatment of industrial wastes; Approaches to prevent industrial pollution; Clean products; Pollution prevention and waste minimization techniques (waste reduction; chemical substitution; production process modification; and reuse and recycling); selection of industrial wastewater treatment systems; applications to selected industries in Libya (petroleum refining; petrochemical industries, steel industry); Treatment of industrial solid wastes; Industrial pollution control regulations. Case studies.

**CE655 Hazardous Waste Engineering and Management (3 Credits – 4 Hours)**

Hazardous waste fundamentals (hazardous waste characteristics; regulations; fate and transport; and toxicology); current management practices (environmental audits; and pollution prevention); treatment and disposal methods (physicochemical processes; biological methods; stabilization and solidification; thermal methods, and land disposal) and site remediation (site characterization; and remedial technologies); guidelines for design, construction, and closure of hazardous waste landfills; environmental monitoring systems; toxicology and risk assessment; hazardous waste generators and transporters; permitting and enforcement of hazardous waste facilities; closure and financial assurance requirements.

**CE661 Advanced Geometric Design (3 Credits – 4 Hours)**

Elements of highway geometric design; Sight distance requirements; Design of horizontal alignment; Design of vertical alignment; Design of highway cross section; Design of highway intersections; Design of parking facilities; Design for pedestrians, cyclists and people of special needs.



**CE662 Advanced Highway Materials** (3 Credits – 4 Hours)

Physical and mechanical properties; Design and performance of highway materials including base and sub-base materials, aggregates, asphalt binders and mixtures; Modified and advanced highway materials (polymers and rubber modified mixtures); Understanding and interpretation of standard and advanced testing of highway materials; Deformation and fatigue behavior of asphalt mixtures; Use of material properties in pavement design methodologies; Inspection and quality control of highway materials.

**CE663 Advanced Pavement Design** (3 Credits – 4 Hours)

Fundamental principles; Properties of pavement components and material characterization; Design of flexible pavements for highway and airport pavements; Design of rigid pavements for highway and airport pavements; Overlay design and strengthening of existing pavements.

**CE664 Highway Construction** (3 Credits – 4 Hours)

Introduction and scope; Construction related to the phases of pavement management; Pavement construction management; Pavement construction and environment; Special materials construction; Reconstruction test results and its effect; Construction data; Construction documentation; Construction economics and decision criteria; Effect of different polices on construction.

**CE665 Pavement Maintenance and Rehabilitation** ((3 Credits – 4 Hours)

Introduction; Principles of maintenance; Typical maintenance procedure; Methods of performance surveys; Methods of structural evaluation; Measurement and evaluation methods; Evaluation instruments and technology; Interpretation of deflection data; Software used in evaluation; Overlay categories; Flexible overlay over flexible pavements; Other techniques used; Component of layer analysis; Back calculation techniques in evaluation based on deflection data.

**CE666 Traffic Operation and Flow Theory** (3 Credits – 4 Hours)

Vehicle-roadway interaction; Equations of motion and car following; Microscopic and macroscopic traffic characteristics; Traffic stream models; Simulation; Queuing theory and shockwave analysis; Traffic data collection and analysis techniques; Signalized intersections analysis and design.

**CE667 Highway Capacity and Level of Service Analysis** (3 Credits – 4 Hours)

Traffic flow parameters and traffic flow characteristics; Concepts of capacity and level of service for different highway facilities; Methodologies of estimating capacity and level of service; Measures directed to mode of transportation; Measures directed to road design and operation elements; Other (non-engineering) methods to road accident reduction; Accident prevention methods; Intelligent transport system application for accident reduction.

**CE668 Traffic Safety and Accident Analysis (3 Credits – 4 Hours)**

Accident trends and cost to society; Traffic accident data collection, analysis and evaluation; Measures of accident reduction with respect to road user; Measures directed to mode of transportation; Measures directed to road design and operation elements; Other (non-engineering) methods to road accident reduction; Accident prevention methods; Intelligent transport system application for accident reduction.

**CE669 Pavement Management System (3 Credits – 4 Hours)**

Pavement Management Process; Pavement Evaluation and Performance; Design alternatives analysis, evaluation and selection; Implementation of PMS and construction and maintenance; Looking ahead.

**CE670 Transportation Planning (3 Credits – 4 Hours)**

Introduction; Transport policy; Observational and participatory traffic and transport surveys; Principles of transport analyses and forecasting; Economic and environmental appraisal of transport projects; Regulatory measures for traffic management; Physical methods of traffic control; Planning for public transport; Planning for pedestrians, cyclists and disabled people; Freight transport planning systems.

**CE671 Advanced Analytical and Digital Photogrammetry (3 Credits – 4 Hours)**

Introduction; Principle of photography; Photogrammetric cameras and other imaging system; Stereoscopy and parallax; Basic geometry of photograph; Elementary photogrammetric operations; Photogrammetric project planning; Orthophoto and orthophoto production; Digital images; Aero-triangulation; Block and Bundle adjustments; Mosaic; Digital Terrain Model DTM.

**CE672 Advanced Geodesy and Map Projection (3 Credits – 4 Hours)**

Introduction; Definition of concepts in Geodesy; The geoid, the ellipsoid, basic surface geometry; Coordinate systems (Cartesian, spherical and ellipsoidal); Spherical and ellipsoidal computations; Plane projections: Developable surfaces, classification of projections; Map projection scale and use of rescaling; Cylindrical projections: equidistance, equi area and Mercator; Transverse Mercator and UTM; Azimuthal projections; Conical projections: Lambert projection; Working with projections: convergence, line scale factor, arc-to-chord correction; Introduction to datum; Change of datum, datum transformation; Datum in the Libya: ED50, ELD79, LGD2006; Libyan Map Projections: LTM2,UTM,LTM16; Height systems: vertical datum, Libyan vertical datum.

**CE673 Advanced Remote Sensing and Data Acquisition and Processing (3 Credits–4 Hours)**

Overview of Remote sensing; Nature of electromagnetic radiation and interactions with the Earth's surface and atmosphere; Platforms, sensors and resolution; Introduction to photography, radar and laser scanning; Remote sensing data acquisition and processing workflows. Calibration and validation; Digital image pre-processing

techniques including image display and enhancement, filtering and image corrections; Image classification techniques for thematic mapping; Applications of remote sensing in mapping, environmental Earth observation and global change monitoring; Challenges and opportunities for remote sensing now and in the future; Training on a selected remote sensing software such as PCI, ENVI or ERDAS.

**CE674 Advanced GPS Theory and Practice (3 Credits – 4 Hours)**

Introduction; GPS description and signal structure; The pseudo range observable; Pseudo range point positioning; Differential positioning; The carrier phase observable; Relative positioning and differencing techniques; Computation of relative position; Ambiguity resolution techniques ; Error sources in GPS; errors affecting GPS, and their mitigation; Modes of GPS positioning; Coordinate systems used with GPS – overview of map projections – datum and coordinate transformations; Third party products; Instruments, applications, field procedures and observation processing; Future directions.

**CE675 GIS Theory and Practice (3 Credits – 4 Hours)**

Characteristics of geographical data and information; Capture of geographical data and information; Data models for Spatial data: Discrete versus continuous field mapping; Thematic Mapping: types of thematic maps, uses of thematic maps, classification models for thematic maps; Continuous data: Sampling and interpolation, DTMs, heights and volumes; Vector Data Attributes and databases: Data management and attribute data; Data formats and data providers: standards, common formats, data providers (formal and informal); Processing and modeling in GIS; Network analysis; GIS interfaces; Web mapping and Location based services; Visualization, design and output from GIS.

**CE676 Advanced Route and Construction Surveying (3 Credits – 4 Hours)**

Introduction; Route location; Elements, design and setting out of horizontal curves; Transition , spiral curves and super-elevation; Elements, design and setting out of vertical curves; Sight distance on horizontal and vertical curves; Base line survey and corridor mapping; Basic methods in alignment and road design; Alternate route survey and design system; Survey for other routes; Introduction on construction surveying; Special setting out survey such as: sewers, canals, bridges, pipelines, dams, etc.; Setting out using laser instruments; Optical tooling alignment; Industrial surveying.

**CE677 Geometric Data Adjustment (3 Credits – 4 Hours)**

Introduction; Error propagation; The concept of adjustment; Least squares adjustment; Elements of probability theory; Variance - Covariance propagation; Introductory statistical analysis; General least squares adjustment; Application in plane coordinates surveys.

**CE678 Offshore Surveying (3 Credits – 4 Hours)**

Introduction; Offshore survey applications; Comparison between onshore and offshore methods; Elements of oceanography , tides and water levels, principles of

underwater acoustic; Fundamentals of radial frequency and acoustic propagation; Marine positioning; shore based and satellite-based radio navigation system (GPS), optical method, dead reckoning system, underwater positioning , integrated positioning systems; Depth determination; ship borne echo-sounding and mechanical methods airborne laser and electromagnetic methods; Integration of survey techniques: Vessel requirements; integration of sensors; integration of software. Calibration of whole systems; Operations for site survey.

**CE679 Close Range Photogrammetry (3 Credits – 4 Hours)**

Introduction; Close-range photogrammetry Cameras; Camera calibration; Image triangulation in close range photogrammetry; Accuracy and reliability; Image processing; Applications of close range photogrammetry in civil engineering, industry, architecture, archeology, police practice; Terrestrial laser scanning; Other 3D-modeling methods.

**CE697 Special Topics (3 Credits – 4 Hours)**

The topics are not listed in department programs and may vary from year to year according to interests of students and instructors.

M.S. students choose and study a topic under the guidance of the department coordinator. Typical contents include advanced fields of study according to recent scientific and technological developments in the related areas. Also, it could be studied from other related departments after getting the permission.

**CE698 Graduate Seminar (1 Credits - 2 Hours)**

This course help students to develop their research proposals, establishing and expanding their research skills and implementing their work through scholarly writing, which can be achieved through the seminar.

The seminar course must to be taken in the second semester of the registration and managed by an instructor who is responsible to prepare the final grade list of all the registered students.

Students must prepare and present their chosen topics through a scientific term paper, which can be shared and discussed with other students and department staff to gain their feedback.

**CE699 Thesis ((6 Credits)**

Student must successfully complete a thesis work in a designated civil engineering problem under the supervision of a staff member.

- ***Learning Objectives (outcomes)***

Upon completion of the Master of Science Program in the Civil Engineering, graduates are expected to attain the following outcomes:

- 1- Develop a spirit of scientific inquiry, research skills, and independent thought and expression.
- 2- Develop creativity and imagination.
- 3- An ability to identify, formulate, and solve engineering problems
- 4- Develop professional expertise and leadership in the fields of civil Engineering
- 5- Apply advanced studies to serve the broader community by involving students in scientific inquiry and in outreach activity

الإعتماد			
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