University of Tripoli
Faculty of Engineering

GEOLOGICAL ENGINEERING DEPARTMENT
Graduate programs

General Information

Geological Engineering Department (GEOE) was founded as one of the six departments at the Faculty of Petroleum and Mining Engineering in 1972, and then joined Faculty of Engineering in 1985. The Department has a rich tradition of leadership in the geosciences, preparing students for professional careers in the engineering geology at the undergraduate and graduate levels. The faculty staff, participating in most if not all of the consultation work held in the country and its alumni are working in various fields of natural resources such as oil, water and mineral resources as well as in geo-engineering and geotechnics.

The Geological Engineering Department consists of six study engineering programs; Petrophysics(1) courses and thesis, Petrophysics(2) courses only, Water Resources(1) courses and thesis, Water Resources(2) courses only , Mineral Resources and Geotechnics. Petrophysics program is aimed to direct graduate students to solve geological problems related to oil and gas reservoirs, while water resources directed toward groundwater modeling studies plus surface and groundwater production management. Whereas, mineral resources will be qualified to search, explore, evaluate, and extract economic ore mineral deposits in Libya. The geotechnics program includes studying geological characteristics and hazards of soil and rock foundations used as sites for building, heavy industrial complexes, highways, bridges, and dams.

Graduate program was launched in 2002 by offering the engineer M.Sc. degree in geological engineering. The graduate program in the Geological Engineering Department is designed to prepare students with sound undergraduate background for in-depth study of techniques in analysis, computation, and design. The versatility and depth in scientific fundamentals acquired by the student enable him to carry out a program of advanced study and research independently.

Vision

The program vision is to be excellence in research, consultation and innovation, in geological engineering among similar programs in Mediterranean region.

Mission

The mission of the program is to provide Libya with quality engineering geology researchers, and offer an excellent consultation in the fields relevant to the geo-engineering needs of Libya's society and Mediterranean region.

Programs

The graduate program in the Geological Engineering Department offers M.Sc. degree in the following six main disciplines:

Program I Petro-physics Engineering (1) ***with courses and thesis***
Program II Petro-physics Engineering (2) ***with courses only***

Program III Water Resources Engineering (1) ***with courses and thesis***
Program IV Water Resources Engineering (2) ***with courses only***

Program V Mineral Resources Engineering
Program VI Geotechnical Engineering

Every (courses and thesis) program is comprised of 24 credits of courses, 1 credit for graduate seminar, and 6 credits for the thesis with a total of 31 credits.
While the (only courses) programs is comprised of 39 credits of courses, 2 credit for 2 seminars.
Students after completion of the required courses are encouraged to select a thesis topic in their area of specialization within the field of Geological Engineering. It is the policy of the department that the selection of a thesis topic and Thesis advisor be a voluntary process which is initiated by the student.

Program I

PROGRAM	*Petrophysics Engineering (1)* ***8 courses, seminar and Thesis***
DEGREE	*M.Sc.*
OBJECTIVES	1. Expose students to the latest developments in the field of oil and gas investigation. 2. Provide students with the appropriate skills and tools to understand and contribute further to such developments. 3. Prepare specialized Petrophysical Engineers capable of understanding, formulating, and solving higher-grade problems in different fields of Petrophysical Engineering. 4. Enable students to have a background and the required skills to conduct high-quality scientific research.

Code	Title	Credits	Hours	ECTS
Faculty Requirements (3 credits)				
GE604	Advanced Engineering Mathematics	3	4	8
GE609	Numerical Methods in Engineering **	3	4	8
Department Requirements (9 credits)				
GeoE611	Advanced Structural Geology and Tectonics **	3	4	8
GeoE612	Environmental Engineering Geology	3	4	8
GeoE613	Advanced Geochemistry **	3	4	8
GeoE614	Application of GIS in Earth Science	3	4	8
GeoE615	Advanced Geostatistics	3	4	8
Elective courses (13 credits)				
GeoE622	Sequence Stratigraphy and its application	3	4	8
GeoE630	Formation Evaluation	3	4	8
GeoE637	Source Rock Evaluation	3	4	8
GeoE639	Applied Biostratigraphy in Oil Exploration	3	4	8
GeoE645	Reservoir Geology and Advanced Recovery	3	4	8
GeoE655	Advanced Basin Analysis and Petroleum Systems Modeling	3	4	8
GeoE669	Reservoir Engineering	3	4	8
GeoE670	Fundamentals of Reservoir Properties	3	4	8
GeoE671	Applied Geophysics	3	4	8
GeoE697	Special Topics	3	4	8
GeoE698	Graduate Seminar **	1	2	10
Thesis (6 Credits)				
GeoE699	M. Sc. Thesis	6	*0*	*50*
Total		**31**	***0***	***124***

*** Mandatory Courses* *ECTS: European Credit Transfer and Accumulation System*

Program II

PROGRAM	*Petrophysics Engineering (2)* ***with courses only***
DEGREE	*M.Sc.*
OBJECTIVES	5. Expose students to the latest developments in the field of oil and gas investigation. 6. Provide students with the appropriate skills and tools to understand and contribute further to such developments. 7. Prepare specialized Petrophysical Engineers capable of understanding, formulating, and solving higher-grade problems in different fields of Petrophysical Engineering. 8. Enable students to have a background and the required skills to conduct high-quality scientific research.

Code	Title	Credits	Hours	ECTS
Faculty Requirements (4 credits)				
GE601	Seminar in Research Methodology **	1	2	10
GE604	Advanced Engineering Mathematics	3	4	8
GE609	Numerical Methods in Engineering **	3	4	8
Department Requirements (9 credits)				
GeoE611	Advanced Structural Geology and Tectonics **	3	4	8
GeoE612	Environmental Engineering Geology	3	4	8
GeoE613	Advanced Geochemistry **	3	4	8
GeoE614	Application of GIS in Earth Science	3	4	8
GeoE615	Advanced Geostatistics	3	4	8
Elective courses (28 credits)				
GeoE622	Sequence Stratigraphy and its application	3	4	8
GeoE630	Formation Evaluation	3	4	8
GeoE637	Source Rock Evaluation	3	4	8
GeoE639	Applied Biostratigraphy in Oil Exploration	3	4	8
GeoE645	Reservoir Geology and Advanced Recovery	3	4	8
GeoE655	Advanced Basin Analysis and Petroleum Systems Modeling	3	4	8
GeoE669	Reservoir Engineering	3	4	8
GeoE670	Fundamentals of Reservoir Properties	3	4	8
GeoE671	Applied Geophysics	3	4	8
GeoE697	Special Topics	3	4	8
GeoE698	Graduate Seminar **	1	2	10
Total		**41**	***0***	***124***

*** Mandatory Courses* *ECTS: European Credit Transfer and Accumulation System*

Program III

PROGRAM	*Water Resources Engineering (1)* ***8 courses, seminar and Thesis***
DEGREE	*M.Sc.*
OBJECTIVES	1. Develop an understanding of the strategic importance of water resources for life. 2. Achieve a satisfactory awareness of the demands of water regionally and globally. 3. Recognize the relationship between water, energy and Agriculture related to sustainability. 4. Emphasize the importance of climatic change, and developing knowledge dealing with water chemistry and its evolution.

Code	Title	Credits	Hours	ECTS
Faculty Requirements (3 credits)				
GE604	Advanced Engineering Mathematics	3	4	8
GE609	Numerical Methods in Engineering **	3	4	8
Department Requirements (9 credits)				
GeoE611	Advanced Structural Geology and Tectonics **	3	4	8
GeoE612	Environmental Engineering Geology	3	4	8
GeoE613	Advanced Geochemistry	3	4	8
GeoE614	Application of GIS in Earth Science	3	4	8
GeoE615	Advanced Geostatistics	3	4	8
Elective courses (13 credits)				
GeoE625	Groundwater hydrology and hydraulics	3	4	8
GeoE631	Groundwater Engineering	3	4	8
GeoE634	Fluid Flow through Porous Media	3	4	8
GeoE640	Surface and Groundwater Contamination	3	4	8
GeoE649	Hydrology of Coastal Area	3	4	8
GeoE660	Advanced Groundwater Modeling Techniques	3	4	8
GeoE661	Geophysical aspects of groundwater hydrology	3	4	8
GeoE662	Application of groundwater hydrology to geotechnics	3	4	8
GeoE666	Water, Energy and Climatic Change	3	4	8
GeoE668	Advanced Field Studies	1	**2**	10
GeoE697	Special Topics	3	4	8
GeoE698	Graduate Seminar **	1	2	10
Thesis (6 Credits)				
GeoE699	M. Sc. Thesis	6	0	*50*
Total		***31***	***0***	***124***

*** Mandatory Courses* *ECTS: European Credit Transfer and Accumulation System*

Program IV

PROGRAM	*Water Resources Engineering (2)* ***with courses only***
DEGREE	*M.Sc.*
OBJECTIVES	5. Develop an understanding of the strategic importance of water resources for life. 6. Achieve a satisfactory awareness of the demands of water regionally and globally. 7. Recognize the relationship between water, energy and Agriculture related to sustainability. 8. Emphasize the importance of climatic change, and developing knowledge dealing with water chemistry and its evolution.

Code	Title	Credits	Hours	ECTS
Faculty Requirements (4 credits)				
GE601	Seminar in Research Methodology **	1	2	10
GE604	Advanced Engineering Mathematics	3	4	8
GE609	Numerical Methods in Engineering **	3	4	8
Department Requirements (9 credits)				
GeoE611	Advanced Structural Geology and Tectonics **	3	4	8
GeoE612	Environmental Engineering Geology	3	4	8
GeoE613	Advanced Geochemistry	3	4	8
GeoE614	Application of GIS in Earth Science	3	4	8
GeoE615	Advanced Geostatistics	3	4	8
Elective courses (28 credits)				
GeoE625	Groundwater hydrology and hydraulics	3	4	8
GeoE631	Groundwater Engineering	3	4	8
GeoE634	Fluid Flow through Porous Media	3	4	8
GeoE640	Surface and Groundwater Contamination	3	4	8
GeoE649	Hydrology of Coastal Area	3	4	8
GeoE660	Advanced Groundwater Modeling Techniques	3	4	8
GeoE661	Geophysical aspects of groundwater hydrology	3	4	8
GeoE662	Application of groundwater hydrology to geotechnics	3	4	8
GeoE666	Water, Energy and Climatic Change	3	4	8
GeoE668	Advanced Field Studies	1	**2**	10
GeoE697	Special Topics	3	4	8
GeoE698	Graduate Seminar **	1	2	10
Total		***41***	***0***	***124***

*** Mandatory Courses* *ECTS: European Credit Transfer and Accumulation System*

Program V

PROGRAM	*Mineral Resource Engineering (**8 courses, seminar and Thesis**)*
DEGREE	*M. Sc.*
OBJECTIVES	1. Instill in students a high-quality education in the areas of investigation, exploration and evaluation of ore minerals and building construction resources. 2. Emphasize students' skills fundamental to the analysis, evaluation, and innovation. 3. Foster in students personal developments to ensure a lifetime of professional success, and an appreciation for the ethical and societal responsibilities of an applied geological engineer.

Code	Title	Credits	Hour	ECTS
Faculty Requirements (3 credits)				
GE604	Advanced Engineering Mathematics	3	4	8
GE609	Numerical Methods in Engineering **	3	4	8
Department Requirements (9credits)				
GeoE611	Advanced Structural Geology and Tectonics **	3	4	8
GeoE612	Environmental Engineering Geology	3	4	8
GeoE613	Advanced Geochemistry **	3	4	8
GeoE614	Application of GIS in Earth Science	3	4	8
GeoE615	Advanced Geostatistics	3	4	8
Elective courses (13 credits)				
GeoE621	Applied Mineralogy	3	4	8
GeoE628	Ore Microscopy	3	4	8
GeoE633	Mineral Deposits of Libya	3	4	8
GeoE643	Geochemical Mineral Exploration	3	4	8
GeoE648	Desert Geology	3	4	8
GeoE654	X- Ray Crystallography	3	4	8
GeoE697	Special Topics	3	4	8
GeoE698	Graduate Seminar **	1	2	10
Thesis (6 Credits)				
GeoE699	M. Sc. Thesis	6	0	***50***
TOTAL		**31**	***0***	***124***

*** Mandatory Courses* *ECTS: European Credit Transfer and Accumulation System*

Program VI

PROGRAM	*Geotechnical Engineering (**8 courses, seminar and Thesis**)*
DEGREE	*M.Sc.*
OBJECTIVES	1. Employ advanced knowledge of geological characteristics and hazards of soil and rock foundations used as sites for building, heavy industrial complexes, highways, bridges, and dams. 2. Develop an advanced understanding of mechanical and engineering properties of all types of rocks to design foundations used as sites for building, heavy industrial complexes, highways, bridges, and dams. 3. Work with advanced techniques, skills, and modern scientific and engineering software tools for professional practice.

Code	Title	Credits	Hours	ECTS
Faculty Requirements (3 credits)				
GE604	Advanced Engineering Mathematics	3	4	8
GE609	Numerical Methods in Engineering **	3	4	8
Department Requirements (9 credits)				
GeoE611	Advanced Structural Geology and Tectonics **	3	4	8
GeoE612	Environmental Engineering Geology	3	4	8
GeoE613	Advanced Geochemistry **	3	4	8
GeoE614	Application of GIS in Earth Science	3	4	8
GeoE615	Advanced Geostatistics	3	4	8
Core courses (13 credits)				
GeoE624	Advanced Soil Mechanics & Foundation Engineering	3	4	8
GeoE627	Advanced Rock Engineering	3	4	8
GeoE636	Soil and Rock mass Enhancement	3	4	8
GeoE642	Rock Fracture Mechanics	3	4	8
GeoE646	Geophysical Methods in Geotechnical Engineering	3	4	8
GeoE651	Tunneling Engineering	3	4	8
GeoE652	Geotechnical Eartquake Engineering	3	4	8
GeoE657	Numerical Methods in Geotechnical Engineering	3	4	8
GeoE658	Offshore Geotechnical Engineering	3	4	8
GeoE668	Advanced Field Studies	1	**2**	10
GeoE697	Special Topics	3	4	8
GeoE698	Graduate Seminar **	1	2	10
Thesis (6 Credits)				
GeoE699	M. Sc. Thesis	6	0	50
TOTAL		**31**	**0**	***124***

*** Mandatory Courses* *ECTS: European Credit Transfer and Accumulation System*

Description of the Graduate Courses

- *Faculty General Courses*

GE 6091 Seminar in Research Methodology (1 Credits – 2 Hours)

This graduate course introduces research methodology in Science and their specific application in Engineering. Definition and development of science, scientific research approach, literature survey, research design, quantitative and qualitative research methodologies, data gathering, writing techniques for thesis, project, and scientific article, ethical principles to be followed when conducting research, ethical principles to be followed when publishing, citation ethics, tips for a successful presentation, students' presentations within the scope of some topics in engineering fields.

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.

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*

GeoE611 Advanced Structural Geology and Tectonics (3 *Credits* – 4 Hours)

Forces and stresses, elastic, plastic and viscous behavior of rocks. Moher circle for stress and strain. Relationship between mechanical properties and structural behavior of rocks. Primary and secondary structures, faults, mechanics and classification of faults. Folds, anticlines and synclines. Fold causes and their classification. Foliation and lineation. Shear zones, internal structure of the earth, continental drift, seafloor spreading. Earthquake seismology continental crust, oceanic crust. Framework of plate tectonics, plates and plate margins. Relative plate motions, forces acting on plates, oceanic ridges and continental rifts, transform faults, subduction zones, mountain ranges, mechanism of plate tectonics.

GeoE612 Environmental Engineering Geology (3 *Credits* – 4 Hours)

Landslide and dam failure, causes and effects of earthquakes, tsunamis, volcanoes, floods, subsidence, hurricanes, coastal erosion, tornadoes, wildfires, climate change

(concepts/ideas ties in with global change), and impacts of extraterrestrial events, For each topic, we focus on personal and societal adjustments to these hazards.

GeoE613 Advanced Geochemistry (3 *Credits* – 4 Hours)

Nature of mineral assemblages from the crystallization of magma. Distribution of elements in igneous, sedimentary, and metamorphic rocks. Evaporites. Trace elements, complex ions, and ion exchange. Atmosphere and hydrosphere geochemistry. Applications of stable and radioactive isotopes in hydrology and geochronology. Environmental geochemistry.

GeoE614 Application of GIS in Earth Science (3 *Credits* – 4 Hours)

GIS overview, Map Projections & Coordinate Systems, Georeferencing with ArcGIS, The Raster Data Model, Spatial Analysis, The Global Positioning System, Geostatistics application in geology and hydrogeology ,Field Data Collection Software, Remote Sensing & GIS, Internet mapping tools, case studies.

GeoE615 Advanced Geostatistics (3 *Credits* – 4 Hours)

Review of matrix algebra and matrix operations. Analysis of sequences of data, Geologic measurement in sequences, Equal spacing or interpolation procedures, Least square method and regression analysis. Filtering or time – trend analysis. Autocorrelation and cross-correlation, cross – association , Foruier series, map analysis, Trend surface and kriging, Analysis of multivariance data, Multiple regression, Discremenant functions, Cluster analysis, Variogram and covariance functions, Ordinary kriging, kriging weights, mapping with kriging.

GeoE697 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.

GeoE698 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.

GeoE699 M.Sc. Thesis (6 Credits)

The student has to work on a research point leading to writing a full text thesis according to the University adapted standard format. The departmental internal

regulations beside the university principal and rules should be followed. He/She should present his/her completed research work in an open session and pass the oral examination from the university-pointed committee in an enclosed session.

- *Petrophysics program courses*

GeoE622 Sequence Stratigraphy and its application (3 Credits – 4 Hours)

Organization and interpretation of stratigraphic successions in time-bounded units of genetically related strata. Sequence stratigraphy, as a predictive branch of stratigraphic analysis, Provides insight into the origin of the entire spectrum of siliciclastic, carbonate and evaporite sediments from shallow to deep settings. Laboratory component involves the interpretation of sequences using outcrop measured sections. Core data. Wireline log sections. Field trips, and 2D and 3D seismic data from modern and ancient settings.

GeoE630 Formation Evaluation (3 *Credits* – 4 Hours)

A detailed review of Wireline well logging and evaluation methods stressing the capability of the measurements to determine normal and special reservoir rock related to reservoir and production problems. Interpretations of routine and special core analysis. Digitizing and log processing of single and multiple well studies utilizing of well logs and geology in evaluating well performance before, during and after production of hydrocarbons. Using formation evaluation parameters in the volumetric determination of petroleum in reservoirs with special emphasis on unitization.

GeoE637 Source Rock Evaluation (3 *Credits* – 4 Hours)

Organic geochemistry, definition of source rocks, organic facies. Quantity and quality of organic material. Controls on total organic carbon (TOC). Rock-Eval pyrolysis. Kerogen composition and classification. Maturity of organic material. Introduction to basin modeling, maturation and thermal history of basins. Biomarkers, application of biomarkers in petroleum geochemistry.

GeoE639 Applied Biostratigraphy in Oil Exploration (3 *Credits* – 4 Hours)

Biostratigraphy , Introduction to the different microfossil groups. Laws of stratigraphy and chronostratigraphy. Age of sediments and palaeoenvironmental indicators. Biostratigraphy and bio facies to identify seismic markers. Integrated biostratigraphical data to build a high-resolution sequence stratigraphy. Biostratigraphical data with other geological data (sedimentlogical, petrographical and geochemical) to maximize its use. Biostratigraphy used in play definition and play based exploration.

Lab. Working examples of applied biostratigraphy for oil exploration from Libya

GeoE645 Reservoir Geology and Advanced Recovery (3 Credits – 4 Hours)

Analysis of geologic controls on composition and architecture of oil and gas reservoirs with emphasis on reservoir heterogeneity resulting from depositional and diagenetic, processes. Geology of carbonate and sandstone reservoirs and other reservoir rock types. Geological and petrophysical determinants of fluid flows and behavior. Effects of different geological structures on reserve oil behavior. Static modeling based on differences of reservoir petrophysical and geological parameters.

GeoE655 Advanced Basin Analysis and Petroleum Systems Modeling (3 *Credits*–4 Hours)

Introduction to sedimentary basins. Classification and structural analysis. Basin forming mechanisms, basin infill dynamics, subsidence history and consequences for reservoir and source rock development and the petroleum system. Geochemical analysis. Temperatures and pressures in sedimentary basins, The petroleum systems modeling approach. Hydrocarbon generation. Hydrocarbon migration. Uncertainty management and quantification**.**

GeoE669 Reservoir Engineering (3 Credits – 4 Hours)

Introduction to reservoir Engineering, fluid pressure regimes, phase behavior, reservoir fluid sampling, porous media, rock-fluid interactions, fluid flow in porous media, well testing, well performance, material balance and natural reservoir drive mechanisms, oil immiscible displacement.

GeoE670 Fundamentals of Reservoir Properties (3 Credits – 4 Hours)

A study of the physical properties of reservoir rocks and the reservoir rock-fluid system as they relate to the production of oil and gas. This course will cover the following topics:
(porosity, isothermal compressibility of reservoir rocks , boundary tension , wettability, capillary pressure, fluid saturations in reservoir rock, effective & relative permeability).

GeoE671 Applied Geophysics (3 Credits – 4 Hours)

This course provides an introduction to geophysics and a context for various geophysical field techniques such as electromagnetics, gravity, DC resistivity and induced polarization, magnetics, and ground penetrating radar surveys. The course will first introduce students to traditional physics topics fundamental to an understanding of geophysics as applied to earth systems. These topics include force, electricity, heat, magnetism, electromagnetism, and thermodynamics. Students will develop competencies using basic geophysical equations to address real-life geoscience problems and predicting the geophysical response to different rock types and structures. An emphasis will be placed on operating geophysical equipment and analysing data collected using a wide array of geophysical techniques. Geophysical case studies will focus on Yukon examples when possible.

- *Water Resources Program courses*

GeoE625 Groundwater hydrology and hydraulics (3 *Credits* – 4 Hours)
Hydrodynamics of aquifers, site investigations, mathematical modeling, input data, calibration and determination of aquifer characteristics. Pattern of groundwater use, well and other intake structures, clogging of wells and safe yield, artificial recharge. Seepage problems at dams, barrages, weirs and levees.

GeoE631 Groundwater Engineering (3 *Credits* – 4 Hours)

Properties of rocks and soils, Water-bearing formations and groundwater occurrence, Fundamental of groundwater flow, Evolution of groundwater engineering, Two dimensional steady state flow, Hydrologic parameters and related equations, Water wells, Management of water basins.

GeoE634 Fluid Flow through Porous Media (3 *Credits* – 4 Hours)

Properties of porous media. Introduction to flow of fluids in porous media. General differential equation governing fluid flow and deformation. Initial and boundary value problems and specific solutions with emphasis on reservoir hydraulics involving pumping well, steady and transient infiltration. Applications of conformal mapping techniques. Hydrodynamic dispersion. Numerical and analog models in porous media flow problems.

GeoE640 Surface and Groundwater Contamination (3 *Credits* – 4 Hours)

Natural processes of ground-water and surface-water interaction, Effects of human activities on the interaction of ground water and surface water, Challenges and opportunities, case studies.

GeoE649 Hydrology of Coastal Area (3 *Credits* – 4 Hours)

Coastal morphology, Sources of salts, Aquifers in coastal areas, water and salt balance, Measures to combat salt intrusion, Estuaries morphology, mixing of fresh and salt water, Tidal effects, Water quality aspects of estuaries mixing, Siltation in coastal and estuaries areas, Case studies.

GeoE660 Advanced Groundwater Modeling Techniques (3 *Credits* – 4 Hours)

Review of groundwater equations. Introduction to mathematical models, analytical and numerical. Modeling protocol, why modeling, modeling procedure, conceptual models, governing equations, computer model codes. Model design, calibration and sensitivity analysis, model verification, validation and sensitivity analysis, Solute transport modeling and case studies.

GeoE661 Geophysical aspects of groundwater hydrology (3 *Credits* – 4 Hours)
Appraisal aspects of groundwater resources. Recapitulation of geology, permeability of rocks, Structural Geology. Aquifers, Origin and occurrence of groundwater. Aquifers in geological structure. Prospecting Methods, the use of various geophysical exploration methods in geohydrology Seepage. Prediction of the seepage amount. Seepage of saline groundwater.

GeoE662 Application of groundwater hydrology to geotechnics (3*Credits* –4 Hours)

Drainage. Basic soil characteristics. Vegetation growth and its effect on drainage. Subsurface flow to drains. Drainage by artificial means. Subsurface field drainage systems. Surface field drainages. Maintenance of drainage works. Hydrological problems in relation to the surface layers (Case Studies).

GeoE666 Water, Energy and Climatic Change (3 *Credits* – 4 Hours)

Oil, water and Climate - An Overview, Carbon dioxide emissions, global warming and climate change, Carbon Cycle, Global Oil Resources and the Oil Peak, Oil consumption and CO2 emissions, Power and Conflicts, Energy Alternatives to Oil and their Connections with Climate, Water Cycle, Water Availability, Water Contamination, Geopolitics of Water, Water Alternatives and their Connections with Energy, Water and Climate, Food, Energy and Water, Challenges and Solutions.

GeoE668 Advanced Field studies (3 Credits – 4 Hours)

This course tailed by the department for graduate students during the summer months under the direction of a department members and it helps the preparation works for the graduate seminar and thesis.

- *Mineral Resources Program courses*

GeoE621 Applied Mineralogy (3 *Credits* – 4 Hours)
Bond types in minerals. Detailed study of different physical properties of minerals and the various uses of minerals in industry and technology based on such properties. Mineral separation based on physical and chemical properties of minerals. Examples of such applications on different mineral groups and species. Advanced study of certain mineral species.

GeoE628 Ore Microscopy (3 *Credits* – 4 Hours)
Polished surfaces of minerals and ore minerals are studied using reflected –light microscope to know texture and to determine paragenesis. Discussion of diagnostic physical and optical properties of opaque minerals and determination of microhardness and reflectivity. Selected suites of ores are described, and petrography is coordinated with hand specimen studies.

GeoE633 Mineral Deposits of Libya (3 *Credits* – 4 Hours)
Occurrence, distribution, origin, as well as geologic control on the development of metallic and non–metallic mineral deposits, geologic evaluation , uses and economic value of these deposits in Libya.

GeoE643 Geochemical Mineral Exploration (3 *Credits* – 4 Hours)
Theory of dispersion of trace elements from mineral deposits and their discovery utilizing rapid analytical techniques. Analysis and statistical interpretation of geochemical data of samples from soils, stream sediments, natural waters, vegetation, and rocks in connection with field problems.

GeoE648 Desert Geology (3 *Credits* – 4 Hours)
Causes, origin, and distribution of deserts. Cycles of erosion in arid regions . Desert landforms and structure. Arid region hydrology, soils and climate. Cause of desert encroachment over coastal regions, solution and protection.

GeoE654 X-Ray Crystallography (3 *Credits* – 4 Hours)
Principals of crystallography, space group theory, internal symmetry in crystals. X-ray diffraction, film techniques and diffractometers. Determination of crystal structures of minerals and inorganic compounds. Introduction to methods of single crystal techniques including Weissenberg and Procession cameras. Single crystal diffractometer.

- *Geotechnical Engineering Program courses*

GeoE624 Advanced Soil Mechanics & Foundation Engineering (3 *Credits* – 4 Hours)
Shear strength and tri-axial shear strength (UU, CD , and CU conditions). Water pressure, consolidation and settlement, clay mechanics. Detailed discussion of variable

types of shallow and deep foundations. Namely isolated footing, strip and mat foundation, piers, piles and micropiles.

GeoE627 Advanced Rock Engineering (3 *Credits* – 4 Hours)
Rock engineering design, rock mass classification. Shear strength of discontinuities, factor of safety and probability of failure. Analysis of rock fall hazards .In situ and induced stresses, rock mass properties. Studies of case histories.

GeoE636 Soil and Rock Mass Enhancement (3 *Credits* – 4 Hours)
Soil enhancement by mixing with lime, clay and cement. Dynamic compaction, hydro-compaction, gravel piles or stone columns, sand columns, geotextile and geogrid. Methods of rock mass supports such as anchors, rock bolts, grouting, jet grouting and mish grouting and others.

GeoE642 Rock Fracture Mechanics (3 *Credits* – 4 Hours)
Principle and theory of failure. Mechanics of fracture and crack growth, fracture toughness, crack propagation, crack control. Testing of crack propagation and fracture toughness.

GeoE646 Geophysical Methods in Geotechnical Engineering (3 *Credits* – 4 Hours)
Introduction to geophysical methods with an emphasis on resistivity and tomology. Shallow seismic methods. Seismic refraction, down hole and cross-hole methods. Refraction micro-tremor (ReMi), ground penetrating Radar (GPR), Gravity, and magnetic methods for geotechnical investigations.

GeoE651 Tunneling Engineering (3 *Credits* – 4 Hours)
Site investigation and data collection. Rock classification, empirical design, analytical design, numerical design. Soft ground tunneling techniques. Hard rock tunneling. Support systems. Mechanical excavation and tunneling services.

GeoE652 Geotechnical Earthquake Engineering (3 *Credits* – 4 Hours)
Introduction to earthquake seismology and plate tectonic theory, seismic hazards, earthquakes and ground motion, wave propagation, ground response analysis. Soil properties for dynamic analysis, modulus and damping curves, liquefaction susceptibility, post liquefaction response, seismic effects on slope stability, retaining structures and foundation design under cyclic and earthquake loading.

GeoE657 Numerical Methods in Geotechnical Engineering (3 *Credits* – 4 Hours)
Fundamental content includes an introduction to continuum mechanics, plasticity models, generalized failure criteria, critical state of soil mechanics, cap models, dilatancy effects, flow rules, hardening rules, consolidation, visco-elasticity, creep behavior. Review of numerical methods, finite element formulation, iterative schemes, time marching schemes, solution of typical boundary value problems. FEM applications to foundations, retaining walls, dams, tunnels, pipelines, human-made and natural slopes in rock and soil.

GeoE658 Offshore Geotechnical Engineering (3 *Credits* – 4 Hours)
Management of municipal solid waste, solid waste disposal in landfills, concepts of unsaturated soil mechanics in geoenviromental engineering, geotechnical issues associated with landfill and mine tailings design, hydrogeological principles, water

budget, contaminant interaction, settlement of landfills operation, maintenance and monitoring, design of environmental control and containment systems, slurry walls, grout curtains, composite liner design and leachate collection systems, geosynthetics, landfill covers, case covers, case studies.

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

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

1- Understand the integrated nature of the disciplines of the Geological Engineering and the Environment.
2- Conduct research contributing to knowledge, including as appropriate both independent and collaborative research, and in conformity with all standards, for responsible conduct of research.
3- Apply advanced studies to identify, understand, formulate, and solve high-grade thermal Power engineering problems.
4- Have an advanced technique to design and conduct experiments, and to represent, evaluate, analyze and interpret the available data.
5- Build professional skills and ethical behaviors in their professional life.
6- Work with advanced techniques, skills, and modern scientific and engineering software tools for professional practice.
7- Communicate, applied in oral, text, and digital formats and consistent with the highest standards.
8- Achieve effective communications in written, oral, and visual means.

الاعتماد			
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الاسم			
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