

قسم الهندسة الجيولوجية
Geological Engineering Department

Geological Engineering is part of the graduate studies program of the faculty of Engineering at the University of Tripoli. It awards a master degree in geological engineering since 2002.

This department has 18 full time staff members.

The number of students who got M. Sc. degree from this department since 2002 was more than 25 students.

Programs:

The department awards M. Sc. Degree in four discipline programs:

1. Geotechnical Engineering program
2. Mineral Resources Engineering program
3. Petrophysical Engineering program
4. Water Resources Engineering program

Program of Study:

The department follows the semester system of studies in which the academic year is divided into two semesters fall and spring each of about 16 weeks duration. The fall semester starts in September and ends in February and the spring semester starts in March and ends in July of each year.

To obtain the Master of Science degree in geological engineering the student **is required to pass a total of 30 semester credits, and to submit and defend a master thesis.**

Admission Requirements:

Admission to the department is restricted to those students who hold a B. Sc. Degree in geological engineering from accredited university with sufficient grade point average as set by the general requirements for postgraduate studies.

In addition, the student must pass a placement test prepared and conducted by the department graduate committee.

Grading system:

The grading system is based on letter grades, in which grades are given as A, B, C, D, F with the possibility of adding plus or minus to each grade (a plus add 0.3 and a minus subtracts 0.3 from the weight given to each letter grade).

Letter grades are as assigned numerical values as follows:

Letter Grade	Numerical Value
A	4.0
B	3.0
C	2.0
D	1.0
F	0.0

Degrees offered by the department:

The department currently offers B. Sc. and M. Sc. degrees in geological engineering.

Areas of Employment:

Research center sectors of oil and gas industry, oil companies, , heavy industry as iron and steel co. , national cement companies, industrial research center, national mining corporation, general water authority, geotechnical consulting offices and engineering firms as well as universities.

Regulations:

The study program must be completed within six semesters. It consists of 30 credits from which 6 credits are faculty requirements, 9 credits are department requirements. The rest 15 credits are taken for each of the above – mentioned programs.

In addition, the student must write a thesis under the supervision of qualified staff member(s). To qualify for M. Sc. status and continue for the thesis part, the student must pass all courses with a grade point average (GPA) of B, i.e., 3 out of 4.

Moreover, the student must give at least one seminar presentation during the research work period. A master thesis of 6 credits must be completed and its evaluation is open to the public. The evaluation is done by three staff members one of them as an external examiner.

Courses offered as faculty requirements (minimum 6 credits all programs):

CODE	Title	Credits
GE 604	Advanced Mathematics	3
GE 609	Numerical Methods	3
GE 606	Advanced Statistics	3

Department Requirements All Programs:

Mandatory Courses (6 credits)

CODE	Title	Credits
GeoE 623	Advanced Structural Geology and Tectonics	3
GeoE 633	Advanced Geochemistry	3

One Mandatory Course (3 credits) from the following three courses (All Programs)

CODE	Title	Credits
GeoE 671	Advanced Applied Sedimentology and Sequence Stratigraphy	3
GeoE 615	Advanced Geostatistics	3
GeoE 621	Environmental Engineering Geology	3

Program Requirements (minimum 15 credits):

I) Petrophysics Program:

Postgraduate studies in petrophysics program is aimed to direct graduate students to solve geological problems related to oil and gas reservoirs.

In other words, geological and petrophysical studies related to new oil and gas discoveries as well as geological development studies of mature oil fields in order to increase oil recovery from such fields.

CODE	Title	Credits
GeoE 625	Regional Petroleum Geology	3
GeoE 673	Formation Evaluation	3
GeoE 675	Reservoir Characterization and Modeling	3
GeoE 677	Source Rock Evaluation	3
GeoE 681	Advanced Basin Analysis	3
GeoE 683	Historical Geology and Micropaleontology	3
GeoE 692	Special Topics (Elective Course)	3

Seminar and Thesis (7 credits)

CODE	Title	Credits
GeoE 697	Graduate Seminar	1
GeoE 699	Thesis	6

II) Mineral Resources Program:

The aim of mineral resources program is to graduate geological engineers who will be qualified to search, explore, evaluate, and extract economic mineral deposits. Meanwhile, postgraduate studies in this field will enable graduates to lead regional exploration and geological mapping projects. Moreover, these studies would enhance research activities concerning search for metallic and non-metallic minerals in Libya. Industrial uses of minerals and rocks can also be investigated particularly after calculating their grades and proved reserves.

CODE	Title	Credits
GeoE 631	Advanced Applied Mineralogy	3
GeoE 635	Ore Microscopy	3
GeoE 637	Non-Metallic Mineral Deposits of Libya	3
GeoE 639	Geochemical Mineral Exploration	3
GeoE 641	Desert Geology	3
GeoE 643	X- Ray Crystallography	3
GeoE 694	Special Topics (Elective Course)	3

Seminar and Thesis (7 credits)

CODE	Title	Credits
GeoE 697	Graduate Seminar	1
GeoE 699	Thesis	6

III) Water Resources Program:

Graduate studies in this field is mainly directed toward groundwater modeling studies plus surface and groundwater production management. Moreover, this program is also interested in research concerning water quality and seawater intrusion problems along many coastal cities in Libya.

CODE	Title	Credits
GeoE 645	Advanced Hydrology	3
GeoE 647	Fluid Flow Through Porous Media	3
GeoE 649	Groundwater Systems Planning and Management	3
GeoE 651	Groundwater Contamination	3
GeoE 653	Geochemistry of Natural Waters	3
GeoE 655	Advanced Groundwater Modeling Techniques	3
GeoE 693	Special Topics (Elective Course)	3

Seminar and Thesis (7 credits)

CODE	Title	Credits
GeoE 697	Graduate Seminar	1
GeoE 699	Thesis	6

IV) Geotechnical Program:

graduate studies in this program include studying geological characteristics and hazards of soil and rock foundations used as sites for building, heavy industrial complexes, highways, bridges, and dams. Moreover, mechanical and engineering properties of all types of rocks must also be investigated for such purposes.

CODE	Title	Credits
GeoE 632	Soil and Rockmass Enhancement	3
GeoE 634	Advanced Soil Mechanics & Foundation Eng.	3
GeoE 636	Tunneling Engineering	3
GeoE 638	Advanced Rock Engineering	3
GeoE 640	Rock Fracture Mechanics	3
GeoE 642	Geophysical Methods in Geotechnical Engineering	3
GeoE 691	Special Topics (Elective Course)	3

Seminar and Thesis (7 credits)

CODE	Title	Credits
GeoE 697	Graduate Seminar	1
GeoE 699	Thesis	6

Courses Contents:

GeoE 631 Advanced Applied Mineralogy (3 credits)

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.

GeoE 633 Advanced Geochemistry (3 credits)

Structural and crystal chemistry, geometry of atomic structure, silicate structures. Solution chemistry, activity and activity coefficients, ionic strength. Geochemistry of the ocean and other natural waters. Complex ions, colloids, and surface chemistry, Ion exchange. The fluid envelopes (air and water envelopes). Construction and interpretation of Eh – pH diagrams of some mineral species. Environmental geochemistry.

GeoE 635 Ore Microscopy (3 credits)

Polished surface 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 determinations of micro hardness and reflectivity. Selected suites of ores are described and petrography is coordinated with hand specimen studies.

GeoE 637 Non-Metallic Minerals Deposits of Libya (3 credits)

Occurrence, distribution, origin, and geologic controls on the development of non-metallic mineral deposits. Geologic evaluation, uses, and economic value of these deposits in Libya.

GeoE 639 Geochemical Minerals Exploration (3 credits)

Theory of dispersion of trace elements from mineral deposits and their discovery utilizing rapid analytical techniques. Mobility of elements in different geochemical environment, pathfinder elements and their uses in the exploration of ore deposits. Analysis and statistical interpretation of data from soils, stream sediments, natural waters, vegetation, and rocks in connection with field problems.

GeoE 641 Desert Geology (3 credits)

Causes, origin, and distribution of deserts. Cycles of erosion in arid regions. Desert landforms and structure. Arid region hydrology, soils and climate. Causes of desert encroachment over coastal regions, solutions and protection.

GeoE 643 X- Ray Crystallography (3 credits)

Principles 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 technique using Weissenberg, procession cameras and single crystal diffractometers.

GeoE 694 Special Topics (3 credits)

Advanced Topics related to mineral resources engineering discipline.

GeoE 645 Advanced Hydrogeology (3 credits)

Darcy's Law and its limits, Hydraulic conductivity and permeability of geological materials, Flow in fractured rocks, unsaturated flow, Elastic properties, and main equations of flow, Hydraulic testing: Models, methods, and applications, Groundwater as resources and their development. Simulation of aquifer resources to pumping, Land subsidence, groundwater in the basin. Hydrologic cycle: Topographic driving forces, Surface features of groundwater flow, Engineering and geologic implications of topographic driving system.

GeoE 647 Fluid Flow Through Porous Media (3 credits)

Fluids and porous matrix properties: Fluid density, Fluid Viscosity, Fluid compressibility, Description of porous media, Porosity, and Matrix and medium compressibility. Pressure and Piezometric head: stress at a point, Hydraulic pressure distribution and piezometric head, The equation of motion of a homogeneous fluids. Generalization of Darcy's Law, Deviation from Darcy's Law, Hydraulic conductivity in isotropic and anisotropic media, Measurement of hydraulic conductivity, Layered porous media. Continuity and conservation equations for a homogeneous fluid: The control volume, Mass conservation in a non-deformable porous media, Mass conservation in consolidating media, Continuity equations, stream functions, and solving boundary and initial value problems.

GeoE649 Groundwater Systems Planning and Management (3 credits)

Principles of water resources management. Tools of water resources management, Estimation of water resources potential, hydrogeological basin water balance. Integrated water resources management.

GeoE 651 Groundwater Contamination (3 credits)

The fundamental fluid transport equation in porous media: Particles, velocities and fluxes in a fluid continuum, The general conservation principles, Equations of mass, momentum and energy conservations in a fluid continuum, Equations of volume and mass conservation, Equation of motion, Hydrodynamic dispersion, Parameters of dispersion. Mass transport in groundwater flow: Mixing, Inorganic and organic reactions. Sources of contamination, Solute pluming, Multi – fluid contamination problems. Modeling contaminant transport.

GeoE 653 Geochemistry of Natural Waters (3 credits)

Structure of water and the occurrence of mass in water, Equilibrium versus kinetic description of reaction, Equilibrium models of reactions, Deviation from equilibrium, Kinetic reactions, Groundwater composition. Chemical reactions: Acid – base reactions, solution, exsolution, volatilization and precipitation, complexation reactions, Reaction on surfaces, Oxidation-reduction reaction, Hydrolysis and isotope processes: Radioactive decay, Isotope reactions; deuterium and oxygen, and carbon 13, Sulfur 34.

GeoE 655 Advanced Groundwater Modeling Techniques (3 credits)

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. Case study. Solute transport modeling and case study.

GeoE 693 Special Topics (3 credits)

Advanced Topics related to water resources program.

GeoE 675 Reservoir Characterization & Modeling (3 credits)

Geological controls on reservoir characteristics as porosity, permeability, thickness and saturation. Detailed studies of reservoir rock facies. Geology of carbonate and sandstone reservoirs and other reservoir rock types. Effects of different geological structures on reserve oil behavior. Nature of fluid contacts in reservoirs. Static modeling based on differences of reservoir petrophysical and geological parameters.

GeoE 677 Source Rock Evaluation (3 credits)

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.

GeoE 681 Advanced Basin Analysis (3 credits)

Nature, origin, and evolution of sedimentary basins. Sedimentary responses to tectonic regimes. Hydrocarbon occurrences in Libyan basins with emphasis on oil and gas reserves determinations in such basins.

GeoE 673 Formation Evaluation (3 credits)

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.

GeoE 625 Regional Petroleum Geology (3 credits)

Interpretation of petroleum geology of selected regions through integration of data including depositional and structural history particularly those informations controlling oil and gas occurrence. Relation of oil accumulation to regional stratigraphy and structure. Geology of major petroleum fields and provinces of the world and methods of exploration for petroleum.

GeoE 692 Special topics (3 Credits)

Advanced topics related to petrophysics program

GeoE 615 Advanced Geostatistics (3 credits)

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 multivariate data, Multiple regression, Discremenant functions, Cluster analysis, Variogram and covariance functions, Ordinary kriging, kriging weights, mapping with kriging.

GeoE 623 Advanced Structural Geology and Tectonics (3 credits)

Forces and stresses, elastic, plastic and viscous behavior of rocks. Mohr 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.

GeoE 621 Environmental Engineering Geology (3 credits)

Application of geology, geologic techniques and geologic reasoning to the broad environmental concerns of society. Analysis of environmental concerns of society. Influence of geological factors on land development. Evaluation of geologic and natural hazards. Role of environmental geochemistry in studying air, water, and soil pollution.

GeoE 683 Historical Geology and Micropaleontology (3 credits)

Biological and physical history of the earth, with emphasis on classification of plants and animals, uses of fossils, methods of correlation.

Microfaunal correlations, stratigraphic sequence of microfaunas. Detailed study of selected microfossil taxa, faunas, and floras. Biostratigraphic principles vertical and horizontal distribution of microfossils in geologic systems, with emphasis on environment of deposition and paleoecology.

GeoE 671 Advanced Sedimentology and Sequence Stratigraphy (3 credits)

Sedimentary processes and deposits. Analysis of depositional systems of sandstone and carbonate reservoirs. Sedimentary environments, continental, marine, and transitional, criteria for recognition of such environments.

Classification of stratigraphic units, principles of correlation. Distribution, sequence and biotic zonation of Paleozoic, Mesozoic, and Cenozoic rocks.

GeoE 632 Soil and Rockmass Enhancement (3 credits)

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.

GeoE 634 Advanced Soil Mechanics & Foundation Engineering (3 crs.)

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.

GeoE 636 Tunneling Engineering (3 credits)

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.

GeoE 638 Advanced Rock Engineering (3 credits)

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.

GeoE 640 Rock Fracture Mechanics (3 credits)

Principle and theory of failure. Mechanics of fracture and crack growth, fracture toughness , crack propagation, crack control. Testing of crack propagation and fracture toughness.

GeoE 642 Geophysical Methods in Geotechnical Engineering (3 credits)

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.

GeoE 691 Special Topics (3 Credits)

Advanced topics related to geotechnical program