Yarmouk University

Faculty of Science

Department of Earth and Environmental Sciences

Proposed Degree Plan for the Master of Science Degree in Earth Sciences

(Thesis Track)

2021

Proposed Degree Plan for the Master of Science Degree in Earth Sciences / Thesis Track

I. The applicant for this program should:

1. Hold a B.Sc. degree in Earth Sciences or any other related fields approved by the department.
2. Fulfill the English Language requirement according to university regulations.
3. Satisfy any other conditions approved by related committees and councils.

II. Master of Science Degree in Earth Sciences is awarded on the completion of the following requirements:

1. The fulfillment of the conditions stated in the regulations of awarding the master's degree at Yarmouk University No. (3) for the year 2011.
2. Completion of the remedial or/and additional courses recommended by the higher studies committee in the department.
3. Completion of (33) credit hours of 600-level courses (with a minimum GPA of 75%) distributed as follows:

a. Obligatory courses (15 credit hours)

No.	Course No.	Course Name	Credit Hours
1	ES 634	Advanced Sediments and Sedimentary Rocks	3
2	ES 641	Advanced Structural Geology and Tectonics	3
3	ES 644	Advanced Remote Sensing and Geographic Information Systems	3
4	ES 652	Advanced Hydrogeology	3
5	ES 653	Advanced Engineering Geology	3

b. Elective courses (9 credit hours):

No.	Course No.	Course Name	Credit Hours
1	ES 602	Geostatistics	3
2	ES 611	Applied Stratigraphy and Microfacies	3
3	ES 613	Advanced Paleontology	3

4	ES 614	Paleoclimate and Quaternary Geology	3
5	ES 622	Clay Mineralogy	3
6	ES 625	Advanced Industrial Rocks and Minerals	3
7	ES 633	Advanced Igneous and Metamorphic Rocks	3
8	ES 654	Advanced Petroleum Geology	3
9	ES 670	Advanced Environmental Geology	3
10	ES 671	Advanced Applied Geochemistry	3
11	ES 677	Engineering and Environmental Geophysics	3
12	ES 678	Advanced Earthquake Seismology	3
13	ES 679	Advanced Exploration Geophysics	3
14	ES 691	Special Topics in Geology	3
15	ENV 651	Advanced Soil Science	3
16	ENV 652	Oceanography	3

4. Successful defense of thesis (9 credit hours). Registration of thesis can be as follows:

Course No. and Name	**Credit hour**
ES 699A Thesis	0
ES 699B Thesis	3
ES 699C Thesis	6
ES 699D Thesis	9

Description of the courses offered in the plan

ES 602-Geostatistics (3 Cr. Hrs.)

Course description

The course includes the study of methods of sampling and data collection. Basics of probability and distribution, correlation and regression analysis, analysis of variance, nonparametric statistics, hypothesis tests, parametric tests versus non-parametric tests. Maps and spatial data, methods of spatial data analysis, spatial prediction and estimation, analysis and modeling of the time series and conservative modeling.

Course objectives

This course aims to give a student an understanding of the various statistical methods used to investigate spatial or spatio-temporal data, with emphasis on applications in geological and environmental research

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Understand the statistical methods used in geology.
2. Collecting samples and statistical data.
3. Understand and implement statistical analysis for geological purposes.
4. An understanding of basic techniques and data.
5. Use appropriate software successfully.

ES 611-Applied Stratigraphy and Microfacies (3 Cr. Hrs.)

Course description

The course includes the following topics: lithostratigraphy, biostratigraphy, chronostratigraphy, magnetostratography, seismic stratigraphy and sequence stratigraphy, how to construct a geologic time scale and identify the typical section for each era, assessment of sequence stratigraphy, temporal deposition interpretation and sedimentation relationship with different biological, climatic and physical changes across geological ages. The course also includes the study of facies, microfacies, and analyses of continental and marine facies. The course includes a geological field trip to the south of Jordan to investigate the stratigraphy and lithological facies of the different geological formations, as well as collecting and describing samples.

Course objectives

The course aims to provide an advanced presentation of the science of stratigraphy and sedimentary facies and its various applications.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Understand all types of stratigraphy (lithological, biological, chronological, magnetism, and seismic).
2. Know and analyze of continental and marine facies.
3. Understand the analysis of sequences based on the sea transgression and regression activities, and understanding the various variables affecting sedimentation.
4. Understand the deposition of stratigraphic sequences in Jordan and linking them to the idealized sections globally.

ES 613-Advanced Paleontology (3 Cr. Hrs.)

Course description

The course includes the study of the characteristics and features of groups of microscopic and large fossils that are environmentally and historically important, studying the uses of fossils in the field of identifying prevailing paleo-environmental conditions, whether continental or marine, identifying index fossil groups able to indicate the age of the hosting rocks, and clarifying examples of these practical applications in global and local formations, identifying vertical and horizontal changes in the distribution of fossils or fossil assemblages and the factors affecting the rock column. The course also includes the application of quantitative and qualitative statistical methods for determining the different environmental ranges of fossils and their paleographic distributions.

The course includes a geological trip to identify the patterns of fossil deposits of the outcrops of the extinct Rhodesian reefs of the Kingdom. A geological trip to the Jordan Valley and southern Jordan regions to learn about the types of formations rich fossils indicative of environments such as Nummulites and ancient and modern coral reefs in the Aqaba region.

Course objectives

The course aims to provide an advanced presentation of paleontology and its various applications.

Learning Outcomes

After studying this course, the student is supposed to be able to:

1. Know the groups of fossils that can be used to study the ages of rocks and the available sedimentary environment conditions.
2. Know appropriate scientific field methods needed to study the geographic distribution of fossils and to determine prevailing paleo-environments and their conditions.
3. An applied field study of research methods, sample collection and handling in the field.
4. Description and classification of fossils.

ES 614-Paleoclimate and Quaternary Geology (3 Cr. Hrs.)

Course description

This course includes the following topics: general characteristics of Quaternary, the main climatic models, the oceanic records, classifications of glacials and inter-glacials periods, chronological methods for dating comprising of radiocarbon dating and uranium argon series, mammalian and pollen fossil records, sea level in the Pleistocene and Holocene, characteristics of the glaciation and inter-glaciation periods. A field trip will be held to Azraq/north of Jordan to check the desert environment. Another trip will be conducted to south of Jordan to know more about Quaternary deposits in Aqaba.

Course objectives

The course aims to provide the students with the understanding of the geological deposits and features in the Quaternary Period, their mapping and classification techniques. It also deals with the study of chronological events, glaciations and environmental changes in Quaternary Period.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Give in-depth knowledge and understanding the history of the latest part of the geological time.

2. Understand the influence of Quaternary Period in climate and relation to biological world in the Earth including hominids.
3. Understand the distribution pattern and characteristics of sedimentary rocks in the continent and marine of the Quaternary Period.
4. know the geological formations and geomorphological features that accompanied the Quaternary era in Jordan and the region.

ES 622-Clay Mineralogy (3 Cr. Hrs.)

Course description

This course includes the following topics: composition, classification, nomenclature, structure; chemical & physical properties of clay mineral groups, principles and applications of X-ray diffraction and thermal differential methods in clay science; electron micrographs & interpretation of crystal shape and size of crystal; ionic-exchange and rheological properties; clay-water system; origin and occurrence of clay minerals in soils, sediments, and sedimentary rocks; and industrial uses.

Course objectives

The course aims to introduce students to clay mineralogy, their properties and uses.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Classify clay minerals.
2. Distinguish clay minerals using x-rays and various analytical and imaging methods.
3. Understand the origin and formation of clay minerals.
4. Know the various industrial uses of clay minerals.

ES 625-Advanced Industrial Rocks and Minerals (3 Cr. Hrs.)

Course description

The course includes: the study, description and classification of industrial minerals and rocks. The course also includes the geology of various industrial minerals, as well as studying the procedures and methods of treatment and exploitation in terms of studying the requirements of industry relevant to their physical and chemical properties. Uses and the economics of minerals and industrial rocks.

This course includes local field trips to study ores and industrial deposits in the field and visits to selected projects related to industrial minerals and rocks.

Course objectives

The course aims to give students an advanced presentation to the industrial rocks and minerals, which requires a good background in rock formation processes and economic geology.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Identify of industrial minerals and rocks.
2. Classify and explanation of the uses of various minerals and rocks.
3. Understand industrial specifications regarding the physical and chemical properties of industrial minerals and rocks.
4. Conduct effective exploration of industrial minerals.

ES 633-Advanced Igneous and Metamorphic Rocks (3 Cr. Hrs.)

Course description

The course includes: Detailed study of the genesis of these rocks, classification, thermodynamic, mineral stability, magmatic processes, tectonic aggregates of igneous rocks, the different metamorphic facies, metamorphism, temperature and pressure estimations during cooling and metamorphism, study the pressure-temperature-time trend in the regional metamorphisms.
The course includes a field trip to the south of Jordan to study the igneous and metamorphic rocks in the field and another field trip will be held to study the basalt in the north east of Jordan.

Course objectives

The course aims to introduce an advanced view for studying the igneous and metamorphic rocks.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Distinguish the texture of different igneous and metamorphic rocks.
2. Classify of igneous and metamorphic rocks.
3. Distinguish igneous rocks types under a microscope.
4. Knowledge of metamorphosis, its criteria, and the types of metamorphic rocks.
5. Knowledge of low- and high-grade metamorphic products.
6. Identify and describe igneous and metamorphic rocks in field.

ES 634- Advanced Sediments and Sedimentary Rocks (3 Cr. Hrs.)

Course description

The course includes: The study of sediment transport and sedimentation processes in terms of aqueous, aeolian, and gravitational forces. A detailed study for the concept of sedimentary facies, facies association and succession, and facies modeling will be addressed, and the importance of these as key tools to interpret the depositional environments. The course also includes the study of the flow types and causes. A comprehensive study of sandstone rocks including a review of the compositional and chemical classification aspects, problem provenances, tectonic environments, digenetic environments and types of cementation, Principles of basin analysis, types of basins, their origin, and development. Tectonics and other controlling factors on basin fills. The global distribution of sedimentary basins in terms of the tectonic context and stratigraphic preservation.

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Course objectives

The course aims to introduce an advanced view for studying Sedimentology and Sedimentary Rocks.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Classify of sedimentary rocks types.
2. Distinguish the types of sedimentary rocks and describe them in the field.
3. Distinguish the different types of sedimentary rocks.
4. Identify and describe their components under a microscope.
5. Understand the concept of renewal of different sedimentation environments, depending on sedimentary rocks and their components.
6. Know the products of metamorphism processes on different sedimentary rocks.
7. Study, to describe and to sample sedimentary rocks in the field.

ES 641-Advanced Structural Geology and Tectonics (3 Cr. Hrs.)

Course description

The course includes: The study of the concepts of structural geology and tectonics, the study and analysis of the field, seismic, and experimental data and the structural analysis, deformational features such as: Faults (terminology, anatomy, displacement, distribution, identifying faults in oil fields, growth of fault population). Folds and folding (geometric description, mechanism, and processes. Joints (characteristics, formation, distribution, morphology, permeability, and fluid flow). Veins (types, formation, and economic importance). Active tectonics (morphotectonics, landforms of normal, reverse and strike slip faults, geomorphic indices, paleoseismology). Contraction regimes (contraction faults, thrust faults, thrusts and folds). Extensional regimes (extensional faults, rifts, half graben and accommodation zone, passive margins, and oceanic rifts). Transform regimes (strike slip faults, transfer faults, development, and anatomy of strike slip faults, transpression and transtension). Tectonics of the Dead Sea transform

The course includes a four-days field trip to south Jordan to study the geologic structures, with concentration on the active Dead Sea Transform fault, with a report submission. Each student will study, summarize, and give a talk of a published article about local or regional structural Geology.

Course objectives

This course aims to give an advanced view of structural geology, structural analysis, and tectonics.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Know the structural analysis methods and the necessary data for this analysis.
2. Revise information related to faults, folds, and joints which were studied at the undergraduate level, in addition of advanced information.
3. Understand the different aspects of active tectonics and paleoseismology and their implication on the Dead Sea Transform
4. Understand the different tectonic regimes (extension, contraction, and strike slip) and the associated major tectonic features
5. Recognize the geologic structures in the field especially the active ones through the field trips
6. Follow the new studies about the Dead Sea transform
7. Study and understand specialized scientific research topics in the field of structural geology and give talks.

ES 644- Advanced Remote Sensing and Geographic Information Systems (3 Cr. Hrs.: 2 hours theory, 1 hour practical)

Course description

The course includes: The fundamental goal of this course is to introduce students to the applications of GIS and remote sensing in geosciences. The first part of the course covers the following topics: major concepts, data sources, spatial analysis, spatial statistics (sampling, patterns, distribution, etc), spatial interpolation, terrain analysis, modelling and 3D analysis. The second part addresses the following topics: the principal concepts of remote sensing, remote sensing data and its characteristics, data processing, interpretation and extraction of information to serve different applications including Geologic mapping, structural Geology soils, hydrology, Geological hazards (landslides, soil erosion, etc.), and mineral exploration.

Course objectives

The fundamental goal of this course is to introduce students to the applications of GIS and remote sensing in geosciences.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Learn about the concept of remote sensing and how it works.
2. Identify the characteristics and types of space and aerial photos.
3. Interpret and process of space and aerial imagery.
4. Understand the fundamentals of geographic information systems.
5. Process and analyzing various geographical data.
6. Implement modeling operations in a GIS environment.
7. Use specialized programs to prepare applied projects on various topics.

ES 652-Advanced Hydrogeology (3 Cr. Hrs.)

Course description

The course includes: The study of the concept of the drainage basin, the geomorphological and geometrical elements of the drainage basin, the physics of evaporation, the different methods of measuring evaporation and evapotranspiration (energy transfer method, energy balance, evaporation ponds method and Penman method), condensation and precipitation theories, precipitation measurement methods, precipitation calculation methods for drainage basin, statistical analysis For rain data; Filtration and surface runoff and the factors affecting them, the most important methods used in calculating infiltration (Horton equation, phi index method, and single and double ring infiltrometers) flow and the concept of flow curve and the relationship between flow and precipitation and calculating the amount of runoff using (flow recorders, experimental equation (Rational) equation (SCS -CN.), The concept of flood frequency curve, and rain intensity curves - duration of precipitation - frequency; aquifers and their characteristics (porosity, permeability, aquifer conductivity, storage capacity), types of reservoirs and their recharge. Principles of groundwater movement to wells.Groundwater quality and chemistry. The course includes practical exercises on how to calculate and measure the different elements of the water cycle, exercises on statistical analysis of precipitation data, and how flood curves and (Intensity-Duration-Frequency) curves work.

Course objectives

The course aims to provide an advanced presentation of the general principles and foundations of hydrogeology.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Do drainage basin outline from a topographic map, aerial photos, and using geographic information systems and determine the geomorphological and geometrical characteristics of the drainage basin.
2. Know and measure evaporation, precipitation, percolation and flow in a variety of ways and do a drainage basin water budget.
3. Do flood analysis including; intensity, frequency and Intensity-Duration-Frequency curves work.
4. Know the concept of underground reservoirs, their types and characteristics.
5. Know the mechanism of groundwater flow into wells
6. Know the chemical components of groundwater and methods of measuring the concentrations of ions that make up the salinity of water.
7. Know how to display chemical analyzes and represent them graphically

ES 653-Advanced Engineering Geology (3 Cr. Hrs.)

Course description

The course is concerned with the study of engineering characteristics of soils and rocks, the methods and techniques used to determine their characteristics, site investigation, water content, subsurface water, slope stability analysis, types of foundations and the influence of subsurface water on the foundations, tunnel construction and construction materials. The course includes six laboratory sessions, two field trips, and writing a general report on the work.

Course objectives

The course aims at giving advanced coverage to the engineering geology and its applications.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Knows the types of foundations for engineering facilities.
2. Using inductive and practical methods to analyze the effect of subsurface water on foundations, steel, slope stability, and subsidence of structures.
3. Knows the types of tunnels, their parts, and the exploratory studies necessary for their construction and methods of construction.
4. Knows the methods used in on-site exploration and the elements of on-site exploration.
5. Distinguish and describe the types of construction materials and their properties.

ES 654-Advanced Petroleum Geology (3 Cr. Hrs.)

Course description

The course includes: A comprehensive interdisciplinary synthesis of different aspects related origin, early diagenesis, character, distribution, and bulk geochemical composition of sedimentary organic matter. There will be a thorough discussion of the processes, mechanisms, and the nature of the distribution of particular organic components and how it can be determined under microscopes. It emphasizes on the maturity of organic matter. It also focuses on the conventional and unconventional resources.

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components and how it can be determined under microscopes. It emphasizes on the maturity of organic matter. It also focuses on the conventional and unconventional resources. This course includes a field trip to the oil shale exposures in the north of Jordan. Students in this course work on project dealing with some examples of organic matter from Jordanian oil shales. In this project, students examine organic matter under microscope and report the paleoenvironment on basis of the type of organic matter.

Course objectives

This course aims to provide an advanced view of petroleum geology and its branches.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Describe the general aspects of the character of organic carbon in sediments.
2. Classify optically (palynologically) the various components of particulate organic matter based on their nature and their biological origin.
3. Explain their characterization by bulk geochemical methods and interpret the physical and ecological controls on their distribution in modern and ancient sediments.
4. Determine the maturity of organic carbons based on various methodologies.
5. Summaries the occurrences of giant petroleum provinces in the world and explain the reason of the hydrocarbon potentiality in these provinces.

ES 670-Advanced Environmental Geology (3 Cr. Hrs.)

Course description

The course includes: An advanced study of human interaction with different geological systems and studying the effects of natural geological hazards such as volcanic activities, earthquakes, landslides and floods, and methods of risk assessment and their implications, dealing and coexistence with them. The course includes topics related to the effects of human activity on natural systems such as groundwater quality and recharge, river systems, coastal hazards, natural sources, energy resources and pollution and includes (water sources and their pollution, mineral sources and their pollution, soil, the environment, energy sources and waste as a source and waste management). The concept of resource sustainability as a long-term concept. Environmental management from a global perspective. Climate change, geology and society. The course also includes some practical exercises to determine risks and methods of assessment, especially for some hazards, especially earthquakes, floods, and landslides.

Course objectives

The course aims to present an advanced presentation of environmental geology, studying natural hazards, and achieving the concept of sustainability.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Discuss the basic concepts of environmental geology and issues related to human population growth and its impact on the natural environment.
2. Understand the dynamics of the Earth as a complex system and the mechanism of occurrence of natural hazards.
3. Discuss the dangers arising from the basic natural hazards and the mechanism of dealing, coexistence and adapting to them.
4. Discuss methods and mechanisms to reduce natural hazards.
5. Determine the most important natural resources and methods of pollution and protection.

6. Understand the human relationship with the environment and discussing some global environmental issues such as climate change.

ES 671-Advanced Applied Geochemistry (3 Cr. Hrs.)

Course description

The course includes: This course includes a study of water-rock geochemistry and geochemical model study of atmospheric and water interaction with rocks, study of isotope geochemistry and geochemical exploration applications, environmental and geochemical modeling applications in the study of geological and environmental problem solutions. The course includes a class project addressing a local environmental topic. Students will be assigned short articles from the trace element chemistry of literature. They will present oral summaries of these articles to the class.

Course objectives

The course aims at giving the student an advanced presentation of applied geochemistry in the fields of rocks, water, and environment.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Understand the basics of hydrochemistry and environment.
2. Understand the interactive processes between the elements of atmosphere, water and rocks.
3. Link the theoretical geochemistry concepts in solving geological and environmental problems.
4. Establish appropriate design for field work, sample collection and handling.
5. Apply computer models to calculate the geochemical processes operating in the geological system in low and high temperature environments.

ES 677-Advanced Engineering and Environmental Geophysics (3 Cr. Hrs.)

Course description

The course includes: Seismic refraction tomography, surface seismic waves, shallow reflective seismic, electrical resistivity tomography (ERT), microgravity, magnetic gradiometry, ground penetrating radar (GPR), and borehole seismic and electric methods. Additionally, the course includes the study and clarification of uses and limitations, data processing, calibration of results with the outcomes of drilling and geotechnical studies, and the interpretation of data. This course involves the collection of real field data using available geophysical instruments, real data processing and interpretation or discussion of previous case studies.

The course includes the study and application of various geophysical methods in environmental and engineering studies and applications. The course introduces technical foundations, clarification of uses and limitations, data processing, calibration with drilling results and geotechnical studies, and interpretation of data. The course includes the following geophysical methods: seismic refraction tomographic, surface seismic waves, shallow seismic reflection, electric resistivity tomography, microgravity, gradiometric magnetism, ground penetrating radar, seismic and electrical well methods. This course includes the implementation of a research project and practical exercises related to collecting real field data using the available geophysical devices, processing real data, practicing the use of appropriate software, interpreting the data, and discussing previous case studies.

Course objectives

The course aims to studying and applying the different geophysical methods in environmental and engineering studies and applications.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Understand engineering and environmental problems that require geophysical investigation.
2. Analyze the problem and choose the appropriate geophysical methods to deal with the problem.
3. Sets the appropriate design for fieldwork and data acquisition.
4. Analyze readings and interpretation of results.
5. Prepare the final report and interpret the results.
6. Conduct a field research project or to comprehend previous case studies and presenting and defending of results.

ES 678-Advanced Earthquake Seismology (3 Cr. Hrs.)

The course covers: The study of earthquake physics and mechanics, seismic waves and propagation, locating earthquake locations and mechanisms of rupture, instrumentation and seismic networks, earthquake applications to study the internal and tectonic structure of Earth, methods of the assessment of seismic hazards and risk, mitigation processes, seismic activity of the Middle East, Especially focusing on the Dead Sea Transform fault system. Additionally, the course involves the implementation of the basic analyzes of seismic data and their interpretation using computer programs and practical exercises using recordings of modern seismic data for local or global seismic networks.

Course objectives

This course aims at studying the science of earthquakes and its various applications.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Understand the dynamics of the planet and its internal structure.
2. Deal with and analyzes seismic recordings.
3. Attain seismic attributes and presenting of results.
4. Realize seismic hazard and risk assessments, and mitigation processes.
5. Understanding the tectonic of the Dead Sea fault and its seismic effects.
6. Attain necessary skills to prepare necessary reports.

ES 679-Advanced Exploration Geophysics (3 Cr. Hrs.)

The course covers: The study of traditional geophysical, and modern surface and borehole methods in exploration operations. Studding geophysical applications related to subsurface studies to explore various natural resources using seismic methods, gravitational methods, magnetic methods, various electrical methods (electrical resistivity, inverse polarization), electromagnetic methods and geophysical well logging. This course aims at employing the integrated application of geophysical methods, processing, and interpretation of results.

Course objectives

This course aims to study advanced geophysical exploration methods and its various applications**.**

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Understand exploration related problems of various natural resources.
2. Identify the problem and to choose the appropriate geophysical methods.
3. Develop appropriate design for field work and data acquisition.
4. Analyze data and interpretation of results.
5. Conduct a field research project or to comprehend previous case studies and presenting and defending of results.
6. Prepare a final report and interpreting of results.

ES 691-Special Topics in Geology (3 Cr. Hrs.)

Course description

The course includes proposing special topics in geology chosen by the course instructor and in coordination with the department council, provided that the faculty member submits a detailed plan for the subject of the course to be presented, so that it covers 40 teaching hours.

Course objectives

The course aims to acquaint students with specific topics in geology that are not covered by the courses offered in the study plan.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Understand the different rationale for the topics at hand.
2. Identifying and describing geological research problems and their scientific implications.
3. Write reports and scientific abstracts.
4. Deal with various sources of knowledge and means of information technology such as libraries, global databases, search engines, and others.
5. Understand the commitment to scientific standards in terms of accuracy, use of scientific references, accurate scientific documentation, citation, standards of scientific publication and scientific integrity.

ENV 651-Advanced Soil Science (3 credit hours)

Course description

The course includes: Definition of soil for engineering, agronomy and environmental science; Soil origin and compositions; Soil classification (7th Approximation USA); Chemical characteristics of soils (pH, colloids, Ion- exchange capacity, adsorption); Soil air, soil water (solution) and aeration; Movement of water in soils (saturated flow and unsaturated flow); Clay minerals, organic matter and their surface chemistry; Physical characteristics (texture, structure, permeability, porosity, bulk density, temperature and color); Plant nutrients and soil plant relation; Soil erosion, compaction, pollution (agro-chemicals) and remediation.

Course objectives

The course aims to introduce students to soil science in engineering, geology, agriculture, and environment.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Describe how soils form and classify their components.
2. Knowledge of soil structure and physical properties.
3. Describe soil water, aeration, and temperature and its effect on living organisms.

4. Describe how soil interacts with the environment, focusing on water and nutrient cycling.
5. Study the interaction of the soil with plants and organisms.
6. Describe the evolution of soil organic matter and how this affects soil properties.
7. Understand how soil properties limit nutrient availability to the roots.
8. Learn about global climate and soil interactions.

ENV 652-Oceanography (3 credit hours)

Course description

The course includes the following topics: An introduction to the basic principles of ocean science: the geology of the ocean basins and the mechanisms of their development, the topography of the ocean floor and the different environments of the ocean floor, the chemistry of sea water, how it develops and the factors affecting it, the distribution of salinity and temperature in ocean waters, the factors that affect them, and the role of the oceans in the cycles of elements In particular the carbon cycle, the physical dynamics of ocean currents, ocean waves and tidal waves. Coastal processes, ocean floor sediments; the impact of human activity on ocean environments (global warming, coastal development, fisheries, alien species, coral bleaching), and the diverse ecosystems of Earth's oceans such as deep-sea thermal water vents, coral reefs and estuaries (bays).

Course objectives

The course aims to learn about the different aspects of oceanography (geology, geomorphology, chemical, biophysical, and environmental) and human influences.

Learning outcomes

After studying this course, the student is supposed to be able to:

1. Understand the geology of the ocean floor and the mechanism of ocean floor formation.
2. Know the topography of the ocean floor and the knowledge of the different environments of the ocean floor and the characteristics of each.
3. Recognize the ocean water movement's surface and deep ocean circulation and triggering mechanisms.
4. Understand the chemistry of sea water, how it is formed, and the factors affecting it.
5. Grasp the most important chemical and physical properties of ocean water.
6. Perceive the human impacts on marine environments and resources.
7. Understand the role of the oceans in global change.

ES 699A-Thesis (0 credit hours)

ES 699B-Thesis (3 credit hours)

ES 699C-Thesis (6 credit hours)

ES 699D-Thesis (9 credit hours)