

## الخطة الدراسية باللغة الانجليزية

The Department of Earth and Environmental Sciences offers a Bachelor's Degree on completion of the following requirements:

1. The fulfillment of the conditions stated in the regulations of awarding the Bachelor's degree. at Yarmouk University No. (2) for the year 1991 and its amendments issued in accordance with the bylaws of awarding academic degrees and diplomas at Yarmouk University No. 76 for the year 1976.
2. University course requirements stated under the above regulations.
3. Faculty of Science course requirements stated earlier.
4. Department course requirements (86 Credit Hrs.):

### **I. Single Major (86 Credit Hrs.):**

#### (1) Obligatory courses (63 Credit Hrs.):

Geo. 102, Chem. 102 , Geo. 105, Geo. 106, Chem. 105, Geo. 210, Geo. 213, Geo. 220, Geo. 222, Geo. 311, Geo. 331, Geo. 333, Geo. 340, Geo. 346, Geo. 348, Geo. 349, Geo. 350, Geo. 361, Geo. 452, Geo., 453, Geo. 455, Geo. 471, Geo. 475A.

#### (2) Elective courses (23 Credit Hrs.):

a - (15 Credit Hrs.) chosen from the 200 level courses or above in Geology.  
Geo. 215, Geo. 252, Geo. 301, Geo. 302, Geo. 334, Geo. 344, Geo. 352, Geo. 354, Geo. 355, Geo. 385, Geo. 411, Geo. 412, Geo. 425, Geo. 432, Geo. 444, Geo. 450, Geo. 456, Geo. 474, Geo. 476, Geo. 477, Geo. 479, Geo. 481, Geo. 482, Geo. 483, Geo. 484, Geo. 486, Geo. 491, Geo. 492, Geo. 499.

b - (8 Credit Hrs.) chosen from courses offered by the other Departments;  
Phys. 102, Phys. 103, Phys. 105, Phys. 106, Stat.105, Stat. 111, Chem.106, Chem. 211, Bio. 102, Bio. 105, Bio. 106, Env. 211A, Env. 251A, CS 130, CIS. 103, MIS 120.

**\* Env. 282 is equivalent to Geo. 282**

**Table (1)**  
**Single Major Credit Hours**

<b>Requirements</b>	<b>Obligatory</b>	<b>Elective</b>	<b>Total</b>
University	21	6	27
Faculty	21	0	21
Department	63	23	86
Total	<i>105</i>	29	<i>134</i>

**II. Major / Minor (86 Credit Hrs.):**

(1) Major in geology (65 Credit Hrs.)

a- Obligatory courses (62 Credit Hrs.):

Geo. 102, Geo. 105, Geo. 106, Chem. 102, Geo. 210, Geo. 213, Geo. 220, Geo. 222, Geo. 311, Geo. 331, Geo. 333, Geo. 340, Geo. 346, Geo. 348, Geo. 349, Geo. 350, Geo. 361, Geo. 452, Geo. 453, Geo. 455, Geo. 471, Geo. 475A.

b- Elective courses (3 Credit Hrs.)

Phys. 102, Phys. 202, Stat. 111, Chem. 211, Bio. 102, Env. 211A, Env. 251A, CIS. 103, MIS 120.

(2) Minor (21 Credit Hrs.) in any of the Departments of the Faculty of Science (including the Environmental Sciences in the Department of Earth & Environmental Sciences) and the Departments of the Faculty of Information Technology and Computer Science according to the minor course listing of each Department.

**Table (2)**  
**Major / Minor Credit Hours**

<b>Requirements</b>	<b>Obligatory</b>	<b>Elective</b>	<b>Total</b>
University	21	6	27
Faculty	21	0	21
Department	62	3	65
Minor	-	-	21

Total			134
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### III. Minor in Geology (21 Credit. Hrs.):

(1) Obligatory courses (14 Credit. Hrs.): Geo.102, Geo. 105, Geo. 106, Geo. 210, Geo. 220, Geo. 340.

(2) Elective courses (7 Credit. Hrs.): chosen from

Geo. 213, Geo. 215, Geo. 222, Geo. 252, Geo. 301, Geo. 302, Geo. 311, Geo. 331, Geo. 333, Geo. 334, Geo. 344, Geo. 346, Geo. 348, Geo. 349, Geo. 350, Geo. 352, Geo. 354, Geo. 355, Geo. 361, Geo. 385, Geo. 411, Geo. 412, Geo. 425, Geo. 432, Geo. 444, Geo. 450, Geo. 452, Geo. 453, Geo. 455, Geo. 456, Geo. 471, Geo. 474, Geo. 475A, Geo. 476, Geo. 477, Geo. 479, Geo. 481, Geo. 482, Geo. 483, Geo. 484, Geo. 486, Geo. 491, Geo. 492, Geo. 499.

**Table (3)**  
**The Significance of the Second Digit**

Num.	Title	Num.	Title
0	<i>General Geology</i>	5	Applied Geology
1	Fossils and Stratigraphy	6	Regional Geology
2	Minerals	7	Geophysics and Geochemistry
3	Rocks	8	Special Topics
4	Structural and Field Geology	9	Special Studies

**Table (4)**

### Courses Offered by the Earth and Environmental Sciences Department in geology

No.	Course No.	Course Name	Weekly Hours		Cr. Hrs.	Prerequisites
			Theory	Lab.		
1.	Geo. 101	General Geology (1)	3	-	3	-
2.	Geo. 102	General Geology (2)	3	-	3	Geo. 101
3.	Geo. 105	Practical Geology (1)	-	3	1	Geo. 101 or concurrent
4.	Geo. 106	Practical Geology (2)	-	3	1	Geo. 102 or concurrent
5.	Geo. 107	Geology for geography students	2	3	3	
6.	Geo. 109	Geology for archaeology students	2	3	3	
7.	Geo. 210	Invertebrate Paleontology	2	3	3	Geo. 102
8.	Geo. 213	Stratigraphy and Historical Geology (1)	2	3	3	Geo. 210
9.	Geo. 215	Paleobotany	2	3	3	Geo. 102
10.	Geo. 220	Mineralogy	2	3	3	Geo. 105, Geo.102
11.	Geo. 222	Optical Mineralogy	2	3	3	Geo. 220

12.	Geo. 252	Hydrology	2	3	3	Geo. 102
13.	Geo. 301	Geomorphology	2	3	3	Geo. 102
14.	Geo. 302	Surveying	1	3	2	Geo. 106, Geography. 271
15.	Geo. 311	Micropaleontology	2	3	3	Geo. 210
16.	Geo. 331	Igneous and Metamorphic Rocks	3	3	4	Geo. 222

17.	Geo. 333	Sedimentary Rocks	2	3	3	Geo.222+Geo.213
18.	Geo. 334	Carbonates and Evaporates	2	3	3	Geo. 333
19.	Geo. 340	Structural Geology (1)	2	3	3	Geo. 106, Geo. 213
20.	Geo. 344	Field Excursions	1	3	2	Geo. 333, Geo. 340
21.	Geo. 346	Field Geology	-	12	4	Geo. 333, Geo. 340
22.	Geo. 348	(GIS) Geographic Information Systems	1	3	2	Ci 100, Geo 213
23.	Geo. 349	Remote sensing in Geology	1	3	2	Geo 333, Geo. 348
24.	Geo. 350	Economic Geology (1)	2	3	3	Geo. 331, Geo. 333
25.	Geo. 352	Economic Geology (2)	2	3	3	Geo. 350
26.	Geo. 354	Computer Applications in Geology	2	3	3	Geo. 340, Ci 100
27.	Geo. 355	Geostatistics	1	3	2	Stat. 101
28.	Geo. 361	Geology of Jordan	3	-	3	Geo. 331, Geo. 333
29.	Geo. 385	Research methods in Geology	2	-	2	Department approval
30.	Geo. 411	Vertebrate Paleontology	2	3	3	Geo. 210
31.	Geo. 412	Palaeoecology	3	-	3	Geo. 210
32.	Geo. 425	Principles of Clay Mineralogy and Their Applications	2	3	3	Geo. 220
33.	Geo. 432	Industrial Rocks and Minerals	2	3	3	Geo. 350
34.	Geo. 444	Geotectonics	2	-	2	Geo. 340
35.	Geo. 450	Exploration Geology	2	3	3	Geo. 350
36.	Geo. 452	Applied Hydrogeology	2	3	3	Geo. 333
37.	Geo. 453	Petroleum Geology	2	3	3	Geo. 333, Geo. 340
38.	Geo. 455	Engineering Geology	2	3	3	Geo. 333, Geo. 340
39.	Geo. 456	Rock and Soil Mechanics	2	3	3	Geo. 455
40.	Geo. 471	Applied Geophysics	2	3	3	Geo. 340
41.	Geo. 474	Engineering Geophysics	2	3	3	Geo. 471
42.	Geo. 475	Principles of Geochemistry	3	-	3	Geo. 331, Geo. 333
43.	Geo. 476	Hydrochemistry	2	3	3	Geo. 452
44.	Geo. 477	Applied Geochemistry	2	3	3	Geo. 475
45.	Geo. 479	Subsurface Geology and Well Logging	2	3	3	Geo. 333, Geo. 471
46.	Geo. 481	Advanced topics in Geology	3	-	3	Department approval
47.	Geo. 482	Marine Geology	3	-	3	Geo. 333
48.	Geo. 483	Advanced Topic in Geophysics	2	3	3	Geo. 471
49.	Geo. 484	Seismology	2	3	3	Geo. 340

50.	Geo. 486	Quaternary Geology	3	-	3	Department approval
51.	Geo. 491	Seminar	1	-	1	Department approval
52.	Geo. 492	Special Topics	3	-	3	Department approval
53.	Geo. 499	Research	3	-	3	Department approval

#### IV. Minor in Environmental Sciences (21 Credit. Hrs.):

a- Obligatory courses (15 Credit. Hrs.):

Env. 101B, Env. 211A, Env. 251A, Env. 316, Env. 361

b- Elective courses (6 Credit. Hrs.): Chosen from

Env. 252, Env. 255, Env. 271, Env. 282, Env. 301, Env. 311, Env. 315, Env. 320, Env. 323, Env. 324, Env. 325, Env. 328, Env. 351, Env. 357, Env. 362, Env. 363, Env. 364A, Env. 376, Env. 381, Env. 392, Env. 399.

**Table (5)**  
**The Significance of the Second Digit**

Num.	Title	Num.	Title
0	General Environment	5	Water and Air
1	Climate and Soil	6	Environmental Management and Protection
2	Pollution and Environmental hazards	7	Natural Resources
3	-----	8	Energy
4	-----	9	Research or Seminar or Special Topics

**Table (6)**  
**Courses Offered by the Earth and Environmental Sciences Department  
in Environmental Sciences**

No.	Course No.	Course Name	Weekly Hours		Cr. Hr.	Prerequisites
			Theory	Lab.		
1.	Env. 100	Environment and Society	3	-	3	-
2.	Env. 101A	Environmental Sciences (1)	3	-	3	-
3.	Env. 101B	Environmental Sciences (2)	3	-	3	-
4.	Env. 103	General Environmental Science (For Non Science Students)	3	-	3	-
5.	Env. 211A	Soil Sciences and Pollution	2	3	3	Env. 101B
6.	Env. 251A	Water Systems and Pollution	3	-	3	Env. 101B

7.	Env. 252	Environmental Hydrology	3	-	3	Env. 101B
8.	Env. 255	Water laboratory	-	3	1	-

Table (6) (Continued)

9.	Env. 271	Wildlife in Jordan	3	-	3	Department approval
10.	Env. 282	Introduction to Marine Science	3	-	3	Department approval
11.	Env. 301	Environmental Geomorphology	3	-	3	Env. 101B
12.	Env. 311	Climatology and Meteorology	3	-	3	Department approval
13.	Env. 315	Environmental Geology ( for non Geology Students)	3	-	3	Department approval
14.	Env. 316	Assessment of Environmental Impact	3	-	3	Env. 101B
15.	Env. 320	Modern Organization and Management Methods	2	-	2	Department approval
16.	Env. 323	Solid Waste	3	-	3	Department approval
17.	Env. 324	The Role of Geology in the Management of Dangerous Waste	3	-	3	Department approval
18.	Env. 325	Air Pollution	3	-	3	Department approval
19.	Env. 328	Radiation Pollution	3	-	3	Department approval
20.	Env. 351	Marine Environment	3	-	3	Department approval
21.	Env. 356	Geographic Information System*	2	3	3	Cs 100 , Env. 211A, Env. 251A
22.	Env. 357	Water Reservoirs (Dams)	3	-	3	Env. 251A
23.	Env. 361	Management of Environmental Systems	3	-	3	Department approval
24.	Env. 362	Environment Protection	3	-	3	Env. 361
25.	Env. 363	Planning and Land Use	3	-	3	Env. 361
26.	Env. 364A	Remote Sensing in the Environment	3	-	3	Department approval
27.	Env. 376	Environmental Chemistry	3	-	-	Env. 211A, Env. 251A
28.	Env. 381	Sources of Energy and Their effects on the Environment	3	-	3	Env. 101B
29.	Env. 391	Seminar	1	-	1	Department approval
30.	Env. 392	Special Topics	3	-	3	Department approval
31.	Env. 399	Research	3	-	3	Department approval

\* Env. 356 is equivalent to Geo. 348

## الخطة الإرشادية باللغة الانجليزية

### Guide Plan (Earth and Environmental Science)

#### First Year

First Semester		Second Semester	
<u>Course</u>	<u>Credit-hrs</u>	<u>Course</u>	<u>Credit-hrs</u>
Geo. 101	3	Geo. 102	3
Geo. 105	1	Geo. 106	1
Chem.101	3	Chem.102	3
Chem.105	1	Bio. 101	3
Math. 101	3	Eng. 111	3
Eng. 101A	3	Cis. 101	3
Phys. 101	3		
<b>Sum</b>	17 Credit hrs	<b>Sum</b>	16 Credit hrs

#### Second Year

First Semester		Second Semester	
<u>Course</u>	<u>Credit-hrs</u>	<u>Course</u>	<u>Credit-hrs</u>
Geo. 210	3	Geo. 213	3
Geo. 220	3	.Geo. 222	3
Ar. 100	3	Ar. 102	3
Stat. 101	3	Geo. 348	2.
Elective course	3	elective	3
		elective	3
<b>Sum</b>	15 Credit hrs	<b>Sum</b>	17 Credit hrs

### Third Year

First Semester		Second Semester	
<u>Course</u>	<u>Credit-hrs</u>	<u>Course</u>	<u>Credit-hrs</u>
Geo. 311	3	Geo. 350	3
Geo. 331	4	Geo. 361	3
Geo. 333	3	Geo. 452	3
Geo. 340	3	Geo. 455	3
elective	3	elective	3
<b>Sum</b>	16 Credit hrs	<b>Sum</b>	15 Credit hrs

Summer Year	
<u>Course</u>	<u>Credit-hrs</u>
Geo. 346	4
elective	3
<b>Sum</b>	7 Credit hrs

### Fourth Year

First Semester		Second Semester	
<u>Course</u>	<u>Credit-hrs</u>	<u>Course</u>	<u>Credit-hrs</u>
Geo. 349	2	Geo. 453	3
Geo. 471	3	elective	3
Geo. 475	3	elective	3
elective	3	elective	3
elective	3	elective	3
elective	2		
<b>Sum</b>	16 Credit hrs	<b>Sum</b>	15 Credit hrs

## وصف المساقات باللغة الانجليزية

### **Geo. 101 - General Geology (1)**

**(3 credit hrs.)**

Nature and structure of the earth. Minerals and rocks. Composition of the Earth's crust. Endo-dynamic forces. Principles of structural geology, earthquakes, volcanoes, taphrogenesis and plate tectonics. The stratigraphic column and introduction to the geology of Jordan

### **Geo. 102 - General Geology (2)**

**(3 credit hrs.)**

Exo-dynamic forces, weathering and gravitational movements of Earth materials, ground and surface water, wind, glaciers, seas, lagoons and oceans as external geological agents..

### **Geo. 103 - Introduction to Geology**

**(3 credit hrs.)**

This course will cover basic Physical and historical geological concepts. These will include the Following: Minerals, Rocks, their Types and properties, Weathering and erosion, Clay minerals and their uses, Geological time (With emphasis on the), Quaternary, Geological hazards (Earthquakes and Volcanoes). Geophysical survey.

### **Geo. 105 - Practical Geology (1)**

**(1 credit hr.)**

Crystal systems and the elements of symmetry. Mineralogy and mineral groups. Igneous, sedimentary and metamorphic rocks: Types and textures. Field trips.

### **Geo. 106 - Practical Geology (2)**

**(1 credit hr.)**

Topographic maps, geologic maps, structural geology, field trips and geological observation.

### **Geo. 107 – Geology for the Geography Students.**

**(3 credit hr.)**

Theory : Introduction, minerals and their groups, Igneous rocks, sedimentary rocks, metamorphic rocks, weathering of rock, external processes, surface and ground water desert and agents of erosion, earthquakes, volcanism.

Lab : Physical properties of minerals, mineral groups, igneous sedimentary and metamorphic rocks, topographic maps, geologic maps, geologic sections, field trips to the surrounding areas.

### **Geo. 109 – Geology for the archeology students**

**(3 credit hrs.)**

Theory : Introduction , mineral groups and their physical properties, igneous rocks, sedimentary rocks, metamorphic rocks, types of weathering, agents of weathering, earthquakes, geologic time, geologic dating, geology of the archeological sites in Jordan.

Lab : Mineral groups, physical properties of minerals, igneous sedimentary and metamorphic rocks, field trips to the surrounding archeological sites to study the building stones and the effect of time agents on them.

### **Geo. 210 - Invertebrate Paleontology**

**(3 credit hrs.)**

Formation of fossils, classification of invertebrate fossils and their correlation with other biota in the geological column.

### **Geo. 213 - Stratigraphy and Historical Geology**

**(3 credit hrs.)**

Marine and continental sedimentary basins, paleoclimatology, stratigraphic correlation, geological eras and ages. Stratigraphy of the Arab countries.

**Geo. 215 – Paleobotany**

**(3 credit hrs.)**

Preservation of plant fossils, classifications of plants, algae, spores plants, gymnosperms, angiosperms, introduction of palynology, ecology of the different plant groups, flora from different geological periods.

**Geo. 220 - Mineralogy**

**(3 credit hrs.)**

Crystallography, crystal chemistry, physical and chemical properties of minerals. The origin of minerals, occurrences, systematic mineralogy. Economic and industrial uses of minerals..

**Geo. 222 - Optical Mineralogy**

**(3 credit hrs.)**

Optical properties of minerals under the microscope using plane polarized, crossed nicols and conoscopic light. Structural classification of minerals and their optical properties with special emphasis on silicates.

**Geo. 252 – Hydrology**

**(3 credit hrs.)**

Hydrological cycle, the earth's atmospheric system, meteorological data, precipitation, evaporation and transportation, surface run off, rivers and drainage systems, hydrograph methods and rating curve, unit hydrograph, Karst hydrograph, infiltration, occurrence of ground water, aquifer system, groundwater movement.

**Geo. 282 - Introduction to Marine Science**

**(3 credit hrs.)**

Hydrological cycle, physical characteristics of sea water, temperature, salinity, density, pressure, relation of marine geology with other branches of oceanography, major division of marine organisms with emphasis on certain specimens.

**Geo. 301 - Geomorphology**

**(3 credit hrs.)**

Definition of the science and its relation to other sciences. Composition of the Earth's crust. Weathering and geomorphic features. Mechanical weathering, chemical weathering, mass wasting and associated geomorphic features, landslides, soil creep, the fluvial geomorphic cycle, types of surface flow, stream erosion, stream flow, deltas, alluvial fans and flood plains, river terraces and their significance. Springs, karst topography, caves and associated phenomena. Glaciers and distribution of coastal geomorphology, marine geomorphic features: Platforms and continental shelves. Topography of the deep sea. Desert features, wind erosion, dunes and loess. Geomorphic features resulting from diastrophism, volcanic activities and their impact on earth features. Earthquakes and their influence on the development of the Earth's surface, fractures and folding.

**Geo. 302 – Surveying**

**(2 credit hrs.)**

Definition of surveying and its importance. Types of surveys and basic definitions. Different methods in representing a sphere in two dimensions. Topographic maps. Instruments. Level, theodolite, plane table, aerial photographs, photogeology, construction of topographic maps. Field applications.

**Geo. 311 – Micropaleontology**

**(3 credit hrs.)**

Foraminifera, ostracods and other micro fossils as a tool for stratigraphic correlation. Field training for the collection of samples, separation of fossils, identification and interpretation.

**Geo. 331 - Igneous and Metamorphic Rocks (4 credit hrs.)**

The interior of the Earth. The role of magma in geologic processes. Igneous rock forming minerals. Textural, mineralogical and chemical classification and description of the different types of igneous rocks. Igneous rock series (intrusive and extrusive). Generation and evolution of magmas. Metamorphism, mechanisms and metamorphic processes. Textural, mineralogical, chemical and facies classification of the different metamorphic rocks.

**Geo. 333- Sediments and Sedimentary Rocks (3 credit hrs.)**

Studying the texture, composition, environments and classification of sedimentary rocks. The relationship to geological structures. Macro and microscopic examination of different sedimentary rocks. Field excursions.

**Geo. 334 - Carbonates and Evaporates (3 credit hrs.)**

Mineralogy and mode of formation, crystal chemistry and the mechanisms of calcium carbonate equilibria, classifications of carbonates, structure classification of evaporates, thermo and solution diagenesis of salt minerals, chemical considerations and the mechanism of formation of dolomite, excess of dolomites as an indicative of the environment, the behavior of Sr, Zn and Mn during carbonate diagenesis, the behavior of Br, Sr, B and F during the salt deposition, the silicate evaporates deposition in recent lakes.

**Geo. 340 - Structural Geology (1) (3 credit hrs.)**

The major types of structures, analysis of forms, classification of structural deformation. Modern theories in structural geology.

**Geo. 344 - Field Excursions (2 credit hrs.)**

The course is based mainly on making regular field trips to nearby areas of distinct structural and geological significance. Instruction on how to orient and locate a site on a topographic sheet, to detect and trace geologic features (contacts, faults, unconformities, etc.) both in nature and on the maps.

**Geo. 346 - Field Geology (4 credit hrs.)**

Geological survey of an area of about 10 Km<sup>2</sup>, including the study of aerial photographs. Geological profiles of the mapped area as well as a report on various field activities is required.

**Geo. 348 – Introduction to GIS (2 credit hrs.)**

Introduction the basics of geographic information systems including the different models of GIS (vector and raster), sources of GIS data, data preparation and processing, the applications of GIS in different disciplines in particular the geosciences and environmental sciences.

**Geo. 349 – Introduction to remote sensing (2 credit hrs.)**

Introduction to the basics of remote sensing science; aerial photography and interpretation, satellite imagery, type, interpretation and application.

**Geo. 350 - Economic Geology (1) (3 credit hrs.)**

A brief history of the use of minerals and the development of economic geology, mineral formation, ore formation, magma and magmatic deposits, late magmatic deposits, pegmatites, hydrothermal mineral deposits, fissure veins, metasomatic and replacement deposits. Genesis and forms of metallic minerals such as nickel, copper, lead, zinc, manganese, gold, silver as well as non-metallic deposits such as phosphate and uranium. Economic deposits from different parts of the world are discussed.

**Geo. 352 - Economic Geology(2)****(3 credit hrs.)**

Nature mineral deposits, mineral deposit of mafic ultramafic, and acidic rocks, Sedimentary Mineral deposits of Iron and manganese, Sedimentary deposits, vein deposits, melanuphie deposits mineralization and plate tectonics, nonmetallic deposits, their nature and classification. Industrial rocks and Minerals their nature, process of formation and distribution. Case history.

**Geo. 354 - Computer Applications in Geology****(3 credit hrs.)**

The main component of computers, introduction to computer applications in Geology, the objectives of data collection and recording, set theory, types of data elements, sampling theory, representation of data for the computer, interpretation, cluster analysis, analysis of orientation data, correlation analysis of qualitative data, symbol plotting and value posting, application of ready packages.

**Geo. 355 – Geostatistics****(2 credit hrs.)**

Statistics and measurements in the earth sciences, probability, distribution, sampling and test of significance, correlation and regression, analysis of variance, non-parametric statistics, conclusion.

**Geo. 361 - Geology of Jordan****(3 credit hrs.)**

Topography, geomorphology, structure, stratigraphy and geological evolution of Jordan as part of the Middle East, with emphasis on mineral, petroleum and water resources and their distribution in the different rock units. Field trips and seminars. Prerequisite: Geo. 213.

**Geo. 385 – Research Methods in Geology****(2 credit hrs.)**

Purpose of this course :

This course is designed to introduce undergraduate students to the processes of scientific research and the design of research projects as applied to modern geosciences. The course will focus on designing and conducting geologic field and laboratory based studies, scientific writing skills, public presentation, and professional ethics.

**Geo. 411 - Vertebrate Paleontology****(3 credit hrs.)**

Origin of vertebrates, jawless vertebrates, the fishes and their evolution and classification, the move of vertebrates from water to land, the evolution of the amphibians since their first appearance in late Devonian and their classification and distribution, the reptiles and their radiation classification and evolution through geological time since their first appearance in carboniferous, the appearance of the dinosaurs in Triassic and their radiation, diversity and evolution in jurassil and cretaceous and their extinction in late cretaceous, evolution of birds and the evolutionary development of the feathers and flying apparatus, the origin of mammah and their classification and radiation, the primates and their early fossils, evolution and radiation, the appearance of human.

**Geo. 412 – Paleoecology****(3 credit hrs.)**

Introduction, depositional environments, classification of organisms, material structure of hard parts of organisms, biostratinomy, biocaenosis, bioturbation, classification of trace fossils, trace fossils as indicators of depositional environment, palaeo-ecology of different geological periods.

**Geo. 425 - Principles of Clay Mineralogy and Their Applications (3 credit hrs.)**

Clay materials and factors controlling their properties, phyllosilicates and their classification, ionosilicate, x-ray identification of clay minerals, ion exchange capacity and sorption, origin and methods of formation of clay minerals, uses of clay in industries.

**Geo. 432 - Industrial Rocks and Minerals (3 credit hrs.)**

The study of industrial rocks and minerals from the aspects of geology, mineralogy, specification, classification and modern technological trends. Industrial rocks: Granite, basalt, pumice, perlite, slate, marble, sand and gravelly sandstone, clay minerals, limestone and dolomite, phosphate, gypsum and halite. Industrial minerals: Flourspar mica, beryl, asbestos, graphite, talc, sulfur, diamond, diatomite, potash, sodium minerals, borates. Practical work: Study of methods used in identification of rocks and minerals using SEM, X-Ray.

**Geo. 444 – Geotectonics (2 credit hrs.)**

Structural patterns and their analysis. Evolution of continents and mountain building, modern plate tectonic theory, sea floor spreading, continental currents, heat flow. Structural units in the crust and plates.

**Geo. 450 - Exploration Geology (3 credit hrs.)**

The geologic base line, ore value and concept of ore body, gathering and processing of geologic data, mapping surface geology, geologic mapping in underground mines, exploration geophysics, exploration geochemistry and geobotany, drilling for geologic information, sampling ore bodies, preparing geologic data for communication, the geologist's role in exploration, exploration programs.

**Geo. 452 – Applied Hydrogeology (3 credit hrs.)**

Elements of hydrogeology cycle: Evaporation, Condensation, Precipitation Runoff and stream flow, infiltration, type of flow. Groundwater: aquifers and aquifer properties, Principles of groundwater flow. Groundwater flow to wells, Methods of groundwater investigation, groundwater quality and chemistry. Groundwater in Jordan.

**Geo. 453 - Petroleum Geology (3 credit hrs.)**

Introduction to petroleum geology and petroleum exploration. Theories about generation and migration of hydrocarbons. Physical and chemical properties of oil and gas. The subsurface environment and its impact on hydrocarbon generation, migration, accumulation and trapping. Sub-surface water, temperature, pressure and hydrodynamics. Physical properties of reservoirs (porosity, permeability and relationships). Classification of traps, methods of exploration (geological, geophysical, drilling and formation evaluation). Worldwide distribution of hydrocarbon accumulations. Petroleum in Jordan, hydrograph analysis, component of hydrographs, direct runoff unit hydrograph, design of dams.

**Geo. 455 - Engineering Geology (3 credit hrs.)**

This course intends to cover the following subjects: the presence of liquids within earth material and their impacts on the physical and geomechanical properties of this material, geological processes (weathering, erosion, and tectonic activity), river engineering and the influence of surface water on the construction sites within river basins and along coastal areas, and studying the stability of slopes, sinkholes and landfill and treatment plant areas.

**Geo. 456 -Mechanical Rocks and Soil (3 credit hrs.)**

Basic Characteristics of soil, seepage, acting on soil (side pressure, shear pressure), consolidation theory, Engineering characteristics of rocks, geometrical analysis of geologic structures, site investigation.

**Geo. 471 - Applied Geophysics (3 credit hrs.)**

Study of various applied geophysical methods, instrumentation and field methodology. Analysis of physical parameters and geophysical anomalies to interpret sub-surface geological structures. Geophysical methods include gravity, magnetic, electric, seismic, geothermal and integrated geophysical studies.

**Geo. 474 - Engineering Geophysics**

**(3 credit hrs.)**

Introduction to geophysical site investigations, decision-making and applied concepts. Electrical and seismic refraction methods. Case studies.

**Geo. 475 - Principles of Geochemistry**

**(3 credit hrs.)**

This course is designed to give students an understanding of the earth and universe as a chemical system. Also, students are taught how to put geochemical data into a geological perspective. Course contents includes an introduction of the Earth and its crust, geochemical classification of the elements, chemical thermodynamics and its utility in geology, crystal chemistry, isotope geochemistry, hydrogeochemistry, geochemistry of igneous, metamorphic and sedimentary rocks.

**Geo. 476 - Hydrochemistry**

**(3 credit hrs.)**

Introduction, importance of water to life, the chemical composition of water, basic chemical terminology. Physical and chemical properties of water, salinity. Chloride, carbonate, sulfate, calcium, magnesium, sodium, potassium. Chemistry and source of trace elements in water, dissolved gases, oxygen, nitrogen, CO<sub>2</sub> - HCO<sub>3</sub> - CO<sub>3</sub> systems in fresh and saline water. Alkalinity, other gases, solutes in water. Nitrogen compounds, phosphorus, silicate, organic compounds, acidity and alkalinity. Types of water hardness.

**Geo. 477 - Applied Geochemistry**

**(3 credit hrs.)**

Distribution of elements in rocks, anomalies, analytical methods, finding low-level anomalies. Soil composition, elemental distribution in soils, primary and secondary distribution, types of elemental bonding, geochemical exploration methods, increasing exploration efficiency sampling, sample analysis, results and interpretation. Geochemical exploration of petroleum, organic chemistry.

**Geo. 479 - Subsurface Geology and Well Logging**

**(3 credit hrs.)**

Geophysical exploration methods, seismic stratigraphy, well logging, subsurface facies analysis, core cutting description, core analysis, subsurface structural maps, preparation and use of thickness map, unconformity analysis, basin classification, reserve estimation.

**Geo. 481 - Advanced Topics in Geology**

**(3 credit hrs.)**

Detailed and extensive study of a special topic from a chosen geological discipline.

**Geo. 482 - Marine Geology**

**(3 credit hrs.)**

Historical review, distribution of oceans, the origin of sea water, temperature, salinity, ocean currents, gases, continental slopes. Factors affecting sedimentation on continental slopes, the importance of the continental shelf as a source of minerals and petroleum, the continental rise, sedimentation and processes affecting the continental rise. Manganese nodules, drowned valleys, warm currents. Glaciation and fluctuation of sea level, paleoenvironmental indicators.

**Geo. 483 – Advanced Topics in Geophysics**

**(3 credit hrs.)**

Deals with exploration methods (radar, low frequency electromagnetic, self induction, geoelectric receptivity tomography, induced and self potential polarization, earth currents, radioactive, heat flow technique and field surveys and their interpretations.

**Geo. 484 – Seismology**

**(3 credit hrs.)**

Introduction to seismology, development of seismology, causes, impacts of earthquakes, seismic waves, seismic stations, seismic coefficient, seismic wave distribution, locating earthquake epicenter earthquake risk, intensity maps of earthquakes, acceleration, earth structure through seismic data, seismicity of Jordan rift.

**Geo. 486 - Quaternary Geology**

**(3 Credit hrs.)**

Introduction to climate and climatic changes, the impacts of this change on the ice cover, ice cover, retreat, sea level rise, distribution of glaciers and rocks and their characteristics.

**Geo. 491 – Seminar**

**(1 credit hrs.)**

**Geo. 492 - Special Topics**

**(3 credit hrs.)**

**Geo. 499 – Research**

**(3 credit hrs.)**

**Course Description of the Minor Specialization  
Courses in the Environmental Sciences in the Department of  
Earth and Environmental Sciences**

**Env. 100 - Environment and Society (3 credit hrs.)**

Environmental concepts, environment components (biotic and abiotic), natural ecosystems, anthropogenic ecosystem. The human community and its effects on the environment, local and international environmental problems. Reserves and their role in protecting endangered species. Local examples.

**Env. 101A - Environment Sciences (1) (3 credit hrs.)**

Introduction to the environment. The atmosphere, hydrosphere, pedosphere, lithosphere and biosphere. Natural ecosystems, biotic and abiotic components. Ecological principles. The flow of energy in the ecosystem. Food chains and food webs. Biological concentrations of chemicals in food chains and webs. Biogeochemical cycles, carbon and oxygen cycles. The nitrogen cycle, water cycle, acme range and limiting factors, succession and climax. Major types of ecosystems, terrestrial ecosystems, aquatic ecosystems, swamp ecosystems and anthropogenic ecosystem. Solid waste.

**Env. 101B - Environment Sciences (1) (3 credit hrs.)**

Introduction to the environment. The atmosphere, hydrosphere, pedosphere, lithosphere and biosphere. Natural ecosystems, biotic and abiotic components. Ecological principles. The flow of energy in the ecosystem. Food chains and food webs. Biological concentrations of chemicals in food chains and webs. Biogeochemical cycles, carbon and oxygen cycles. The nitrogen cycle, water cycle, acme range and limiting factors, succession and climax. Major types of ecosystems, terrestrial ecosystems, aquatic ecosystems, swamp ecosystems and anthropogenic ecosystem. Solid waste. Population growth, the environment and human health, food energy, land use management, non-renewable resources. Water, air and sources of pollution. Energy sources and uses.

**Env. 103 – General Environment Science (3 credit hrs.)**

Introduction to the environment, the atmosphere, hydrosphere, lithosphere, pedosphere. Ecosystems including the biotic and abiotic components. Energy flow and the food web. Biogeochemical cycles. Man and environment, ancient and modern land use. Man and environmental change past and present, Evolution and development of Man from an environmental perspective. Past and current climate change.

**Env. 211A - Soil Science and Pollution (3 credit hrs.)**

Introduction, soil classification, soil formation factors. Physical, chemical and biological properties of soil, soil description. The practical part of the course includes 12 laboratory experiments related to soil sciences.

**Env. 251A - Water System and Pollution (3 credit hrs.)**

Study of saline water systems, fresh water systems, sources of pollution, chemical inorganic pollutants, heavy metal pollution, dissolved salts (Ammonia, nitrate, phosphate, etc.).

**Env. 252 – Hydrology (3 credit hrs.)**

Hydrologic cycle, evaporation and precipitation. Drainage basin analysis, runoff and stream flow, surface water quality. Infiltration and soil moisture. Groundwater, types of aquifers. Groundwater recharge and movement, ground water quality. Natural and human impact on water resources.

**Env. 255 – Water laboratory****(1 credit hr.)**

Analysis of topographic maps & hydrograph analysis & separation, water level contour map. Groundwater pollution through pumped wells, physical properties of water, suspended and dissolved contents. Chemical analysis of water (Major cations & anions), B O D and C O D tests. Biological analysis of water, field trips.

**Env. 271 - Wildlife in Jordan****(3 credit hrs.)**

Biogeographical distribution, wildflowers in Jordan, (distribution, density, species, diversity and endangered species). Wild fauna (Reptiles, mammals and birds. Their distribution and density). Problems of wildlife in Jordan. The importance of wildlife conservation, parks and reserves. Jordan's national strategy for wildlife conservation, laws and regulations.

**Env. 282 - Introduction to Marine Science****(3 credit hrs.)**

Hydrological cycle, physical characteristics of sea water, temperature, salinity, density, pressure, relation of marine geology with other branches of oceanography, major division of marine organisms with emphasis on certain specimens.

**Env. 301 – Environmental Geomorphology****(3 credit hrs.)**

Surficial processes and landform development as controlled by climate, geomorphic processes and soil sequences, analysis of drainage basins, weathering, erosion, mass wasting, surface water, groundwater, desert geomorphology, stream flow, climate change and landscape development. Changes in geomorphic activity resulting from human impact, geomorphic processes and natural hazards.

**Env. 311 - Climatology and Meteorology****(3 credit hrs.)**

Principle concepts. Stratification of the atmosphere, atmospheric energy, the sun and its role in atmospheric circulation, the dynamic atmosphere and balance. Monitoring of climatic components, atmospheric system, atmospheric conditions, cloud physics, methods of climate prediction.

**Env. 315 - Environment Geology (for non Geology Students)****(3 credit hrs.)**

Principle concepts, natural hazards (Floods, landslides, earthquakes, volcanoes, storms and cyclones, natural weathering). The effect of human activities on the Earth's surface (water use, urbanization, industry, agriculture, weathering), various land uses.

**Env. 316 - Assessment of Environmental Reflection****(3 credit hrs.)**

Main principles, handling environmental reflection, important methods and techniques for environmental reflection, advantages of environmental reflection, inspection of environmental hazards, assessment of reflection and procedure to control environmental hazards, management and inspection of environmental hazards. Local and international case studies.

**Env. 320 - Modern Organization and Management Methods****(2 credit hrs.)**

Basic concepts, land and its natural properties, development approaches. Modern organization and market economy. Modern planning in the view of land owners, importers, investors and the public sector. Land development, forces affecting land development, local and international case studies.

**Env. 323 - Solid Waste****(3 credit hrs.)**

Introduction to solid waste, sources of solid waste, (municipal, industrial, agricultural, sludge, mining, building and demolition wastes). Collection and transport, transfer stations, treatment and disposal, marine dumping, sanitary landfills, incineration, pyrolysis and recycling.

**Env. 324 -The Role of Geology in the Management of Dangerous Waste (3 credit hrs.)**

Concepts of general geological and hydrogeological principles, geological techniques, subsurface geology, applied geophysics, waste properties, subsurface processes, landfill sites and waste processing.

**Env. 325 - Air Pollution (3 credit hrs.)**

Introduction, air pollutants (gas and particles pollutants), distribution of pollution, sources of air pollution (industry, transportation, agriculture), effects of pollution on humans and animals, flora, materials, buildings and climate, prevention of air pollution, measurement of air pollution, monitoring of air pollution, air pollution control, laws and administration.

**Env. 328 - Radiation Pollution (3 credit hrs.)**

Principle concepts of radiation. Dosimetry and determination of safe doses, sources of radiation (natural and man made), uses of radioactive materials, radiation effects on humans and the environment, radioactive waste, management of radioactive waste, protection from radioactive waste. Cycling of radioisotopes in the environment.

**Env. 351 - Marine Environment (3 credit hrs.)**

Characters of marine ecosystems, (salinity, temperature, pressure, stratification of water, waves, sea tides). River estuaries environments, reefs and marshes, coastal environments, shallow and deep oceans.

**Env. 356 - Geographic Information Systems . (3 credit hrs.)**

Definition of geographic information systems in terms of types of different models of data, identify the different sources of data for geographic information systems and methods of introduction and addressed. As is exposure to GIS applications in various sciences, especially geology and environmental applications.

**Env. 357 - Water Reservoirs (Dams) (3 credit hrs.)**

Study of hydrologic data required for dam construction. Types and aims of dams, site selection, construction materials, uses of reservoir water (domestic, irrigation, energy, hydroelectric generation, etc). Environmental impact. Political, economic and legislative aspects of dams.

**Env. 361 - Management of Environmental Systems (3 credit hrs.)**

Introduction to environmental ecosystems, arid and semi-arid systems, forest and hilly areas, agricultural low-lying lands.

**Env. 362 – Environmental Protection (3 credit hrs.)**

Introduction, air pollution and control, water pollution and control, Soil pollution and control, Pesticides, wildlife protection, Jordanian environmental Law.

**Env. 363 - Planning and Land Use (3 credit hrs.)**

Definition of concepts, land and its uses, decision making, planning and the environment, how to use land and ways of preserving it, planning for land use.

**Env. 364A - Remote Sensing in the Environment (3 credit hrs.)**

A two part course. The first part aims to show the principles of remote sensing (physical principles), sensing of natural features, models. The second part aims to study environmental

applications in weather, study of earth topography, plant cover, minerals, desertification, hazards and disaster.

**Env. 376 - Introduction to Environmental Chemistry (3 credit hrs.)**

Introduction :Units to measure quantities, conversion between units, Units of concentrations. Solutions and concentration. Standard solutions. Blank determinations. Precision and accuracy. Errors. Sensitivity. Detection limits. Introduction to environmental laboratory equipment. The atmosphere : General considerations, composition, carbon dioxide, nitrogen oxides, hydrocarbons and photochemical oxidants, sulphur oxides, particulates, temperature inversion and the greenhouse effects sources and effects.

Water : Carbon dioxide – carbonate species in water bodies, pH, detergents, nutrients, synthetic organic pesticides, oil, toxic metals, sources and effects.

**Env. 381 - Sources of Energy and Their Effects on the Environment (3 credit hrs.)**

Introduction, principles of energy conversion, energy distribution, thermo-dynamics, storage of mechanical, chemical, electrical and thermal energy, economics of energy, environmental pollution resulting from energy use (climate, air, etc.).

**Env. 391 - Seminar (1 credit hr.)**

**Env. 392 - Special Topics (3 credit hrs.)**

**Env. 399 – Research (3 credit hrs.)**

**\* Env.348 is equivalent to Geo.348**

