Yarmouk University

Faculty of Science

Department of Earth and Environmental Sciences

Faculty of Science

Department of Earth and Environmental Sciences

Bachelor's Degree in

Applied Geology

2021

Degree Plan for the Bachelor's Degree in Applied Geology

The Department of Earth and Environmental Sciences at Yarmouk University offers a bachelor's degree in Applied Geology upon the 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: 27 Credit hours and it includes.
   a- Obligatory Course Requirement: 15 Credit Hours (Table 1).

Table (1): University Requirements (15 Obligatory Credit Hours)

No.	Course Code	Course No.	Course Name	Credit Hours	Prerequisite
1.	HUM	117	الريادة والابتكار	1	---
2.	HUM	118	القيادة والمسؤولية الاجتماعية	1	---
3.	HUM	119	المهارات الحياتية	1	---
4.	HUM	120	مهارات الاتصال والتواصل (اللغة الإنجليزية)	3	---
5.	HUM	121	مهارات الاتصال والتواصل (اللغة العربية)	3	---
6.	PS	102	التربية الوطنية	3	---
7.	MILT	100A	والمواطنة العلوم العسكرية	3	---
8.	EL	099	مهارات لغة إنجليزية – استدراكي	Remedial	---
9.	AL	099	لغة عربية – استدراكي	Remedial	---
10.	COMP	099	مهارات حاسوب – استدراكي	Remedial	---
Total				15	

   b- University Elective Requirements: the student selects 12 Credit Hours (Table 2).

Table (2): University Elective Courses (must select 12 Credit Hours)

Humanity Courses			
NO.	Course Code	Course Name	Credit Hours
1.	HUM 101	الثقافة الاعلامية	3

2.	HUM102	المواطنة والانتماء	3
3.	HUM 103	الاسلام فكر وحضارة	3
4.	HUM 104	الفن والسلوك	3
5.	HUM 105	اسهام الاردن في الحضارة الانسانية	3
6.	HUM 106	مقدمة في دراسة الثقافات الانسانية	3
7.	HUM 107	حقوق الانسان	3
8.	HUM 108	مهارات التفكير	3
9.	HUM 109	النظم الاسلامية	3
10.	HUM 110	الثقافية السياحية والفندقية	3
11.	HUM 111	تاريخ القدس	3
12.	HUM 112	مقدمة في جغرافية الأردن	3
13.	HUM 113	الفكر التربوي الإسلامي	3
14.	HUM 114	الحاكمية الرشيدة والنزاهة	3
15.	HUM 115	التربية القانونية	3
16.	HUM 116	كتابات الأردن القديمة	3
17.	HUM 122	الاقتصاد والمجتمع	3
18.	HUM 123	الفنون الأدائية	3
Scientific Courses			
1.	SCI 101	البيئة والصحة العامة	3
2.	SCI 102	تكنولوجيا المعلومات والمجتمع	3
3.	SCI 103	اللياقة البدنية للجميع	3
4.	SCI 104	مهارات التواصل الفعال	3
5.	SCI 105	الطاقة المتجددة	3
6.	SCI 106	الادارة وتنمية المجتمع	3
7.	SCI 107	البحث العلمي	3
8.	SCI 109	الثقافة الرقمية	3
9.	SCI 110	التنمية والبيئة	3
10.	SCI 111	مبادئ الوبائيات والمناعة المجتمعية	3

3. Faculty of Science course requirements: Students in the faculty of science must take 21 Credit Hours. The faculty of science courses are listed in Table 3.

Table (3): Faculty of Science required course (21 Credit Hours)

No.	Course Code	Course Name	Credit Hours	Prerequisite
1.	MATH 101	Calculus (1)	3	---
2.	PHYS 101	General Physics (1)	3	---
3.	CHEM 101	General Chemistry (1)	3	---
4.	BIO 101	General Biology	3	---
5.	STAT 101	Principles of Statistics (1)	3	---
6.	EES 101	General Geology	3	---
7.	CS 110	Selected Programming Language	3	---
	Total		**21**	----

4. **Department Course Requirements:**

The Applied Geology courses are labeled with (AG) plus 3 digit numbers. The second numeric digit indicates the field of the course as follows:

Table (4): The Significance of the Second Digit Number in Applied Geology Cources

No.	Title	No.	Title
0	General Geology	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

I. **Single Major in Applied Geology** (86 Credit Hrs.):

(1) **Compulsory Courses** (71) (Credit Hrs.):

Chem. 105, Math. 102 , AG 105L, AG 108, AG 210, AG 210L, AG 213, AG 213L, AG 220, AG 220L, AG 222L, AG 331, AG 331L, AG 333 AG 333L, AG 340, AG 340L, AG 342L, AG 346L, AG 348, AG 348L, AG 349, AG 349L, AG 350, AG 350L, AG 354, AG 361, AG 371, AG 371L, AG 432, AG 452, AG 452L, AG 453, AG 453L, AG 455, AG 455L, AG 475, AG 475L, AG 479, AG 479L, AG 486.

Table (5): Compulsory courses for Applied Geology

Course no.	Course name	Credit Hours	Prerequisites	Equivalent course	Status
Chem. 105	**General Chemistry (1) Laboratory**	1	Chem. 101 or Chem. 104, or concurrently with	105ك	Old
Math. 102	**Calculus (2)**	3	Math. 101	102 ر	Old
AG 101	**General Geology**	3	-	EES 101	Modified
AG 105L	**General Geology Laboratory**	1	AG 101, or concurrently with	EES 105 And the EES 106	Rate
AG 108	**Geomorphology**	3	AG 101	None	New
AG 210	**Applied Paleontology**	2	AG 108 + *concurrently with AG 210L	EES 210	New
AG 210L	**Applied Paleontology Laboratory**	1	* concurrently with AG 210	EES 210L	New

AG 213	**Stratigraphy and Historical Geology**	2	AG 210 + * Concurrently with AG 213L	EES 213	Modified
AG 213L	**Stratigraphy and Historical Geology Laboratory**	1	*Concurrently with AG 213	EES 213L	Modified
AG 220	**Mineralogy**	2	AG 105L + *Concurrently with AG 220L	EES 220	Old
AG 220L	**Mineralogy Laboratory**	1	*Concurrently with AG 220	EES 220L	Old
AG 222L	**Optical Mineralogy Laboratory**	1	AG 220, AG 220L	EES 222L	Modified
AG 331	**Igneous and Metamorphic Rocks**	3	AG 222L + *Concurrently with AG 331L	EES 331	Modified
AG 331L	**Igneous and Metamorphic Rocks Laboratory**	1	*Concurrently with AG 331	ESS 331L	Modified
AG 333	**Sediments and Sedimentary Rocks**	2	AG 220, AG 220L + *Concurrently with AG 333L	EES 333	Modified
AG 333L	**Sediments and Sedimentary Rocks Laboratory**	1	*Concurrently with AG 333	ESS 333L	Modified
AG 340	**Structural Geology and Tectonics**	2	AG 105L, AG 213 + * Concurrently with AG 340L	EES 340	Modified
AG 340L	**Structural Geology and Tectonics Laboratory**	1	*Concurrently with AG 340	EES 340L	Modified
AG 342L	**Geological Field Techniques Practical**	2	AG 333, AG 340	None	New
AG 346L	**Field geology Practical**	4	AG 342L	EES 346	Modified
AG 348	**Introduction to GIS**	2	AG 340 + *Concurrently with AG 348L	EES 348	Modified
AG 348L	**Introduction to GIS Laboratory**	1	*Concurrently with AG 348	EES 348L	Modified
AG 349	**Remote sensing in Geology**	2	AG 348 + *Concurrently with AG 349L	EES 349	Modified
AG 349L	**Remote Sensing in Geology Laboratory**	1	* Concurrently with AG 349	EES 349L	Modified

AG 350	**Economic Geology**	2	AG 333 + *Concurrently with AG 350L	EES 350	Modified
AG 350L	**Economic Geology Laboratory**	1	*Concurrently with AG 350	EES 350L	Modified
AG 354	**Environmental Geology**	3	AG 108, AG 340	EES 102	Modified
AG 361	**Geology of Jordan**	3	AG 333	EES 362	Modified
AG 371	**Applied Geophysics**	2	Phys. 101, Math. 101, AG 340 + *Concurrently with AG 371L	EES 471	Modified
AG 371L	**Aplied Geophysics Laboratory**	1	*Concurrently with AG 371	EES 471L	Modified
AG 432	**Industrial Rocks and Minerals**	3	AG 350	EES 432	Modified
AG 452	**Applied Hydrogeology**	2	Math. 101, AG 333 + *Concurrently with AG 452L	EES 452	Modified
AG 452L	**Applied Hydrogeology Laboratory**	1	*Concurrently with AG 452	EES 452L	Modified
AG 453	**Petroleum Geology**	2	AG 333, AG 340 + *Concurrently with AG 453L	EES 453	Modified
AG 453L	**Petroleum Geology Laboratory**	1	*Concurrently with AG 453	EES 453L	Modified
AG 455	**Engineering Geology**	2	AG 333 + *Concurrently with AG 455L	EES 455	Modified
AG 455L	**Engineering Geology Laboratory**	1	*Concurrently with AG 455	EES 455L	Modified
AG 475	**Applied Geochemistry**	2	AG 331 + *Concurrently with AG 475L	EES 475	Modified
AG 475L	**Applied Geochemistry Laboratory**	1	*Concurrently with AG 475	EES 475L	Modified
AG 479	**Subsurface Geology and Well Logging**	2	AG 371 + *Concurrently with AG 479L	EES 479	Modified
AG 479L	**Subsurface Geology and Well Logging**	1	*Concurrently with	EES 479L	Modified

	Laboratory		AG 479		
AG 486	**Quaternary Geology**	2	AG 213, AG 333	None	New
***Note: Students who are registering for the first time for these courses must concurrently register for the theoretical and practical or laboratory courses, if any.**					

(2) Elective courses (15) (Credit Hrs.): Divided into two groups:

a. First Group:

The student selects 6 credit hours from the following classes (Table 6): AG 311 , AG 311L , AG 334, AG 335, AG 385, AG 412, AG 444, AG 482, AG 484, AG 492, ENV 251, ENV 312.

Table (6): List of the 1st group of elective courses offered by the Department of Earth and Environmental Sciences for Applied Geology Major

Course no.	Course name	Credit Hours	Prerequisites	Equivalent course	Status
AG 311	**Microfossils**	2	AG 210, *Concurrently with AG 311	EES 311	Old
AG 311L	**Microfossils Laboratory**	1	*Concurrently with AG 311	ESS 311L	Old
AG 334	**Carbonates and Evaporators**	3	AG 333	EES 334	Modified
AG 335	**Geology of Phosphate Deposits**	3	AG 333	None	New
AG 385	**Methods of Scientific Research in Geology**	3	AG 333, AG 340	EES 385	Modified
386L AG	**Applied Geodetic Survey (Practical)**	2	AG 348	None	New
AG 412	**Paleoenvironment**	3	AG 333	EES 412	Modified
AG 444	**Earth Tectonics**	3	AG 340	EES 444	Old
AG 482	**Marine Geology**	3	AG 333	EES 482	Modified

AG 484	**Earthquake Seismology**	3	AG 340	EES 484	Modified
AG 492	**Special Topics in Geology**	3	AG 333	EES 492	Modified
ENV 251	**Aquatic Systems and Pollution**	3	-	EES 251	Old
ENV 312	**Climatology and Meteorology**	3	-	EES 312	Old
***Note: Students who are registering for the first time for these courses must concurrently register for the theoretical and practical or laboratory courses, if any.**					

b. Second Group: The student selects 9 credit hours from the following classes (Table 7): AG 252, AG 302, AG 302L, AG 386L, AG 448, AG 448L, AG 456, AG 474, AG 474, AG 476L, AG 480, AG 491, ENV 211, ENV 211L.

Table (7): List of the 2nd group of elective courses offered by the Department of Earth and Environmental Sciences for Applied Geology Major

Course no.	Course name	Credit Hours	Prerequisites	Equivalent Course	Status
AG 252	**Applied Hydrology**	3	AG 108	EES 252	Modified
AG 302	**Fundamentals of Surveying**	2	AG 105L	EES 302	Modified
AG 302L	**Fundamentals of Surveying Laboratory**	1	*Concurrently with AG 302	EES 302L	Modified
AG 386L	**Applied Geodetic Survey (Practical)**	2	AG 349	None	New
AG 448	**Applications in Geographic Information Systems**	2	AG 348	None	New
AG 448L	**Applications in Geographic Information Systems Laboratory**	1	AG 348	None	New
AG 456	**Petroleum Source-Rocks Evaluation**	3	AG 453	None	New
AG 474	**Engineering Geophysics**	2	AG 371	EES 475	Modified
AG 474	**Engineering Geophysics Laboratory**	1	*Concurrently with AG 474	EES 475L	Modified

AG 476L	**Geophysical Field Techniques (Practical)**	2	AG 371	None	New
AG 480	**Exploration and Mining Geology**	3	AG 350	None	New
AG 491	**Seminar in Geology**	1	AG 346L	EES 491	Modified
ENV 211	**Soil and Soil Pollution**	2	*Concurrently with ES 211L	EES 211	Old
ENV 211L	**Soil and Soil Pollution Laboratory**	1	*Concurrently with ES 211	EES 211L	Old
***Note: Students who are registering for the first time for these courses must concurrently register for the theoretical and practical or laboratory courses, if any.**					

The number of credit hours required according to the university, faculty, and department is summarized in Table 8.

Table (8): Single Major Credit Hours

Requirements	Obligatory	Elective	Total
University	15	12	27
Faculty	21	0	21
Department	71	15	86
Total			**134**

II. **Major / Minor in Applied Geology: (86 Credit Hrs.), (Table 9):**

1) Major in Applied Geology (65 Credit Hrs.):

Chem. 105, Math. 102 , AG 105L, AG 108, AG 210, AG 210L, AG 213, AG 213L, AG 220, AG 220L, AG 222L, AG 331, AG 331L, AG 333 AG 333L, AG 340, AG 340L, AG 342L, , AG 346L, AG 348, AG 348L, AG 349, AG 349L, AG 350, AG 350L, AG 354, AG 361, AG 371, AG 371L, AG 452, AG 452L, AG 453, AG 453L, AG 455, AG 455L, AG 475, AG 475L, AG 486.

2) Minor (21 Credit Hrs.): in any Department of the Faculty of Sciences or the Faculty of Information Technology and Computer Sciences according to the minor listing of each Department.

Table (9): Major / Minor Credit Hours

Requirements	Obligatory	Elective	Total
University	15	12	27
Faculty	21	0	21

Department	65	0	65
Minor	21		21
Total			**134**

III. **Minor in Applied Geology: (21 Credit Hrs.):**

1) Compulsory courses (15 Credit Hrs.):

AG 105L, AG 108, AG 210, AG 210L, AG 213, AG 220, AG 220L, AG 354 *.

*: The minor student in Applied Geology is exempted from the pre-requisite requirement for the Environmental Geology course (AG 345).

2) Elective courses (6 credit hours): selected by the student from the following courses:

AG 222L, AG 252, AG 302, AG 302L, AG 311, AG 311L, AG 331, AG 331L, AG 340, AG 340L, AG 350 *, AG 350L *, AG 349 *, AG 349L *, AG 444 *, AG 452 *, AG 452L *, AG 486 *, AG 491 *.

***:** The minor student in Applied Geology is exempted from the prerequisite conditions of these courses

V. Minor in Minor in Environmental Sciences: (21 Credit Hrs.):

1) Compulsory courses (15 Credit Hrs.):

ENV 104, ENV 211, ENV 211L, ENV 251, ENV 323, ENV 363.

2) Elective courses (6 credit hours): selected by the student from the following courses:

ENV 255, ENV 312, ENV 316, ENV 325, ENV 328, ENV 351, ENV 357, ENV 362, ENV 365, ENV 382, ENV 391, ENV 392, ENV 399.

Table (10): The Significance of the Second Digit Number in Environmental Sciences Cources

No.	Title	No.	Title
0	General Environment	5	Water and Air
1	Climate and Soil	6	Environmental Management and Protection
2	Pollution and Environmental Hazsrds	7	Natural Resources
3		8	Energy
4		9	Research or Seminar or Special Topics

Table (11): Compulsory Courses offered by the Department of Earth and Environmental Sciences For a minor in Environmental Sciences

Course no.	Course name	Credit Hours	Prerequisites	Equivalent Course	Status
ENV 104	**Environmental Sciences**	3	-	EES 104	Old
ENV 211	**Soil and Soil Pollution**	2	*Concurrently with ENV 211L	EES 211	Old
ENV 211L	**Soil and Soil Pollution Laboratory**	1	*Concurrently with ENV 211	EES 211L	Old
ENV 251	**Aquatic Systems and Pollution**	3	ENV 104	EES 251	Old
ENV 323	**Integrated Solid Waste Management**	3	ENV 104	EES 323	Old
ENV 363	**Management of Environmental Systems**	3	ENV 104	EES 363	Old

Table (12): Ellective Courses offered by the Department of Earth and Environmental Sciences For a minor in Environmental Sciences

Course no.	Course name	Credit Hours	Prerequisites	Equivalent Course	Status
ENV 255	**Water Chemistry Laboratory**	1	-	EES 255	Old
ENV 312	**Climatology and Meteorology**	3	-	EES 312	Old
ENV 316	**Environmental Impact Assessment**	3	ENV 104	EES 316	Old
ENV 325	**Air pollution**	3	ENV 104	EES 325	Old
ENV 328	**Radiation Pollution**	3	ENV 104	EES 328	Old
ENV 351	**Marine Environment**	3	ENV 251	EES 351	Old
ENV 357	**Water Rservoirs (Dams)**	3	ENV 251	EES 357	Old
ENV 362	**Environmental Protection**	3	ENV 104	EES 362	Old
ENV 365	**Sewage Management**	3	ENV 104	EES 365	Old
ENV 382	**Energy Sources and their Environmental Impacts**	3	ENV 104	EES 382	Old
ENV 391	**Seminar in the Environment**	1	Department approval	EES 391	Old
ENV 392	**Special Topics in the Environment**	3	Department approval	EES 392	Old
ENV 399	**Research in the Environment**	3	Department approval	EES 399	Old

Table (13): Equivalent courses between the old and new degree plans of the Applied Geology courses

Ccourse no.	Course Name	Equivalent Course
AG 101	**General Geology**	EES 101
AG 105L	**General Geology Laboratory**	EES 105
AG 108	**Geomorphology**	None
AG 210	**Applied paleontology**	EES210
AG 210L	**Applied Paleontology Laboratory**	EES210L
AG 213	**Stratigraphy and Historical Geology**	EES 213
AG 213L	**Stratigraphy and Historical Geology Laboratory**	EES 213L
AG 220	**Mineralogy**	EES 220
AG 220L	**Mineralogy Laboratory**	EES 220L
AG 222L	**Optical Mineralogy Laboratory**	EES 222L
AG 252	**Applied Hydrology**	EES 252
AG 302	**Fundamentals of Surveying**	EES 302
AG 302L	**Fundamentals of Surveying Laboratory**	EES 302L
AG 311	**Microfossils**	EES 311
AG 311L	**Microfossils Laboratory**	ESS 311L
AG 331	**Igneous and Metamorphic Rocks**	EES 331
AG 331L	**Igneous and Metamorphic Rocks Laboratory**	ESS 331L
AG 333	**Sediments and Sedimentary Rocks**	EES 333
AG 333L	**Sedimentary and Sedimentary Rocks Laboratory**	ESS 333L
AG 334	**Carbonates and Evaporators**	EES 334
AG 335	**Geology of Phosphate Deposits**	None
AG 340	**Structural Geology and Tectonics**	EES 340
AG 340L	**Structural Geology and Tectonics Laboratory**	EES 340L
AG 342L	**Geological Field Techniques Practical**	None
AG 346L	**Field geology Practical**	EES 346
AG 348	**Introduction to GIS**	EES 348
AG 348L	**Introduction to GIS Laboratory**	EES 348L
AG 349	**Remote Sensing in Geology**	EES 349
AG 349L	**Remote Sensing in Geology Laboratory**	EES 349L
AG 350	**Economic Geology**	EES 350
AG 350L	**Economic Geology Laboratory**	EES 350L
AG 354	**Environmental Geology**	EES 102
AG 361	**Geology of Jordan**	EES 362
AG 371	**Applied Geophysics**	EES 471

AG 371L	**Aplied Geophysics Laboratory**	EES 471L
AG 385	**Methods of Scientific Research in Geology**	EES 385
386L AG	**Applied Geodetic Survey (Practical)**	None
AG 412	**Paleoecology**	EES 412
AG 432	**Rocks and Industrial Minerals**	EES 432
AG 444	**Earth Tectonics**	EES 444
AG 448	**Applications in Geographic Information Systems**	None
AG 448L	**Applications in Geographic Information Systems Laboratory**	None
AG 452	**Applied Hydrogeology**	EES 452
AG 452L	**Applied Hydrogeology Laboratory**	EES 452L
AG 453	**Petroleum Geology**	EES 453
AG 453L	**Petroleum Geology Laboratory**	EES 453L
AG 455	**Engineering Geology**	EES 455
AG 455L	**Engineering Geology Laboratory**	EES 455L
AG 456	**Petroleum Source-Rocks Evaluation**	None
AG 474	**Engineering Geophysics**	EES 474
AG 474L	**Engineering Geophysics Laboratory**	EES 474L
AG 475	**Applied Geochemistry**	EES 475
AG 475L	**Applied Geochemistry Laboratory**	EES 475L
AG 476L	**Geophysical Field Techniques (Practical)**	None
AG 479	**Subsurface Geology and Well Logging**	EES 479
AG 479L	**Subsurface Geology and Well Logging Laboratory**	EES 479L
AG 480	**Exploration and Mining Geology**	None
AG 482	**Marine Geology**	EES 482
AG 484	**Earthquake Seismology**	EES 484
AG 486	**Quaternary Geology**	EES 486
AG 491	**Seminar in Geology**	EES 491
AG 492	**Special Topics in Geology**	EES 492

Table (14): Equivalent courses between the old and new degree plans of the minor in Envoiromental Scineces courses

No. of course	Course Name	Equivalent Course
ENV 104	**Environmental Sciences**	EES 104
ENV 211	**Soil and Soil Pollution**	EES 211
ENV 211L	**Soil and Soil Pollution Laboratory**	EES 211L
ENV 251	**Water Systems and Pollution**	EES 251
ENV 255	**Water Chemistry Laboratory**	EES 255

ENV 312	**Climatology and Meteorology**	EES 312
ENV 316	**Environmental Impact Assessment**	EES 316
ENV 323	**Integrated solid Wste Management**	EES 323
ENV 325	**Air Pollution**	EES 325
ENV 328	**Radiation Pollution**	EES 328
ENV 351	**Marine Environment**	EES 351
ENV 357	**Water Reservoirs (Dams)**	EES 357
ENV 361	**Managment of Environmental systems**	EES 361
ENV 362	**Environmental Protection**	EES 362
ENV 365	**Sewage Management**	EES 365
ENV 382	**Energy Sources and their Environmental Impacts**	EES 382
ENV 391	**Seminar in the Environment**	EES 391
ENV 392	**Special Topics in the Environment**	EES 392
ENV 399	**Research in Environment**	EES 399

Courses description for BSc degree in Applied Geology

AG. 101 - General Geology (3 credits: compulsory, theoretical)

This course aims to briefly introduce students to basic geological topics.

The course includes the following topics: Introduction to Geology. Minerals: definition, properties and classification. Rocks: Definition and Introduction to the Rock Cycle. Igneous rocks: their definition, characteristics and classification. Volcanic activity and volcanoes. Sedimentary rocks: an introduction to weathering and erosion, properties of sedimentary rocks and their classification. Metamorphic rocks: definition, characteristics and classification. Seismic activity: earthquake mechanism and distribution, seismic magnitude and intensity, internal structure of the Earth. Earth's crust structures: definition, characteristics, and classification. Plate tectonics: continental drift, oceanic spreading, plate tectonics and their distribution, plate boundaries, plate movement dynamics and their consequences. The geological time scale: the evolution of the earth, its components, and the geological history.

After completing this course, the student is expected to be able to:

1- Be a brief knowledge of the planet Earth and its various spheres.
2- Distinguish the main mineral groups (silicates and non-silicate.
3- Familiarize with the different types of rocks (igneous, sedimentary, and metamorphic), and the concept of weathering and its products.
4- Learn about volcanic activity, its distribution and effects in brief.
5- Learn about plate tectonics.
6- Learn about earthquakes, their mechanism of occurrence, their distribution and their effects in a brief manner.
7- Distinguish the different types of geological structures
8- Learn about the geological time scale, its components, and the distinctive features of some geological periods and eras.

AG. 105L - General Geology Laboratory (3 credits: compulsory, practical)

This course aims to introduce students to crystal systems and mineral groups, and the different types of rocks, as well as an introduction to topographic and geological maps.

The course includes the following topics: Crystalline systems. Mineral groups and their physical properties. Igneous rocks. Sedimentary rocks. Metamorphic rocks. Topographic, contour, and scale of maps. Geological maps of horizontal and inclined layers, geological sections, geological column. The course includes a short scientific trip to nearby areas to learn about rocks in the field, and the various deformation structures, and training in making a sketch, describing them, and taking notes.

After completing this course, the student is expected to be able to:

1. Practically identifies the major crystal systems and distinguishes between them.
2. Know the main mineral groups and determine their distinctive physical properties.
3. Identify the different types of rocks and distinguish between them.
4. Learn about topographic maps, scale and coordinates.
5. Reading and drawing geological maps and sections of horizontal and inclined layers.
6. Drawing the geological column.

7. Take into account the health and safety requirements in the field.

AG. 108 - Geomorphology (3 credits: elective, theoretical)

This course aims to define the concept of geomorphology and how land surface features related to internal and external earth processes.

The course includes the following topics: definition of geomorphology and its relation with other sciences. Developments of earth surface landforms, internal and external causes. Weather processes (Chemical and physical). Erosion, transportation and deposition of sediments. Soil development and soil types. Land features resulted from surficial earth processes including Mass wasting on slopes, Surface water (runoff, drainage basins, rivers, deltas, and lakes), groundwater and karst features. Desert landscapes. Glaciers and glacial landscapes. Sea waves and coastal landscapes, continental shelf, continental slope and ocean basin. Also this course will include the study of landforms resulted from internal earth processes such as earthquakes and volcanos.

After completing this course, the student is expected to be able to:

1. Know and understand the science of geomorphology
2. Know the temporal and special scales in which different landscapes are developing
3. Know the surficial landscapes of weathering, erosion transportation and deposition by rivers, groundwater, wind, glaciers and sea waves.
4. Know landscapes developed by mass wasting on slopes.
5. Know landscapes developed by internal earth processes such as earthquakes and volcanic activity
6. Know the topography of ocean floor

AG. 210 - Applied Paleontology (2 credits: compulsory, theoretical)

This course aims to understand how fossils are formed and how to use fossils to solve geological problems and spatial and temporal distribution of fossils.

The course includes the following topics: the invertebrate fossil groups such as: gastropods, cephalopods, brachiopods, bivalves and echinoderms. This course includes different microfossil groups as well such as: bacteria, dinoflagellates, coccolithophores, pollens and spores, foraminifera, diatoms, radiolarian, ostracodes. Each week, we will explore a different group of fossils and use those fossils to address the main themes of creation, evolution, extinction, paleoecology, age determination and correlation. This course includes a field trip to the fossiliferous rock successions in the north of Jordan.

After completing this course, the student is expected to be able to:

1. Understand how fossils form and the benefits and limitations to using them to solve geological problems.
2. By spending time with each phylum, student will have a fuller understanding of the temporal and spatial distribution of fossils.
3. Gain skills on how modern techniques assessing and analyzing data.
4. Understand the legal and ethical issues surrounding fossil collecting and protection of resources.
5. Use the microfossils in the age determination.

6. Use micro and macrofossils in paleo-environmental construction.

AG. 210L - Applied Paleontology Laboratory (1 credits: compulsory, practical)
This course aims to provide students with basic knowledge on fossilization and how to identify each fossil group.
The course includes the following exersises: fossilization, gastropods, cephalopods, brachiopods, bivalves and echinoderms, bacteria, dinoflagellates, coccolithophores, pollens and spores, foraminifera, diatoms, radiolarian, ostracodes.
After completing this course, the student is expected to be able to:

1. Identify the morphological characteristics of each fossil group and how to classify each group.
2. Understand the marker species and how to use marker species in biostratigraphy.
3. Understand how to construct the paleo-environment based on the fossil records.

AG. 213 - Stratigraphy and Historical Geology (2 credits: compulsory, theoretical)
This course aims to provide an overview of stratigraphy and historical geology, principles of stratigraphy, correlation, dating methods, geological time scale and its divisions, types of stratigraphical units, and a general study of the geological history of Jordan.
The course includes the following topics: an introduction to the historical development of geology as a scientific discipline and an overview of the methods used by the geologist to reconstruct the history of the Earth. the development of stratigraphy and current stratigraphical classifications, different types of stratigraphical units, rock sequences, surface exposures, stratigraphical correlation, development of the geological time scale, indications and type of unconformities, Stratigraphy as a tool in the exploration for natural resources. **The course includes field trip with an overnight stay to the city of Aqaba.**
After completing this course, the student is expected to be able to:

1. Distinguish types of unconformities and their stratigraphic reflections.
2. Realize the stratigraphic units and principles of stratigraphy and their applications.
3. Defining and describing different sedimentary facies and utilizing them in describing geologic history.
4. Correlate between stratigraphic sections in different locations.
5. Subdivision of sedimentary sequence bearing fossils into different biozone.
6. learn reasons for mass extinction in the geologic history of the earth.
7. know the general history of Jordan through the geologic time.
8. Consider health and safety requirements in the field.

AG. 213L - Stratigraphy and Historical Geology Laboratory (1 credit: compulsory, practical)

This course aims to explore the different lithostratigraphic units, classification of sedimentary rocks and to learn how to measure and describe a sedimentary rock sequence in the field.

The course includes the following topics: Study of general principles of historical geology with a focus on the evolution of Earth and life over time. an overview of different types of sedimentary rocks, with an emphasis on principles of stratigraphy such as fossil record, depositional environments, correlation, and interpretation of palaeofacies maps.

After completing this course, the student is expected to be able to:

1. Explain the depositional environments on the basis of sedimentary rocks characteristics and fossil content.
2. Determination of relative age of the rock units.
3. Identify and classify fossils (index fossils) and their use to define relative age and depositional environment.
4. trained to establish a litho- and bio-stratigraphical correlation between different stratigraphic sequences in different locations.
5. Demonstrates an understanding of biozonation techniques and the apply these techniques to specific examples.

AG. 220 - Mineralogy (2 credits: compulsory, theoretical)

This course aims to learn about minerals and crystals and their various systems.

The course includes the following topics: introduction, external shapes of crystals and includes crystallization, growth of crystals, their internal arrangement, elements of symmetry, crystal shapes, crystal symmetry, and crystalline varieties. The internal arrangement and internal symmetry of the crystals. X-ray diffraction in crystals. Description of mineral groups, including pure elements, sulfides, oxides, hydroxides, halides, carbonates, nitrates, borate, sulfates, chromates, molybdates, tungstates, phosphates, arsenic, vanadium, and silicates, which include a description of isolated silicates, aggregate silicates, ring silicates, chain-silicates, laminate silicates, and tecto-silicates.

After completing this course, the student is expected to be able to:

1. Distinguish between minerals and other substances.
2. Learn about crystalline systems and elements of crystal symmetry.
3. Distinguish between different minerals depending on their physical properties.
4. Understand crystalline and mineral structures, and the reasons for the occurrence of deformations in some mineral structures.

AG. 220L – Mineralogy Laboratory (1 credit: compulsory, practical)

This course aims to introduce practical study of mineral groups by extracting the physical properties, distinguishing the crystals systems and crystals symmetry for wood crystals specimens, and computing the mineral's formula using mineral chemical analysis.

The course includes the following topics: a practical study of mineral samples for all basic mineral groups by extracting the most important physical properties. A practical application to distinguish crystalline systems and to know the elements of crystal symmetry. Calculating the chemical formulas for some mineral analyzes.

After completing this course, the student is expected to be able to:

1. Distinguish between the minerals and the other materials.
2. Calculate the mineral formula by knowing the chemical composition.
3. Distinguish the crystal systems.
4. Identify crystal symmetry.
5. Extract the most important physical properties of mineral hand samples.
6. Identify and classify minerals based on their physical properties and chemical composition.

AG. 222L – Optical Mineralogy Laboratory (1 credit: compulsory, practical)
This course aims to distinguish the different symmetrical elements that define the crystal structure. Describe a variety of physical and chemical techniques used in the identification of minerals. Identify specimens of at least 24 distinct mineral species. Categorize mineral samples based on their chemical composition and mineral group. discriminate between polarized and non-polarized light. differentiate between Uniaxial and Biaxial Indicatrix. distinguish the optical properties of isotropic minerals and anisotropes.
The course includes the following topics: a brief study of the formation, occurrence, and association of minerals with an emphasis on mineral identification through the study of their chemical, physical and crystallographic properties. A fundamental background in optics to identify minerals optically. Differentiate between polarized and un polarized light, how the light interacted with matter; Indicatrix; Optics of Isotropic and Anisotropic material; Interference Phenomena, Extinction, Twinning, zoning and pleochroism.
After completing this course, the student is expected to be able to:
1. Identify common rock-forming minerals in hand specimen and in thin section
2. Using diagnostic physical, optical, and chemical properties
3. Infer about the formation environment of a silicate mineral using only its formula.
4. Predict the physical properties of a substance from its symmetry content.
5. Differentiate between various parts of the polarizing microscope.
6. Differentiate the optical properties of minerals.

AG. 252 – Applied Hydrology (2 credits: elective, theoretical)
This course aims to introduce applied surface water hydrology, study the elements of the hydrologic cycle and to measure hydrologic cycle elements theoretically and practically.
The course includes the following topics: introduction about water importance, distribution, water cycle, energy transformation during water cycle and its environmental importance. Concept of drainage basin and water budget. Evaporation and evapotranspiration. its relation to humidity and methods of measuring humidity and evapotranspiration. Condensation, cloud formation and types of clouds. Precipitation, forms of precipitation, methods and instruments used to measure precipitation. Runoff and infiltration, factors influence infiltration and common method used to measure infiltration and runoff. Water movement in the unsaturated zone. Water situation in Jordan. **This course will also include field visit to a neighboring weather station and field visit to Zara River to do some hydrologic measurements.**

After completing this course, the student is expected to be able to:

1. Know water impotence and its distribution.
2. Know importance of energy transformation during water cycle.
3. Know the concept and components of drainage basin.
4. make a water budget for water body of drainage basin.
5. Know the concept of each of the elements of the hydrologic cycle and how to calculate and measure it.
6. Know about water resources in Jordan and
7. Take cure of field safety requirements.

AG. 302 – Fundamentals of Surveying (2 credits: elective, theoretical)

This course aims to cover fundamental concepts and principles of surveying and surveying methods.

The course includes the following topics: introduce the principles of surveying; basic error theory and analysis in measurement and calculations; principles of measurements of distances, areas, and volumes; angles measurement (horizontal and vertical); coordinates geometry in surveying calculations; leveling (longitudinal and cross sections, contour lines, grids); princples of photogrammetric surveying; introduction to surveying methods and surveying devices such as tape, level, theodolite, total station, terrestrial laser scanner, and GNSS.

After completing this course, the student is expected to be able to:

1. Relate the basic concepts of surveying.
2. Understand the methods of surveying and operate different surveying devices .
3. Perform surveying calculations.
4. Understand the methods of leveling.
5. Understand the basics of photogrammetic surveying.

AG. 302L – Fundamentals of Surveying Laboratory (1 credit: elective, practical)

This course aims to introduce several surveying applications through the use of different surveying instrumentation (Total Station, Digital Level, Theodolite, GNSS, Terrestrial laser scanner (TLS)).

This course includes the following topics: Introduction to measuring units, direct distance measurements with tapes and optical distance measurements, levels and leveling, longitudinal profiles and cross sections, contouring, precise height measurements using a leveling device, area and volume computations, setting out and staking out using total station and RTK-GNSS, angular measurements by theodolite, traverse surveys and computations, and mapping.

After completing this course, the student is expected to be able to:

1. Work with various measurement units and map scales.
2. Have the knowledge and practical skills to complete a survey using different field surveying measurement devices that can be utilized for various purposes and build their practical skills therein.
3. Calculate the area and volume of irregular shapes.
4. Develop and enhance teamworking skills.
5. Have an understanding of the health and safety requirements in the field.

AG. 311 - Microfossils (2 credits: elective, theoretical)

This course aims to discuss the micro-organism life in the ancient life emphasizing on its skeletons, classifications, distributions, age determinations, and paleo-environmental constriction.

This course includes the following topics: foraminifera, ostracodes, coccolithophores, dinoflagellates, diatoms, radiolaria, pollens and spores. **This course includes a field trip to the chalk successions north of Jordan.**

After completing this course, the student is expected to be able to:

1. Understand application of each group.
2. Know the various microfossil groups theoretically and works in the lab.
3. Understand the comprehensive concept of fossilization and its use in age determination and paleo-environmental construction.

AG. 311L – Microfossils Laboratory (1 credit: elective, practical)

This course aims to provide students with an overview on the different microfossil groups, extraction of microfossils from rocks, and its uses in solving geological problems.

This course includes the following topics: studying of the following groups: foraminifera, ostracodes, coccolithophores, dinoflagellates, diatoms, radiolaria, pollens and spores.

After completing this course, the student is expected to be able to:

1. Identify and classify the different microfossil groups
2. Understand the paleo-environmental interpretation of these groups
3. Determine the best group to solve the geological problems
4. Conclude the stratigraphical results from microfossils, like age and correlations.
5. Understand how to define the age based on the microfossil groups.

AG. 331 - Igneous and Metamorphic Rocks (3 credits: compulsory, theoretical)

This course aims to define the science of igneous and metamorphic rocks, their classification, and their uses in practical life.

The course includes the following topics: study thermodynamics and petrography of igneous rocks and their composition. Classical petrography, rock geochemistry, origin and evolution of magma, Cal-alkaline volcanic and plutonic rocks, basaltic and ultramafic igneous rocks of alkaline and sub-alkaline composition, metamorphic processes include the metamorphic record of the original rock, degree of metamorphism, and facies of metamorphism. Petrography composition, structures, and textural classification of metamorphic rocks represent their composition graphically.

The course includes a scientific trip to the basaltic rocks of eastern Jordan to learn about the nature of basalt rocks there, and another trip to southern Jordan with an overnight stay in Aqaba to learn about the nature and features of granitic rocks in southern Jordan.

After completing this course, the student is expected to be able to:

1. Define and differentiate between different igneous and metamorphic rocks.
2. To train on classifying intrusive igneous rocks and metamorphic rocks and their texture.
3. Be trained in classification, texture, and type of volcanic rocks.

4. Understand the microscopic properties of the minerals that make up igneous and metamorphic rocks.
5. Understand the features of metamorphic and igneous rocks under petrographical microscope, and their locations in Jordan.
6. Learn about the uses of igneous and metamorphic rocks in practical life.

AG. 331L - Igneous and Metamorphic Rocks Laboratory (1 credits: compulsory, practical)

This course aims to a detailed study of igneous and metamorphic rocks

The course includes the following topics: a detailed practical study of igneous and metamorphic rocks, classification of igneous and metamorphic rocks, study of the texture and mineral composition of the different types of igneous and metamorphic rocks.

After completing this course, the student is expected to be able to:

1. distinguish and classify hand samples and microscopic slides, which include:
1. The different types of igneous and metamorphic rocks.
2. The group of Non-foliated metamorphic rocks and their textures.
3. The group of foliated metamorphic rocks and their textures.
4. The group of extrusive (volcanic) igneous rocks and their textures.
5. The group of intrusive igneous rocks and their textures.

AG. 333 - Sediments and Sedimentary Rocks (2 credits: compulsory, theoretical)

The course aims to introduce students to the various types of sediments & sedimentary rocks that exist in nature, and to demonstrate the importance of their study from pure & applied scientific viewpoints.

This course includes the following topics: the role of weathering processes, erosion and transport and deposition in sediment formation; burial, compaction, diagenesis and lithification; abundance of sedimentary rocks in earth's crust; general scheme of sedimentary rocks and sediments classification; positives of studying sedimentary rocks and sediments study; concept of facies, Walther's Law, facies association, and facies sequence; factors that control types of sediments, sedimentary rocks and facies; method of studying sediments and sedimentary rocks; grain size analysis; grain morphology; grain fabric; sedimentary structures; paleocurrents analysis, (13) rudaceous sediments (conglomerates and breccias); sandstones; mudrocks; carbonate rocks (limestone, dolostone); phosphates; evaporates; ironstone and; siliceous deposits.

After completing this course, the student is expected to be able to:

1. Determine the type of sediments and sedimentary rocks in terms of their composition, texture, structures, granulometry, facies and environments.
2. Have the skills for conducting different techniques to identify petrography, physical and chemical characteristics of sediments and sedimentary rocks.
3. analyze and interpret paleocurrents of sedimentary layers.
4. Describe rock cores and rock cuttings of oil-discoveries.
5. Relate geological hazards to the type of induced sediments.
6. Assert the great significance of sediments and sedimentary rocks as hydrocarbon and water reservoirs, and economic industrial rocks and mineral deposits.

AG. 333L - Sediments and Sedimentary Rocks Laboratory (1 credits: compulsory, practical)

The course aims to strengthen the practical skills in the field of sedimentary rocks and sediments.

This course includes the following topics: a set of exercises and practical applications are organized which come in line with the theoretical part. These involve identification of sedimentary particles under stereoscopic microscope; lithostratigraphic correlation of rock facies; grain size analysis and use of ternary system to classify sedimentary rocks and sediment; analysis of grain morphology (grain shape, rounding, sphericity, flatness and elongation); paleocurrents analysis; identification of sedimentary rocks and sedimentary structures; thin-section study of sandstones, conglomerates, siltstone and shales); thin-sections study of carbonate rocks and evaporites.

After completing this course, the student is expected to be able to:

1. Identify different types of sedimentary particles by using stereoscopic microscope.
2. Recognize the different types of sedimentary structures in sedimentary layers.
3. Understand the concept of sedimentary facies and interpret it in the field work.
4. Choose and select the appropriate methods for analyzing sedimentary rocks and sediments.
5. Study and investigate thin-sections of sedimentary rocks under the polarized microscope.
6. Consider health and safety requirements in field work.

AG. 334 - Carbonates and Evaporites (3 credits: elective, theoretical)

This course aims to provide an advanced demonstration on the different Carbonate and the Evaporite rocks and minerals.

This course includes the following topics: the study of Carbonate and Evaporite minerals, their environments and their natural composition, the crystal chemistry and the mechanics of the calcium carbonate equilibrium, the classifications of carbonate and evaporite rocks, their formation and their composition, the diagenesis of limestone and evaporites, the study of the behavior of Mn, Zn, and Sr elements through carbonate development, the study of the behavior of F, B, Sr, Br elements, during Evaporite precipitation, development of evaporites and silicates in newly formed lakes, active and inactive karst activities, economic importance of carbonate rocks and evaporites. **The course includes scientific field trips to study these rocks in the Dead Sea, Aqaba, and Azraq Oasis.**

After completing this course, the student is expected to be able to:

1. Find Out about the different types and components of Carbonate and evaporites rocks and minerals.
2. Understand the environments and classifications of the Carbonate and evaporite rocks and minerals.
3. Be familiar with the uses of Carbonate and evaporite rocks and minerals in life and modern industry.
4. Learn about the karst and diagenetic activities of carbonate and evaporites rocks.
5. Consider health and safety requirements in the field.

AG. 335 - Geology of Phosphate Deposits (3 credits: elective, theoretical)

This course aims to introduce students to the origins of phosphate deposits and their uses.

The course includes the following topics: The origin and genesis of phosphates, Phosphate rock minerals, Classification of phosphate rocks, phosphate rock characteristics, geochemical distribution, sedimentary phosphorite and weathering derivatives, mining and beneficiation of phosphate rock, processing and use of phosphate rock, phosphate production, Manufacture of phosphate fertilizers, Rock phosphate reserves in the world and Middle East, and resource estimates, Jordanian phosphate rock in terms of availability, type, composition, nature, formation, reserve estimates, mining operations and production. **The course includes a scientific trip to the mines of the Jordan Phosphate Company to learn about the nature of phosphate presence in Jordan and production processes.**

After completing this course, student are expected to be able to:

1. Identify the origin of phosphate deposits.
2. Be familiarized with the properties of phosphate rocks.
3. Know how to handle and use phosphate.
4. Know how phosphate is produced.
5. Recognize the manufacturung process of phosphate fertilizers.
6. Learn about phosphates in Jordan, their locations and uses.
7. Understand the health and safety requirements in the field.

AG. 340 - Structural Geology and Tectonics (2 credits: compulsory, theoretical)

This course aims to give the students an introduction about stress and strain and their application in materials and rocks. Description of the different geological structures. In addition to an introduction to tectonics of the earth.

This course includes the following topics: the following topics: Introduction to structural geology and tectonics. Force and stress. Strain. Joints and veins: Description, systems, origin and their economic importance. Faults: Description, recognition, systems, and economic importance. Folds: Description, types, and origin. Major earth structures and plate tectonics.

After completing this course, the student is expected to be able to:

1. Understand the concept of stress and strain and their application in structural geology.
2. Recognize the different types of geological structures theoretically and in the field.
3. Understand the practical importance of structural geology.
4. Recognize the major structures of the earth associated with the plate boundaries.

AG. 340L - Structural Geology and Tectonics Laboratory (1 credit: compulsory, practical)

This course aims to study the attitude of linear and planer features in geology, the use of the geological compass, and draw and analyze the geological and structural maps.

This course includes the following topics: attitude of lines and planes and using the geological compass. Structural maps and cross sections. Stereographic projection.

Tectonic applications. **A field trip to a neighboring area to study the geological structures in the field.**

After completing this course, the student is expected to be able to:

1. Understand the attitude of planes (strike and dip) and lines (trend and plunge).
2. Recognize the geological structures in the field.
3. Draw and analyze the geological and structural maps and cross sections.
4. Learn the projection techniques and their application in structural geology.
5. Using the geological compass in measuring the attitude of beds and structures.
6. Understand some tectonic application such as calculating the ocean spreading rate and the velocity of plates.
7. Consider the measures of safety and security in the field.

AG. 342L – Geological Field Techniques Practical (2 credits: compulsory, practical)

This course aims to teach the students the basic geological field techniques.

This course includes the following topics: safety field measures. Geological maps and coordinates. Recognizing and description of bedding successions in the field. Using the field notebook and taking field notes. Position finding in the field. Using geological compass. Measuring and projection of bedding attitude. Measuring and projection of faults and joints. Drawing columnar and cross sections. Field photographs and field sketches. Sampling methods and preparing thin sections. Concentration on the professional ethics in both geological work and the scientific research. **The course includes field trips to the neighboring areas. The course is scheduled in the spring semester on Thursdays.**

After completing this course, the student is expected to be able to:

1. Read and interpret the published geological maps.
2. The ability to use the geological compass.
3. Recognize the geological formations in the field.
4. Describe the beds, outcrops, and samples in an accurate scientific method.
5. Accurate recording the field notes and measurements.
6. Field measurements and presentation of bedding, faults, and joints.
7. Drawing columnar sections of different rock types.
8. Drawing cross sections and field sketches.
9. Prepare microscopic thin sections.
10. Writing field reports.
11. Consider the field safety and security.

AG. 346L - Field Geology Practical (4 credits: compulsory, practical)

This course aims to give the students a field practice to map a specific area with a perfect scientific method.

This course includes the following topics: prepare a geological map with an appropriate scale depending on the field work. Plotting dip and strike measurements on the map. Different methods of plotting geological contacts on the map. Plotting faults and folds on the map. Drawing different cross sections. Description of the geological formations. Writing a geological report for the study area. The grading depends on field test, final report, geological map and appendices, field notebook, and presentations. The course is scheduled in the summer semester of the third year. Concentration on the professional geological and scientific ethics.

After completing this course, the student is expected to be able to:

1. Know the different methods of geological mapping.
2. Plot the geological contacts, dip and strike measurements on the map.
3. Recognize the geological structures and plot them on the map.
4. Describe the rocks and fossils in the field.
5. Draw cross sections from the geological map.
6. Write a geological report including description of rocks, structures, and the environment of deposition. It includes also the geological map and the cross sections.
7. Consider the safety and security in the field.

AG. 348 - Introduction to GIS (2 credits: compulsory, theoretical)

The course aim to introduce GIS in terms of type of data (vector and raster), analysis methods, and applications.

The course includes the following topics: fields and applications of GIS, types of data (vector and raster), sources of GIS data, methods of data entry and its processing analysis methods, and GIS applications in different disciplines particularly in geology and environment.

After completing this course, the student is expected to be able to:

1. Distinguish between the types of data used in GIS.
2. To apply methods of vector and raster data analysis.
3. To identify sources of data utilized in GIS.
4. Apply GIS in geological applications.

AG. 348L - Introduction to GIS Laboratory (1 credit: compulsory, practical)

This course aims to use GIS software for creating, management and analysis of geospatial data.

The course includes the following topics: practical exercises about the elements of GIS, data collection and editing, management and analysis of data, methods of data analysis particularly in geosciences, and geovisualization.

After completing this course, the student is expected to be able to:

1. Be familiar with the GIS software and its tools.
2. Edit the geospatial data.
3. Apply the processing and analytical methods.
4. Design maps for production.
5. Distinguish between different coordinate systems and how to make transformations.

AG. 349 - Remote Sensing in Geology (2 credits: compulsory, theoretical)

This course aims to cover the principles of remote sensing, the types of electromagnetic radiation, data types and their characteristics.

The course includes the following topics: introduce the basics of remote sensing and photogrammetry; electromagnetic radiation and its characteristics; characteristics of aerial photographs and satellite imagery; the types and characteristics of remote sensors; remote sensing classification based on wavelength regions, energy sources, and based on platforms; interpret images collected from various sensors, and remote

sensing applications in different disciplines. The course also covers the principles and uses of remote sensing software.

After completing this course, the student is expected to be able to:

1. Be familiarized with the principles on which remote sensing is based, its various techniques, methods, and skills.
2. Learned about different types of aerial photos and satellite images.
3. Can analyze aerial and satellite images and use it in various applications.
4. Be familiarized with methods of processing aerial and satellite images.
5. Be proficient in the visual interpretation and automatic processing of digital satellite images.

AG. 349L - Remote Sensing in Geology Laboratory (1 credit: compulsory, practical)

This course aims to recognize, interpret, and analyse aerial photos and various satellite images.

The course includes the following topics: introduce students to analyzing aerial photographs and satellite images and addresses the following topics: the principles of remote sensing science, electromagnetic radiation and its laws, studying and analyzing aerial photos and various satellite images; methods of processing satellite images and their use in different applications using ENVI software.

After completing this course, the student is expected to be able to:

1. Perform calculations using the laws of electromagnetic radiation (Maxwell's Wave Theory, Quantum Theory, Stephan Boltzman Law, and Wien's Displacement Law) and recognize the relationships between them.
2. Measure and analyze reflected rays for target identification.
3. Use the ENVI software in terms of basic concepts, key features, and tools.
4. Combine multiple images into a single composite image (mosaicking).
5. Complete a visual and automated interpretation, and choose the appropriate methods for analysis of satellite imagery.
6. Use remote sensing data to examine many applications in the fields of geosciences and environment science.

AG. 350 - Economic Geology (2 credits: compulsory, theoretical)

This course aims to distinguish the important factors in evaluating promising ores and the factors that affect the percentage of ore quality, study metallic mineral resources, and identify the main steps in establishing and operating mines.

The course includes the following topics: providing students with knowledge related to the history of mineral use, the development of economic geology, the geology of mineral deposits, mineral ores and their origins: the formation of early and late magmatic ores, pegmatite ores, the formation of hydrothermal solutions and minerals formed from them, veins and their types, ores of dissolution and substitution. The formation of metamorphic and sedimentary ore deposits. It includes the study of the origins and methods of formation of metallic ores, such as: nickel, copper, lead, zinc, manganese, gold and silver, in addition to non-metallic deposits such as phosphate and potash. Giving students examples of economic mineral ores in different regions of the world.

After completing this course, the student is expected to be able to:

1. Learn about the history of mineral usage and the development of economic geology.
2. Learn about the geology of mineral deposits, mineral ores and their origin: the origin and formation of early and late magmatic ores, pegmatite ores, the formation of hydrothermal solutions and minerals formed from them, the veins and their types, ores for dissolution and substitution, the formation of metamorphic deposits, and the formation of sedimentary ores.
3. Learn about the origins and methods of formation of different metallic ores.

AG. 350L - Economic Geology Laboratory (1 credit: compulsory, Practical)

This course aims to introduce the concept of economic geology and its application in geology.

The course includes the following topics: understanding the concept of economic geology and its practical applications in geology, with a focus on the most important mathematical methods to calculate ore reserves and identify the ore minerals either by using the ore microscope or interpretation of X-ray diffraction.

After completing this course, the student is expected to be able to:

1. Understand the role of a geologist in the various stages of economic ores exploration.
2. Calculate ore reserves by calculating the average grade, tonnage, and volume of the ore.
3. Understand the methods of sample collection in the field and the methods of ore separation.
4. Apply manual interpretation of the x-ray diffraction results.

AG. 354 - Environmental Geology (3 credits: compulsory, theoretical)

This course aims to introduce student to basic concepts of environmental geology and natural hazards and human interact with its environment.

The course includes the following topics: philosophy of environmental geology, Earth processes and natural hazards including earthquakes, volcanic activity, floods, landslides and earth subsidence. Course will focus on evaluation and adaptations of the risks for each of the natural hazards. Water resources and its pollution, soil and environment. Environmental management from global perspectives, global climatic change and desertification. Geology and environmental health. **This course will also include field visit to sites endangered by natural hazards such as sinkholes in Dead Sea area and road- side landslides along Amman Irbid Highway.**

After completing this course, the student is expected to be able to:

1. Be aware of the basic concepts of environmental geology and natural hazards.
2. Know the hazards of earthquakes, volcanos, floods and landslides and evaluating their risks and know how to adapt with hazard and minimize risk.
3. Know main water resources and their source of pollution.
4. Know soil formation, soil types and how to protect soil.
5. Know the concept of environmental management from global perspective.
6. Take cure of field safety requirements.

AG. 361 - Geology of Jordan (3 credits: compulsory, theoretical)

This course aims to study the geology and morphology of Jordan and its natural resources.

The course includes the following topics: study of the stratigraphy of Jordan starting from the Pre-Cambrian to the Cenozoic, volcanic activities, geological structures, Jordan's geomorphology, mineral resources, water resources, the course includes organizing scientific field trips, as follows:

i) the first trip to southern Jordan to get acquainted with the rocks of the pre-Cambrian Era, Paleozoic sequence, the Jordanian geomorphology, and some geological structures in the south such as Aqaba rift. **ii)** the second trip to northern Jordan to get acquainted with the Mesozoic and Cenozoic rock units and some geological structures in the north such as Ajlun Dome and Koura basin.

After completing this course, the student is expected to be able to:

1. Know and distinguish the different rock units of Jordan.
2. Know the main geological structures of Jordan.
3. Know the geomorphology of Jordan.
4. Know the geological natural resources available in Jordan and their various uses.
5. Consider the health and safety requirements in the field.

AG. 371 - Applied Geophysics (2 credits: compulsory, theoretical)

This course aims to study the basic geophysical methods.

This course includes the following topics: introduction to geophysics, seismic exploration methods: theoretical principles, different methods (refraction and reflection), field data collection and interpretation, electrical exploration methods: theoretical principles, different methods (electrical resistivity and electromagnetism), field data collection and interpretation, Gravitational exploration methods: theoretical principles, temporal and spatial changes in the Earth's gravitational field, field data collection, processing and interpretation, magnetic exploration methods: theoretical principles, temporal changes in the ground magnetic field, field data collection, processing and interpretation

After completing this course, the student is expected to be able to:

1. Familiarize himself with basic physical concepts of different geophysical methods.
2. Understand the different determinants of different geophysical methods.
3. Choose the most appropriate geophysical method for different applications.
4. Conducting field geophysical surveys.
5. Handle geophysical data of the main methods and their interpretation.

AG. 371L - Applied Geophysics Laboratory (1 credit: compulsory, practical)

This course aims to study the practical side of the Applied Geophysics course.

This course includes the following topics: seismic refraction method: introduction, mathematical laws, study and interpretation of seismic refraction data for two horizontal layers, and then expand by studying and interpreting seismic refraction seismic data for a number of horizontal and inclined layers. Interpretation of data associated with faults and dealing with different determinants of the seismic refractive method. Implement a field experiment that includes collecting refraction field data and interpretation. Reflection seismic method: introduction, mathematical laws, processing

shallow reflective data and calculating different velocities, interpretation of data, acknowledge of deep seismic data and integrated interpretation methods using appropriate software. Gravitational method: introduction, mathematical laws, training in implementing various temporal and spatial corrections (drift and tidal changes, free air, bouguer, terrain), data processing and separation of the residual gravitational field from the regional gravitational field and calculation of gravitational anomalies maps, interpretation of gravity data using direct mathematical modeling using simple bodies gravitational data (i.e. the sphere, cylinder, etc.). Magnetic method: introduction, mathematical laws, application of various corrections, data processing, separation of the residual magnetic field from the regional field, calculation of magnetic anomaly maps, modeling and interpretation of results, and implementation of a field experiment to collect magnetic data. Electrical method (electrical resistivity): introduction, mathematical laws, processing electrical data to study the horizontal and vertical changes or sounding, interpretation of results manually and using appropriate software, and carrying out a field experiment for different electrical resistivity survey methods. The course includes a field trip to carry out geophysical survey work in nearby locations and outside the city.

After completing this course, the student is expected to be able to:

1. Execute the basic geophysical surveys methods (seismic, gravity, electrical and electrical).
2. Understand the applications of different geophysical methods in terms of field work and data handling in terms of correction and processing.
3. Interpret the results properly.
4. Preparing geophysical reports for the various applications.
5. Observe health and safety requirements in the field.

AG. 385 - Methods of Scientific Research in Geology

(3 credits: elective, theoretical)

This course aims to introduce students to scientific methods and skills for research and development of scientific writing, critical reading and diction skills.

The course includes the following topics: methods of designing research projects in geology, designing field and laboratory geological studies, critical reading of previous studies or summaries, developing scientific writing skills, learning about the components of research or scientific report, designing and preparing tables and illustrations and diagrams and how to include them in the text, and writing Autobiography, presenting a scientific lecture, scientific citation, methods of sound scientific documentation, clarifying the concept of plagiarism, and focusing on the ethics of scientific research.

After completing this course, students are expected to be able to:

1. Read and interpret data from previous studies.
2. Have the writing skills for conducting research and completing scientific reports.
3. Design a scientific research project.
4. Have gained the ability to present work, attended lectures, and have participated in scientific discussions.

AG. 386L – Applied Geodtic Survey (practical) (2 credits: elective, practical)

The course aims to teach the basics of global navigation satellite systems (GNSS), laser ground scanning (TLS), and 3D reconstructions based on ground and aerial imaging surveys using unmanned aerial vehicles (UAV) by using the Structure from Motion (SfM) method to create 3D point cloud for different geological features or for topographic mapping.

The course includes the following topics: a brief overview of the geodetic methods and components and presenting the best ways to use them through classroom lectures, demonstrations and field exercises. High-precision positioning with static and mobile GPS/GNSS and high-resolution terrain analysis using TLS and SfM while tracking potentially imperceptible changes in the Earth's surface and monitoring landslides and subsidence. Track sedimentary surfaces and objects using specialized tools and software to extract detailed information from the Digital Outcrop Model. Measuring and multiplying the inclination of layers, faults, and joints, and their projection and representation through a stereonet analysis. Create field trips and selected geological sections for virtual training. The course includes a field trip to carry out surveying techniques using TLS and UAVs in close quarters and outside the city suffering from landslide problems.

After completing this course, students are expected to be able to:

1. Deeper understanding geodetic survey methods using (GPS, LiDAR and SfM).
2. Developed a better awareness of the challenges and benefits of integrating geodetic field methods in different geological applications with field components.
3. Be familiarized with geodesy tools for geological and natural hazards issues.
4. Use Agisoft MetaShape Pro to create a 3D point cloud from aerial and ground images and analyze the resulting 3D geological model.
5. Design and conduct static and/or mobile GPS/GNSS surveys to measure ground control points.
6. Distinguish and describe layers, and outcrop geological formations in an accurate scientific-technical manner.
7. Measuring a geological bedding planes, faults, joints, and fractures from 3D models, and representing readings by various graphical methods.
8. Making high-resolution topographic maps and monitoring deformations and landslides.
9. Writing field and technical reports.
10. Understand and apply health and safety requirements in the field.

AG. 412 - Paleoenvironment (3 credits: elective, theoretical)

This course aims to identify and explain the main concepts in paleoenvironment, analyzing fossils and reconfiguring their paleoenvironments.

This course includes the following topics: the study of major sedimentary environments, the types of fossils present, the processes of fossilization, and how the biological systems of certain environment was changed over time. And the biological, physical, and chemical factors that affect modern environments, and how they can be used in understanding ancient environmental conditions, depending on the fossils remains.

After completing this course, the student is expected to be able to:

1. Acquire the skills necessary to interpret a set of data on ancient environmental information.
2. To gain knowledge to understand current environmental changes and evolutionary adaptations of organisms in response to environmental changes.
3. Discusses important concepts and issues in ancient ecology, such as phylogeny, biogeochemistry, fossil biography, and fossil historiography.
4. Determine the components of marine sediments and their environmental importance.
5. Using fossil and sedimentary information in reconstructing the ancient environment
6. Evaluating the changes and diversity of ancient neighborhoods over time and evaluating the causes of major extinctions and evolutionary events resulting from ancient geological and environmental changes.
7. Identify and explain the most common large fossils that existed during the Paleozoic, Mesozoic and Cenozoic Eras of Jordan.

AG. 432 - Industrial Rocks and Minerals (3 credits: compulsory, theoretical)
This course aims to study industrial rocks and minerals.
The course includes the following topics: study the industrial minerals and rocks from the following aspects: characteristics, specifications, uses, classification, and recent technical and technological trends. Study of the most important industrial rocks such as: granite, basalt, pumice, slate, marble, sandstone, limestones, dolomitic rocks, phosphates, gypsum rocks, and salt rocks. Study of the most important industrial minerals such as: feldspar, clay minerals, mica minerals, asbestos, graphite, talc, sulfur, diamonds, diatomite, potash minerals, sodium minerals, and borates. And study the methods used to identify minerals and industrial rocks.
After completing this course, the student is expected to be able to:
1. Distinguish between industrial rocks and industrial minerals.
2. Use the appropriate analysis method to find out the industrial minerals and rocks.
3. Learn about the most important uses of industrial minerals and rocks.

AG. 444 – Earth Tectonics (3 credits: elective, theoretical)
This course aims to give an introduction to the plate tectonics and the major structures of the earth.
The course includes the following topics: introduction to the whole earth structures. Theory of plate tectonics. Types of plate boundaries. Extensional tectonics, rifting and sea floor spreading. Contraction tectonics, fold and thrust belts. Shear tectonics, strike slip and transform faults. Active tectonics and their applications. **The course includes a geologic field trip to the Jordan Valley and the Dead Sea.**
After completing this course, the student is expected to be able to:
1. Understand the major structures of the earth and the plate tectonics.
2. Understand the major stresses affecting the earth lithosphere (tension, compression, and shear) and their results in extensional faults, folds and thrusts, and transform faults.
3. Describe the characteristics and the processes associated with every type of plate boundary.

4. Know the different features associate with the active tectonics and their examples from the Dead Sea transform.
5. Take in consideration the conditions of safety and security in the field.

AG. 448 - Applications in Geographic Information Systems (2 credits: elective, theoretical)

This course aims to introduce advanced GIS applications in geological and environmental natural processes.

The course includes the following topics: types of models, applications in hydrology, groundwater, natural hazards, spatial statistics, image analysis, case studies such as modeling landslides, floods, earthquakes, etc.

After completing this course, the student is expected to be able to:

1. Distinguish between the types of models in GIS.
2. Model natural processes such as landslides.
3. Study a real-life problem and recommend appropriate solutions.

AG. 448L – Applications in Geographic Information Systems Laboratory (1 credits: elective, practical)

This course aims to use GIS software in understanding and studying the geological and environmental natural processes.

The course includes the following topics: practical exercises to learn about the advanced tools and functions of GIS such as interpolation, map algebra, map overlay, hydrology, groundwater, analyzing patterns, mapping clusters, spatial distribution, modeling spatial relationships, processing satellite images and their analysis, and a project.

After completing this course, the student is expected to be able to:

1. Apply the advanced analytical tools and functions in GIS.
2. Model natural processes.
3. Implement a real-life problem.

AG. 452 - Applied Hydrogeology (2 credits: compulsory, theoretical)

This course aims to present a brief description of the hydrologic cycle and how can be measured theoretically, and introduce the concept of aquifers, its characteristics and groundwater flow.

The course includes the following topics: brief introduction to the hydrologic cycle and its elements, drainage basin and water budget. Drainage basin characteristics, porosity, permeability and hydraulic conductivity. Types of aquifers, water table and potentiometric surface. Aquifer properties, transmissivity, Storativity, specific storage and compressibility of aquifer materials. Principle of groundwater flow and flow to wells. Concept of hydraulic head. Methods of groundwater exploration (resistivity methods). Groundwater chemistry and quality. This course may include a pumping test to neighboring groundwater wells.

After completing this course, the student is expected to be able to:

1. Know the element of the hydrologic cycle and do drainage basin water budge.
2. Know the concept of aquifers, aquifer types and their characteristics and properties.
3. Know the principles of groundwater flow and Darcy's law.

4. Know some groundwater exploration methods.
5. Know groundwater major chemical components and how ions concentration can be measured.
6. Observe health and safety requirements in the field.

AG. 452L - Applied Hydrogeology Laboratory (1 credit: compulsory, practical)
This course aims to do some hydrological and hydrogeological measurements and experiments.
The course includes the following topics: practical exercises on water budget calculations, computing evaporation, average precipitation, runoff and infiltration; preparing groundwater maps; calculating porosity and permeability to consolidated and unconsolidated samples; calculation uniformity coefficient for sediments, pumping test and representation of water chemistry.
After completing this course, the student is expected to be able to:
1. Do water budget to a drainage basin.
2. Compute evaporation and average precipitation to drainage basin.
3. Compute cross sectional area, water velocity and discharge to river reach.
4. Prepare water level maps manually and using software's.
5. Compute porosity for consolidated and unconsolidated samples.
6. Compute uniformity coefficient and sorting to sediments samples.
7. Compute permeability to sediments samples.
8. Know computations to pumping test.
9. Do graphical representation of water chemical analysis.

AG. 453 - Petroleum Geology (2 credits: compulsory, theoretical)
This course aims to provide fundamental concepts of petroleum geology and the processes that associated with oil and gas generation.
This course includes the following topics: introduction to petroleum geology and petroleum exploration, Theories on 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. **This course includes a field trip to the National Petroleum Company or a visit Risha field / eastern Jordan.**
After completing this course, the student is expected to be able to:
1. Understand the basic knowledge of oil and gas generation and migration.
2. Understand the different methods of oil and gas exploration emphasizing on the drilling techniques.
3. Determine the problems associated with drilling techniques.
4. Evaluate the maturity of organic carbons in the source rocks.
5. Understand the integration between the petroleum components.
6. Observe health and safety requirements in the field.

AG. 453L - Petroleum Geology Laboratory (2 credits: compulsory, practical)
This lab aims to provide students with knowledge and skills to study petroleum geology.
This course includes the following topics: correlation between wells by using lithology, biostratigraphy and wireline logging, transgression and regression of sea, progradation and retrogradation of facies, lag time, one-dimension modeling and burial history chart, cutting description, build up masterlog and clarify geologist tasks in petroleum industry, pressure calculations.
After completing this course, the student is expected to be able to:

1. Gain skills on lithostratigraphical and biostratgraphical correlations.
2. Explain the depositional environment, shorelines, and facies movements.
3. Use the subsurface maps.
4. Determine the position of exploration and production wells.
5. Calculate the lagtime and timestrocks.
6. Describe briefly the cutting samples.
7. Prepare the daily, weekly, and annual reports.
8. Determine and describe the petroleum's shows in the samples.
9. Understand the characteristics the petroleum basin by using the modern techniques such as the burial history chart.

AG. 455 - Engineering Geology (2 credits: compulsory, theoretical)
This course aims to introduce students to the physical properties of earth materials and the factors affecting them, and their practical applications for engineering purposes.
This course includes the following topics: identifying and measuring the important physical properties of earth materials, analysis of the effects of the presence of fluids in earth materials, surficial geological processes (weathering, erosion, and tectonic activities), site investigation methods and techniques for engineering purposes, study the impact of water drainage on the sites of engineering constructions and coastal operations and the study slope stability, study and analysis of earth subsidence and sinkholes, an analytical study of landfill and dam sites.
After completing this course, the student is expected to be able to:

1. Learn about the physical properties of the soil.
2. Recognize the impact of water on the soil.
3. Learn about the impact of differnt geological structures on the facilities design
4. Learn the methods and process of site Investigation
5. Identify engineering construction problems and methods for solving and mitigating their risks.
6. Conduct various labrotary tests to determine physical properties and classification of earth materials.

AG. 455 - Engineering Geology Laboratory (1 credit: compulsory, practical)
This course aims to conduct practical engineering experiments to examine the soil and see the impact of water on it.
This course includes the following topics: engineering experiments for soil inspection, humidity measurement, grain size analysis and soil classification, plasticity

and liquid limits measurment, porosity and permeability tests, density estimation, soil/proctor compaction test, unconfined compression and shear strength tests.

After completing this course, the student is expected to be able to:

1. Know the physical properties of the soil.
2. Recognize the impact of water on the soil.
3. Conduct various geotechical laboratory test related to forces.
4. Identify the engineering problems of construction related to the earth material and how to solving it.

AG. 456 - Petroleum Source-Rocks Evaluation (3 credits: elective, theoretical)

This course aims to provide an overview on the source rock and their importance in the petroleum system and how the petroleum generated. This course is also aimed to understand the biological and chemical methods used to assess the maturity of organic matter.

This course includes the following topics: define the source rock, and factors affect the preservation of organic matter, classification of organic matter, the biological paleo-thermometer (vitrines, and spores) and chemical paleo-thermometers (rock eval, and chromatography). This course includes studying the isotopes to understand the accumulations of organic carbon. An overview of the source rock and oil shales in Jordan will be given in this course. **This course includes a field trip to the oil shale deposits north of Jordan.**

After completing this course, the student is expected to be able to:

5. Understand the source rock and it forms.
6. Gain skills in analyzing and interpret maturity data.
7. Evaluate the potentiality of the hydrocarbon system.
8. Evaluate the source rock and oil shales in Jordan based on its production to matured oil and gas.

AG. 474 - Engineering Geophysics (2 credits: elective, theoretical)

This course aims to study and apply various shallow geophysical methods in engineering projects.

This course includes the following topics: introduction, the role of geophysical methods in engineering projects (such as projects of dams, roads, and high-risk structures such as bridges, nuclear reactors, etc.) and various near-surface geophysical applications (such as studying landslides, subsidence and cavities, etc.), the physical properties of earth materials, the various engineering geophysical methods (normal and tomographic refractive seismic surveys, surface seismic wave analysis, normal and tomographic electrode resistivity survey (ERT), and ground penetrating radar (GPR), micro-gravity, gradient magnetism, geophysical borehole methods), fundamentals and applications, equipment, methods of field work, data analysis, processing and interpretation.

After completing this course, the student is expected to be able to:

1. Understand the importance and role of engineering geophysics in solving various engineering problems.
2. Understand the different determinants of the different methods.

3. Choose the most appropriate geophysical method for the different engineering applications.
4. Deal with geophysical data using sound scientific methodology and reaching solutions to engineering problems.

AG. 474L - Engineering Geophysics Laboratory (1 credit: elective, practical)
This course aims to study and apply shallow geophysical methods in engineering studies from a practical point of view.
This course includes the following topics: introduction, uses and limitations, training in the following engineering geophysical methods: tomographic refraction seismicity, surface seismic wave analysis (active and passive), electro-tomographic resistivity, microgravity, gradient magnetism, and ground penetrating radar (GPR). This course includes designing field work, collecting field data using available geophysical devices, processing real data using appropriate software and interpretation, and discussing previous case studies.
After completing this course, the student is expected to be able to:
1. Execute engineering geophysical surveys.
2. Choose the most appropriate geophysical method for various problems or projects.
3. Handle geophysical data in terms of correction and processing.
4. Interpret the results properly.
5. Prepare geophysical reports for various applications.
6. Observe health and safety requirements in the field.

AG. 475 – Applied Geochemistry (2 credits: compulsory, theoretical)
This course aims to understand the evolution of the Earth and its crust from a geochemical perspective.
This course covers the following topics: The first part of the course will cover the principles of geochemistry, starting with the cosmic and crustal abundance of the elements, Goldschmidt's rules, major and minor element distribution and behavior in the major rock types, phase diagrams and principles of isotope geochemistry (stable and radioisotopes). The second part will explore some of the applied aspects of geochemistry. This will include hydrogeochemistry (including it's implications regarding groundwater sourcing and quality), geochemical exploration for economic resources, and palaeoclimatic studies.
After completing this course, the student is expected to be able to:
1. Describe the geochemical evolution of the solar system and the Earth.
2. Understand the evolution of the Earth and its crust viewed from a geochemical perspective.
3. Apply the basic principles of hydrogeochemistry to predict the outcome of interactions between liquids and rocks and the formation of sediments.
4. Understand the processes involved in the distribution and transportation of chemicals between the atmospheric, continental and marine environments.
5. Understanding the geochemistry of near-surface water.

AG. 475L - Applied Geochemistry Laboratory (1 credit: compulsory, practical)
This course aims to study and implement different geochemical experiments.

This course includes the following topics: the study of the geochemical properties of geological samples through the application of specific geochemical analyses and the use of laboratory devices, which include: measuring moisture content, measuring the percentage of organic matter by burning and titration, measuring the percentage of carbonate material, measuring the percentage of phosphates, the phase curve, measuring cation exchange capacity , measuring the pH of geological samples, in addition to understanding the thermodynamics of chemical reactions and the structure of silicate minerals, the chemistry of isotopes and their equations and their applications in age estimation.

After completing this course, the student is expected to be able to:

1. Calculate the percentage of moisture in a geological sample.
2. Determine the percentage of organic matter within a geological sample using the method of burning and titration.
3. Determine the percentage of carbonate within a geological sample using the Calcium Meter device and titration.
4. Determine the percentage of phosphates in a soil sample based on the optical density (absorption) of the prepared solution using a spectrophotometer.
5. Understand the structure and diversity of silicate minerals, depending on the ways their main building blocks are bound together.
6. Study and analysis of phase diagrams for specific chemical systems.
7. Measure the cation exchange capacity of geological materials.
8. Measure the pH of geological samples.
9. Determine ages depending on the radioactive isotopes.
10. Observe health and safety requirements in the laboratory.

AG. 476L – Geophysical Field Techniques (Practical) (2 credits: elective, practical)

This course aims to provide the students with real-life training of different geophysical field techniques, including field surveys using basic geophysical methods devices, processing, interpretation, and presentation of results in appropriate ways.

The course includes the following topics: designing and implementing geophysical surveys in the field, practical training on the use of basic geophysical methods devices (seismic, electrical, magnetic, and ground penetrating radar) for various exploratory goals and applications, data collection and processing using manual approaches, and training on appropriate software to process and interpret data collected by the student, writing of professional reports, discussion and presentation of results. The course includes a number of trips to carry out geophysical surveys of nearby sites with the aim of training students on the use of various equipment and collecting real data from the field.

After completing this course, the student is expected to be able to:

1. Deal efficiently with basic geophysical methods equipment.
2. Design and implement geophysical surveys for various exploratory applications.
3. Process and interpret data by manual methods and by using specialized software properly.
4. Provide the results of various surveys professionally through written reports and oral presentations.
5. Take into account the health and safety requirements in the field.

AG. 479 – Subsurface Geology and Well Logging (2 credits: compulsory, theoretical)

This course aims to introduce the basic physical concepts of deep surface and deep geophysical exploration methods.

This course includes the following topics: Introduction to deep geophysical exploration methods, expansion in the reflexology seismic method, well testing methods and petrophysical analysis, seismic or seismic data and their processing, paper and interactive interpretation of two- and three-dimensional seismic data, preparation and analysis of structural subsurface maps, construction of subsurface models for basins Sedimentary.

After completing this course, the student is expected to be able to:

1. Familiarize himself with basic physical concepts for deep surface and deep geophysical exploration methods.
2. Learn about the different types of well probes.
3. Execute calculations and petrophysical analysis.
4. Deal with 2D and 3D seismic data and interpretation.
5. Prepare subsurface maps and building subsurface models.

AG. 479L – Subsurface Geology and Well Logging Laboratory (1 credit: compulsory, practical)

This course aims to train the student to use deep and borehole geophysical exploration methods in the studying of subsurface geology and the preparation of compositional maps necessary for oil studies and other relevant applications.

This course includes the following topics: reviewing methods of deep geophysical exploration, training in reading maps of gravitational and magnetic surveys, determining the boundaries of sedimentary basins and subsurface structures, training on paper interpretation of 2D seismic data, training on using relevant softwares necessary for interactive interpretation of 2D and 3D seismic data for faults and seismic horizons, Time-to-Depth conversion of readings and maps from time to depth domains, identification of seismic horizons and seismic facies, training on the use of well logging data for the study of subsurface environments, petrophysical analysis (i.e. Volume of shale using different logs, porosity calculation, calculation of oil saturation, preparation and analysis of structural subsurface maps, construction of subsurface models for sedimentary basins.

After completing this course, the student is expected to be able to:

1. Familiarize himself with basic physical concepts for deep and deep geophysical exploration methods.
2. Learn about well logging methods and their applications.
3. Carry out various petrophysical analyzes.
4. Deal with 2D and 3D seismic data and their interpretation.
5. Prepare structural subsurface maps and building subsurface models using appropriate software.

AG. 480 – Exploration and Mining Geology (3 credits: elective, theoretical)

This course aims to provide the necessary knowledge and advanced training to students wishing to see; future employment in the mining industry.

This course includes the following topics: identifying the best practices related to the role of the geologist working in the field of mineral exploration and mining, an introduction to the Jordanian relevant legislation and regulations related to mining and environmental operations, stages, methods and techniques of surface and underground exploration, sampling techniques for estimating mineral resources and reserves, carrying out chemical analyzes of elements and minerals, selecting appropriate chemical laboratories, quality control and assurance, drilling techniques, planning and management of drilling programs, geological description of drilling results, sampling, data presentation and interpretation, estimation of mineral resources using manual methods and geostatistical methods, introduction to three-dimensional modeling techniques and programs for the analysis of spatial distribution or resources, sediment quality and evaluation of mineral resources, an introduction to surface and subsurface mining methods and processes, the role of the geologist during production processes, environmental aspects mining and tailings management. The course included solving exercises and training on the use of software related to the concept of exploration and mining, as well as reviewing previous study cases. **The course includes a scientific trip to one of the exploration or mining sites in Jordan.**

After completing this course, the student is expected to be able to:

1. Understand the role and responsibilities of the geologist during exploration and mining operations.
2. Learn about the stages of exploration and mining, from reconnaissance to the feasibility study.
3. Know the methods and techniques of field exploration.
4. Perform geological modeling, estimation and evaluation of mineral resources.
5. Understand the role of mining geology in production.
6. Get to know the concept of mine waste management.
7. Take into account the requirements of health and safety and community responsibility in the field and mine sites.

AG. 482 – Marine Geology (3 credits: elective, theoretical)

This course aims to study marine geology, ocean distribution, developments and properties.

This course includes the following topics: briefing on marine geology, oceans distribution. Plate tectonics and sea floor spreading, seafloor development. Topography of ocean floor, continental margins, passive and active margins. Oceans sediments. Sea water and it properties. Ocean water movements and ocean currents and relation to atmospheric circulation. Ocean resources.

After completing this course, the student is expected to be able to:

1. Know the history of oceanography, Earth oceans origin.
2. Know the topography and developments of oceans.
3. Know ocean sediments, types and sources and developments.
4. Know the physical and chemical properties of seawater.
5. Know ocean circulation, importance and developments.

AG. 484 – Earthquake Seismology (3 credits: elective, theoretical)

This course aims to introduce students to earthquake seismology and its applications.

This course includes the following topics: the development of earthquake seismology and its applications, causes and effects of earthquakes, seismic waves, seismic monitoring stations and their equipment, seismic parameters and seismic wave paths, locating earthquakes using seismograph records, earthquake hazards and maps of intensity and ground acceleration, the structure of the earth inferred from seismic data, tectonics and seismicity of the Jordan Dead Sea Rift and the Arabian Plate. The course includes a scientific trip to the Jordanian Seismological Observatory (JSO) to learn more their responsibilities, real-time seismic monitoring processes and its various applications.

After completing this course, the student is expected to be able to:

1. Acquire the basic concepts in seismology.
2. Distinguish between measures of the intensity and magnitude various scales of earthquakes.
3. Understand the different seismic phases, and their role in determining the internal structure of the Earth.
4. Handle seismic data and determining seismic waves and their arrival times.
5. Locate earthquake epicenters and the depths of seismic focus using different approaches.
6. Estimate the size of the seismic hazard.

AG. 486 – Quaternary Geology (2 credits: compulsory, theoretical)

This course aims to provide fundamental information on the characteristics of the Quaternary deposits.

This course includes the following topics: basic information on the Quaternary period and its general characteristics, water-continent configuration, and the famous formations of Quaternary in region and globe. Emphasis will be on climatic conditions necessary for desert forming and on the elements of climate that can be affected by the climate change. This course focuses on study the weather and how it could influence the different types of erosions and sedimentation and study of desert morphology, drainage pattern, soil, and the system whole.

Field trips will be held to Azraq/north of Jordan to check the desert environment. Another one will be conducted to south of Jordan to know more about Quaternary deposits in Aqaba.

After completing this course, the student is expected to be able to:

1. Understand the environmental conditions of the desert
2. Differentiate between different geological formations that could be found in the desert as resulted from erosion processes.
3. Understand the distribution pattern and characteristics of sedimentary rocks in the continent and marine.
4. Perform a field study for different Quaternary facies in Jordan.

AG. 491 – Seminar in Geology (1 credit: elective, theoretical)

The course includes geological topics at the fourth year level determined by the course instructor and provides a comprehensive course plan covering one hour per week, provided that the head of the department approves the detailed course plan before it is presented in the course schedule for the next semester. Emphasis is placed on

professional ethics for geological work and scientific research ethics, and taking into account them in terms of assignments, reports, lectures, etc. submitted by students.

AG. 492 – Special Topics in Geology (3 credits: elective, theoretical)
Special topics in geology covered by this course includes the study of special topics not included in the study plan, courses are determined by the course instructor and provides a comprehensive course plan covering 3 hours per week, provided that the head of the department approves the detailed course plan before it is presented in the course schedule for the next semester. Emphasis is placed on professional ethics of geological work and scientific research, taking into account the in terms of assignments, reports, lectures, etc. submitted by students.

Courses description for the minor in Envoronmental Scinces

ENV. 104 – Environmental Sciences (3 credits: compulsory, theoretical)

The course aims to shed light on some basic concepts of environment, earth structure and spheres, and the components of natural ecosystems, the relationship of living components with each other and their relationship to non-living components, stability of natural ecosystems, disturbing the environmental balance and adapting to environmental changes. The course also aims to explain the factors affecting the population, population growth, population density, geographical distribution of the population, and the effect of population on the environment and pollution. Study air pollution and sources, classify air pollutants, and discuss the most predominant environmental problems related to air pollution.

The course includes the following topics: Familiarizing with basic environmental science concepts, learning about the human impact on the environment, learning about the planet's envelopes and natural ecosystems, learning about how people affect the environment and pollution, studying air pollution, sources of air pollution, and the main environmental problems related to air pollution

After completing this course, the student is expected to be able to:

1. To know the concepts of environmental science.
2. To know the human impact on the environment.
3. To know the earth structure and spheres
4. To know the natural ecosystems
5. To know the impact of the population on the environment and pollution
6. To know the sources of air pollution and the main environmental problems related to air pollution.

ENV. 211 – Soil and Soil Pollution (2 credits: compulsory, theoretical)

This course aims to introduce the soil concept, its compositions, forming processes, and properties, and remediation measures.

The course includes the following topics: the definition of soil science; the constituents of soil and the factors of soil formation including physical, chemical, and biological properties; soil classification; soil erosion and pollution and remediation measures.

After completing this course, the student is expected to be able to:

1. Upon completion of this course the students will be able to:
2. Understand the physical, chemical, and biological characteristics of soil.
3. Understand the soil classification system.
4. Understand the measurement method of soil properties.
5. Identify and address some major environmental problems affecting soil.

ENV. 211L – Soil and Soil Pollution Laboratory

(1 credit: compulsory, practical)

This course aims to introduce the students to conducting practical measurements pertaining to soil

The course includes the following topics: minerals and rocks, moisture, sampling, density, permeability, grain size analysis, sieving, field capacity, saturation percentage,

content of organic matter, carbonate, pH, dissolved salts, and the elemental concentration.

After completing this course, the student is expected to be able to:

1. Identify the soil parent material.
2. Understand the physical properties of soil.
3. Understand the chemical properties of soil.
4. Classify the soil.

ENV. 251 – Aquatic Systems and Pollution (3 credits: compulsory, theoretical)

This course aims to introduce the students to the hydrological cycle and its importance, major aquatic systems, and sources and treatment of pollution.

The course includes the following topics: importance of water, water distribution in the earth water structure, the chemical, physical, and thermal properties of water, water cycle elements, fresh water systems (ponds and lakes, stream and rivers, and wetlands), marine systems (oceans and seas), ecological limiting factors in aquatic environments, pollution of aquatic systems, and the water situation in Jordan.

After completing this course, the student is expected to be able to:

1. Understand the importance of the chemical structure of water and the water distribution on the earth.
2. Understand the chemical, physical, and thermal properties of water and their importance.
3. Understand the main characteristics of fresh water and marine and the major limiting factors in the aquatic environments.
4. Understand the concept of pollution and the main pollutants in the aquatic systems.
5. Understand the environmental situation of water in Jordan.

ENV. 255L – Water Chemistry Laboratory (1 credit: elective, theoretical)

This course aims to train students to conduct water analyses.

The course includes the following topics: will consist of 10 laboratory sessions, during which student will be taught surface and groundwater sampling; laboratory safety measures; water quality and quality control and assurance; solution concentrations and measurement; water sample preparation and instruments; measuring water pH, electrical conductivity (EC), and total dissolved solids (TDS), major cations (Na, Ca, Mg, K), major anions (Cl, SO4, HCO3, CO3), nitrogen compounds, phosphorus, total alkalinity, hardness, turbidity, dissolved oxygen BOD (biological oxygen demand), COD (chemical oxygen demand), and some heavy metals in water.

After completing this course, the student is expected to be able to:

1. Understand the importance and procedures of water quality analysis.
2. Identify the different devices used to analyze water samples.

ENV. 312 – Climatology and Meteorology (3 credits: elective, theoretical)

This course aims to familiarize students with the atmospheric layers, thermodynamics, and the impacts on the earth, as well as the methods of weather forecasting.

The course includes the following topics: basic concepts (gaseous thin layer, atmospheric layers, turbulent atmosphere, forces and causes of turbulence, the sun and

the energy of the atmosphere, and a review of thermodynamics), observations and measurements (temperature, humidity, wind, pressure, deposition, and monitoring networks), the atmospheric system (the homogenous layer, diffusive and convective equilibriums, tropopause, dry air composition), state of the atmosphere, the physics of the clouds, the dynamics of the atmosphere, radiation in the atmosphere and its impact on the environment, and weather forecasting methods.

After completing this course, the student is expected to be able to:

1. Identify the weather and climate elements.
2. Understand the formation and development of weather and climate conditions.
3. Understand the theory of climate change.
4. Understand weather forecasting and analysis.

ENV. 316 – Environmental Impact Assessment(3 credits: elective, theoretical)

This course aims to introduce the students to the principles and techniques of Environmental Impact Assessment (EIA) reporting and their application on case studies.

The course includes the following topics: the principles of EIA and its origins and development; organizing an EIA; prediction of impacts and evaluating impact significance; mitigation; reporting and reviewing the EIA; decision-making, monitoring and follow up; and EIA examples.

After completing this course, the student is expected to be able to:

1. Understand the principles of EIA.
2. Understand the origins and development of EIA.
3. Identify the steps for organizing an EIA.
4. Understand the methods of impacts prediction and evaluation of impact significance.
5. Understand the EIA reporting and review steps, the decision-making process, and the methods of impacts prediction.

ENV. 323 – Integrated Solid Waste Management (3 credits: compulsory, theoretical)

This course aims to familiarize students with the sources of solid waste and processes and techniques of disposal and re-use.

The course includes the following topics: solid waste management, anthropogenic and natural ecosystems, sources of solid waste (domestic, industrial, hazardous, agricultural, and others), solid waste collection and transportation, treatment and disposal (on-site disposal, sea and ocean dumping, landfilling, composting and incineration), methods of resource recovery from waste (reuse, recycling, reprocessing and conversion waste, and recapturing heat energy), the steps of integrated solid waste management.

After completing this course, the student is expected to be able to:

1. Identify and distinguish solid waste.
2. Understand the different sources of solid waste and methods of transportation, collection, treatment and disposal.
3. Understand the steps of integrated solid waste management.
4. Understand the methods of resource recovery from waste.

ENV. 325 – Air Pollution (3 credits: elective, theoretical)

This course aims to introduce students to the major air pollutants, its sources and environmental impacts, and monitoring and control methods.

The course includes the following topics: air pollution (gaseous pollutants, aerosols, particulate matter, and mechanisms of transportation); sources of air pollution (industries, transportation sector, and agricultural activities), the effects of air pollution on human health and welfare, vegetation, animals, construction, and the climate; air pollution control (methods and monitoring of air pollution); and international and national quality standards and treatment techniques.

After completing this course, the student is expected to be able to:

1. Understand the concepts related to air and its components and layers.
2. Understand the quality of air pollutants and their classifications and measurements.
3. Identify the reduction methods of air pollution.
4. Understand the methods of measuring air quality and the quantity of pollutants.
5. Understand Jordan's air quality conditions, control techniques, and responsible authorities.

ENV. 328 – Radiation Pollution (3 credits: elective, theoretical)

This course aims to familiarize students with the principles of radioactivity, its sources and environmental impacts, and management of radioactive waste.

The course includes the following topics: the 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 and its management, protection from radioactive waste, and cycling of radioisotopes in the environment.

After completing this course, the student is expected to be able to:

1. Understand the principle concepts of radioactivity and its properties, types, and detection.
2. Identify the sources of radiation and the types of radioactive materials.
3. Understand the environmental effects of radiation.
4. Understand radiation protection techniques and radioactive waste disposal.

ENV. 351 – Marine Environment (3 credits: elective, theoretical)

This course aims to introduce students to marine ecosystems and their characteristics, marine pollution, and protection techniques.

The course includes the following topics: introduction to marine environments and their characteristics and importance; the physical, chemical, and geological aspects, of marine ecosystems (marshes, mangroves, coral reefs, grasslands, lagoons, and tidal flats); threats to marine environment, marine pollution and its types; climate change; and protection techniques for the marine environment.

After completing this course, the student is expected to be able to:

1. Identify the marine ecosystems and their characteristics.
2. Understand the major threats to the marine environment and marine pollution.
3. Understand treatment methods and control of marine pollution.

ENV. 357 – Water Rservoirs (Dams) (3 credits: elective, theoretical)

This course aims to introduce students to the types of dams, site selection, and the environmental and economic dimensions of dam construction.

The course includes the following topics: dam types and their objectives, site selection, and construction materials; the hydrologic data required for quantification of water volume collected by the dam including precipitation (spatial and temporal distribution); water station measurements, evaporation, and infiltration; the geotechnical criteria for the suitability of foundations based on stratigraphy, geologic structures (weathering, landslides, faults, folds, joints, and exposed and subsurface rocks formations; the political, legislative, and economic aspects of dams; and the environmental impacts (sediment accumulation, rate of sedimentation, sources of sediment, and the impact of sediments on water quality). Examples of dams from Jordan are examined.

After completing this course, the student is expected to be able to:

1. Identify the various types of dams.
2. Determine the type of dam to be constructed and the necessary building materials.
3. Identify the types of rocks, tectonic movements, and any seismic activity in the area.
4. Understand the solution techniques for geological and environmental problems and the stability of dams and calculating dam storage capacity.
5. Identify the types of sediment, rates of sedimentation, and the sources and impacts of sediments on water quality.

ENV. 362 – Environmental Protection (3 credits: elective, theoretical)

This course aims to familiarize students with the techniques, strategies, and importance of environmental protection.

The course includes the following topics: the goals of environmental protection, natural and anthropogenic sources of pollution, concept of pollution, air pollution and control, human impacts on water (modification of rivers and dam construction, urbanization and its effects on water, human impacts on lake level, and deforestation and its effect on river and groundwater), major soil problems (pollution with agrochemicals such as fertilizers and pesticides), cleaner production, wildlife protection, and Jordan environmental law.

After completing this course, the student is expected to be able to:

1. Distinguish between natural and anthropogenic sources of pollution and the concept of pollution.
2. Understand the air pollutants and their control methods and soil pollution with agrochemicals.
3. Understand the concept of wildlife protection.
4. Understand the concept of integrated pest control and the concept of cleaner production.
5. Understand the human impacts on water.

ENV. 363 – Management of Environmental Systems

(3 credits: compulsory, theoretical)

This course aims to introduce students to the steps and techniques of environmental management for a variety of environmental systems.
The course includes the following topics: the fundamentals of environmental and ecosystem management (including sustainability and resources management). It introduces students to the basic knowledge of environmental management practices and provides a broad view of relevant concepts. In addition, the course illustrates application of these ideas and frameworks through a series of case studies. It primarily focuses on management of dryland systems, and students initially learn a variety of terminology, classifications of drylands, and drylands degradation with emphasis on desertification problem (causes, forms and mitigation). The students also are introduced to the marine and coastal environments, and the various aspects of coastal zone (terminology, types, processes, and human impacts) and integrated coastal zone management are explore The third part of this course focuses on management of forest and woodland systems (importance, threats, and management strategies).
After completing this course, the student is expected to be able to:

1. Explain the physical and environmental characteristics of drylands and how drylands form.
2. Evaluate the natural and anthropogenic causes, processes, and consequences of degradation in dryland environments.
3. Provide a general view of the extent and character of the global forests and outline forest management implementation.
4. Diagnose problems and issues and implement coastal zone management strategies.
5. Outline the need for sustainable development in coastal zones.

ENV. 365 – Sewage Management (3 credits: elective, theoretical)
This course aims to familiarize students with wastewater sources, characteristics, treatment, and re-use.
The course includes the following topics: water and wastewaters, sources and characteristics of wastewaters, centralized and decentralized sewage systems in domestic wastewater treatment, self-purification of water, treatment of wastewater, reuse of sewage effluent in artificial groundwater recharge, sludge treatment and its utilization in methane generation, and utilizing treated sewage sludge in agriculture.
After completing this course, the student is expected to be able to:

1. Identify water and wastewater and the sources of wastewater.
2. Understand sludge treatment and its utilization in energy production and agriculture.
3. Understand the concept of self-purification of water and domestic wastewater treatment methods.
4. Understand the concept of reusing sewage effluent in agriculture and artificial groundwater recharge.
5. Understand the concept of centralized and decentralized sewage systems.

ENV. 382 – Energy Sources and their Environmental Impacts (3 credits: elective, theoretical)
This course aims to familiarize students with the sources of energy and their environmental impacts and sustainability.

The course includes the following topics: demand and supply locally and globally, matter, energy and energy conversion, fossil energy sources and their environmental impacts, regenerative energy sources and their environmental impacts, uranium, nuclear and fusion energy and their environmental impacts, energy storage, and the energy laws in Jordan.

Upon completion of this course the students will be able to:

1. Identify energy demand and supply locally and globally and understand the concept of matter, energy and energy conversion.
2. Understand the energy laws in Jordan.
3. Understand uranium and nuclear energy and their environmental impacts.
4. Understand the different energy storage methods and regenerative energy sources and their environmental impacts.
5. Identifythe fossil energy sources and their environmental impacts.

ENV. 391 – Seminar in the Enviroroment (1 credit: elective, theoretical)

This one-hour course covers 400-level environmental topics selected by the course instructor on condition of approval of course plan by department head prior to offering the course.

ENV. 392 – Special Topics in the Enviroroment

(3 credits: elective, theoretical)

This course discusses topics not included in the courses of the study plan. The instructor will determine the subject of the course and provide a comprehensive plan of the course (three hours per week).

ENV. 399 – Research in the Enviroement (3 credits: elective, theoretical)

This course defines natural sciences and introduces scientific research methods, information collection, types of articles, samples and types of sampling, data assessment, organizing a research paper, sections of a scientific research article, ethics of scientific research and research management.