CURRICULUM FOR TWO-YEAR ASSOCIATE DEGREE / BS (4-YEAR) IN GEOLOGY (UNDER HEC UG-POLICY 2023)

SESSION 2023 - 24 & ONWARDS

DEPARTMENT OF GEOLOGY

UNIVERSITY OF MALAKAND

INCHARGE
Department of Geology
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

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ELIGIBILITY CRITERIA FOR ADMISSION IN BS GEOLOGY (4-Year)

Intermediate Science with minimum 45% marks from the following groups:

1. Pre-Medical Group
2. Pre-Engineering Group
3. Other Groups (studied at least two subjects from Chemistry, Physics, Computer Science, and Mathematics)
4. Three years Diploma in Associate Engineering (DAE) equivalent to F.Sc.

DEGREE AWARDING	BS Geology (4-Year)
DURATION OF THE PROGRAM	Minimum Four Years (8 Semesters)
TOTAL CREDIT HOURS	137 Credit Hours

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MARKS BREAKDOWN FOR COURSES IN BS GEOLOGY (4-YEAR)

(As per University of Malakand approved policy)

Item	Maximum Marks for Courses
Mid Term Examination	30%
Internal Marks (Assignments, Quizzes, Presentations)	20%
Final Term Examination	50%
TOTAL	**100%**

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DEGREE REQUIREMENTS FOR BS (4-YEAR) GEOLOGY

S. No.	Categories	Number of Courses	Credit Hours
1	General Education Cluster	12	30
2	Interdisciplinary/Allied Courses	04	12
3	Major Courses	31	89
4	Field Experience / Internship	01	03
5	Capstone Project (Thesis)	01	03
6	The Teaching of Holy Quran with Translation (For Muslims students only)	In all Semesters (From 1st to 8th)	Non-Credit Hour Course
Total		**49**	**137**

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BS GEOLOGY (4-YEAR) SCHEME OF STUDIES: FRAMEWORK

General Education Cluster			
12 Courses			
30 Credit Hours			
Title	**Courses**	**Proposed Courses**	**Credit hours**
Arts and Humanities *	1	Seerah and its Contemporary Applications سیرت رسول ﷺ اور اس کی عصری معنویت (Any course from Arts & Humanities in General Education Cluster can be selected for non-Muslims)	02
Natural Sciences *	1	Basic Physics / General Science	03 (2+1)
Social Sciences *	1	Introduction to Sociology / Introduction to Archaeology	02
Functional English **	1	Functional English	03
Expository Writing **	1	Introduction to Expository Writing	03
Quantitative Reasoning **	2	Quantitative Reasoning-I (Mathematics)	03
		Quantitative Reasoning-II (Statistics)	03
Islamic Studies ** (OR) Religious Education/Ethics in lieu of IslamicStudies only for non-Muslim students	1	Islamic Studies / Ethics (non-Muslims)	02
Ideology and Constitution of Pakistan **	1	Ideology and Constitution of Pakistan	02
Information and Communication Technologies (ICT) **	1	Introduction to Information and Communication Technologies	03 (2+1)
Entrepreneurship **	1	Entrepreneurship	02
Civics and Community Engagements**	1	Community Social Work / Civics and Community Engagements	02
Total	**12**		**30**

Major Courses			
31 Courses			
89 Credit Hours			
Title	**Credit Hours**	**Title**	**Credit Hours**
Physical Geology	03 (2+1)	Hydrogeology	03 (2+1)
Geomorphology	03 (2+1)	Gemology	03 (2+1)
Fieldwork: Peshawar Basin	02	Field Geology	03
Principles of Stratigraphy	03 (2+1)	Petroleum Geology	03 (2+1)
Invertebrate Paleontology	03 (2+1)	Economic Geology	03 (2+1)
Optical Mineralogy and Petrography	03 (2+1)	Fieldwork: Tectonic Evolution of the Himalayas	02
Sedimentology	03 (2+1)	Environmental Geology	03

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Structural Geology	03 (2+1)	Geology and Tectonics of Pakistan	03
Stratigraphy of Pakistan	03	Engineering Geology	03 (2+1)
Micropaleontology	03 (2+1)	Mineral Prospecting and Exploration	03 (2+1)
Igneous Petrology	03 (2+1)	Applied Structural Techniques	03 (2+1)
Fieldwork: Stratigraphic Setup of Sub-Himalayas	02	Fieldwork: Structural Framework of Lesser Himalayas	02
Geo-tectonics	03 (2+1)	Carbonate and Clastic Sedimentology	03 (2+1)
Descriptive Mineralogy	03 (2+1)	Petroleum Engineering	03 (2+1)
Metamorphic Petrology	03 (2+1)	Sedimentary Depositional Systems	03 (2+1)
Sequence Stratigraphy	03 (2+1)		
Total			**89**

Interdisciplinary/Allied Courses	
04 Courses	
12 Credit Hours	
Title	**Credit Hours**
Geophysics	03 (2+1)
Inorganic Chemistry	03 (2+1)
Geochemistry	03 (2+1)
GIS and RS	03 (2+1)
Total	**12**

Title	**Credit Hours**
Field Experience / Internship	03
Capstone Project (Thesis)	03
Total	**06**

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SCHEME OF STUDIES FOR 2-YEAR ASSOCIATE DEGREE / BS (4-YEAR) IN GEOLOGY

*Semester I		Course Title	Marks	Credit Hour (CH)	Total CH
Gen-Ed	ENG 101	Functional English	100	3+0	03
Gen-Ed	PHYS 111 /GS 117	Basic Physics / General Science	100	2+1	03
Gen-Ed	SOC 116 / ARC 114	Introduction to Sociology / Introduction to Archaeology	50	2+0	02
Gen-Ed	CS 110	Introduction to Information and Communication Technologies	100	2+1	03
Gen-Ed	ISL 112/ ETH 118	Islamic Studies / Ethics (for non-Muslims)	50	2+0	02
Major	GEOL 111	Physical Geology	100	2+1	03
Total			**500**		**16**

*Semester II		Course Title	Marks	Credit Hour (CH)	Total CH
Gen-Ed	ENG 102	Introduction to Expository Writing	100	3+0	03
Gen-Ed	QR 101	Quantitative Reasoning-I (Mathematics)	100	3+0	03
Gen-Ed	PSC 111	Ideology and Constitution of Pakistan	50	2+0	02
Gen-Ed	SW 213/ SOC 114	Community Social Work / Civic and Community Engagements	50	2+0	02
Gen-Ed	ISL 113	Seerah and its Contemporary Applications سیرت رسول ﷺ اور اس کی عصری معنویت / (Any course from Arts & Humanities in General Education Cluster can be selected for non-Muslims)	50	2+0	02
Major	GEOL 112	Geomorphology	100	2+1	03
Major	GEOL 113	Fieldwork: Peshawar Basin	50	0+2	02
Total			**500**		**17**

*Semester III		Course Title	Marks	Credit Hour (CH)	Total CH
Gen-Ed	QR 102	Quantitative Reasoning-II (Statistics)	100	3+0	03
Gen-Ed	MGT 215	Entrepreneurship	50	2+0	02
Inter-Disp	CHEM 235	Inorganic Chemistry	100	2+1	03

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Major	GEOL 211	Principles of Stratigraphy	100	2+1	03
Major	GEOL 212	Optical Mineralogy and Petrography	100	2+1	03
Major	GEOL 213	Invertebrate Paleontology	100	2+1	03
Total			**550**		**17**

***Semester IV**		**Course Title**	**Marks**	**Credit Hour (CH)**	**Total CH**
Major	GEOL 214	Stratigraphy of Pakistan	100	3+0	03
Major	GEOL 215	Field Geology	100	3+0	03
Major	GEOL 216	Sedimentology	100	2+1	03
Major	GEOL 217	Structural Geology	100	2+1	03
Major	GEOL 218	Micropaleontology	100	2+1	03
Major	GEOL 219	Fieldwork: Stratigraphic Setup of Sub-Himalayas	50	0+2	02
Total			**550**		**17**

***Semester V**		**Course Title**	**Marks**	**Credit Hour (CH)**	**Total CH**
Major	GEOL 311	Geo-tectonics	100	2+1	03
Major	GEOL 312	Igneous Petrology	100	2+1	03
Major	GEOL 313	Gemology	100	2+1	03
Major	GEOL 314	Descriptive Mineralogy	100	2+1	03
Inter-Disp	GEOL 315	Geophysics	100	2+1	03
Major	GEOL 316	Metamorphic Petrology	100	2+1	03
Total			**600**		**18**

***Semester VI**		**Course Title**	**Marks**	**Credit Hour (CH)**	**Total CH**
Major	GEOL 317	Geology and Tectonics of Pakistan	100	3+0	03
Major	GEOL 318	Sequence Stratigraphy	100	2+1	03
Major	GEOL 319	Petroleum Geology	100	2+1	03
Inter-Disp	GEOL 321	Geochemistry	100	2+1	03
Major	GEOL 322	Economic Geology	100	2+1	03
Major	GEOL 323	Fieldwork: Tectonic Evolution of the Himalayas	50	0+2	02
Total			**550**		**17**

***Semester VII**		**Course Title**	**Marks**	**Credit Hour (CH)**	**Total CH**
Major	GEOL 411	Environmental Geology	100	3+0	03
Major	GEOL 412	Petroleum Engineering	100	2+1	03

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Inter-Disp	GEOL 413	GIS and RS	100	2+1	03
Major	GEOL 414	Field Experience / Internship	100	0+3	03
Major	GEOL 415	Applied Structural Techniques	100	2+1	03
Major	GEOL 416	Sedimentary Depositional Systems	100	2+1	03
Total			**600**		**18**

***Semester VIII**		**Course Title**	**Marks**	**Credit Hour (CH)**	**Total CH**
Major	GEOL 417	Engineering Geology	100	2+1	03
Major	GEOL 418	Carbonate and Clastic Sedimentology	100	2+1	03
Major	GEOL 419	Mineral Prospecting and Exploration	100	2+1	03
Major	GEOL 421	Hydrogeology	100	2+1	03
Major	GEOL 422	Fieldwork: Structural Framework of Lesser Himalayas	50	0+2	02
Major	GEOL 500	Capstone Project / Thesis	100	0+3	03
Total			**550**		**17**
Grand Total				**137**	

***The Teaching of Holy Quran with Translation is a non-credit hour compulsory course only and would be taught in all semesters (from 1st to 8th semester).**

Note:

Courses included in the General Education Category are designed by the respective departments including their course codes, credit hours and titles (reflected in the scheme of studies). All such courses approved by the Syndicate are available on the university website. For any query the office of the Registrar Academics may be approached for clarification/guidance.

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DETAIL OF COURSES FOR BS GEOLOGY (4-YEAR)

COURSE TITLE: **PHYSICAL GEOLOGY**
COURSE CODE: **GEOL 111**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to impart basic knowledge of geology. This will help the students to understand various types of minerals, rocks (igneous, sedimentary, and metamorphic), geological processes and structural features operative within and on the surface of the earth.

Course Contents

Introduction and scope of geology; importance and relationship with other sciences; history and philosophy of geology; Earth as a member of the solar system; its origin, age, composition and internal structure; introduction to plate tectonics, Isostasy; mountain building processes; earthquakes and volcanoes; weathering and erosion; introduction, identification and classification of rocks; sedimentary, igneous and metamorphic structures; physical properties of mineral; introduction to fossils in sedimentary rocks; introduction to folds, faults, joints, cleavage, foliation, lineation; Geological Time Scale; Concept and techniques of geological dating, relative and absolute dating; Use of Brunton Compass and GPS, etc.

Labs

Identification of basic rock types and minerals. Geological time scale and evolution of life, major geological events. Epicentre measurements.

Recommended Books

1. Physical Geology (20th Edition) by Charles Plummer, Diane Carlson, Lisa Hammersley, 2022, McGraw-Hill
2. The Earth by Tarbuck, E. J. and Lutgens, F. K., 2020. Merill, Columbus.
3. Laboratory Manual in Physical Geology (9th Edition), Richard M. Busch, 2011, American Geological Institute, Pearson Education.
4. How Does Earth Work: Physical Geology and Process of Science by Smith, G. and Pun, A., 2006, Prentice Hall.

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5. Lab Manual for Physical Geology by Jones, Norris. W., Johns and Charles E., 2005, McGraw-Hill.

COURSE TITLE: GEOMORPHOLOGY
COURSE CODE: GEOL 112
COURSE NATURE: MAJOR
CREDIT HOURS: (2+1)
TOTAL MARKS: 100

Objectives and Learning Outcomes

This course is designed to acquire knowledge about the formation of various landforms on the surface of the earth. This will help the students to understand the processes by which various types of structures developed on the earth surface due to erosional and depositional processes.

Course Contents

Geomorphological processes; weathering and erosion; Mass wasting and its types; glaciers, their erosional and depositional landforms; geological work of wind and associated features; erosional and depositional work of surface and subsurface water; drainage pattern, stream meandering and development of flood plains; erosional and depositional work of sea; geomorphic cycles and associated landforms produced by tectonics and volcanic activity; introduction to topographic maps, geological maps, aerial photographs and satellite imageries.

Labs

Concept of scale and maps, topographic maps and digital elevation model. Identification of geomorphic features by using models and topographic maps, geological maps and its components and relief maps.

Recommended Books

1. Fundamentals of Geomorphology (4th Edition) (2017), by Richard John Hugget, Routledge (Taylor and Francis Group)
2. Geomorphology: The Mechanics and Chemistry of Landscapes, Robert S. Anderson, Suzanne P. Anderson, 2010, Cambridge University Press
3. Landscapes and Geomorphology: A Very Short Introduction, Andrew Goudie, Heather Viles, 2010, Oxford University Press.
4. Tectonic Geomorphology, Douglas W. Burbank, Robert S. Anderson, 2000, John Wiley and Sons.
5. Elementary Exercises upon Geological Maps by Platt, J. I., 1961, Thomas Murby and Co.

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COURSE TITLE: **FIELDWORK: PESHAWAR BASIN**
COURSE CODE: **GEOL 113**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(0+2)**
TOTAL MARKS: **50**

Objectives and Learning Outcomes

This preliminary field trip will help the students to identify various types of criteria to recognize different types of rocks (igneous, sedimentary and metamorphic) exposed in Peshawar Basin along with other geological and geomorphological features.

Course Contents

Techniques used for conducting geological fieldwork; Use of GPS and Base Maps; Use of Brunton / Silva Compass; Identification of Igneous Rocks based on color and texture on outcrop scale; Identification of Sedimentary Rocks based on Texture, Structures and Fossils; Identification of Metamorphic Rocks based on Structures and Mineralogical Composition; Field based exercises; Collection of representative rocks, minerals, and fossils. Field assignments and report writing.

Recommended Books

1. Basic Geological Mapping by Barnes, J.W. and Lisle, R.J., 2004, John Wiley and Sons.
2. Geology in the Field by Compton, R.R. 1985, John Wiley and Sons.
3. Field Geology by Lahee, F. H. 1961, McGraw-Hill.
4. Related published geological maps and sections of Peshawar Basin and adjoing areas.

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COURSE TITLE: **PRINCIPLES OF STRATIGRAPHY**
COURSE CODE: **GEOL 211**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to acquire knowledge about principles of stratigraphy, stratigraphic code of Pakistan, stratigraphic successions formed during different geologic time with special focus on Pakistan.

Course Contents

Concept of Historical Geology; Principles of stratigraphy; laws of geology; geological time scale with divisions; unconformities, classification and nomenclature of stratigraphic units: lithostratigraphic, biostratigraphy and chronostratigraphic units; principle of stratigraphic correlation; International Stratigraphic codes; Sedimentary basins of Pakistan; Basement Complexes exposed in Pakistan; Precambrian to Carboniferous Stratigraphy of Peshawar Basin, Hazara Area and Salt/Trans-Indus Ranges.

Labs

Preparation of stratigraphic columns and their correlation, isopach and stratigraphic maps. Exercises on the principles of stratigraphy.

Recommended Books

1. Principles of Sedimentology and Stratigraphy, Fifth edition, by Sam Boggs Jr., 2014, Pearson.
2. Stratigraphy of Pakistan by Geological Survey of Pakistan, 2009, Memoir 22, Geological Survey of Pakistan, Quetta.
3. Applied Stratigraphy by EAM Koutsoukos., 2005. Springer.
4. Principles of Stratigraphy by Weller, J. M., 1962, Harper Brothers.

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COURSE TITLE: **OPTICAL MINERALOGY AND PETROGRAPHY**
COURSE CODE: **GEOL 212**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to help the students to identify the minerals in igneous, sedimentary, and metamorphic rocks using polarizing microscope and classify the rocks on the basis of rock texture and mineral composition.

Course Contents

Introduction to polarizing microscope; optical properties of minerals in plane polarized light and under crossed nicols; description of optical properties of common rock forming minerals; mineralogy and common texture of igneous, sedimentary, and metamorphic rocks.

Labs

Identification of common minerals under the polarizing microscope on the basis of optical properties; study of rocks and minerals in thin sections, texture, and composition; classification of rocks using different techniques, volume estimates and other elementary petrographic techniques.

Recommended Books

1. Introduction to Optical Mineralogy by Nesse, W.D., 2003, Oxford University Press.
2. Minerals in Thin Sections by Perkins, D., 2000, Prentice Hall.
3. Atlas of Rock-Forming Minerals in Thin Sections by MacKenzie, W.S. Guilford, C.P., 1980, John Wiley and Sons.
4. Optical Mineralogy by Kerr, P.F., 1959, McGraw-Hill.

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COURSE TITLE: **INVERTEBRATE PALEONTOLOGY**
COURSE CODE: **GEOL 213**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to acquire knowledge about various types of fossils and their significance. This will help the students to understand the modes of fossilization, general features, morphology, and classification of different fossils.

Course Contents

Introduction to fossils and their significance, modes of fossilization. General features, morphology, and classification of major invertebrate phyla i.e., coelenterata, brachiopoda, mollusca, arthropoda (trilobite) and echinodermata (echinoidea), Sponges.

Labs

Identification of the above listed fossils in hand specimen.

Recommended Books

1. Invertebrate Palaeontology and Evolution (4th Edition), by E. N. Clarkson, 2007, published by Blackwell Publishing Company.
2. Invertebrate Paleontology and Evolution by Clakson, E.N.K., 1998, Blackwell Publishing.
3. Principles of Paleontology by Raup, D.M. and Stanley, S.M., 1985, W.H. Freeman and Co.
4. Invertebrate Fossils by Moore, R. C., Lalicker, C. G. and Fischer, A. G., 1952, McGraw-Hill.

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COURSE TITLE: STRATIGRAPHY OF PAKISTAN
COURSE CODE: GEOL 214
COURSE NATURE: MAJOR
CREDIT HOURS: (3+0)
TOTAL MARKS: 100

Objectives and Learning Outcomes

To know about the sedimentary basins as well as the Stratigraphic set-up of Pakistan from Carboniferous to Recent.

Course Contents

The Carboniferous stratigraphy of the Khyber Agency. Permian sequence of the Khyber Agency, Kashmir and Chitral. Permian system of the Salt Range. The passage of marine Permian into marine Triassic: the controversy of the Permo-Triassic boundary. The Jurassic stratigraphy of Pakistan. Marine transgression during the Jurassic period. The Cretaceous stratigraphy of Pakistan. The Tertiary stratigraphy of Pakistan. Development of Flysch and Siwalik basins, the supply of detritus and their corresponding stratigraphic successions. Major extinction units exposed in geology of Pakistan and their stratigraphic significance.

Recommended Books

1. Stratigraphy of Pakistan by Geological Survey of Pakistan, 2009, Memoir 22, Geological Survey of Pakistan, Quetta.
2. Stratigraphy and historical geology of Pakistan by Kazmi, A.H and Abbasi, I.A., 2008, Graphic Publishers, Karachi, Pakistan.
3. Geology and Tectonics of Pakistan by Kazmi and Jan 1997. Graphic Publisher Karachi.
4. The Geology of Stratigraphic Sequences by Miall, A.D., 1997, Springer.
5. Petroleum Geology of Pakistan by Kadri, 1995. PPL Karachi.

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COURSE TITLE: FIELD GEOLOGY
COURSE CODE: GEOL 215
COURSE NATURE: MAJOR
CREDIT HOURS: (3+0)
TOTAL MARKS: 100

Objectives and Learning Outcomes

This course is designed to understand the geological mapping techniques in the field. This will help the students in learning the use of field equipments and data acquisition and preparation of geological maps and cross-sections.

Course Contents

Introduction of topographic and geological maps; methods and techniques of surface and subsurface geological mapping; introduction to instruments for geological mapping; interpretation of geological maps with reference to outcrop patterns; correlation techniques; field description of igneous, metamorphic and sedimentary rocks; modes of geological illustration including structural contour, isopach and lithofacies maps, block and fence diagrams; preparation of geological maps and cross sections; awareness and compliance of Health and Safety Environment (HSE) particularly during geological work.

Recommended Books

1. Introduction to Field Geology. Bevier, M. L., 2006. McGraw-Hill Ryerson.
2. Geology in the Field by Compton, R. R., 1985, John Wiley and Sons.
3. Elements of Field Geology by Himus, G. W. and Sweeting, G. S., 1968., University Tutorial Press Ltd.
4. Field Geology by Lahee, F.H., 1961, McGraw-Hill.

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COURSE TITLE: **SEDIMENTOLOGY**
COURSE CODE: **GEOL 216**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to acquire knowledge about various types of sedimentary rocks and their diagenesis. This will help the students to understand the classification of the sedimentary rocks.

Course Contents

Introduction to sedimentology; origin, transportation and deposition of sediments; texture of sedimentary rocks and their statistical parameters; sedimentary structures, their classification, morphology, significance and paleocurrent analysis; classification and description of sedimentary rocks; provenance of sediments; diagenesis; concepts of sedimentary facies and facies associations; diagnostic features of glacial, eolian, fluvial, lagoonal, lacustrine, deltaic, tidal, turbidites and marine environments. Sedimentary basin, its types and their association with respect to tectonics.

Labs

Grain size analysis of sediments and sedimentary rocks; megascopic and microscopic study of sedimentary rocks for classification; use of ternary diagrams, discrimination diagrams for tectonic setting; study of primary sedimentary structures and their uses in facing or top bottom. Rose diagrams and paleocurrent analysis.

Recommended Books

1. Petrology of Sedimentary Rocks by Boggs Jr. S., 1992, Merril Publishing Co.
2. Applied Sedimentology by Selly, R. C., 1988, Chapman and Hall.
3. Principles of Sedimentology by Friedman, G. M. and Sanders, J. E., 1978, John Wiley and Sons.
4. Sedimentary Rocks by Pettijohn, F. J., 1975, Harper and Row.

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COURSE TITLE: **STRUCTURAL GEOLOGY**
COURSE CODE: **GEOL 217**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to acquire knowledge about the pre- and post-deformational structures and their development in the crust. This will help in understanding the mechanics of deformation and types of structures to deal with exploration of natural resources and geohazards assessment.

Course Contents

Introduction to structural geology, stress and strain; Mohr circle of stress; factors controlling the mechanical behavior of rocks; folds, geometry and classification of folds, The mechanics of folding; Faults, slip and separation, types of faults, criteria for recognition of fault; joints, terminology, geometry and classification; foliation: terminology, classification and relationship with bedding; lineation: terminology and classification; tectonites; primary structures and facing based on primary structures.

Labs

Map exercises, linear and planar structures, and construction of geological cross-sections; orthographic projections (geometrical exercises) and stereographic projections.

Recommended Books

1. Structural Geology of Rocks and Regions, George H. Davis, Stephen J. Reynolds, Charles F. Kluth, 2011, John Willy and Sons.
2. Structural Geology, Haakon Fossen 2010, Cambridge University Press.
3. Structural Geology: An Introduction to Geometrical Techniques, Donal M. Ragan, 2009, Cambridge University Press.
4. Laboratory Exercise Book in Structural Geology by Ghauri, A. A. K., 1989, National Centre of Excellence in Geology, University of Peshawar.
5. Foundation of Structural Geology by Park, R. G., 1983, Blackie.

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COURSE TITLE: **MICROPALEONTOLOGY**
COURSE CODE: **GEOL 218**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to acquire knowledge about various microfossils and their distribution in geological succession.

Course Contents

Introduction to micropaleontology and microfossils, i.e., foraminifera, bryozoan, ostracods, conodonts, radiolarians, diatoms and dinoflagellates.

Labs

Identification of the above listed microfossils.

Recommended Books

1. Microfossils by Brasier, M. D., 1980, Allen and Unwin.
2. Introduction to Marine Micropaleontology by Haq and Boersman, 1980, Elsevier.
3. Plankton Stratigraphy by Balli and Saunders, 1986, Oxford University Press.
4. Microfossils (2nd Ed.) by Howard A. Armstrong and Martin D. Brasier, 2005, Blackwell Publishing.

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COURSE TITLE: **FIELDWORK: STRATIGRAPHIC SETUP OF SUB-HIMALAYAS**
COURSE CODE: **GEOL 219**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(0+2)**
TOTAL MARKS: **50**

Objectives and Learning Outcomes

The second-year field work will be performed for about two weeks. This course is designed to identify various types of sedimentary rocks, field stratigraphy, fossils, structural features, and landforms in the field. This will help the students to understand various types of criteria to recognize sedimentary rocks and other geological features in the field.

Course Contents

Detail study of the Precambrian to Recent Stratigraphic Successions of the Salt and Trans-Indus Ranges. Identification of each stratigraphic unit based on lithology, type locality, fossils, contacts, and its stratigraphic position in the field. Demarcation of the depositional environment of each unit based on syn-depositional sedimentary structures and fossil contents. Identification of unconformities as well as major extinction episodes in the stratigraphic set-up of Salt and Trans-Indus Ranges. The controversy of the Permo-Triassic and KT boundaries. Periods of marine transgression and regressions. Field assignments and report writing.

Recommended Books

1. Stratigraphy of Pakistan by Geological Survey of Pakistan, 2009, Memoir 22, Geological Survey of Pakistan, Quetta.
2. Stratigraphy and historical geology of Pakistan by Kazmi, A.H and Abbasi, I.A., 2008, Graphic Publishers, Karachi, Pakistan.
3. Geology and Tectonics of Pakistan by Kazmi and Jan 1997. Graphic Publisher Karachi
4. Petroleum Geology of Pakistan by Kadri, 1995. PPL Karachi.
5. Geological maps of Salt and Trans Indus Ranges by Gee.

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COURSE TITLE: **GEO-TECTONICS**
COURSE CODE: **GEOL 311**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to acquire knowledge about plate tectonics, various types of plate boundaries, their kinematics, and dynamics. This will help the students to conceive the mountain building phenomenon, understand seismicity, volcanism and metallogeny.

Course Contents

Theory and introduction to plate tectonics. Concept of continental drift and sea floor spreading, oceanic ridges and trenches; continental rifts; intra-oceanic islands; hot spot and mantle plumes; plates and plate boundaries; relative and absolute plate motions; extensional, compressional and transpressional tectonics; subduction zones; transform and transcurrent faults; introduction to neo-tectonics and related hazards, application of geotectonic in natural resource exploration.

Labs

Specified maps/assignments/labs related to continental drift, seafloor spreading and extensional, compressional and transform plate margins.

Recommended Books

1. Plate Tectonics: Continental Drift and Mountain Building, Wolfgang Frisch, Martin Meschede, Ronald C. Blakey, 2010, Springer.
2. Plate Tectonics – Geodynamics, Turcotte, D. L.; Schubert, G. 2002, Cambridge University Press Tectonics by Moores, E. M. and Twiss, R. J., 1995, W. H. Freeman and Co.
3. Global Tectonics by Keary, P. and Vine, F. J., 1996, Blackwell.
4. Plate Tectonics: How it Works by Cox, A. and Hort, R. B., 1986, Blackwell.
5. The Evolving Continents by Windley, B. F., 1984, John Wiley and Sons.

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COURSE TITLE: **IGNEOUS PETROLOGY**
COURSE CODE: **GEOL 312**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to acquire knowledge about the origin of magma and the role of magmatic processes in the formation of igneous rocks. The learning outcomes include understanding the classification of various igneous rocks and their genesis in different tectonic settings.

Course Contents

Composition, origin, differentiation, and evolution of magma; classification of igneous rocks; mineralogy, petrology and occurrence of the following series, tholeiitic, calc-alkaline and alkali-olivine basalt, basalt–andesite series; study of granite, granodiorite, syenite, carbonatite, mafic and ultramafic rocks, and ophiolites; lamprophyres; facies analysis of volcanic rocks; mode of occurrences and types of extrusive rocks; texture and structure of igneous rocks; economic importance of igneous rocks.

Labs

Megascopic and microscopic identification and description of igneous rocks. Discrimination diagrams. Exercises on Ternary plots of IUGS classification based on their origin.

Recommended Books

1. Petrology: Igneous, Sedimentary and Metamorphic by Blatt, H., Tracy, R. and Owens, D., 2005, W. H. Freeman and Co.
2. Igneous and Metamorphic Petrology by Best, M. G., 2002, Black Well.
3. Petrology of Igneous and Metamorphic Rocks by Hyndmann, D.W., 1995, McGraw-Hill.
4. Igneous Petrogenesis by Wilson, M., 1989, Unwin Hyman.

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COURSE TITLE: **GEMOLOGY**
COURSE CODE: **GEOL 313**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

The Curriculum of gemology is designed to provide students all required knowledge about gemstones, their occurrences, their physical and chemical properties and the internationally employed scientific methods for the identification and grading of Gemstones. After completion of the course of Gemology one can work anywhere in the world in the gem and jewelry sector or can start his or her own gem business.

Course Contents

Physical and optical properties related to gemstones, color and causes of colors in gemstones, special optical properties, chatoyancy, asterism, luminescence, play of colors, labradorescence etc. construction and working of gemological instruments, polar scope, refractometer, dichroscope, spectroscope, study of emission and absorption spectroscope. Classification of gemstones, detailed study of all gemstone families; Diamond, Corundum, Beryl, Topaz, Tourmaline, Spinel, Quartz, and other gem verities. Synthetic gemstones, history of synthetics, methods of manufacturing, methods of differentiation between natural and synthetic gemstones, imitation gemstones like glass, plastic etc. Synthetic diamonds and their methods of manufacturing and methods of identification. Construction and working of gemological microscope, study of different various microscopic natural and synthetic inclusions, their classification and identification of natural versus synthetic based on microscopic inclusion. Gemstone treatment and their identification, methods of gemstone enhancements, dyeing and irradiation, heat treatment principles and practices, various types of diffusion and other types of enhancement. Processes of gem cutting, styles of gem cutting, grading and evaluation of gemstones, world gem deposits and gem deposits of Pakistan, introduction to gemstone mining methods.

Labs
Visit to Gem and Gemological labs/centers for identification of gems and their associated processes.

Recommended Books
1. Gemstone Identification Blue Chart by Herve Nicolas Lazzarelli Chart Ed. 2022.
2. Gems 6th edition by O'Donoghue, M., 2006, Butterworth Heinemann.
3. Philips Guide to Gems by Oldershaw, C., 2006, Octopus Publishing.

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4. Gems and Precious stones by Lyman, K., 2005, A Fireside Book.
5. Identification of Gemstones by O'Donoghue, M., 2003, Butterworth Heinemann.

COURSE TITLE: DESCRIPTIVE MINERALOGY
COURSE CODE: GEOL 314
COURSE NATURE: MAJOR
CREDIT HOURS: (2+1)
TOTAL MARKS: 100

Objectives and Learning Outcomes

This course is designed to acquire knowledge about the physical and optical properties of various rock forming minerals and related phase diagrams. The outcomes include the learning and identifying various silicate and non-silicate minerals, identification of various rock types and the environment in which they are formed.

Course Contents

Classification of minerals; study of internal structure; polymorphism and isomorphism; paragenesis, physical and optical properties of the common silicate and non-silicate mineral groups; introduction to X-Ray diffractometry and universal stage; one component; binary and ternary systems; introduction to crystallography, elements of symmetry.

Labs

Megascopic and microscopic identification of common rock forming minerals.

Recommended Books

1. Mineralogy by Perkins, D., 2002, Prentice Hall.
2. A Color Atlas of Rocks and Minerals in Thin Sections by Mackenzie, W.S. and Adams, A.E. 1996, John Wiley and Sons.
3. Manual of Mineralogy by Klein,C., Hurlbut, C.S., Dana, J.D., 1993, Wiley, New York.
4. An Introduction to Rock Forming Minerals by Deer, W. A., Howie, R. A. and Zussman, J., 1992, Longman.
5. Principles of Mineralogy by William, H.B., 1990, Oxford University Press.

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COURSE TITLE: **GEOPHYSICS**
COURSE CODE: **GEOL 315**
COURSE NATURE: **INTER-DISCIPLINARY / ALLIED COURSE**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to acquire knowledge about subsurface geology based on different geophysical methods, with an aim to understand the structure of the earth, exploration of natural resources, and assessment of geohazards.

Course Contents

Difference between Geology and Geophysics, Introduction and basic concepts of Gravity methods, survey design, Earth's gravitational field, Gravitational force, acceleration and potential, Application of Newton's law of Gravitation, Relation of Gravity with rock density, Gravity exploration and its importance for subsurface study. Basic concepts involved in Magnetic methods, Magnetism of Earth, Magnetic susceptibility of rocks. Use of Radiometric methods in Geophysics, natural radiation, Radioactive minerals and decay, Radiation detectors. Introduction and basic concepts of Electrical (Resistivity, induced polarization (IP), Self-potential (SP) and Electromagnetic methods and their properties associated with rocks. Role of Seismic methods in Geophysics, Elasticity (stress and strain), Types of Seismic waves, Attenuation of seismic energy, Refraction and Reflection of seismic waves, Velocities of seismic waves, Diffraction, Seismic sources, Surface waves methods.

Labs
Analysis and interpretation of geophysical data about seismic; gravity, magnetic; electrical, and seismicity.

Recommended Books
1. Field Geophysics by John Milsom and Asger Eriksen, John Willey & Sons, Ltd., Publication Fourth Edition (2011).
2. Whole Earth Geophysics (An introductory textbook for geologists and geophysicists) by Robert J. Lillie, Prentice Hall, (1999).
3. Introduction to geophysical exploration by Philip Kearey and Michael Brooks, Blackwell Science, Second Edition (1991)
4. Introduction to geophysical prospecting by Milton B. Dobrin and Carl H. Savit, McGRAW-HILL, Fourth Edition (1988)
5. Basic exploration Geophysics by Edwin S. Robinson and Cahit Coruh, John Wiley & Sons, (1988)

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COURSE TITLE: **METAMORPHIC PETROLOGY**
COURSE CODE: **GEOL 316**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to acquire the knowledge about the solid-state transformation of pre-existing igneous, metamorphic, and sedimentary rocks into metamorphic rocks. The learning outcomes include familiarization with metamorphic processes and the resulting textures and structures in the metamorphic rocks. It will also expose the students to include understanding on the classification of various metamorphic rocks and their genesis in different tectonic settings.

Course Contents

Introduction to metamorphism; limits of metamorphism; agents of metamorphism; types, grades, zones and facies of metamorphism; metamorphic diffusion and differentiation; study of thermal and regional metamorphism of igneous, argillaceous, calcareous and arenaceous rocks; metamorphism in relation to plate tectonics; study of textures and structures of metamorphic rocks; metamorphism and deformation; history and dating of metamorphic rocks; differentiation between metamorphism and metasomatism; paired metamorphic belts. Himalayan and pre-Himalayan metamorphism in Pakistan.

Labs

Megascopic and microscopic identification and description of metamorphic rocks. Discrimination diagrams. Petrographic and hand specimen identification of metamorphic textures, structures, and metamorphic history of rocks. ACF and AKF ternary diagrams and petrogenesis.

Recommended Books

1. Igneous and Metamorphic Petrology by Best, M. G., 2002, Black Well.
2. Introduction to Igneous and Metamorphic Petrology, Winter, J.D., 2001, Prentice Hall.
3. Petrology of Igneous and Metamorphic Rocks, by Hyndmann, D. W., 1995, McGraw-Hill.
4. Metamorphic Petrology by Turner, F. J., 1981, McGraw-Hill.
5. Metamorphism and Plate Tectonic Regimes by Ernst, W. G, 1975, Hutchison and Ross, Inc.

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COURSE TITLE: **GEOLOGY AND TECTONICS OF PAKISTAN**
COURSE CODE: **GEOL 317**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(3+0)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to acquire knowledge about the geology and tectonics, tectono-stratigraphy of Pakistan. This will help the students to learn about the tectonic elements, distribution of natural resources, and to assess the geohazards in Pakistan.

Course Contents

Introduction of general geology and tectonics of Pakistan. Physiographic and tectonic divisions; geology and stratigraphy of the accreted terrains such as Karakoram and Kohistan plate, Indian plate, stratigraphy, and structure of foreland basins, Chamman fault, Makran convergence zone, and southern Indus basins, oroclines and suture zones. Himalayan and pre-Himalayan orogenic events, magmatism, and metamorphism (pre-Himalayan and post-Himalayan); Economic mineral and fuel deposits of Pakistan. Description of Gondwanian, Tethyan and Laurasian domains.

Recommended Books

1. Metallogeny and Mineral Deposits of Pakistan by Kazmi, A. H., and Abbasi, S. G., 2001, Orient Petroleum Incorporation.
2. Geology and Tectonics of Pakistan by Kazmi, A. H. and Jan, M. Q., 1997, Graphic Publishers.
3. Geology of Pakistan by Bender, F. K. and Raza, H. A. (eds.), 1995, Gebruder Borntraeger.
4. Geodynamics of Pakistan by Farah, A. and DeJong, K. A. (eds.), 1979, Geological Survey of Pakistan.
5. Geology of Himalaya by Gansser. A., 1964, John Wiley and Sons.

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COURSE TITLE: **SEQUENCE STRATIGRAPHY**
COURSE CODE: **GEOL 318**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to acquire knowledge about various types of stratigraphic sequences and their relationship with sea level changes. This will help the students to learn about the formation of various sedimentary rock sequences during geologic time.

Course Contents

Introduction, history, concept, and significance of sequence stratigraphy; data sources: seismic reflections, outcrops, well logs, core; seismic facies; sea level changes, their causes, and effects; accommodation, eustatic and relative sea curve; hierarchy of sequence stratigraphic elements; types of sequences and systems tracts; high resolution sequence stratigraphy, biostratigraphy, seismic stratigraphy and chronostratigraphy; applications to hydrocarbon exploration and basin analysis.

Labs

Interpretation of seismic reflections; picking up/identification of sequence boundaries, system tracts and seismic facies. Exercises on published case studies from any sedimentary basin.

Recommended Books

1. Sequence Stratigraphy by Emery, D. and Myers, K. J., 1996, Oxford, Blackwell.
2. Sequence Stratigraphy and Facies Association by Posamentier, H. W., et al., 1993, Blackwell.
3. Siliciclastic Sequence Stratigraphy in Well Logs, Cores and Outcrops by Van Wagoner, J. C., et al., 1990, AAPG Meth Expl. Ser. No.7.
4. Sea-level Changes an Integrated Approach by Wilgus, B. S., et al., 1988. SEPM.
5. Seismic Stratigraphy: Application to H-carbon Exploration by Payton, C. W., 1977, AAPG Mem. 26.

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COURSE TITLE: PETROLEUM GEOLOGY
COURSE CODE: GEOL 319
COURSE NATURE: MAJOR
CREDIT HOURS: (2+1)
TOTAL MARKS: 100

Objectives and Learning Outcomes

This course is designed to acquire knowledge about the processes involved in the formation, migration, and accumulation of petroleum in the rocks and drilling and well logging techniques for petrophysical evaluation and production of oil and gas. This will help the students to learn about the global occurrences of oil and gas with special emphasis on Pakistan so that they can effectively use their knowledge in the exploration and development of the country's energy resources.

Course Contents

Introduction and history of hydrocarbon exploration; the nature and classification of petroleum hydrocarbons, their origin, composition of petroleum, stages of petroleum generation, migration and accumulation, traps, seal and cap rocks; source rock-evaluation; kerogen and its types; maceral and its types; petroleum basins; basic concepts of hydrocarbon exploration techniques, geochemical and geophysical; oil field waters; reservoir rocks characterization, reservoir fluid. Total known petroleum systems and petroleum provinces of Pakistan.

Labs

Preparation of various types of subsurface maps, e.g., isopach, isochore and isoliths. Preparation of fence diagrams. Analysis of TOC and pyrolysis data.

Recommended Books

1. Elements of Petroleum Geology, Richard C. Selley, 1998, Acad. Press.
2. Petroleum Geology of Pakistan by Kadri, 1995. PPL Karachi.
3. Guidelines for evaluating petroleum source rock using programmed pyrolysis by Peters, K. E., 1986, AAPG Bulletin, v. 70, p. 329.
4. Petroleum Geology by North, F. K., 1985, Allen and Unwin.
5. Petroleum formation and occurrence by Tissot, B.P.; Welte, D. H., 1984. A new approach to oil and gas exploration, 2nd ed: Springer Verlag, Berlin, 699 P.
6. Geology of Petroleum by Leverson, A. I., 1970, W. H. Freeman and Co.

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COURSE TITLE: **GEOCHEMISTRY**
COURSE CODE: **GEOL 321**
COURSE NATURE: **INTER-DISCIPLINARY / ALLIED COURSE**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to provide basic understanding about geochemistry and how the distribution and dispersion of elements in minerals and rocks within different prevailing environments. How the geochemical signature (s) are created to provide the heterogeneity that led towards useful geochemical proxies / tools. These proxies can play an important role in mineral exploration and in the provenance domain.

Course Contents

Development of geochemistry as a discipline; composition of meteorites; origin and cosmic abundance of elements; geochemical structure of the earth; geochemical classification of elements; polymorphism and pseudomorphism; geochemical cycle; mobility and dispersion of elements under different geochemical environments; introduction to geochemistry of igneous, metamorphic and sedimentary rocks; geochemical anomalies and their application in mineral exploration; introduction to geochemical analytical techniques; introduction to organic geochemistry, organic matter, types, and its importance in petroleum industry.

Labs

Processing and interpretation of geochemical data on the basis of binary and ternary diagrams interpretation.

Recommended Books

1. Geochemistry, W.M. White, 2020 John Wiley & Sons.
2. Geochemistry. Pathways and Processes by McSween, H. Y., Jr, Richardson, S. M. and Uhle, M. E., 2003, Columbia University Press, New York.
3. Geochemistry by Brownlow, A. H., 1996, Prentice Hall.
4. Geochemistry in Mineral Exploration by Rose, A. W., Hawkes, H. H. and Webb, J.S., 1983, Whitstable Litho Ltd.
5. Introduction to Geochemistry by Krauskopf, K. B., 1967, McGraw-Hill.

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COURSE TITLE: ECONOMIC GEOLOGY
COURSE CODE: GEOL 322
COURSE NATURE: MAJOR
CREDIT HOURS: (2+1)
TOTAL MARKS: 100

Objectives and Learning Outcomes

This course is designed to acquire knowledge about different economic minerals and their significance with emphasis on the local reserves. This will help the students to understand the mineral formation processes, environments, and economic deposits in the area.

Course Contents

Introduction to economic geology; economic minerals; economic rocks; their classification; environment of formation; relation to plate tectonic settings; geological exploration; introduction to hydrocarbons; coal; gemstones; copper; lead; zinc; iron; gold, salt, manganese, gypsum, bauxite; barite; fluorite; clays; phosphorite; building stones; dimension stones; industrial rocks; industrial minerals; radioactive minerals; economic mineral deposits in Pakistan; mineral resources in Punjab, Sindh, Khyber Pakhtunkhwa and Baluchistan.

Labs

Economic rocks and mineral identification with special emphasis on their use in mineral industry.

Recommended Books

1. Economic Geology: Principles and Practice by Walter L. Pohl – 2011, John Wiley and Sons.
2. Introduction to mineral exploration by Charles and Micheal. 2006, Black well.
3. Introduction to Mineral Exploration, 2nd edition, by Moon, C.J., Whateley, M.K.G. and Evans, A.M. (Editors). 2006, Blackwell Publishing, Oxford.
4. Metallogeny and Mineral Deposits of Pakistan by Kazmi, A. H. and Abbas, S.G., 2001, Orient Petroleum Inc.
5. Ore Deposit Geology by Edward, R. and Atkin sons, K.,1986, Chapman and Hall.

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COURSE TITLE: **FIELDWORK: TECTONIC EVOLUTION OF THE HIMALAYAS**
COURSE CODE: **GEOL 323**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(0+2)**
TOTAL MARKS: **50**

Objectives and Learning Outcomes
The duration of field work will be for about two weeks and is designed to identify various types of igneous and metamorphic rocks, their stratigraphic position, genesis, and their association with major tectonic elements in the field. Exercises will include the construction of profiles and cross sections, outcrop sketches, and geological mapping techniques.

Course Contents
Identification of metamorphic rocks on the basis of their texture, structure and composition; demarcation of metamorphism types, grades, zones and facies on the basis of physical characteristics; role of tectonics and magmatism in regional dynamothermal metamorphism; delineation of convergence/subduction zone based on metamorphic rocks/minerals; identification of ultramafic rocks based on their essential mineral constituents; association of ultramafic rocks with convergent plate boundaries; chemical alteration of ultramafic rocks; evolution of Kohistan Island Arc and timings of their respective magmatism; Pre-orogenic, syn-orogenic and post-orogenic intrusions in Kohistan Batholiths; Uplifting of oceanic lithosphere/ophiolites; identification of plate boundaries based on rock types and other associated features; significance of mélange zones; economic mineralization along tectonic boundaries; host rocks for precious gemstones associated with igneous and metamorphic activities; collisional zones of major plates in North Pakistan; tectonostratigraphic study of the leading edges of Indian and Eurasian plates; crustal anatexis and intrusion of leuco-granitic plutons; geographical subdivisions of Himalayan Orogenic Belt into Karakoram, Hindukush and Himalayas based on their geographical position; physiographic units associated with glaciers and river system; observing active tectonism/seismic prone zone by repeatedly land sliding and rock avalanches. Identification of orogenic types based on geological features and rock types in field. Field assignments and report writing.

Recommended Books
1. Metallogeny and Mineral Deposits of Pakistan by Kazmi, A. H., and Abbasi, S. G., 2001, Orient Petroleum Incorporation.
2. Geology and Tectonics of Pakistan by Kazmi and Jan 1997. Graphic Publisher Karachi.
3. Geology of Pakistan by Bender, F. K. and Raza, H. A. (eds.), 1995, Gebruder Borntraeger.
4. Geology of Himalaya, Karakorum, Hindukush in Pakistan by Tahirkheli, R. A. K., 1982, Geol. Bull., University of Peshawar.
5. Geology of Himalaya by Gansser. A., 1964, John Wiley and Sons.

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COURSE TITLE: ENVIRONMENTAL GEOLOGY
COURSE CODE: GEOL 411
COURSE NATURE: MAJOR
CREDIT HOURS: (2+1)
TOTAL MARKS: 100

Objectives and Learning Outcomes

This course is designed to acquire knowledge about the role of geology in environmental degradation. This will help the students to learn how various geological processes and related human activities are involved in contaminating our ecosystem.

Course Contents

Introduction to environmental geology; management of natural resources; global climatic changes; environmental controls for erosion, desertification and coastal degradation; introduction to environmental impact assessment and initial environmental examination; environmental impact of mining, dams, reservoirs, highways, their assessment and controls; geological hazards such as floods, landslides, earthquakes, tsunamis, volcanoes, glaciers and shoreline processes and their remedial measures; industrial pollution, solid and liquid waste disposal, groundwater contaminations, river lake and marine pollution and their impact on human health; clean sources of energy, introduction to acid mine drainage.

Labs

Sampling techniques and preparation of air, water, soil and rocks for geochemical analysis. Exercises can be done on published data.

Recommended Books

1. Geology and the Environment by Bernard W. Pipkin, D. D. Trent, Richard Hazlett. 2010. Yolande Cossio. USA.
2. Environmental Geology: Handbook of field methods and case studies Klaus. Knödel, Gerhard Lange, Hans-Jürgen. Voigt. 2007, Springer, New York.
3. Environmental Geology by Montgomery, C. W., 2005, McGraw-Hill.
4. Environmental Geology by Keller, E. A., 2000, Prentice Hall, Publishing Co. New Jersey, US.

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COURSE TITLE: PETROLEUM ENGINEERING
COURSE CODE: GEOL 412
COURSE NATURE: MAJOR
CREDIT HOURS: (2+1)
TOTAL MARKS: 100

Objectives and Learning Outcomes

This course is designed to acquire knowledge about subsurface hydrocarbon exploration using well logs, to understand well drilling techniques and other various operations at wellsite, and measurements of reservoir properties.

Course Contents

Introduction to petroleum engineering: drilling, reservoir, and production; drilling rigs and equipments, introduction to drilling operations; wellsite geology and mudlogging; drilling fluids, composition and functions; casings and cementation operations**;** well control; natural driving mechanisms; secondary and enhanced oil recovery; well completion**;** reservoir rock properties; coring operations; pressure maintenance; common drilling problems and preventive measures; HSE at well site; wireline logging.

Labs

Visit to well/drilling sites, class-based wireline logs exercises using related softwares.

Recommended Books

1. The geological interpretation of well logs by M. H. Rider, New York: John Wiley and Sons, 1996.
2. Log Interpretation Principles/Applications by Schlumberger., 1987: Houston, Schlumberger Educational Services, 198.
3. Basic well-log analysis for geologists by Asquith GB (1982): American Association of petroleum geologists (AAPG), methods in exploration, pp 216
4. Petroleum Engineering Drilling & Well Completion, by Carl Gatlin. ISBN: 9780136621553**.**
5. Fundamentals of Petroleum Engineering, by Kate Van Dyke, ISBN: 9780886982317 5th ed. 2011.

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COURSE TITLE: **GIS AND RS**
COURSE CODE: **GEOL 413**
COURSE NATURE: **INTER-DISCIPLINARY / ALLIED COURSE**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

The basic aim of the course is to understand basic knowledge regarding GIS, RS and different types of data sets and data models, to understand the concepts of RS and satellite image processing techniques and to analyze spatial data.

Course Contents

Introduction to Geographical Information System; data types, data models and structures; data sources and capturing techniques; displaying and manipulating spatial information, vector data preparation, GPS Survey; Introduction to the Concept of RS, electromagnetic spectrum, atmospheric interaction; Technology of Remote Sensing (Orbits, Satellites, Sensors and Platforms); applications of Remote Sensing, satellite image processing cycle, image enhancement, data fusion and mosaicking and information extraction (classification and vectorization).

Labs

To know about the available data sets (DEM, satellite imageries), Exploring GIS Data set in Arc Catalog by using available softwares, working on vector data in GIS (Scanning, Digitization and Editing), Integrating GPS data in GIS Environment, Applications of GIS, ERDAS Imagine, ENVI - Environment, Noise Corrections, Geometric Corrections, Radiometric Corrections.

Recommended Books

1. Introduction to Geographic Information Systems by Kang-Tsung Chang. 2010. McGraw-Hill Publishers.
2. GIS: Fundamentals, Applications and Implementations by Elangovan. 2006. McGraw-Hill Publishers.
3. Michael N. Demers 2002, Fundamentals of Geographic Information System, John Wiley and Sons, Inc., Singapore.
4. Thomas M. Lilles and Ralph W. Kiefer, 2000, Remote Sensing and Image Interpretation John Wiley and Sons.
5. James B. Campbell, 1996, Introduction to Remote Sensing, the Guilford Press, New York, USA.

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COURSE TITLE: **FIELD EXPERIENCE / INTERNSHIP**
COURSE CODE: **GEOL 414**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(0+3)**
TOTAL MARKS: **100**

Field experience is a professional learning experience that offers meaningful and practical work experience related to a student's field of study or career interest. It is an opportunity to apply knowledge gained in the classroom with practice in the field.

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COURSE TITLE: **APPLIED STRUCTURAL TECHNIQUES**
COURSE CODE: **GEOL 415**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

To enable the students to get familiar with the advanced level understanding of various structural elements found in the Earth crust and types of illustration used in structural analysis. After completion of this course the students will be able to conduct structural analysis in different types of terrains and will be able to prepare different types of surface and subsurface maps and cross sections.

Course Contents

Folds: Introduction and classification of folds using layer thickness variation, dip isogons, the Busk construction, fold orientation: projection techniques, fold sections and profiles, fold mechanisms – single and multilayers. Faults, Normal faults, Strike-slip faults, thrust faults, terminology of folds and thrust belts, construction of balanced cross sections, drawing a deformed-state cross-sections, restoring a cross-section, evaluating, and improving a section, regional shortening calculations, applications of balanced cross sections. Joints and deformation bands, introduction and geometric classification of joints, joint analysis in uniformly dipping strata, joint analysis in folded strata, deformation band shear zones. Foliation and Lineation, primary and secondary foliations, morphology of foliations, continuous foliation, spaced foliation, mechanisms of foliation, development, geological context of foliation and lineation development, mineral lineation.

Labs

Exercises on interpretation on geological maps, Exercises on construction of structure contour maps, Exercises on construction of fold profiles by Busk and Kink methods, Exercises on construction of balance cross-section, plotting planar and linear structures using stereographic projections.

Recommended books

1. Applied Subsurface Geological Mapping with Structural Methods by Tearpock, D., Bischke R., 2002, 2nd Edition.
2. Structural Geology by Twiss, R. J., Moores, E. M., 1992. Freeman and Company, New York
3. Analysis of geological structures. Cambridge University Press. Cambridge by Price, N. J., Cosgrove, J. W., 1990.
4. Basic Methods of Structural Geology by Marshak, G., and Mitra, G., 1988. Prentice Hall Englewood Cliffs, New Jersey.

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5. The techniques of modern structural geology Ramsay, J. G., Huber, M. I., 1987. Volume 2: Folds and Fractures. Academic Press, London

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COURSE TITLE: **SEDIMENTARY DEPOSITIONAL SYSTEMS**
COURSE CODE: **GEOL 416**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

The basic aim of the course is to understand basic knowledge regarding Sedimentary Basins and their depositional setup, details of major depositional systems operating in different parts of the basins, Continental, Transitional and Deep marine systems. The students will be able to understand Basin mechanisms, Environment of deposition, and Sedimentary rock deposits in various depositional settings.

Course Contents

Overview of Sedimentary Process and types of sedimentary basins. Depositional Systems: Lacustrine Systems, Desert Systems, Glacial System, Fluvial System, Delta System, Intertidal Environments, Estuaries & Lagoons, Barrier Islands System, Terrigenous shelves & shallow seas, Reef & Carbonate Platform Systems, Continental Slop & Rise System, Deep Ocean System and Turbidites.

Labs

Published case studies from major depositional systems (fluvial, deltaic, marginal marine, marine, slope and deep basin). Lab exercises based on examples from known sedimentary systems of Pakistan.

Books Recommended

1. Depositional Systems by Davies R.A. Latest Ed.
2. Depositional Environments & Facies. Sedimentary Structures. 1983
3. Sedimentary Environments: Processes, Facies and Stratigraphy. H.G. Reading. Blackwell Latest Ed.
4. Depositional Sedimentary Environments Reineck and Sigh. 1980

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COURSE TITLE: **ENGINEERING GEOLOGY**
COURSE CODE: **GEOL 417**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to develop students' ability to apply geological knowledge to the identification, evaluation, and mitigation of geological hazards and to prepare students for professional careers in engineering geology, geotechnical engineering, and related fields. Upon completion of the course, the students will be able to classify the rocks for construction of different structures and to identify geological hazards and their behavior on rock mass.

Contents

Introduction to Engineering Geology and its applications, prepare and interpret geological maps and reports, communicate effectively about geological issues to both technical and non-technical audiences, use of geotechnical testing equipment's, geotechnical problem, their causes, effects and solutions, case studies of small and mega engineering projects in Pakistan.

Labs

Los Angeles Abrasion Test on Aggregates, Unconfined Compression Test, Gradation Test, Slump Test, Specific Gravity, Water absorption and Porosity

Recommended Books

1. Engineering Geology by F.G. Bell, 2007
2. Practical Engineering Geology by Steve Hencher – 2012. Amazon.
3. Engineering Geology: Principles and Practice by David George Price, Michael de Freitas – 2008. Springer.
4. Engineering Geology by F G Bell – 2007. Buttersworth.
5. Foundations of Engineering Geology by Waltham, T, 2002.
6. Engineering Materials for Highways and Buildings by Khalid Hassan Siddiqui, Ferozsons (Pvt.) Ltd. 1996.

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COURSE TITLE: **CARBONATE AND CLASTIC SEDIMENTOLOGY**
COURSE CODE: **GEOL 418**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course will enable the students to acquire knowledge about carbonate mineralogy, components, classification, cyclicity in carbonates, diagenetic processes & products and dolomitization models. Students will also learn about texture and classification of clastic sedimentary rocks, paleocurrent and provenance analysis of clastic rocks.

Course Contents

Introduction to Carbonate Rocks; carbonate mineralogy and chemistry; carbonate components; classification of carbonates by Folk and Dunham; Carbonate microfacies; major controls on carbonate sedimentation; carbonate platforms, rimmed shelves, epeiric, isolated platforms ramps, and drowned platforms; depositional processes and sequences in carbonate rocks; cyclicity in carbonates; diagenetic processes and products; dolomite and dolomitization models.

Texture of clastic sedimentary rocks, Sedimentary structures, their classification, and hydrodynamic conditions; Facies and facies association; Paleocurrent analysis and provenance of clastic rocks; Diagenesis of clastic rocks.

Labs:

Identification of carbonate rocks in hand specimen and thin sections; staining; microfacies interpretations and XRD techniques.
Petrographic study and classification of clastic rocks; recording, plotting and interpretation of data for paleocurrent analysis; Provenance of clastic rocks.

Recommended Books

1. Microfacies of carbonate rocks. Analysis, interpretation and application by Flugel, E., 2004, Springer
2. Petrology of Sedimentary Rocks by Boggs Jr. S., 1992, Merril Publishing Co.
3. Carbonate Sedimentology by Tucker, M. E. and Wright, V. P., 1990, Blackwell Scientific Publications.

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4. Sedimentary Petrology, An Introduction by Tucker, M. E., 1981, Black Well Scientific Publications Osney Mead.
5. Sedimentary Rocks by Pettijohn, F. J., Harper and Row., 1975.

COURSE TITLE: MINERAL PROSPECTING AND EXPLORATION
COURSE CODE: GEOL 419
COURSE NATURE: MAJOR
CREDIT HOURS: (2+1)
TOTAL MARKS: 100

Objective and Learning Outcomes

To introduce the students to reserves and grades calculation to evaluate the ore deposits. At the end the students should be able to understand different prospecting techniques and differentiate between prospecting and exploration.

Course Contents

Introduction to Mineral Prospecting; Mineral prospecting techniques, Importance of prospecting claims to mineral discovery and exploration; Field exploration techniques; Geochemical exploration techniques (principles of geochemical dispersion, choice of media for sampling, field methods and sampling theory, analytical methods and quality control, and data interpretation, geochemical and metallogenic provinces; geochemical survey of rock, soil, water and stream sediments for mineral exploration). Geophysical exploration techniques (principal geophysical techniques, including magnetic, electromagnetic, electrical, radiometric, gravity and seismic methods as applied to mineral exploration).

Labs

Case studies and exercises on geochemical and geophysical data interpretation.

Recommended Books

1. Geological Methods in Mineral Exploration and Mining, Second Edition, by Roger Marjoribanks, Springer-Verlag Berlin Heidelberg 2010.
2. Introduction to Mineral Exploration, 2nd edition, by Moon, C. J., Whateley, M. K. G. and Evans, A. M. (Editors). 2006, Blackwell Publishing, Oxford.
3. Mineral Prospecting Manual by Chaussier, J. B. and Morer, J., 1987, North Oxford Academic.

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4. Geochemistry in Mineral Exploration by Rose, A. W., Hawkes, H. E. and Webb, J. S., 1983, Whitstable Litho Ltd.
5. Techniques in Mineral Exploration by Reedman, J. H., 1979, Applied Science Publishers

COURSE TITLE: **HYDROGEOLOGY**
COURSE CODE: **GEOL 421**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(2+1)**
TOTAL MARKS: **100**

Objectives and Learning Outcomes

This course is designed to acquire knowledge about the exploration of groundwater resources and their management. This will help the students to learn how to manage and conserve water resources, how to overcome the acute shortage of water supply and how to maintain its purity for meeting the present demand as well as the demand of the future generation.

Course Contents

The hydrologic cycle. Aquifer system and types; occurrence and movement of groundwater; hydrologic properties of rocks and their measurements, fluctuation of groundwater levels and causes; recharge and discharge of ground water; groundwater exploration by geological, hydro-geological and geophysical methods; water logging and causes of water table declination; groundwater chemistry, salinity, quality analysis and deterioration of water quality. Groundwater resources of Pakistan.

Labs

Study and preparation of hydro-geologic maps; graphical presentation of published chemical data of groundwater. Exercises on analysis and interpretation of published case studies.

Recommended Books

1. Hydrogeology: objectives, methods, applications by Ric Gilli, Eric Gilli, Christian Mangan, 2012, CRC Publishers Taylor and Francis Group, USA.

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2. Fundamentals of Hydrology by Tim Davie. 2012. Rourledge for Taylor and Francis Group, USA.
3. Elementary Hydrogeology by Singh. 2010. Prentice Hall, USA.
4. Applied Hydrogeology by Fetter, C. W., 1994, MacMillan Pub. Co.
5. Groundwater Resource Evaluation by Walton, W. C., 1970, McGraw-Hill.

COURSE TITLE: **FIELDWORK: STRUCTURAL FRAMEWORK OF LESSER HIMALAYAS**
COURSE CODE: **GEOL 422**
COURSE NATURE: **MAJOR**
CREDIT HOURS: **(0+2)**
TOTAL MARKS: **50**

Objectives and Learning Outcomes

The duration of field work will be for about two weeks and is designed to identify various types of geological structures and their associated deformation elements in the field. Exercises will include the construction of profiles, geological mapping, cross sections, and outcrop sketches. After completing this fieldwork activity, the students will be able to carry out their independent research in the field of structural geology, stratigraphy, sedimentology, paleontology, and tectonics.

Course Contents

Identification of active tectonic elements based on neotectonics; hazards of active tectonics; neotectonics behavior of faults and folds; observation of neotectonics in Northern Potwar Deformed Zone and Hill/Kalachitta Ranges; recognition of tectonic geomorphology; recognition of active faults and criteria for identifying active faulting in field; fault scarp morphology; structural and geological mapping; to fully understand the deformational structures and their kinematics in the thin skin deformed zones, projections and structural analysis, the cross-sectional balancing, restoration of cross-section, neotectonics behavior of various structural features; fracture evaluation; use of global positioning system in field; identification of thick and thin skin deformations; Field assignments and report writing.

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Recommended Books

1. Basic Geological Mapping by Barnes, J. W. and Lisle, R. J., 2004, John Wiley and Sons.
2. Field Geology by Lahee, F. H. 1987, McGraw-Hill.
3. Geology in the Field by Compton, R. R. 1985, John Wiley and Sons.
4. Elements of Field Geology by Himus, G. W. and Sweeting, G. S., 1968., University Tutorial Press Ltd.
5. Basic Geological Mapping by Barnes, J. W. and Lisle, R. J., 2004, John Wiley and Sons.

COURSE TITLE: CAPSTONE PROJECT / THESIS
COURSE CODE: GEOL 500
COURSE NATURE: MAJOR
CREDIT HOURS: 3
TOTAL MARKS: 100

A capstone project allows students to bring together the concepts, principles, and methods that they have learned in their course of study and to apply their knowledge and acquired competencies to address the real-world problems.

Note:

Courses included in the General Education Category are designed by the respective departments including their course codes, credit hours and titles (reflected in the scheme of studies). All such courses approved by the Syndicate are available on the university website. For any query the office of the Registrar Academics may be approached for clarification/guidance.

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