UNIVERSITY OF SARGODHA
OFFICE OF THE REGISTRAR
(ACAD BRANCH)

NOTIFICATION

On the recommendations of Academic Council made in its 24th (1/2025) meeting held on 26.08.2025, the Syndicate in its 72nd (4/2025) meeting held on 12.09.2025 has approved the revised curriculum of following programs for implementation w.e.f. **Fall 2025**.

I.	BS in Geology	(Annex-'**A**')
II.	BS in Environmental Sciences	(Annex-'**B**')

(WAQAR AHMAD)
Additional Registrar (General)

No. SU/Acad/25/1160

Dated: 28.10.2025

Distribution:

- Chairman, Department of Earth Sciences
- Controller of Examinations
- Director Academics

C.C:

- Dean, Faculty of Sciences
- Director, QEC
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File

Annex-A

Scheme of Studies

BS Geology

w.e.f Fall,2025

Vetted

1. **Title of Degree Program: BS in Geology**
2. **Program Learning Objectives:**

The BS Geology program is structured to help students become knowledgeable about the Earth's processes and history. Through this program, students learn how to analyze and solve problems related to the Earth's dynamics. They also develop skills like identifying different types of rocks and minerals, using advanced geological tools and technologies, and interpreting geological maps and data. The program aims to equip students with practical abilities in fieldwork, research, and data analysis, which can be applied to real-world geological challenges. These accomplishments will prepare students for careers in fields like as energy resources exploration, mineral resources exploration, Mega structure and Dams construction, surface and subsurface water resources management and geohazards studies.

3. **Program Structure:**

Duration	Minimum 4-Years (8-Semesters), Maximum 6-Years (12-Semesters)
Admission Requirements:	Atleast 45% Marks in HSSC (Part I/II) I- FSc (Pre-Engineering)/ FSc (Pre-Medical) II- ICS (with combination of atleast any two subject i.e.,Math, Physics, Chemistry and Biology) III- DAE (1st & 2nd Year) 5 seats reserved IV- Intermediate (Part I/II) with Geology 5 seats reserved.
Degree Completion Requirements:	Students are required to study 139 credit hours and pass all courses of BS program for the completion of this degree as notified below securing a minimum CGPA 2.5 out of 4.00 to obtain degree after 8 semesters.

4. **General Education (Gen Ed) Requirements: (Mandatory/Core Curses):**

Sr. No.	Semester	Course Code	Course Title	Credit Hours	Prerequisite
1.	2	URCG-5112	Fables, Wisdom Literature and EPIC	2(2-0)	Nil
2.	4	URCG-5114	Basic Science	3(2-1)	Nil
3.	2	URCG-5116	Science of Society-I	2(2-0)	Nil
4.	1	URCG-5118	Functional English	3(3-0)	Nil
5.	3	URCG-5119	Expository Writing	3(3-0)	Nil
6.	2	URCG-5120	Exploring Quantitative Skills	3(3-0)	Nil
7.	3	URCG-5121	Tools for Quantitative Reasoning	3(3-0)	Nil
8.	1	URCG-5105 URCG-5126	Islamic Studies (OR) Religious Education/Ethics	2(2-0)	Nil
9.	3	URCG-5122	Ideology and Constitution of Pakistan	2(2-0)	Nil
10.	1	URCG-5123	Applications of Information and Communication Technologies (ICT)	3(2-1)	Nil
11.	4	URCG-5124	Entrepreneurship	2(2-0)	Nil
12.	4	URCG-5125	Civics and Community Engagement	2(2-0)	Nil
13.	1	URCG-5129 URCG-5131	Understanding of Holy Quran-I/ Fehm-e-Quran-I/ Ethics-I	1(0-1)	Nil
14.	2	URCG-5130 URCG-5132	Understanding of Holy Quran-II/ Fehm-e-Quran-II/ Ethics-II	1(0-1)	Nil
15.	3	URCG-5127	Seerat of the Holy Prophet (SAW)	1(1-0)	Nil
16.	2	URCG-5128	Pakistan Studies	2(2-0)	Nil
			GE Courses Credit Hours Total	35	

5. **Compulsory Courses:**

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1.	GEOL-5101	Fundamental of Geology	3(3-0)	Nil
2.	GEOL-5102	Geomorphology	3(3-0)	Nil
3.	GEOL-5103	Mineralogy	3(3-0)	Nil
4.	GEOL-5104	Paleontology	3(2-1)	Nil
5.	GEOL-5105	Stratigraphy	3(3-0)	Nil
6.	GEOL-5106	Geological Fieldwork-I	2(0-2)	Nil
7.	GEOL-5107	Environmental Geology	3(3-0)	Nil

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8.	GEOL-5108	Sedimentology	3(2-1)	Nil
9.	GEOL-5109	Petrology	3(2-1)	Nil
10.	GEOL-5110	GIS and Remote Sensing	3(2-1)	Nil
11.	GEOL-5111	Geotectonics	3(2-1)	Nil
12.	GEOL-5112	Structural Geology	3(2-1)	Nil
13.	GEOL-5113	Geological Fieldwork-II	2(0-2)	Nil
14.	GEOL-6114	Geophysics	3(2-1)	Nil
15.	GEOL-6115	Geochemistry	3(2-1)	Nil
16.	GEOL-6116	Petroleum Geology	3(2-1)	Nil
17.	GEOL-6117	Engineering Geology	3(2-1)	Nil
18.	GEOL-6118	Hydrogeology	3(3-0)	Nil
19.	GEOL-6119	Geology of Pakistan	3(3-0)	Nil
20.	GEOL-6120	Geological Fieldwork -III	2(0-2)	Nil
21.	GEOL-6121	Sequence Stratigraphy	3(2-1)	Nil
22.	GEOL-6122	Scientific Writing and Research Methods	3(3-0)	Nil
23.	GEOL-6123	Geological Fieldwork -IV	2(0-2)	Nil
24.	GEOL-6124	AI and Computational Geology	3(2-1)	Nil
Major Compulsory Courses Credit Hours Total				68

6. **Mandatory Elective Courses (Specializations) :**

Specialization I : Mineralogy

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1	GEOL-6130	Analytical Techniques in Mineralogy	3(3-0)	Nil
2	GEOL-6131	Applied Mineralogy-Petrology	3(3-0)	Nil
3	GEOL-6132	Clay Mineralogy and Soil Chemistry	3(3-0)	Nil
4	GEOL- 6133	Crystal Chemistry and Mineral Structures	3(3-0)	Nil
5	GEOL- 6134	Gemology	3(3-0)	Nil
6	GEOL- 6135	Geochemistry	3(3-0)	Nil
7	GEOL- 6136	Igneous Petrology	3(3-0)	Nil
8	GEOL- 6137	Sedimentary petrology	3(3-0)	Nil
9	GEOL- 6138	Rare earth and platinum group	3(3-0)	Nil
10	GEOL- 6139	Industrial Mineralogy	3(3-0)	Nil
11	GEOL- 6140	Mineral prospecting	3(3-0)	Nil
12	GEOL- 6141	Mineral deposits	3(3-0)	Nil
Major Elective Courses Credit Hours Total*			21	

Specialization II: Engineering Geology

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1	GEOL- 6145	Soil Mechanics and Foundation Engineering	3(3-0)	Nil
2	GEOL- 6146	Rock Mass Classification & Geotechnical Engineering	3(3-0)	Nil
3	GEOL- 6147	Soil Mechanics and Foundation Engineering	3(3-0)	Nil
4	GEOL- 6148	Geotechnical Engineering	3(3-0)	Nil
5	GEOL- 6149	Concrete and Asphalt Technology	3(3-0)	Nil
6	GEOL- 6150	Dam and Reservoir Engineering Geology	3(3-0)	Nil
7	GEOL- 6151	Geomechanics	3(3-0)	Nil
8	GEOL- 6152	Aggregate and Building Material in Pakistan	3(3-0)	Nil
9	GEOL- 6153	Tunnel Engineering and Underground Excavation	3(3-0)	Nil
10	GEOL- 6154	Landslide Hazard Analysis and Mitigation	3(3-0)	Nil
11	GEOL- 6155	Slope Stability Analysis	3(3-0)	Nil
12	GEOL- 6156	AI and Data Analytic in Geotechnical Engineering	3(3-0)	Nil
Major Elective Courses Credit Hours Total*			21	

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Specialization III : Petroleum Geology

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1	GEOL.- 6160	Basin Analysis	3(3-0)	Nil
2	GEOL.- 6161	Petroleum Engineering	3(3-0)	Nil
3	GEOL.- 6162	Reservoir Geology	3(3-0)	Nil
4	GEOL-6163	Petroleum Geology of Pakistan	3(3-0)	Nil
5	GEOL.- 6164	AI and Machine Learning in Hydrocarbon Exploration	3(3-0)	Nil
6	GEOL.- 6165	Geomechanics in Petroleum System	3(3-0)	Nil
7	GEOL.- 6166	Hydrocarbon Geochemistry	3(3-0)	Nil
8	GEOL.- 6167	Offshore oil and Gas Exploration	3(3-0)	Nil
9	GEOL.- 6168	Reservoir Characterization and Rock Properties	3(3-0)	Nil
10	GEOL.- 6169	Petroleum System Modeling	3(3-0)	Nil
11	GEOL.- 6170	Unconventional Hydrocarbon Resources	3(3-0)	Nil
12	GEOL.- 6171	Well log Interpretation and Petrophysical Analysis	3(3-0)	Nil
Major Elective Courses Credit Hours Total*			21	

Specialization IV : Geophysics

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1	GEOL.- 6175	AI & Machine Learning in Exploration Geophysics	3(3-0)	Nil
2	GEOL.- 6176	Application of Remote Sensing in Geophysics	3(3-0)	Nil
3	GEOL.- 6177	Borehole Geophysics & Logging Techniques	3(3-0)	Nil
4	GEOL.- 6178	Geophysical Data Processing & Interpretation	3(3-0)	Nil
5	GEOL.- 6179	Geophysical Inversion Techniques	3(3-0)	Nil
6	GEOL.- 6180	Gravity & Magnetic Exploration Methods	3(3-0)	Nil
7	GEOL- 6181	Hydro Geophysics	3(3-0)	Nil
8	GEOL.- 6182	Induced Seismicity & Reservoir Characterization	3(3-0)	Nil
9	GEOL.- 6183	Marine Geophysics & Oceanic Exploration	3(3-0)	Nil
10	GEOL.- 6184	Near Surface Geophysics	3(3-0)	Nil
12	GEOL.- 6185	Rock Physics & Petrophysical Analysis	3(3-0)	Nil
13	GEOL.- 6186	Seismic Reflection Techniques	3(3-0)	Nil
11	GEOL.- 6187	Seismology & Earthquake Physics	3(3-0)	Nil
Major Elective Courses Credit Hours Total*			21	

7. **Interdisciplinary/Allied courses: minimum 12 credit hours:**

Interdisciplinary/Allied courses will be offered after 4th semester maximum 4 courses

1.	GEOG-5101	Fundamentals of Geography	3(3-0)	Nil
2.	URCM-5107	Mathematics I	3(3-0)	Nil
3.	URCM-5108	Mathematics II	3(3-0)	Nil
4.	CHEM-5101	Physical Chemistry	3(3-0)	Nil
5.	CHEM-5102	Inorganic Chemistry	3(3-0)	Nil
6.	PHYS- 5101	Mechanics	3(3-0)	Nil
7.	STAT-5121	Introduction to Statistics	3(3-0)	Nil
8.	GEOG-5109	Climatology	3(3-0)	Nil
9.	GEOG-6118	Environmental Geography	3(3-0)	Nil
10.	MATH-6139	Fluid Mechanics-I	3(3-0)	Nil
11.	MATH-6140	Fluid Mechanics-II	3(3-0)	Nil
12.	MATH-6134	Heat Transfer	3(3-0)	Nil
13.	GEOG-5104	Map Work	3(2-1)	Nil
14.	GEOG-5112	Principles of Cartography	3(1-2)	Nil
		Total Interdisciplinary Courses Credit Hours	12	

8. **Capstone project: Minimum 03 credit hours:**

1.	GEOL-6190	**Capstone Project**	3(0-3)	

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Scheme of Studies
BS in Geology

Semester-I

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-1	URCG-5118	Functional English	3(3-0)	Nil
GE-2	URCG-5105/ URCG-5126	Islamic Studies (OR) Religious Education/Ethics	2(2-0)	Nil
GE-3	URCG-5123	Applications of Information and Communication Technologies (ICT)	3(2-1)	Nil
GE-4	URCG-5129 URCG-5131	Understanding of Holy Quran-I/Fehm-e-Quran-I/ Ethics-I	1(0-1)	Nil
Major-1	GEOL-5101	Fundamentals of Geology	3(3-0)	Nil
Major-2	GEOL-5102	Geomorphology	3(3-0)	Nil
Major-3	GEOL-5103	Mineralogy	3(3-0)	Nil

Semester Total Credit Hours: 18

Semester-II

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-5	URCG-5112	Fables, Wisdom Literature and EPIC	2(2-0)	Nil
GE-6	URCG-5116	Science of Society-I	2(2-0)	Nil
GE-7	URCG-5120	Exploring Quantitative Skills	3(3-0)	Nil
GE-8	URCG-5130 URCG-5132	Understanding of Holy Quran-II/ Fehm-e-Quran-II/ Ethics-II	1(0-1)	Nil
GE-15	URCG-5128	Pakistan Studies	2(2-0)	Nil
Major-4	GEOL-5104	Paleontology	3(2-1)	Nil
Major-5	GEOL-5105	Stratigraphy	3(3-0)	Nil
Major-6	GEOL-5106	Geological Fieldwork-I	2(0-2)	Nil

Semester Total Credit Hours: 18

Semester-III

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-9	URCG-5127	Seerat of the Holy Prophet (SAW)	1(1-0)	Nil
GE-10	URCG-5119	Expository Writing	3(3-0)	Nil
GE-11	URCG-5121	Tools for Quantitative Reasoning	3(3-0)	Nil
GE-12	URCG-5122	Ideology and Constitution of Pakistan	2(2-0)	Nil
Major-7	GEOL-5107	Environmental Geology	3(3-0)	Nil
Major-8	GEOL-5108	Sedimentology	3(2-1)	Nil
Major-9	GEOL-5109	Petrology	3 (2-1)	Nil

Semester Total Credit Hours: 18

Semester-IV

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-13	URCG-5114	Basic Science	3(2-1)	Nil
GE-14	URCG-5124	Entrepreneurship	2(2-0)	Nil
GE-15	URCG-5125	Civics and Community Engagement	2(2-0)	Nil
Major-10	GEOL-5110	GIS and Remote Sensing	3(2-1)	Nil
Major-11	GEOL-5111	Geotectonics	3(2-1)	Nil
Major-12	GEOL-5112	Structural Geology	3(2-1)	Nil
Major-13	GEOL-5113	Geological Fieldwork-II	2(0-2)	Nil

Semester Total Credit Hours: 18

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Semester-V

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-14	GEOL-6114	Geophysics	3(2-1)	Nil
Major-15	GEOL-6115	Geochemistry	3(3-0)	Nil
Major-16	GEOL-6116	Petroleum Geology	3(2-1)	Nil
Major-17	GEOL-6117	Engineering Geology	3(2-1)	Nil
ID-1	-----	*Interdisciplinary/Allied course-I	3(3-0)	Nil
ID-2	-----	*Interdisciplinary/Allied course-II	3(3-0)	Nil

Semester Total Credit Hours: 18

Semester-VI

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-18	GEOL-6118	Hydrogeology	3(3-0)	Nil
Major-19	GEOL-6119	Geology of Pakistan	3(3-0)	Nil
Major-20	GEOL-6120	Geological Field Work-III	2(0-2)	Nil
Major-21	GEOL-61XX	Elective I**	3(3-0)	Nil
ID-3	-----	*Interdisciplinary/Allied course-III	3(3-0)	Nil
ID-4	-----	*Interdisciplinary/Allied course-IV	3(3-0)	Nil

Semester Total Credit Hours: 17

Semester-VII

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-22	GEOL-6121	Sequence Stratigraphy	3(2-1)	Nil
Major-23	GEOL-6122	Scientific Writing and Research Methods	3 (3-0)	
Major-24	GEOL-6123	Geological Field Work-IV	2 (0-2)	Nil
Major- 25	GEOL-61XX	Elective II	3(3-0)	Nil
Major-26	GEOL-61XX	Elective III	3 (3-0)	Nil
Major-27	GEOL-61XX	Elective IV	3 (3-0)	Nil

Semester Total Credit Hours: 17

Semester-VIII

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-28	GEOL-6124	AI and Computational Geology	3(1-2)	Nil
Major-29	GEOL-61XX	Elective V	3(3-0)	Nil
Major-30	GEOL-61XX	Elective VI	3(3-0)	Nil
Major-31	GEOL-61XX	Elective VII	3(0-3)	Nil
Compulsory	GEOL-6190	Capstone Project	3(0-3)	Nil

Semester Total Credit Hours: 15

Degree Program Total: 139

Note: In accordance with Revised Curricula for Geology Degree Programs notified vide letter no. HEC/CD/NCRC/GEOLOGY/2025/7167 dated April 10, 2025, 3 credit hours supervised internship is required or can be replaced by two Geological Field Works (minimum 2 credits each) under the supervision of faculty.

* To be offered from Interdisciplinary/Allied courses

** To be offered from respective specializations courses group list depending upon available resources at department

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URCG-5118	Functional English	3(3-0)

The course aims at providing understanding of a writer's goal of writing (i.e. clear, organized and effective content and to use that understanding and awareness for academic reading and writing. The objectives of the course are to make the students acquire and master the grammatical academic writing skills. The course would enable the students to develop argumentative writing techniques. The students would be able to logically add specific details on the topics such as facts, examples and statistical or numerical values. The course will also provide insight to convey the knowledge and ideas in an objective and persuasive manner. Furthermore, the course will also enhance the students' understanding of ethical considerations in writing academic assignments and topics including citation, plagiarism, formatting and referencing the sources as well as the technical aspects involved in referencing.

Contents

1. Developing Analytical Skills
2. Transitional devices (word, phrase and expressions)
3. Development of ideas in writing
4. Reading Comprehension
5. Precis Writing
6. Developing argument
7. Sentence structure: Accuracy, variation, appropriateness, and conciseness
8. Appropriate use of active and passive voice
9. Organization and Structure of a Paragraph
10. Organization and structure of Essay
11. Types of Essays

Recommended Texts:

1. Bailey, S. (2011). Academic writing: A handbook for international students (3rd ed.). New York: Routledge.
2. Eastwood, J. (2011). A Basic English grammar. Oxford: Oxford University Press.
3. Swales, J. M., & Feak, C. B. (2012). *Academic writing for graduate students: Essential tasks and skills* (3rd ed.). Ann Arbor: The University of Michigan Press.
4. Swan, M. (2018). *Practical English usage* (8th ed.). Oxford: Oxford University Press.

Suggested Readings:

1. Biber, D., Johansson, S., Leech, G., Conrad, S., Finegan, E., & Quirk, R. (1999). *Longman grammar of spoken and written English*. Harlow Essex: MIT Press.
2. Cresswell, G. (2004). *Writing for academic success*. London: SAGE.
3. Johnson-Sheehan, R. (2019). *Writing today*. Don Mills: Pearson.
4. Silvia, P. J. (2019). *How to write a lot: A practical guide to productive academic writing*. Washington: American Psychological Association
5. Thomson, A. J., & Martinet, A. V. (1986). *A Practical English Grammar*. Oxford: Oxford University Press

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URCG-5105	Islamic Studies (Compulsory)	2(2-0)

Introductory/compulsory foundation course

Islamic Studies engages in the study of Islam as a textual tradition inscribed in the fundamental sources of Islam: Qur'aan and Hadith, history and particular cultural contexts. The area seeks to provide an introduction to and a specialization in Islam through a large variety of expressions (literary, poetic, social, and political) and through a variety of methods (literary criticism, hermeneutics, history, sociology, and anthropology). It offers opportunities to get fully introductory foundational basis of Islam in fields that include Qur'aanic studies, Hadith and Seerah of Prophet Muhammad (PBUH), Islamic philosophy, and Islamic law, culture and theology through the textual study of Qur'aan and Sunnah.

- To make students understand the relevance and pragmatic significance of Islam in theirlives.
- To make learners comprehend the true spirit of Islam with reference to modernworld.
- To generate a sense of Islamic principles as a code of living that guarantee the effective solutions to the current challenges ofbeing.
- To provide Basic information about IslamicStudies
- To enhance understanding of the students regarding IslamicCivilization
- To improve Students skill to perform prayers and otherworships
- To enhance the skill of the students for understanding the issues related to faith and religious life.

Contents

1. Introduction to Qur'aanic Studies — تعارف قرآن مجید

1) Basic Concepts of Qur'aan — قرآن مجید کا بنیادی تعارف

2) History of the compilation of Qur'aa — تاریخ جمع وتدوین قرآن مجید

3) Uloom-ul-Qur'aan — علوم القرآن

مطالعہ قرآن (تعارف قرآن مجید، منتخب آیات کا ترجمہ و تفسیر: سورۃ البقرہ آیات 1-5، 284-286؛ سورۃ الحجرات آیات 1-18؛ سورۃ الفرقان آیات 63-77؛ سورۃ المومنون آیات 1-11؛ سورۃ الاحزاب آیت 6، 21، 32- 33، 40، 56- 59؛ سورۃ الانعام آیات 151-153؛ سورۃ الصف آیات 1- 14؛ الحشر آیات 18- 20؛ آل عمران آیات 190- 192؛ النحل آیات 12-14؛ لقمن آیت 20، حم السجدہ آیت 53

2. Introduction to Hadith — تعارف حدیث

1) Legal Status of Hadith — حدیث کی قانونی حیثیت

2) History of the compilation of Hadith — تاریخ تدوین حدیث

3) Classifications of Hadith — حدیث کی اقسام

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Department of [illegible]

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SUB CAMPUS BHALWAL

متن حدیث: 1 درج ذیل سو موضوعات پر احادیث کا مطالعہ

1۔ اعمال کا دارومدار نیت پر منحصر ہے۔ 2۔ بہترین انسان قرآن کا طالب علم اور اس کا معلم ہے۔ 3۔ کتاب و سنت گمراہی سے بچنے کا ذریعہ ہیں 4۔ ارکان اسلام 5۔ اسلام، ایمان، احسان اور قیامت کی نشانیاں، 6۔ بچوں کو نماز کی تلقین 7۔ دین کا کبر، فہم اللہ کی خاص عنایت ہے 8۔ حصول علم، تلاوت قرآن اور عمل کی اہمیت و فضیلت، 9۔ روز محشر پیش ہونے والے مناہب، 10۔ حقوق اللہ کے ساتھ ساتھ حقوق العباد کا خیال رکھنا بھی لازم ہے 11۔ حسن خلق کی عظمت اور فحش و بد گوئی کی مذمت 12۔ دنیا و آخرت کی بھلائی کی ضامن چار چیزیں، 13۔ ہلاک کر دینے والی سات چیزیں، 14۔ بے عمل مبلغ کا عبرت ناک انجام، 15۔ ہر شخص نگران ہے اور ہر شخص مسئول

3. Sirah of the Prophet (PBUH)	سیرت النبی ﷺ
1. Significance of Seerah Studies	مطالعہ سیرت کی ضرورت و اہمیت
2. Prophetic principles of Character building	تعمیر سیرت و شخصیت کا نبوی منہاج

اقامت دین کا نبوی طریق کار، اقامت دین بعد خلافت راشدہ، میثاق مدینہ، خطبہ حجۃ الوداع، اخلاقی تعلیمات، تحلیل اجتماعیت اور اسوہ حسنہ، قرآن مجید میں سیرت سرور عالم کا بیان، غزوات نبوی ﷺ کے مقاصد و حکمتیں

4. Islamic Culture & Civilization	اسلامی تہذیب و تمدن
1) Basic Concepts of Islamic Civilization	اسلامی تہذیب کا مفہوم
2) Historical evaluation of Islamic Civilization	اسلامی تہذیب کا تاریخی ارتقاء
3) Salient feature of Islamic Civilization	اسلامی تہذیب کی نمایاں خصوصیات
4) Islamic Civilization and Contemporary Issues	اسلامی تہذیب و تمدن اور معاصر مسائل

ملی تہذیب کے عوامل و عناصر، اسلامی تہذیب کے علمی، معاشرتی اور سماجی اثرات، تہذیبوں کے تصادم کے نظریے کا تنقیدی جائزہ، تہذیبی تصادم کے اثرات و نتائج، طبعی، حیاتیاتی اور معاشرتی علوم میں مسلمانوں کا کردار، ناموران مسلمان سائنسدان

Pre-Requisites: Nil

Recommended Books

1) Hameed ullahMuhammad, —Emergence ofIslam ,IRI,Islamabad
2) Hameed ullah Muhammad, —Muslim Conduct ofState
3) Hameed ullah Muhammad, _Introduction toIslam
4) Ahmad Hasan, —Principles of Islamic Jurisprudence, Islamic Research Institute, International Islam University, Islamabad (1993)
5) Dr.Muhammad Zia-ul-Haq,—Introduction to Al Sharia Al Islamia, Allama Iqbal Open University. Islamabad(2001)
6) Dr. Muhammad Shahbaz Manj, Teleeemat-e- Islam

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URCG-5126	Religious Education/ ETHICS	2(2-0)

Course Contents:

1. Meaning and Scope of Ethics.
2. Relation of Ethics with:
   - (a) Religion
   - (b) Science
   - (c) Law
3. Historical Development of Morality: (a). Instinctive Moral Life.
   - (b). Customary Morality.
   - (c). Reflective Morality.
4. Moral Theories:
   - (a). Hedonism (Mill)
   - (b). Intuitionism (Butler)
   - (c). Kant's Moral Theory.
5. Moral Ethics and Society.
   - (a). Freedom and Responsibility. (b). Tolerance
   - (c). Justice
   - (d). Punishment (Theories of Punishment)
6. Moral Teachings of Major Religions: a). Judaism
   - b). Christianity
   - c). Islam
7. Professional Ethics:
   - a). Medical Ethics
   - b). Ethics of Students
   - c). Ethics of Teachers
   - d). Business Ethics

Recommended Texts:

1. William Lillo. An Introduction to Ethics., London Methuen & Co. latest edition.
2. Titus, H.H. Ethics for Today. New York: American Book, latest edition.
3. Hill, Thomas. Ethics in Theory and Practice. N.Y. Thomas Y. Crowel, latest edition
4. Ameer Ali, S. The Ethics of Islam. Culcutta: Noor Library Publishers, latest edition
5. Donaldson, D M. Studies in Muslim Ethics. London: latest edition. 6. Sayeed, S.M. A.(Tr.) Ta'aruf-e-Akhlaqiat. Karachi: BCC&T, Karachi University of

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URCG-5123	Applications of Information & Communication Technologies (ICT)	3 (2-1)

The course introduces students to information and communication technologies and their application in the workplace. Objectives include basic understanding of computer software, hardware, and associated technologies. How computers can be used in the workplace, how communications systems can help boost productivity, and how the Internet technologies can influence the workplace. Students will get basic understanding of computer software, hardware, and associated technologies. They will also learn how computers are used in the workplace, how communications systems can help to boost productivity, and how the Internet technologies can influence the workplace.

Contents

1. Introduction, Overview of Information Technology.
2. Hardware: Computer Systems & Components, Storage Devices.
3. Software: Operating Systems, Programming and Application Software.
4. Databases and Information Systems Networks.
5. File Processing Versus Database Management Systems.
6. Data Communication and Networks.
7. Physical Transmission Media & Wireless Transmission Media.
8. Applications of smart phone and usage.
9. The Internet, Browsers and Search Engines.
10. Websites and their types.
11. Email Collaborative Computing and Social Networking.
12. E-Commerce.
13. IT Security and other issues.
14. Cyber Laws and Ethics of using Social media.
15. Use of Microsoft Office tools (Word, Power Point, Excel) or other similar tools depending on the operating system.
16. Other IT tools/software specific to field of study of the students if any.

Recommended Texts::

1. Discovering Computers 2022: Digital Technology, Data and Devices by Misty E. Vermaat, Susan L. sebok; 17th edition.

Suggested Readings:

1. Computing Essentials 2021 by Timothy J. O'Leary and Linda I. O'Leary, McGraw Hill Higher Education; 26th edition.
2. Computers: Understanding Technology by Fuller, Floyd; Larson, Brian: edition 2018.

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URCG-5129	Understanding of Holy Quran-I	1(1-0)

Annex-'CXXI'

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Model Course Outline
for the Course Understanding of Quran – I

Course Title: Understanding of Quran – I
Course Book: Muallim ul Quran (Volume 1, 2 & 3) by Dr Ubaid ur Rahmon
Credit Hours: 1 (0-1)
Contact Hours: 3 per week
Weeks: 15-16 (45-48 hours)

Course Learning Outcomes:

By the end of this course, students will be able to:

1. Develop the ability to understand basic words of the Quran, phrases and sentences that do not contain verbs (unit 1 to 5 of Muallim ul Quran Book) and then sentences having present tense (first half of unit 6 of Muallim ul Quran Book).
2. Acquire a strong foundation for understanding long verses of the Quran with clarity.
3. Comprehend Quranic vocabulary, particles (operative & non operative particles) , compounds (Adjective & Possessive compound), pronouns (singular & plural) and types of plural through hundreds of Quranic sentences.
4. Recognize and understand different styles of Quranic sentences, including nominal sentence, emphatic sentence, double emphatic sentence, negative sentence, interrogative sentence, oath –based sentences.
5. Strengthen understanding of fundamental Quranic linguistic styles, expressions and idioms.
6. Understand at least 30 to 40 % of each page of the holy Quran.

Provision of material, content and books:

- **Paper book:** All volumes are available in printed book form.
- **Tutorial videos:** Teaching video of each lesson available on YouTube.
- **Confirmation Videos:** A complete series of confirmation videos of all lessons is available in which the student can confirm his answers.
- **A flipbook:** A flipbook edition is also accessible.
- **Helping material:** Helping material for the teachers like quizzes, question papers and images available on website.

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Course Outline:

Weeks	Lectures (1.5 hrs)	Units	Lessons	Assignments/Home Task	Linguistic Rules
1.	1.	1	1-8	Writing the meaning of Quranic words Lesson 1-8	Proper Noun Masculine & Feminine
	2.	1	9-14	Writing the meaning of Quranic words 9-14	Two kinds of plural Concept of (و) "And" Common Noun
2.	1.	1	15-17	Writing the meaning of Quranic words, phrases & translation of Sentences 15-17	Demonstrative Noun (This & That for Masculine (هذا- هذه) Demonstrative Noun (This & That for Feminine) (تلك- تلك)
	2.	1	18-19 & Revision (Unit 1)	Writing the meaning of Quranic words , phrases & translation of Sentences 17-19 Quiz	Laam for emphasis (لام للتأكيد) Superlative Degree like أكبر Revision of all Quranic Sentences
3.	1.	Unit 2	1-3	Writing the meaning of Quranic words, phrases & translation of Sentences 1-3	Emphatic Particle لن Preposition "For" (اللام) Preposition (في)
		2	4-6	Writing the meaning of Quranic words, phrases & translation of Sentences 4-6	Preposition (على- من- إلى)
4.	1.	2	7- 9	Writing the meaning of Quranic words & translation of Sentences 7-9	Preposition (الباء) Absolute Negation Particle Exceptive Particle (لا النافية للجنس)(ما النافية) (إلا)
		2	10-13 & Revision (Unit 2)	Writing the meaning of Quranic words, phrases & translation of Sentences 10-13 Quiz	Subordinating Conjunction(أن), Was (كان), Vocative Particle(حرف النداء)

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5.	1.	Unit 3	1-2	Writing the meaning of Quranic phrases 1-2	Quranic Adjective Compounds (صفت و موصوف)
	2.	3	3-5	Writing the meaning of Quranic phrases & translation of sentences 3-5	Quranic Possessive Construction (مضاف و مضاف الیہ)
6.	1	3	5-7	Writing the meaning of Quranic phrase translation of sentences 6-7	Quranic Possessive Construction (مضاف و مضاف الیہ)
	2.	3	8-10 & Revision (Unit 3)	Writing the meaning of Quranic phrase & translation of sentences 8-10 Quiz	Active Participle (اسم الفاعل), Passive Participle (اسم المفعول), Dual (مثنی)
7.		Unit 4	1-2	Writing the meaning of Quranic phrase & translation of sentences 1-2	Personal Pronoun He(ھو المتصل) Possessive Pronoun His ہ المتصل)
	2.	4	3-4	Writing the meaning of Quranic phrase & translation of sentences 3-4	Possessive Pronoun with prepositions like فی بیتہ Pronoun "His" with prepositions like لہ، منہ، فیہ
8.		4	5-8	Writing the meaning of Quranic sentences 5-8	Personal Pronoun You(انت المتصل) Possessive Pronoun Your ك المتصل) Possessive Pronoun with prepositions like فی بیتك Pronoun "Your" with prepositions Like لك، منك، فیك
	7.	Mid Term			

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9.	1.	4	9-12	Writing the meaning of Quranic phrases & sentences 9-12	Personal Pronoun She(هی المنفصل) Possessive Pronoun Her ها المتصل) Possessive Pronoun with prepositions like فی بیتها Pronoun "Her" with prepositions like لها،
	2.	4	13-16	Writing the meaning of Quranic phrases & sentences 13-16	Personal Pronoun I (انا المنفصل) Possessive Pronoun Her ی المتصل) Possessive Pronoun with prepositions like فی بیتیPronoun "My" with prepositions like لی
10.	1	4	17 & Revision Unit 4	Revision of all Quranic sentences of Unit 4 Quiz	Adverb (حال)
	2.	Unit 5	1-2	Writing the meaning of Quranic phrases & sentences 1-2	Masculine Plural جمع المذکر السالم و جمع المذکر السالم المسبوق بحرف الجر
11.	1.	5	3-4	Writing the meaning of Quranic phrases & sentences 3-4	Possessive Construction with Plurals جمع المذکر السالم المسبوق بالاضافة
	2.	5	5-6	Writing the meaning of Quranic phrases, sentences & verses 5-6	Personal Pronoun They (هم المنفصل) Possessive Pronoun Their هم المتصل)
12.	1.	5	7-8	Writing the meaning of Quranic phrases, sentences & verses 7-8	Possessive Pronoun with prepositions like فی بیتهمPronoun "Their" with prepositions like لهم
	2.	5	9-11	Writing the meaning of Quranic phrases, sentences & verses 9-11	Personal Pronoun You (انتم المنفصل) Possessive Pronoun Your کم المتصل) Possessive Pronoun with prepositions

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					like في بيتكم
13.	1.	5	12-14	Writing the meaning of Quranic phrases & sentences & verses 12-14	Pronoun "Your" with prepositions like لكم Personal Pronoun We (نحن المنفصل) Possessive Pronoun Our نا المتصل
	2.	5	15-16	Writing the meaning of Quranic sentences & Verses 15-16	Possessive Pronoun with prepositions like في بيتنا Pronoun "Our" with prepositions like لنا
14.	1.	5	17-18	Writing the meaning of Quranic sentences & Verses 17-18	Demonstrative Pronoun These, Those (هؤلاء- أولئك)
	2.	5	19-23	Writing the meaning of Quranic sentences & Verses 19-23	ما / إلا، إن / إلا، إنما، ليس، ما ، (أم، لن، بل، كأن) (الا، ليس، اليوم، يومئذ، سبحان، مايشاء، قل، إذن، بئس، نعم، كلا، ما ادراك، حسب، أعلم بـ، مصير، مرجع، دينا(تمييز)
15.	1.	5	Revision Unit 5	Quiz	
	2.	5	1-3 (till Page 16)	Writing the meaning of Quranic Verbs &Translation of Quranic Sentences & Verses (1-3)	Introduction of Present Tense(فعل مضارع) & Verbal Sentence (جملة فعلية) Present Tense الفعل المضارع صيغة المفرد يعلم
16.	1.	6	3 (From Page 17) & 4 -5	Translation of Quranic Sentences & Verses 3-5	Present Tense الفعل المضارع صيغة المفرد يعلم
	2.	6	6	Translation of Quranic Sentences & Verses	Present Tense الفعل المضارع صيغة الجمع يعلمون

URCG-5131	Ethics-I	1(1-0)

1-Course Description

The Ethics-I course is designed to provide students with a comprehensive understanding of ethical principles, practices, and theories in various societal contexts. Throughout this degree program, students will explore the complexities of ethical theories of semitic and non-semitic religions along with decision-making and develop critical thinking skills to navigate moral dilemmas. This course will also enable the students to interact with others religious identities with humanistic, inclusive and holistic approach

2- Learning Objectives

This course aims to:

1. Introduce students to the fundamental concepts, scope, and importance of ethics.
2. Explore the relationship between law, morality, and social values.
3. Develop a clear understanding of virtuous and immoral ethics and their impact on individual and collective life.
4. Study the role of major religious figures in the moral development of human society and enable students to apply ethical principles for personal development, conflict resolution, and social harmony.

3- Learning Outcomes

By the end of the course, students will be able to:

1. Students will be able to identify and analyze major ethical theories, values, and their scope in social and individual life.
2. Differentiate between law and ethics, and analyze their interrelationship.
3. Identify types of virtuous and immoral ethics and assess their social impacts.
4. Examine the ethical teachings of major religions and their relevance in contemporary society.
5. Apply ethical principles to address modern challenges in personal and professional life.

4-Course Structure

1. Interactive lectures, Group discussions and debates
2. Reflection papers and presentations
3. Assignments and Quiz

Course Contents

Unit 1: Introduction and Fundamentals of Ethics

1. Literal and terminological definition of ethics
2. Literal and terminological definition of values
3. Relationship between law and ethics
4. Need, importance, and scope of ethics

Unit 2: Types of Ethics and Their Impact on Society

- Virtuous ethics: concept, types, benefits, and outcomes
- Immoral ethics: concept, types, and harms
- Role of ethics in social refinement and establishment of peace

Unit 3: Virtuous Ethics (Akhlaq-e-Hasanah)

- Concept, need, and importance of virtuous ethics
- Scope of virtuous ethics in the light of religions
- Major virtues in revealed and non-revealed religions
- Impact of virtuous ethics on individual and collective life

Unit 4: Immoral Ethics (Akhlaq-e-Razilah)

- Concept of immoral ethics
- Social problems caused by immoral ethics
- Practical consequences of immoral ethics
- Major vices in revealed and non-revealed religions

Unit 5: Role of World Religious Figures in Moral Development

- Prophet Moses (AS): Introduction, miracles, and role in moral refinement
- Prophet Jesus (AS): Introduction, miracles, and role in moral refinement
- Prophet Muhammad (ﷺ): Introduction, miracles, and role in moral refinement

Textbook

1. Izutsu, T. (2002). *Ethico-Religious Concepts in the Qur'an*. McGill-Queen's University Press.

Suggested Readings

1. Gert, B. (2005). *Morality: Its Nature and Justification*. Oxford University Press.
2. MacIntyre, A. (2007). *After Virtue: A Study in Moral Theory*. University of Notre Dame Press.
3. [illegible] P. Abu Hamid (2004). [illegible] Press Society.
4. Nasr, S. H. (1994). *The Heart of Islam: Enduring Values for Humanity*. Harper One.
5. Beauchamp, T. L., & Childress, J. F. (2019). *Principles of Biomedical Ethics*. Oxford University Press.
6. Hasan, Z. (2010). *Ethics in Islam: Key Concepts and Contemporary Challenges*. Islamic Research Institute.

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GEOL - 5101	Fundamentals of Geology	3(3-0)

Course Brief:

This course is designed to acquire the knowledge about the basic concepts of geology. This will help the students to get knowledge about various types of rocks, minerals and the processes of their formation. Geology is the core discipline of the earth sciences and encompasses many different phenomena, including plate tectonics and mountain building, volcanoes and earthquakes, and the long-term evolution of Earth's atmosphere, surface and life.

Course Learning Objectives:

The goal of the Geology undergraduate program is to equip students with the fundamental knowledge of the diverse fields of Geology (encompassing Geomorphology & Surface Processes, Hydrology & Low-Temperature Geochemistry, Sedimentology & Paleoecology, and Tectonics and Solid-Earth Processes). In addition, it is critical that students learn to think like a scientist and to apply the scientific method in their coursework and in their lives. It helps to know the geologic time scale and place important geologic events in a temporal framework.

Course Contents:

1. Introduction and scope of geology; importance and relationship with other sciences;
2. History and philosophy of geology; Earth as a member of the solar system;
3. Earth's origin, age, composition and internal structure;
4. Introduction to plate tectonics, Isostasy; mountain building processes;
5. Earthquakes and volcanoes; weathering and erosion;
6. Introduction, identification and classification of rocks and minerals;
7. Sedimentary, igneous and metamorphic structures;
8. Introduction to fossils in sedimentary rocks;
9. Introduction to folds, faults, joints, cleavage, foliation, lineation and unconformities;
10. Geological Time Scale; Law of Superposition, present is key to the past and Law of Faunal Succession;
11. Concept and techniques of geological dating, relative and absolute dating; evolution of life on earth;
12. Use of Brunton Compass and GPS, etc.

Recommended Texts:

1. Plummer, C. C., Carlson, D. H., &Hammersley, L. (2016). *Physical geology*. New York: McGraw- Hill.
2. Plummer, C. C., McGeary, D., & Carlson, D. H. (2000). *Physical Geology: Earth Revealed*. New York: McGraw-Hill.

Suggested Readings:

1. McGeary, D., Carlson, D. H., & Plummer, C. C. (2011). *Physical geology*. New York: McGraw-Hill.
2. Smith, G., & Pun, A. (2013). *How Does Earth Work? Physical Geology and the Process of Science: Pearson New International Edition*. London: Pearson Higher Education.
3. McClay, K. R. (1999). *The mapping of geological structures*. Hoboken: John Wiley & Sons.

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GEOL-5102	Geomorphology	3(3-0)

Course Brief:

This course is designed to acquire the knowledge about the formation of various landforms on the surface of the earth. This will help the students to understand the processes by which the various types of structures developed on the earth surface due to erosional and depositional processes. In addition, it is critical that students learn to think like a scientist and to apply the scientific method in their coursework and in their lives. It helps to know the geologic time scale and place important geologic events in a temporal framework. Identify and interpret common fossils, common rock-forming minerals and rock-forming processes, Interpret environments of deposition of sedimentary rocks, Identify common rocks and interpret them with respect to tectonics.

Course Contents:

1. Geomorphological processes
2. Weathering and erosion
3. Glaciers and their erosional and depositional landforms
4. Geological work of wind and associated features
5. Erosional and depositional work of surface and subsurface water
6. Valley and base-level development and its types
7. Drainage pattern, stream and erring and development of flood plains
8. The erosional and depositional work of sea
9. Development of coastal landform: Geomorphic cycles and associated landforms produced by tectonics and volcanic activity
10. Introduction to tectonic geomorphology
11. Introduction to topographic maps
12. Aerial photographs and satellite imageries

Lab. Work

1. Identification of geomorphic features by using topographic maps,
2. Relief maps and interpretation of 3D relief diagrams on computer.

Recommended Texts:

1. Summerfield, M. A. (2014). *Global geomorphology*. Vale of White Horse: Routledge.
2. Bierman, P. R., Montgomery, D. R., & Massey, C. A. (2013). *Key Concepts in Geomorphology-NSF supports community-based creation of a new style of textbook.* In AGU Fall Meeting Abstracts.

Suggested Readings:

1. Adrian, A. (2012). *Introducing geomorphology: a guide to landforms and processes*. London: Routledge.
2. Gregory, K. J., & Lewin, J. (2014). *The basics of geomorphology: key concepts*. London: Routledge.
3. Mayes, A. (2012). *Geomorphology*. London: Routledge.

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GEOL-5103	Mineralogy	3(3-0)

Course Brief:

This course is a graduate level course of Mineralogy. As mineralogy is the sub discipline of geology which deals with the study of minerals. So the course is designed to acquire the knowledge about the physical and optical properties of various rock forming minerals and related phase diagrams. This will help the students in learning how various silicate and non-silicate minerals can be identified and how these are formed during different P-T conditions.

Course Learning Objectives:

This course will equip students with the important traditional content of mineralogy including crystallography, chemical bonding, controls on mineral structure, mineral stability, and crystal growth to provide a foundation that enables students to understand the nature and occurrence of minerals. Physical, optical, and X-ray powder diffraction techniques of mineral study will also be described in detail.

Course Contents:

1. Introduction to mineralogy and crystallography
2. Classification of minerals
3. physical and optical properties of the common silicate and non-silicate mineral group
4. study of internal structure of minerals
5. Isomorphism, polymorphism and pseudomorphism
6. crystal systems
7. Elements of symmetry
8. Crystal notation
9. Study of normal classes of crystallographic systems.
10. crystal chemistry paragenesis
11. introduction to X-Ray diffractometry and universal stage and their application
12. Phase equilibrium studies
13. one component, binary and ternary system

Lab. Work

1. Megascopic and microscopic identification of common rock forming minerals
2. Construction and interpretation of phase diagrams from given experimental data
3. Lab work related to XRD and Universal stage.

Recommended Texts:

1. Blackburn, W. H., & Dennen, W. H. (1994). *Principles of mineralogy*. New York: McGraw-Hill.
2. Dana, J. D. (2004). *Manual of Mineralogy*. Hoboken: John Wiley.

Suggested Readings:

1. Nesse, W. D. (2016). *Introduction to mineralogy*. Oxford: Oxford University Press.
2. Nesse, W. D. (1991). *Introduction to optical mineralogy*. Oxford: Oxford University Press.
3. Pichler, H., & Schmitt-Riegraf, C. (2012). *Rock-forming minerals in thin section*. Berlin: Springer Science & Business Media.

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URCG-5112	Fables, Wisdom Literature and EPIC	2(2-0)

The course will enable students to explore human experiences, cultivate an appreciation of the past, enrich their capacity to participate in the life of their times, and enable an engagement with other cultures and civilizations, both ancient and modern. But independently of any specific application, the study of these subjects teaches understanding and delight in the highest achievements of humanity. The three components of the course, including fables, wisdom literature and epic, will enable the learners to explore and understand the classic tradition in literature. Development of personal virtue, a deep Sufi ethic and an unwavering concern for the permanent over the fleeting and the ephemeral are some of the key themes explored in the contents that will develop an intimate connection between literature and life.

Course Contents:

1. Fables
   The Fables of Bidpai
   The Lion and the Bull
   The Ring-dove
   The Owls and the Crows
   Selected poem from Bang-i-Dara
2. Gulistan-e- Sa'di
   Ten hikāyat from John T. Platts, The Gulistan
3. Epic THE SHAHNĀMA OF FIRDAUSI

Recommended Texts:

1. John T. P. (1876). *The Gulistan; or, Rose Garden of Shaikh Muslihu'd- Din Sa'di of Shirāz.*
   London: Wm. H. Allen.
2. Chishti, Y.S. (1991). *Sharah-i bang-i darā.* Lahaur: Maktaba-i ta'mir-i insaniyat

Suggested Readings:

1. Thackston, W. (2000). A Millennium of Classical Persian Poetry. Maryland: Ibex Publishers.
2. Wood, R. (2013). Kalila and Dimna: Fables of Conflict and Intrigue. United Kingdom: Medina
   Publishing, Limited.

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URCG-5116	Science of Society-I	2 (2-0)

Course Description:
This course will introduce students with the subject matter of social science, its scope, nature and ways of looking at social phenomenon. It will make the participants acquaintance with the foundations of modern society, state, law, knowledge and selfhood. While retaining a focus on Pakistani state and society, students will encounter theoretical concepts and methods from numerous social science disciplines, including sociology, politics, economics anthropology and psychology and make them learn to think theoretically by drawing on examples and case studies from our own social context. Students will be introduced to the works of prominent social theorists from both western and non-western contexts. Instruction will include the use of written texts, audio-visual aids and field visits.

Learning Outcomes:
The course has following outcomes:
It will

- Introduce student with the nature of human social behavior and foundations of human group life
- Analyze the reciprocal relationship between individuals and society.
- Make student aware with the nature of societies existing in modern world
- Make students familiar with the philosophy of knowledge of social sciences Introduce students with the works of prominent theories explain human group behavior
- Help students to understand the foundations of society including culture, socialization, politics and economy
- Introduce students with various dimensions of social inequalities with reference to gender, race, ethnicity and religion
- Make them aware about the understanding of various themes pertains to social science in local context
- Help them recognize the difference between objective identification of empirical facts, and subjective formulation of opinionated arguments

Course Outlines;

1. **Introduction to Social Sciences**
   - Social world, Human Social behavior, Foundations of society
   - Evolution of Social sciences
   - Philosophy of Science
   - Scope and nature of social sciences
   - Modernity and social sciences
   - Branches of social science: Sociology, Anthropology, Political Science, Economics

   Society and Community, Historical evolution of Society

   - Types of Societies
   - Foraging society, Horticultural society, Pastoralist society
   - Agrarian societies, Industrial society, Postindustrial society
2. **Philosophy of Knowledge in social Science and social inquiry**
   - Understanding social phenomenon
   - Alternative ways of knowing
   - Science as a source to explore social reality
   - Objectivity, Value-Free research
   - Positivism vs Interpretivism
   - Qualitative vs Quantitative
3. **Culture and Society**
   - Idea of Culture, Assumptions of Culture

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- Types, Components, Civilization and culture
- Individual and culture. Cultural Ethnocentrism, Cultural Relativism
- Outlook of Pakistani culture
- Global Flows of culture, Homogeneity, Heterogeneity

4. **Social Stratification and Social inequality**
   - Dimensions of inequality, Social class
   - Gender, Race, Religion, Ethnicity, Caste
   - Patterns of social stratification in Pakistan
   - Class, caste system in agrarian society
   - Ascription vs Achievement, Meritocracy
   - Global stratification in modern world, Global patterns of inequality
5. **Personality, Self and Socialization**
   - Concept of self, Personality
   - Nature vs Nurture, Biological vs Social
   - Development of Personality
   - Socialization as a process, Agents of socialization
   - Socialization and self/group identity
6. **Gender and Power**
   - Understanding Gender
   - Social construction of Patriarchy
   - Feminism in Historical context, Gender Debates
   - Gender and Development
   - Gender issues in Pakistani society, Women Participation in politics, economy and education
   - Toward a gender sensitive society, Gender mainstreaming
7. **Pakistan: State, Society, Economy and Polity**
   - Colonialism, colonial legacy, National identity
   - Transformation in Pakistani society: Traditionalism vs Modernism
   - Economy, Informality of Economy, Modern economy and Pakistan
   - Political Economy, Sociology of Economy

Recommended Texts:

1. Giddens, A. (2018). Sociology (11th ed.). UK: Polity Press.
2. Henslin, J. M. (2018). Essentials of Sociology: A Down-to-Earth Approach.(18th Edition) Pearson Publisher.
3. Macionis, J. J. (2016). Sociology (16th ed.). New Jersey: Prentice-Hall.
4. Qadeer, M. (2006) Pakistan - Social and Cultural Transformation in a Muslim Nation.
5. Smelser, N.J. and Swedburg, R., The Handbook of Economic Sociology, Chapter 1 'Introducing Economic Sociology', Princeton University Press, Princeton.
6. Systems of Stratification | Boundless Sociology (no date). Available at: https://courses.lumenlearning.com/boundless-sociology/chapter/systems-of-stratification/
7. Jalal, A. (ed.) (1995) 'The colonial legacy in India and Pakistan', in Democracy and Authoritarianism in South Asia: A Comparative and Historical Perspective. Cambridge: Cambridge University Press (Contemporary South Asia)
8. Zaidi, S. A. (2015) Issues in Pakistan's Economy: A Political Economy Perspective. Oxford University Press. Chapter 26
9. Akhtar, A. S. (2017) The Politics of Common Sense: State, Society and Culture in Pakistan. Cambridge: Cambridge University Press.
10. Smelser, N.J. and Swedburg, R., The Handbook of Economic Sociology, Chapter 1 'Introducing Economic Sociology', Princeton University Press, Princeton.

URCG-5120	Exploring Quantitative Skills	3(3-0)

This is an introductory-level undergraduate course that focuses on the fundamentals related to the quantitative concepts and analysis. The course is designed to familiarize students with the basic concepts of mathematics and statistics and to develop students' abilities to analyze and interpret quantitative information. Through a combination of theoretical concepts and practical exercises, this course will also enable students cultivate their quantitative literacy and problem solving skills while effectively expanding their academic horizon and breadth of knowledge of their specific major / field of study.

Course Learning Outcomes

By the end of this course, students shall have:

1. Fundamental numerical literacy to enable them work with numbers, understand their meaning and present data accurately;
2. Understanding of fundamental mathematical and statistical concepts;
3. Basic ability to interpret data presented in various formats including but not limited to tables, graphs, charts, and equations etc.

Contents

1. Numerical Literacy:

i. Numbers system and basic arithmetic operations;

ii. Units and their conversions, dimensions, area, perimeter and volume;

iii. Rates, ratios, proportions and percentages;

iv. Types and sources of data;

v. Measurement scales;

vi. Tabular and graphical presentation of data;

vii. Quantitative reasoning exercises using number knowledge.

2. Fundamental mathematical concepts:

i. Basics of geometry (lines, angles, circles, polygons etc.);

ii. Sets and their operations;

iii. Relations, functions, and their graphs;

iv. Exponents, factoring and simplifying algebraic expressions;

v. Algebraic and graphical solutions of linear and quadratic equations and inequalities;

vi. Quantitative reasoning exercises using fundamental mathematical concepts.

3. Fundamental Statistical Concepts:

i. Population and sample;

ii. Measures of central tendency, dispersion and data interpretation;

iii. Rules of counting (multiplicative, permutation and combination);

iv. Basic probability theory;

v. Introduction to random variables and their probability distributions;

vi. Quantitative reasoning exercises using fundamental statistical concepts.

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Recommended Texts

1. Sevilla, A., & Somers, K. (2012). *Quantitative reasoning: tools for today's informed citizen*. New Jersey, John Wiley & Sons.

2. Burzynski, D., & Ellis, W. (2008). *Fundamentals of mathematics*. USA, Saunders College Publishing.

Suggested Readings

1. Zaslow, E. (2020). *Quantitative reasoning: thinking in numbers*. Cambridge, Cambridge University Press.

2. de Mesquita, E. B., & Fowler, A. (2021). *Thinking clearly with data: A guide to quantitative reasoning and analysis*. New Jersey, Princeton University Press.

3. Bennett, J., & Briggs, W. (2019). *Using & understanding mathematics: a quantitative reasoning approach*. Pearson.

4. Rosen, K. H., & Krithivasan, K. (2012). *Discrete mathematics and its applications* (Vol. 6). New York: McGraw-Hill.

5. Chatfield, C. (2018). *Statistics for technology: a course in applied statistics*. Routledge.

6. Lock, R. H., Lock, P. F., Morgan, K. L., Lock, E. F., & Lock, D. F. (2020). *Statistics: Unlocking the power of data*. New Jersey, John Wiley & Sons.

M.F

CHAIRPERSON
Department of Earth Sciences
UNIVERSITY OF SAN [illegible]
BARCOCHA

URCG-5130	Understanding of the Holy Quran – II	1 (1-0)

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URCG-5130

Model Course Outline
for the Course Understanding of Quran – II

Course Title: Understanding of Quran – II
Course Book: Muallim ul Quran (Volume 3, 4 & 5) by Dr Obaid ur Rahman
Credit Hours: 1 (0-1)
Contact Hours: 3 per week
Weeks: 15-16 (45-48 hours)

Course Learning Outcomes:
By the end of this course, students will be able to:

1. Directly comprehend hundreds of Quranic sentences & verses.
2. Understand at least 80 to 85 % of each page of the holy Quran.
3. Understand common verses across different Quranic topics.
4. Achieve proficiency in the basic and advance linguistic aspects of the Arabic language.
5. Understand the difference between Quranic verbs in various forms, such as present, past and imperative.
6. Develop the ability to understand long verses of the holy Quran independently and then c prehend their interpretation.

Provision of material, content and books:

- **Paper book:** All volumes are available in printed book form.
- **Tutorial videos:** Teaching video of each lesson available on YouTube.
- **Confirmation Videos:** A complete series of confirmation videos of all lessons is available in which the student can confirm his answers.
- **A flipbook:** A flipbook edition is also accessible.
- **Helping material:** Helping material for the teachers like quizzes, question papers and images is available on website.

Course Outline:

Weeks	Lectures	Units	Lessons	Assignments/Home Task	
1.	1.	6	6	Understanding & Translation of Verses	Present Tense صيغة جمع مذكر غائب مثل يصبرون
	2.	6	7-8	Understanding & Translation of Verses	Present Tense صيغة جمع مذكر غائب مثل يحبون
2.	1	6	9-10	Understanding & Translation of Verses	Present Tense صيغة مفرد مذكر مخاطب (تنصر) وجمع مذكر مخاطب (تصبرون)
	2.	6	11-12	Understanding & Translation of Verses	Present Tense صيغة جمع مذكر مخاطب (تعبدون)

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					صيغة المتكلم (أنا)
3.	1.	6	13	Understanding & Translation of Verses	Present Tense صيغة جمع المتكلم (نحن)
		6	14-15	Understanding & Translation of Verses	Negative Imperative صيغة المفرد وصيغة الجمع , لا تفعل، لا تفعلوا
4.	1.	6	16-17	Understanding & Translation of Verses	Conditional Sentences & masdar moawal (مصدر مؤول)
	2.	6	18-19	Understanding & Translation of Verses	Laam ottaleel (لام التعليل) & Laam ul jhood(لام الجحود)
5.	1.	6	20-21	Understanding & Translation of Verses	Present with object pronouns & Passive Voice
	2.	6	Revision (Unit 6)	Quiz	
6.	1.	Unit 7	1 (sec 1-3)	Understanding & Translation of Verses	Past Tense صيغة المفرد المذكر
	2.	6	1 (Sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة المفرد المذكر
7.	1.	6	1 (Sec 5-6)	Understanding & Translation of Verses	Past Tense صيغة المفرد المذكر
	2.	6	1 (Sec 7-9)	Understanding & Translation of Verses	Past Tense صيغة المفرد المذكر
8.	1.	7	Revision	Understanding & Translation of Verses QUIZ	Past Tense صيغة المفرد المذكر
		MID TERM			
9.	1.	7	2 (sec 1-2)	Understanding & Translation of Verses	Past Tense صيغة الجمع المذكر عبدوا
	2.	7	2 (sec 3)	Understanding & Translation of Verses	Past Tense صيغة الجمع المذكر عبدوا
10.	1.	7	2 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع المذكر عبدوا
	2.	7	2 (sec 6-7)	Understanding & Translation of Verses	Past Tense صيغة الجمع المذكر عبدوا
11.	1.	7	3 (sec 1-2)	Understanding & Translation of Verses	Past Tense صيغة الجمع المتكلم عبدنا

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	2.	7	3 (sec 2-3)	Understanding & Translation of Verses	Past Tense صيغة الجمع المتكلم هدنا
12.	1.	7	3 (sec 3-4)	Understanding & Translation of Verses	Past Tense صيغة الجمع المتكلم هدنا
	2.	7	3 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع المتكلم هدنا
13.	1.	7	4 (sec 1-2-3)	Understanding & Translation of Verses	Past Tense صيغة الجمع المخاطب هدتم
	2.	7	4 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع المخاطب هدتم
14.	1.	7	5-6	Understanding & Translation of Verses Quiz	Past Tense صيغة المتكلم و المخاطب هدتُ ، هدتَ
	2.	7	7	Understanding & Translation of Verses	Past Tense صيغة المؤنث الغائب هدتْ
15.	1.	7	8	Understanding & Translation of Verses	Passive Voice (Past Tense) فعل مجهول المفرد
	2.	7	9	Understanding & Translation of Verses	Passive Voice (Past Tense) فعل مجهول الجمع
16.	1.	8	1-4	Understanding & Translation of Verses	Imperative Verb for singular فعل الأمر للمفرد
	2.	7	5-8	Understanding & Translation of Verses	Imperative Verb for plural فعل الأمر للجمع

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URCG-5132	Ethics – II	1 (1-0)

Ethics-II

URCG-5132

1 (0-1)

1-Course Description

The course *Ethics-II* is designed to provide students with a deeper understanding of ethical principles and practices from both Semitic and non-Semitic religions, as well as their application in professional and social contexts. Students will engage with Jewish, Christian, Islamic, Hindu, Buddhist, Sikh, Confucian, and Jain ethical traditions. The course emphasizes moral reasoning, decision-making, tolerance, and peacebuilding. It aims to cultivate an inclusive, humanistic, and holistic approach towards ethical living and interfaith engagement.

2- Learning Objectives

The course objectives are to:

1. Understand the fundamental principles and theories of ethics.
2. Introduce the ethical and moral teachings of Judaism, Christianity, Islam, and Hinduism.
3. Explore the ethical teachings of non-Semitic religions such as Buddhism, Sikhism, Confucianism, and Jainism.
4. Develop critical thinking skills to evaluate ethical arguments and theories.
5. Promote ethical leadership and interfaith harmony.

3- Learning Outcomes

By the end of this course, students will be able to:

1. Identify and analyze major ethical theories and teachings from world religions.
2. Understand the role of religions in improving moral values and social behavior.
3. Demonstrate ethical decision-making in various personal and professional contexts.
4. Recognize the impact of ethical decisions on individuals, communities, and society.
5. Apply skills of ethical leadership, including communication, conflict resolution, and inclusive engagement.

4-Course Structure

1. Interactive lectures, Group discussions and debates
2. Reflection papers and presentations
3. Assignments and Quiz

Course Contents

Unit 1: Ethical Teachings of Semitic Religions

- Judaism and its ethical teachings
- Christianity and its ethical teachings
- Islam and its ethical teachings

Unit 2: Ethical Teachings of Non-Semitic Religions

- Hinduism and its ethical teachings
- Sikhism and Buddhism: ethical values and practices
- Confucian and Jain ethical traditions

Unit 3: Professional Ethics

- Ethics for students and teachers
- Ethics in doctor–patient relationships
- Ethics in trader–customer interactions

Unit 4: Concept and Significance of Tolerance

- Definition, need, and importance of tolerance
- Teachings of Semitic religions on tolerance and their contemporary relevance
- Teachings of non-Semitic religions on tolerance and their contemporary relevance

Unit 5: Foundational Values and Ethics for Peacebuilding in Society

- Respect for sacred scriptures, personalities, places of worship, and religious symbols
- Promotion of tolerance and broadmindedness
- Encouragement of dialogue and harmony
- Benevolence towards humanity
- Establishment of justice and fairness
- Patience, forbearance, and forgiveness

Textbook

- Kidder, R. M. (2009). *How Good People Make Tough Choices: Resolving the Dilemmas of Ethical Living*. Harper.

Suggested Readings

1. Barash, D. P., & Webel, C. P. (2014). *Peace and Conflict Studies*. Sage.
2. Smart, N. (1998). *The World's Religions*. Cambridge University Press.
3. Nasr, S. H. (2003). *The Heart of Islam: Enduring Values for Humanity*. HarperOne.
4. Sharma, A. (2006). *Hindu Ethics: Purity, Abortion, and Euthanasia*. SUNY Press.
5. Harvey, P. (2000). *An Introduction to Buddhist Ethics: Foundations, Values and Issues*. Cambridge University Press.
6. Cawagas, H., & Perkinson, J. (2013). *A Cross-Cultural Dialogue on Ethical Leadership*. Wilfrid Laurier University Press.
7. Confucius. (1998). *The Analects*. Oxford University Press.

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CHAIRMAN

URCG-5128	Pakistan Studies	2(2-0)

This course is designed to provide students with a comprehensive exploration of Pakistan's identity, spanning geographical, historical and cultural dimensions. It delves into the diverse landscape, ancient civilizations, and rich cultural heritage that define Pakistan. Moreover, it examines the socio-cultural and political transformations in Pakistan over time including democratic transitions and military interventions. The aim of this course is to inculcate in students a nuanced understanding of Pakistan's past, present, and potential future trajectories, enabling them to critically evaluate the complex dynamics shaping the nation's development.

Course Learning Outcomes

By the end of this course, student will be able to:

1. Have enhanced knowledge of the geographical, historical and political aspects of Pakistan.
2. Understand the society and cultural of Pakistan.
3. Understand and explain the scio-economics developments in Pakistan.
4. Explore contemporary issues and challenges faced by Pakistan and their implications for the future.

Contents

1. Introduction to Pakistan:

- Geographical location and significance.
- Historical background: Ancient civilizations in the region.
- Factors leading to the creation of Pakistan

2. Political History of Pakistan:

- Formative phase
- Military interventions and democratic transitions.

3. Geography of Pakistan:

- Physiography: Mountains, plains, plateaus, deserts, valleys and coastal areas.
- River system: Indus river and its tributaries;
- Climatic regions of Pakistan.

4. Society and Culture of Pakistan:

- Socio- cultural diversity.
- Language and literature of Pakistan.

5. Economics Development of Pakistan:

- Agriculture and industrial sectors of Pakistan.
- Economic challenges of Pakistan.

6. Contemporary Issues:

- Foreign relations of Pakistan.
- Security challenges: terrorism, extremism, regional conflicts.
- Environmental problems and sustainable development (SDGs).
- Media and social change.

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SUGGESTED READING MATERIALS

1. "Jinnah of Pakistan" by Stanley Wolpert
2. "The sole Spokesman: Jinnah, the Muslim League, and the Demand for Pakistan" by Ayesha Jalal
3. "The struggle for Pakistan" by Ishtiaq Hussain Qureshi
4. "Pakistan, the Formative Phase, 1857-1948" by Khalid B. Sayeed
5. "Pakistan Studies: A Book of Readings" by Sikandar Hayat
6. "Constitutional and Political History of Pakistan" by Hamid Khan
7. "Trek to Pakistan" by Ahmad Saeed and Kh. Mansur Sarwar
8. "Pakistan: A Modern History" by Ian Talbot
9. "Politics in Pakistan: The Nature and Direction of Change" by Khalid B. Sayeed
10. "Physical Geography of Pakistan" by Umar Jahangir
11. "A Geography of Pakistan: Environment, people, and Economy" by Fazle Karim Khan
12. "Pakistan's Foreign Policy: An Historical Analysis" by S.M. Burke
13. "Separatism in East Pakistan" by Rizwan Ullah Kokab
14. "Being Pakistani: Society, Culture and the Arts" by Raza Rumi
15. "Pakistani's Culture Heritage: Socio-Economic and Technological Aspects" edited by Abdul Jabbar Khan
16. "Language and Politics in Pakistan" by Tariq Rahman
17. Sociology" by Horton and Hunt
18. "Pakistan in the Twentieth Century: A Political History" by Lawrence Ziring
19. "Economic Development of Pakistan" by Ishrat Husain
20. "Issues in Pakistan's Economy" by S. Zaidi

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GEOL - 5104	Paleontology	3(2-1)

Course Brief:

This course is designed to acquire the knowledge about the various types of fossils and their significance. This will help the students to understand various morphological features of fossils; their classification, identification and distribution in geologic time. This course will provide interested students with a better understanding of one of the most valuable tools in stratigraphic and paleo environmental analyses, fossils. The course will introduce the major marine and non-marine invertebrate taxonomic groups found in the fossil record and what we know about them – their stratigraphic range, modes of life, and environmental preferences. This course is designed to acquire the knowledge about the various types of fossils and their significance.

Course Learning Objectives:

This course will help the students to understand various morphological features of fossils; their classification, identification and distribution in geologic time. The main objectives of this subject are to identify the major fossil invertebrate groups and their stratigraphic and paleo environmental significance, to apply the techniques used in the processing of samples for paleontological analyses. to apply fossil data analyses and statistical applications used for biostratigraphic and paleo environmental interpretation, to use paleontological data to solve biostratigraphic, paleo environmental, paleo ecological, environmental, and ecological problems.

Course Contents:

1. Introduction to fossils and their significance;
2. Modes of fossilization,
3. Study of morphology, range and broad classification of major invertebrate phyla i .e Coelenterata, Brachiopoda, Mollusca, Arthropoda (trilobite) and Echinodermata (echinoidea);
4. Introduction to micro fossils;
5. Introduction to paleobotany;
6. Introduction and classification of major vertebrates i.e. mammals, amphibians, reptiles and picies;
7. Introduction to Micropaleontology i.e. Foraminifera, Briozone, Ostrocodes and Conodonts etc.
8. Index fossils;
9. Introduction to major invertebrate and microfossils of Pakistan.

Recommended Texts:

1. Moore, R. C., Lalicker, C. G., Lalicker, C. G., & Fischer, A. G. (2000). *Invertebrate fossils*. New York: McGraw-Hill.
2. Woods, H. (1926). *Palaeontology, invertebrate*. Cambridge: CUP Archives.

Suggested Readings:

1. Raup, D. M., Raup, D., & Stanley, S. M. (1978). *Principles of paleontology*. New York: Macmillan.
2. Clarkson, E. N. K. (2009). *Invertebrate palaeontology and evolution*. Hoboken: John Wiley & Sons.
3. Levinton, J. S., & Levinton, J. S. (2000). *Genetics, paleontology, and macroevolution*. Cambridge: Cambridge University Press.

GEOL - 5105	Stratigraphy	3(3-0)

Course Brief:

This course is a graduate course of stratigraphy. The rocks are formed during the full geological time from oldest Precambrian to Recent Quaternary. This course is designed to understand the basic division of geological time scale (GTS). Different litho, bio and chorono stratigraphic divisions of time scale. This course is designed to acquire the knowledge about the various stratigraphic successions formed during different geological time.

Course Learning Objectives:

This course will help the student to understand the stratigraphic set up of various regions, especially Pakistan. Initially, the basic principles and laws of stratigraphic will be teach in the class. Then the application of these laws/ principles is used to evaluate the structures and correlations of different geological features formed during the geological time will be understand by the students. This course also includes the principles of correlations.

Course Contents:

1. Principles of stratigraphy;
2. Laws of superposition and faunal succession;
3. Geological time scale with divisions;
4. Classification and nomenclature of stratigraphic units
5. Lithostragraphic
6. Biostratigraphy and chrono stratgraphic units; contacts; litho-and-biofacies;
7. Principle of stratigraphy correlation;
8. Stratigraphy code of Pakistan;
9. Outline of stratigraphy of Pakistan; principles of biostratigraphy and biostratigraphy zones; biostratigraphy techniques and procedures; biostratigraphy of Pakistan.

Recommended Texts:

1. Shah, S. I. (2000). *Stratigraphy of Pakistan*. Quetta: Geological Survey of Pakistan.
2. Kazmi, A. H., & Abbasi, I. A. (2008). *Stratigraphy & historical geology of Pakistan*. Peshawar: Department & National Centre of Excellence in Geology.

Suggested Readings:

1. Boggs Jr, S. (2014). *Principles of sedimentology and stratigraphy*. London: Pearson Education.
2. Kazmi, A. H., & Abbasi, I. A. (2008). *Stratigraphy & historical geology of Pakistan*. Peshawar: Department & National Centre of Excellence in Geology.
3. Shah, S. M. I. (1980). *Stratigraphy and economic geology of Central Salt Range*. Quetta: Geological Survey of Pakistan.

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GEOL - 5106	Geological Fieldwork-I	2(0-2)

Course Brief:

This course is designed to identify various types of rocks, field stratigraphy, fossils, structural features and landforms in the field. This will help the students to understand various types of criteria to recognize rocks and other geological features in the field. The course emphasizes the basic skills essential to identify rocks according to different aspects, correlation & features also to locate yourself in the field and make essential field observations and measurements.

Course Learning Objectives:

The geological field build confidence and practical knowledge in the students to elaborate geological structures in the field during their field survey, which will give them more energy for the future. As geology is the subject of field and to explore the earth which is not possible without fieldwork. During the first two years, students will perform about two weeks of fieldwork. It will lead to becoming familiar with major rocks and basic geological mapping techniques. Each field trip will be followed by report writing and Viva Voce / Evaluation.

Course Contents:

1. Field based exercises
2. Identification different rock types.
3. Identification of different geological features
4. Identification of different geomorphic features
5. Identify different mass wasting phenomenon in field
6. Basic concept of relief and elevation
7. Essential field observations and measurements
8. Utilization of different types of maps in field
9. Topographic maps
10. Basic geological mapping techniques
11. Each field trip will be followed by report writing and Viva Voce / Evaluation.

Recommended Texts:

1. Coe, A. L. (Ed.). (2010). *Geological field techniques*. Hoboken: John Wiley & Sons.
2. Lambert, D. (2000). *The field guide to geology*. New York: Infobase Publishing.

Suggested Readings:

1. Barnes, J. W., & Lisle, R. J. (2013). *Basic geological mapping*. Hoboken: John Wiley & Sons.
2. Lahee, F. H. (2000). *Field geology*. New York: McGraw-Hill.
3. Compton, R. R., & Compton, R. R. (2000). *Geology in the Field*. New York: Wiley.

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URCG-5127	Seerat of the Holy Prophet (SAW)	1(1-0)

Seerat of the Holy Prophet مطالعہ سیرت النبی صلی اللہ علیہ وسلم

Course Code : URCG-5127

Title	Description
Semester	
Nature of Course	
No. of C.Hrs.	1(1-0)
Total Teaching weeks	18
Objectives of the Course	۱۔ طلباء کو مطالعہ سیرت کی ضرورت و اہمیت سے آگاہ کرنا ۲۔ تعمیر شخصیت میں مطالعہ سیرت کے کردار کو واضح کرنا ۳۔ بعثت نبوی کے موقع پر اقوام عالم کی عمومی صورت حال سے آگاہ کرنا ۴۔ رسول اکرم صلی اللہ علیہ وسلم کی مکی اور مدنی زندگی کا اس طرح مطالعہ کروانا کہ طلباء ان واقعات سے نتائج کا استنباط کر سکیں ۵۔ طلباء کو عہد نبوی کی معاشرت، سیاست، معیشت سے آگاہ کرنا

Course Description

S.No.	Title	Description
1	حضور صلی اللہ علیہ وسلم کے ابتدائی حالات زندگی	۱۔ حضور صلی اللہ علیہ وسلم کا خاندانی حسب و نسب ۲۔ پیدائش اور ابتدائی تربیت ۳۔ لڑکپن اور جوانی کے حالات زندگی
2	بعثت نبوی کے وقت دنیا کے حالات (۱)	۱۔ بعثت نبوی کے وقت اہم تہذیبیں ۲۔ عرب، مصر، حبشہ، بازنطینی، ساسانی
3	مکی عہد میں دعوت اسلام	۱۔ مکی عہد میں دعوت اسلام
4	مدنی عہد میں دعوت اسلام	۱۔ مدنی عہد میں دعوت اسلام
5	خصائص النبیؐ	آپ کا حلیہ مبارک
6	خصائص النبیؐ	بحیثیت استاد و معلم
7	خصائص النبیؐ	بحیثیت داعی
8	خصائص النبیؐ	بحیثیت سربراہ ریاست
9	خصائص النبیؐ	ذاتی محاسن اور عالمگیر اثرات

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ناموس رسالت	محمد انس الحق	10
غیر مسلموں سے تعلقات	اسوہ حسنہ اور عصر حاضر	11
اسوہ حسنہ کی روشنی میں گھریلو زندگی	اسوہ حسنہ اور عصر حاضر	12
مستشرقین اور مطالعہ سیرت	اسوہ حسنہ اور عصر حاضر	13
وطن سے محبت اور سیرت	اسوہ حسنہ اور عصر حاضر	15
مستشرقین کے اعتراضات اور ان کے جوابات	اسوہ حسنہ اور عصر حاضر	16

نصابی کتب

نمبر شمار	نام مؤلف	نام کتاب
1	ابن ہشام	السیرۃ النبویۃ
2	مولانا شبلی النعمانی/سید سلمان ندوی	سیرۃ النبی صلی اللہ علیہ وسلم
3	قاضی محمد سلیمان سلمان منصور پوری	رحمۃ للعالمین
4	مولانا سید ابوالحسن علی ندوی	نبی رحمت صلی اللہ علیہ وسلم
5	ڈاکٹر یٰسین مظہر صدیقی	عہد نبوی کا نظام حکومت
6	ڈاکٹر فاضل علوی	انسان کامل

حوالہ جاتی کتب

نمبر شمار	نام مؤلف	نام کتاب
1	سید ابوالاعلیٰ مودودی	سیرت سرور عالم صلی اللہ علیہ وسلم
2	مولانا صفی الرحمن مبارکپوری	الرحیق المختوم
3	ڈاکٹر محمد کرم شاہ الازہری	ضیاء النبی صلی اللہ علیہ وسلم
4	ڈاکٹر اکرم ضیاء العمری	السیرۃ النبویۃ الصحیحۃ
5	مولانا صفی الرؤف دانا پوری	اصح السیر

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URCG- 5119	Expository Writing	3(3-0)

This course prepares undergraduates to become successful writers and readers of English. The course helps students develop their fundamental language skills with a focus on writing so that they can gain the confidence to communicate in oral and written English outside the classroom. The course is divided into five units and takes a Project-based Learning approach. Unit themes target the development of 21st century skills and focus on self-reflection and active community engagement. The course completion will enable the students to develop communication skills as reflective and self-directed learners. They will be able to intellectually engage with different stages of writing process, and develop analytical and problem-solving skills to address various community-specific challenges.

Course Contents:

1. Self-Reflection
   - Introduction to the basics of the writing process
   - Introduction to the steps of essay writing
   - Prewriting activities: Brainstorming, listing, clustering and freewriting
   - Practicing Outlining of the essay
2. Personalized Learning
   - Learning Process, Learning Styles, Goal Setting and Learning Plan
3. Oral Presentation
   - Structure and Significance, Content Selection and Slide Presentation, Peer Review
4. Critical Reading Skills
   - Introducing Authentic Reading (Dawn and non-specialist academic books/texts)
   - Reading Strategies and Practice: Skimming, scanning, SQW3R, Annotating, Detailed reading and note-taking, Standard Test Practice: TOEFL and IELTS, Model Review Reports and Annotated Bibliographies
5. Community Engagement
   - Student-led brainstorming on local versus global issues, Identifying research problems
   - Drafting research questions, Drafting interview/survey questions for community research (in English or L1)
   - Engaging students in Critical reading, Presenting interview/ survey information, Field work
   - Writing Community Engagement Project
6. Letter to the Editor
   - Types of letters, Format and purpose of letter to the editor, Steps in writing letter-to-editor

Recommended Texts:

1. Bailey, S. (2011). Academic writing: A handbook for international students (3rd ed.). New York: Routledge.
2. Swales, J. M., & Feak, C. B. (2012). *Academic writing for graduate students: Essential tasks and skills* (3rd ed.). Ann Arbor: The University of Michigan Press.

Suggested Readings:

1. Cresswell, G. (2004). *Writing for academic success*. London: SAGE.
2. Johnson-Sheehan, R. (2019). *Writing today*. Don Mills: Pearson.
3. Silvia, P. J. (2019). *How to write a lot: A practical guide to productive academic writing*. Washington: American Psychological Association.

M.F

URCG-5121	Tools for Quantitative Reasoning	3(3-0)

This is a sequential undergraduate course that focuses on logical reasoning supported with mathematical and statistical concepts and modeling / analysis techniques to equip students with analytical skills and critical thinking abilities necessary to navigate the complexities of modern world. The course is designed to familiarize students with the quantitative concepts and techniques required to interpret and analyze numerical data and to inculcate ability in students the logical reasoning to construct and evaluate arguments, identify fallacies, and think systematically. Keeping the pre-requisite course of Quantitative reasoning (I) as its base, this course will enable students further their quantitative. Logical and critical reasoning abilities to complement their specific major field of study

Course Learning Outcomes

By the end of the course, student shall have:

1. Understanding of logic and logical reasoning:
2. Understanding the basic quantitative Modeling and Analyses.
3. Logical reasoning skills and abilities to apply them to solve quantitative problems and evaluate arguments;
4. Ability to critically evaluate quantitative information to make evidence based decisions through appropriate computational tools.

Contents

1. Logic, Logical and Critical Reasoning:

i. Introduction and importance of logic,

ii. Introductive, deductive and abductive approaches of reasoning,

iii. Propositions, arguments (valid; invalid), logical connectives, truth tables and propositional equivalences,

iv. Logical fallacies,

v. Venn Diagrams,

vi. Predicates and quantifiers,

vii. Quantitative reasoning exercises using logical reasoning concepts and techniques.

2. Mathematical Modeling and Analyses:

i. Introduction to deterministic models,

ii. Use of linear function for modeling in real-world situations,

iii. Modeling with the system of linear equation and linear solutions,

iv. Elementary introduction to derivatives in mathematical modeling,

v. Linear and exponential growth and decay models,

vi. Quantitative reasoning exercises using mathematical modeling.

3. Statistical Modeling and Analyses:

i. Introduction to probabilistic models,

ii. Bivariate analysis, scatter plots,

iii. Simple linear regression model and correlation analysis,

iv. Basics of estimation and confidence interval,

v. Testing of hypothesis (z-test; t-test),

vi. Statistical inference in decision making,

vii. Quantitative reasoning exercise using statistical modeling.

M.F

Recommended Texts

1. Bennett, J., & Briggs, W. (2019). *Using & understanding mathematics: a quantitative reasoning approach*. Pearson.

2. Rosen, K. H., & Krithivasan, K. (2012). *Discrete mathematics and its applications* (Vol. 6). New York: McGraw-Hill.

Suggested Readings

1. Epp, S. S. (1990). *Discrete mathematics with applications*. Wadsworth Publ. Co..

2. Budnick, F. S., Quinn, S., Bowser, K., & Flaherty, E. H. (1993). *Applied mathematics for business, economics, and the social sciences*. New York: McGraw-Hill.

3. Bluman, A. (2014). *Elementary Statistics: A step by step approach 9e*. McGraw Hill.

4. Mann, P. S. (2007). *Introductory statistics*. John Wiley & Sons.

5. Babones, S. (2013). Applied statistical modeling. *(No Title)*.

6. Green, S. W., Wolf, I.k., Stewrat, B. W. (2022). SAT Study Guide Premium. Barrons

M.F

URCG-5122	Ideology and Constitution of Pakistan	2(2-0)

Course Description:
This course focuses on ideological background of Pakistan. The course is designed to give a comprehensive insight about the constitutional developments of Pakistan. Starting from the Government of India Act, 1935 till to date, all important events leading to constitutional developments in Pakistan will be the focus of course. Failure of the constitutional machinery and leading constitutional cases on the subject. Moreover, students will study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan. It will also cover the entire Constitution of Pakistan 1973. However, emphasis would be on the fundamental rights, the nature of federalism under the constitution, distribution of powers, the rights and various remedies, the supremacy of parliament and the independence of judiciary

Outline:

- **Ideology of Pakistan**

Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
Two Nation Theory and Factors leading to Muslim separatism.

- **Constitutional Developments**

Salient Feature of the Government of India Act 1935
Salient Feature of Indian Independence Act 1947
Objectives Resolution
Salient Feature of the 1956 Constitution
Developments leading to the abrogation of Constitution of 1956
Salient features of the 1962 Constitution
Causes of failure of the Constitution of 1962
Comparative study of significant features of the Constitution of 1956, 1962 and 1973

- **Fundamental rights**
- **Principles of policy**
- **Federation of Pakistan**
  President
  Parliament
  The Federal Government
- **Provinces**
  Governors
  Provincial Assemblies
  The Provincial Government
- **The Judicature**
  Supreme Court
  High Courts
  Federal Shariat Courts
  Supreme Judicial Council
  Administrative Courts and tribunals
- **Islamic Provisions in Constitution**
- **Significant Amendments of Constitution of Pakistan 1973**

M.F

Recommended Books:

1. Constitutional and Political History of Pakistan by Hamid Khan

2. Mahmood, Shaukat and Shaukat, Nadeem. Constitution of the Islamic Republic of Pakistan, 3rd re edn. Lahore: Legal Research Centre, 1996.

3. Munir, Muhammad. Constitution of the Islamic Republic of Pakistan: Being a Commentary on the Constitution of Pakistan, 1973. Lahore, Law Pub., 1975.

4. Rizvi, Syed Shabbar Raza. Constitutional Law of Pakistan: Text, Case Law and Analytical Commentary. 2nd re edn. Lahore: Vanguard, 2005.

5. The Text of the Constitution of the Islamic Republic of Pakistan, 1973 (as amended).

6. Fundamental Laws of Pakistan by A.K. Brohi

M.F

GEOL - 5107	Environmental Geology	3(3-0)

Course Brief:

This course is designed to acquire the knowledge about the role of geology in the environmental degradation. As a discipline, environmental geology deals with using geological knowledge to address interactions between humans and the physical environment: the biosphere, the lithosphere, the hydrosphere, and, to some degree, the atmosphere. Environmental geology is a multidisciplinary subject that covers a broad range of topics, ranging from Earth materials and their use to Earth processes, including natural hazards and their impact on human lives. The environmental effects of exploring Earth resources is also an integral component of the course.

Course Learning Objectives:

This course will enable the students to learn how the various geological processes and related human activities are involved in contaminating our ecosystem. managing geological and hydrogeological resources such as fossil fuels, minerals, water (surface and ground water), and land use. Studying the earth's surface through the disciplines of geomorphology, and defining and mitigating exposure of natural hazards on humans managing industrial and domestic waste disposal and minimizing or eliminating effects of pollution, and performing associated activities, often involving litigation.

Course Contents:

1. Introduction to environmental geology, management of natural resources, climatic changes.
2. Environmental controls for erosion, desertification and coastal degradation.
3. Introduction to environmental impact assessment and initial environmental examination.
4. Environmental impact of mining, dams, reservoirs.
5. Environmental impact of Highways, their assessment and controls.
6. Geological hazards such as floods, landslides.
7. Earthquakes, tsunamis, volcanoes.
8. Glaciers and shoreline processes and their remedial measures;
9. Industrial pollution, solid and liquid waste disposal.
10. Groundwater contaminations.
11. River lake and marine pollution and their impact on human health.
12. Clean sources of energy, introduction to acid mine drainage.

Recommended Texts:

1. Pipkin, B. W., Trent, D. D., Hazlett, R., & Bierman, P. (2013). *Geology and the Environment.* Boston: Cengage Learning.
2. Knödel, K., Lange, G., & Voigt, H. J. (2007). *Environmental geology: handbook of field methods and case studies.* Amsterdam: Springer Science & Business Media.

Suggested Readings:

1. Montgomery, C. W. (1992). *Environmental Geology.* Dubuque: Wm C. Brown Publishers.
2. Armand, N. A., & Polyakov, V. M. (2004). *Radio propagation and remote sensing of the environment.* New York: CRC Press.
3. Pipkin, B. W., Trent, D. D., Hazlett, R., & Bierman, P. (2013). *Geology and the Environment.* Boston: Cengage Learning.

GEOL - 5108	Sedimentology	3(2-1)

Course Brief:

This course is designed to acquire the knowledge about various types of sedimentary rocks and their digenesis. Sedimentary rocks illuminate many of the details of the earth's history: effects of sea level change, global climate, tectonic processes, and geochemical cycles are all recorded in the sedimentary strata of the earth. This course will cover basics of fluid flow and sediment transport, sedimentary structures and textures, and forming the bridge between modern landforms and ancient rocks' depositional sedimentary environments.

Course Learning Objectives:

This course will help the students to understand the classification and depositional system of the sedimentary rock as well as the provenance of sediments and sedimentary structures. It's also enable students to understand the role of tectonic for sedimentary rocks.

Course Contents:

1. Introduction to sedimentology
2. Origin, transportation and deposition of sediments
3. Texture of sedimentary rocks and their statistical parameters
4. Sedimentary structures, their classification, morphology, significance and paleocurrent analysis
5. Classification and description of sedimentary rocks
6. Provenance of sediments; diagenesis; concepts of sedimentary facies and facies association
7. Physical-chemical controls of the sedimentary environments
8. Diagnostic features of glacial, eolian
9. Fluvial, lagoonal, acustrine, deltaic, tidal, turbidites and marine environments
10. Tectonic controls of sedimentation.

Lab. Work

1. Grain size analysis of sediments and sedimentary rocks,
2. Megascopic and microscopic study of sedimentary rocks for classification,
3. Use of ternary diagrams, discrimination diagrams for tectonic setting,
4. Separation and identification of heavy minerals,
5. Study of primary sedimentary structures and their uses in facing or top bottom,
6. Rose diagrams and paleocurrent analysis.

Recommended Texts:

1. Prothero, D. R., & Schwab, F. (2004). *Sedimentary geology*. New York: Macmillan.
2. Pettijohn, F. J., Potter, P. E., & Siever, R. (2012). *Sand and sandstone*. Berlin: Springer Science & Business Media.

Suggested Readings:

1. Boggs Jr, S. (2014). *Principles of sedimentology and stratigraphy*. London: Pearson Education.
2. Reineck, H. E., & Singh, I. B. (2012). *Depositional sedimentary environments: with reference to terrigenous clastics*. Berlin: Springer Science & Business Media.
3. Selley, R. C. (2000). *Applied sedimentology*. Amsterdam: Elsevier.

M.F

GEOL-5109	Petrology	3(2-1)

Course Brief:

This course is a graduate level course of Igneous - Metamorphic Petrology. It is the study of magma and the rocks that solidify from magma. The composition of igneous rocks and minerals can be determined via a variety of methods of varying ease, cost, and complexity. This course also includes the tectonic activities related to magmatic processes and different types of igneous rocks on different tectonic margins. . This course also includes different rock structures which developed due to metamorphism so it's beneficial for students to recognize different rock features in metamorphic rocks of field area. Metamorphic rocks are the most common rock type on Earth, and their study allows us to put constraints on the pressure, stress and temperature conditions in the crust and mantle. Metamorphism affects rocks in different ways by changing their composition and shapes.

Course Learning Objectives:

This course will enable students to understand the mechanism and factors affecting the magma, its magmatic evolution and the rocks that solidify from magma. Students will learn the composition of igneous rocks and minerals It also enables students to understand the mechanism and types of metamorphism as well as the factors that affect the process of metamorphism.

Course Contents:

1. Mantle-magma systems and source of magma
2. Physico-chemical factors in magmatic evolution.
3. Tectonism-magmatism relationship
4. Igneous activity related to convergent plate boundary and divergent plate boundary environments
5. Intracontinental hot spots
6. Petrogenesis of igneous rocks
7. Ophiolites
8. Introduction to metamorphism
9. Types, grades, zones and facies of metamorphism
10. Metamorphic diffusion and differentiation
11. Metamorphism in relation to plate tectonics
12. Study of textures and structures of metamorphic rocks
13. Differentiation between metamorphism and metasomatism
14. Paired metamorphic belts

Recommended Texts:

1. Best, M, G. (2013). Igneous and metamorphic petrology. Honoken: John Wiley & Sons.
2. Hyndman, D. W. (2000). Petrology of igneous and metamorphic rocks. New York: McGrawHill.
3. . McBirney, A. R. (1993). Igneous petrology. Burlington: Jones & Bartlett learning.

Suggested Reading:

1. Gillen, C. (2012). Metamorphic geology: an introduction to tectonic and metamorphic processes. Amsterdam: Springer Science & Business Media.
2. Philpotts, A. & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge: Cambridge University Press.

URCG-5114	Basic Science	3 (2-1)

Life, its characteristics, natural science, biology and its branches; Importance of Flora & Fauna in biodiversity; Importance of Natural Compounds in daily life, medicine and human health; Latest developments in natural sciences (Biotechnology); Ecosystem and its components; Environment and its components; Pollutants and their effect on the environment (Greenhouse effect, global warming, acid rains, water pollution and ozone depletions etc); Introduction to micro-organism and its types (bacteria, fungi, viruses)

Practical:

1: Field Survey of Flora & Fauna and their identification

2: Study of herbarium

3: Study of Museum

Recommended Texts:

1. Keddy, P.A. *(2017). Plant ecology origins, processes, consequences.* Cambridge, University Press.
2. Canadell, J.G., Diaz, S., Heldmaier, G., Jackson, R.B., Levia, D.F., Schulze, E.D. & Sommer, U. (2019). *Ecological studies.* Springer.
3. Bhat, S.V., Nagasampagi, B.A. & Sirakumar, M. (2006). Chemistry of Natural Products. Springer Science
4. De, A.K. (2019). *Environmental Chemistry.* New Age International Press

Suggested Readings:

1. Fath, B. (2018). *Encyclopedia of ecology.* Elsevier.
2. Ajith, H .. Urmas. P., Pastur, G. M & Iversion L. R. (2018). *Ecosystem services from forest landscpes:* broadsclaes consideration. 1st Edition. Springer International Publishing AG.
3. Xu, R., Ye, Y. & Zhao, W. (2011). *Introduction to Natural Product Chemistry.* CRC Press
4. Tayler, D.J., Green, N.P.O. & Stout, G.W. (1997). *Biological Science* 1&2. Cambridge University Press
5. Tayler, M.R., Simon, E.J., Dickey, D.J. & Hogan, K.A. (2020). *Campbell Biology: Concepts & Connections* (10th Edition). Pearson

URCG-5124	Entrepreneurship	2(2-0)

This course addresses the unique entrepreneurial experience of conceiving, evaluating, creating, managing, and potentially selling a business idea. The goal is to provide a solid background with practical application of important concepts applicable to the entrepreneurial environment. Entrepreneurial discussions regarding the key business areas of finance, accounting, marketing and management include the creative aspects of entrepreneurship. The course relies on classroom discussion, participation, the creation of a feasibility plan, and building a business plan to develop a comprehensive strategy for launching and managing a new venture.

Course Learning Objectives

1. To enhance the 'entrepreneurial intentions' of the students by improving their natural willingness to start a business.
2. To understand the process of entrepreneurship and learn the ways to manage it by working individually in the class and in the form of groups outside the class to conduct field assignments.
3. To educate the students about the practical underpinnings of the entrepreneurship with the aid of practical assignments and idea pitching.

Course Contents:

1. **Background:** What is an Organization, Organizational Resources, Management Functions, Kinds of Managers, Mintzberg's Managerial Roles.
2. **Forms of Business Ownership:** The Sole proprietorship, Partnership, Joint Stock Company
3. **Entrepreneurship:** The World of the Entrepreneur, what is an entrepreneur? The Benefits of Entrepreneurship, The Potential Drawbacks of Entrepreneurship, Behind the Boom: Feeding the Entrepreneurial Fire.
4. **The Challenges of Entrepreneurship:** The Cultural Diversity in Entrepreneurship, The Power of "Small" Business, Putting Failure into Perspective, The Ten Deadly Mistakes of Entrepreneurship, How to Avoid the Pitfalls, Idea Discussions & Selection of student Projects, Islamic Ethics of Entrepreneurship.
5. **Inside the Entrepreneurial Mind:** From Ideas to Reality: Creativity, Innovation, and Entrepreneurship, Creativity – Essential to Survival, Creative Thinking, Barriers to Creativity, How to Enhance Creativity, The Creative Process, Techniques for Improving the Creative Process, Protecting Your Ideas, Idea Discussions & Selection of student Projects.
6. **Products and technology, identification opportunities**
7. **Designing a Competitive Business Model and Building a Solid Strategic Plan:** Building a strategic plan, Building a Competitive Advantage, The Strategic Management Process, Formulate strategic options and select the appropriate strategies, Discussion about execution of Students' Project.
8. **Conducting a Feasibility Analysis and Crafting a Winning Business Plan:** Conducting a Feasibility Analysis, Industry and market feasibility, Porter's five forces model, Financial feasibility analysis. Why Develop a Business Plan, The Elements of a Business Plan, What Lenders and Investors Look for in a Business Plan, Making the Business Plan Presentation.
9. **Building a Powerful Marketing Plan:** Building a Guerrilla Marketing Plan, Pinpointing the Target Market, Determining Customer Needs and Wants Through Market Research. Plotting a Guerrilla Marketing Strategy: How to Build a Competitive Edge, Feed Back & Suggestions on Student Project, Islamic Ethics for Entrepreneurial Marketing

10. **E-Commerce and the Entrepreneur:** Factors to Consider before Launching into E-Commerce, Ten Myths of E-Commerce, Strategies for E-Success, Designing a Killer Web Site, Tracking Web Results, Ensuring Web Privacy and Security, Feed Back & Suggestions on Student Project.
11. **Pricing Strategies:** Three Potent Forces: Image, Competition, and Value, Pricing Strategies and Tactics, Pricing Strategies and Methods for Retailers, The Impact of Credit on Pricing.
12. **Attracting Venture Capitalist:** Projected Financial Statements, Basic Financial Statements, Ratio Analysis, Interpreting Business Ratios, Breakeven Analysis, Feed Back &Suggestions on Student Project,
13. **Idea Pitching:** Formal presentation, 5-minutes pitch, funding negotiation and launching.

Recommended Texts:

1. Scarborough, N. M. (2011). *Essentials of entrepreneurship and small business management.* Publishing as Prentice Hall, One Lake Street, Upper Saddle River, New Jersey 07458..

Suggested Readings:

1. Burstiner, I. (1989). *Small business handbook.* Prentice Hall Press.

URCG-5125	Civics and Community Engagement	2(2-0)

Course Description:

The Civics and Community Engagement course is designed to provide students with an understanding of the importance of civic participation, culture and cultural diversity, basic foundations of citizenship, group identities and the role of individuals in creating positive change within their communities. The course aims at developing students' knowledge, skills and attitudes necessary for active and responsible citizenship.

Learning outcomes:

After completing this course, students will be able to

- Understand the concepts of civic engagement, community development, and social responsibility.
- Understand rights and responsibilities of citizenship
- Understand cultural diversity in local and global context
- Analyze the significance of civic participation in promoting social justice, equity, and
- democracy.
- Examine the historical and contemporary examples of successful civic and community engagement initiatives.
- Identify and assess community needs, assets, and challenges to develop effective strategies for community improvement.
- Explore the ethical implications and dilemmas associated with civic and community engagement.
- Develop practical skills for effective community organizing, advocacy, and leadership.
- Foster intercultural competence and respect for diversity in community engagement efforts.
- Collaborate with community organizations, stakeholders, and fellow students to design and implement community-based projects.
- Reflect on personal growth and learning through self-assessment and critical analysis of community engagement experiences.

Course Content:

Introduction to Civics & Community Engagement

- Overview of the course: Civics & Community Engagement
- Definition and importance of civics
- Key concepts in civics: citizenship, democracy, governance, and the rule of law
- Rights and responsibilities of citizens

Citizenship and Community Engagement

- Introduction to Active Citizenship: Overview of the Ideas, Concepts, Philosophy and Skills
- Approaches and Methodology for Active Citizenship

Identity, Culture, and Social Harmony

- Concept and Development of Identity, Group identities
- Components of Culture, Cultural pluralism, Multiculturalism, Cultural Ethnocentrism, Cultural relativism, Understanding cultural diversity, Globalization and Culture, Social Harmony,
- Religious Diversity (Understanding and affirmation of similarities & differences)
- Understanding Socio-Political Polarization
- Minorities, Social Inclusion, Affirmative actions

Multicultural society and Inter-cultural dialogue

- Inter-cultural dialogue (bridging the differences, promoting harmony)
- Promoting intergroup contact/ Dialogue
- Significance of diversity and its impact
- Importance and domains of Inter-cultural dialogue

M.F

Active Citizen: Locally Active, Globally Connected

- Importance of active citizenship at national and global level
- Understanding community
- Identification of resources (human, natural and others)
- Utilization of resources for development (community participation)
- Strategic planning, for development (community linkages and mobilization)

Human rights, constitutionalism and citizens' responsibilities

- Introduction to Human Rights
- Human rights in constitution of Pakistan
- Public duties and responsibilities
- Constitutionalism and democratic process

Social Institutions, Social Groups, Formal Organizations and Bureaucracy

- Types of Groups, Group identities, Organizations
- Bureaucracy, Weber's model of Bureaucracy
- Role of political parties, interest groups, and non-governmental organizations

Civic Engagement Strategies

- Grassroots organizing and community mobilization
- Advocacy and lobbying for policy change
- Volunteerism and service-learning opportunities

Social Issues/Problems of Pakistan

- Overview of major social issues of Pakistani society

Social Action Project

Recommended Books:

1. Kennedy. J. K., & Brunold, A. (2016). Regional context and Citizenship education in Asia and Europe. New Yourk: Routledge, Falmer.
2. Henslin, James M. (2018). Essentials of Sociology: A Down to Earth Approach (13th ed.). New York: Pearson Education
3. Macionis, J. J., & Gerber, M.L. (2020). Sociology. New York: Pearson Education

Suggested Readings:

1. Glencoe McGraw-Hill. (n.d.). Civics Today: Citizenship, Economics, and Youth.
2. Magleby, D. B., Light, P. C., & Nemacheck, C. L. (2020). Government by the People (16th ed.). Pearson.
3. Sirianni, C., & Friedland, L. (2005). The Civic Renewal Movement: Community-Building and Democracy in the United States. Kettering Foundation Press.
4. Bloemraad, I. (2006). Becoming a Citizen: Incorporating Immigrants and Refugees in the United States and Canada. University of California Press.
5. Kuyek, J. (2007). Community Organizing: Theory and Practice. Fernwood Publishing.
6. DeKieffer, D. E. (2010). The Citizen's Guide to Lobbying Congress. TheCapitol.Net.
7. Rybacki, K. C., & Rybacki, D. J. (2021). Advocacy and Opposition: An Introduction to Argumentation (8th ed.). Routledge.
8. Kretzmann, J. P., & McKnight, J. L. (1993). Building Communities from the Inside Out: A Path Towards Finding and Mobilizing a Community's Assets. ACTA Publications.
9. Patterson, T. E. (2005). Engaging the Public: How Government and the Media Can Reinvigorate American Democracy. Oxford University Press.
10. Love, N. S., & Mattern, M. (2005). Doing Democracy: Activist Art and Cultural Politics. SUNY Press.

M. F

GEOL – 5110	GIS & Remote Sensing	3(2-1)

Course Brief:

This course is designed to introduce principles, concepts and applications of Geographic Information Systems (GIS) and Remote Sensing (RS): a decision support tool for planners and managers of spatial information and to obtain information on the earth from decimeter level to km level locally and globally. The catalog description is to introduction concepts, terminology, methods of Geographic Information System (GIS) technology and mapping science.

Course Learning Objectives:

The main Purpose and Objectives of Course is to gain a basic, practical understanding of GIS concepts, techniques and real world applications Class discussions, reading assignments, and class lectures prepare students to develop a mapping project based on the assumptions and interpretations of data selected by the student.

Course Contents:

1. Introduction to Geographical Information System
2. Data types, data models and structures
3. Data sources and capturing techniques
4. Displaying and manipulating spatial information
5. Introduction to the concept of RS
6. Technology of Remote Sensing (Orbits, Satellites, Sensors and Platforms)
7. Applications of Remote Sensing, satellite image processing cycle
8. Mosaicing and information extraction (classification and vectorization)
9. Have a basic, practical understanding of GIS concepts, techniques and real world Applications.
10. Have an understanding of the technical language of GIS.
11. Know how GIS is utilized in the larger context of business needs and IT strategies.
12. Understand the basic concepts of geography necessary to efficiently and
13. Accurately use GIS technology.
14. Understand basic GIS data concepts.
15. Have an ability to perform basic GIS analysis of concepts.
16. Have demonstrated a practical application of GIS.
17. Have practical experience using basic GIS tools.
18. Have an understanding of GIS and its relationship to mapping software development.
19. Have an appreciation of GIS career options and how to pursue them.

Recommended Texts:

1. Gupta, R. P. (2017). *Remote sensing geology*. Heidelberg: Springer.
2. Chang, K. T. (2008). *Introduction to geographic information systems*. Boston: McGraw-Hill.

Suggested Readings:

1. Duckham, M., Goodchild, M. F., & Worboys, M. (Eds.). (2003). *Foundations of geographic information science*. Boca Raton: CRC Press.
2. DeMers, M. N. (2008). *Fundamentals of geographic information systems*. Hoboken: John Wiley & Sons.

M.F

GEOL - 5111	Geotectonics	3(3-0)

Course Brief:

This course is designed to acquire the knowledge about the various types of plate boundaries, their kinematics and dynamics. The course comprises recent knowledge on structure and development of the Earth, especially of its crust and mantle. There are discussed older and new geological ideas concerning development of the crust, the accent is put on the plate tectonics.

Course Learning Objectives:

This course will help the students to understand the mountain building activity and changes that occurred on the earth with the passage of time. In particular, it describes the processes of mountain building, the growth and behavior of the strong, old cores of continents known as crotons, and the ways in which the relatively rigid plates that constitute the Earth's outer shell interact with each other. Tectonics also provides a framework for understanding the earthquake and volcanic belts.

Course Contents:

1. Concept of geosyncline and sedimentary basins
2. Sea floor spreading
3. Oceanic ridges and trenches
4. Continental rifts
5. Intra-oceanic islands
6. Hot spot and mantle plumes
7. Continental drift and reconstruction
8. Concept of plate tectonics
9. Historical perspective
10. Mechanism of plate tectonics
11. Plates and plate boundaries
12. Relative and absolute plate motions
13. Extensional, compressional and transpressional tectonics
14. Subduction zones
15. Transform and transcurrent faults
16. Introduction to neo-tectonics and related hazards
17. Application of geotectonic in natural resource explorations.

Lab Work

Specified assignments/projects.

Recommended Texts:

1. Belousov, V. V., & Maxwell, J. C. (2000). *Basic problems in geotectonics*. New York, McGraw-Hill.
2. Keary, P., Vine, F., & Panza, G. F. (2000). *Global Tectonics*. Hoboken: Wiley-Blackwell.

Suggested Readings

1. Turcotte, D., & Schubert, G. (2014). *Geodynamics*. Oxford: Cambridge university press.
2. Belousov, V. V. (2000). *Fundamentals of geotectonics*. Moscow: Izdatel'stvo Nedra.
3. Cox, A., & Hart, R. B. (2009). *Plate tectonics: how it works*. Hoboken: John Wiley & Sons.

GEOL - 5112	Structural Geology	3(2-1)

Course Brief:

This course is a graduate course of structural geology. Different natural structures of earth are formed by the forces acting on the earth crust. This course is designed to acquire the knowledge about the deformational structures and their kinematics in the crust. This will help in understanding the deformational mechanism of various types of rocks and the mapping of the resultant structures. The major forces its classification is also included in this course. Different structures for example folds, faults, unconformities are formed by the forces acting on the surface of the earth.

Course Learning Objectives:

This course is designed to first understand the phenomenon by which these structures are formed, their terminologies and classification of different structures. The lab work is included to enhance the knowledge about the practical use of the applications of engineering for the purpose of structural interpretations.

Course Contents:

1. Stress, concept, classes, Mohr circle of stress,
2. Strain, types of strain, measures of strain, stress-strain diagram
3. Factor controlling the mechanical behavior of rocks
4. Fold Geometry
5. Mechanism of fold formation
6. Faults
7. Classification of faults
8. Foliation: Terminology, Classification
9. Lineation: Terminology, Classification
10. Unconformity: Terminology, Classification
11. Tectonites

Lab. Work

1. Map Exercise and construction of geological cross sections
2. Stereographic projections
3. Use of structural computer software.

Recommended Texts:

1. Twiss, R. J., & Moores, E. M. (1992). *Structural geology*. New York: Macmillan.
2. Ragan, D. M., & Ragan. (2000). *Structural geology*. New York: John Wiley & Sons.

Suggested Readings

1. Davis, G. H., Reynolds, S. J., & Kluth, C. F. (2011). *Structural geology of rocks and regions*. Burlington: John Wiley & Sons.
2. Park, R. G. (2013). *Foundation of structural geology*. London: Routledge.
3. Fossen, H. (2016). *Structural geology*. Cambridge: Cambridge University Press.

M.F

CHAIRMAN
DEPARTMENT OF EARTH SCIENCES
UNIVERSITY OF SARGODHA
SARGODHA

GEOL - 5113	Geological Fieldwork-II	2(0-2)

Course Brief:

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

This course will help the students to get knowledge about various structures, features and other processes occurred in the field. The main goal of this subject is to acquire the fundamental geological field skill of mapping. The course emphasizes the basic skills essential to identify rocks according to different aspects , correlation & features also to locate yourself in the field and make essential field observations and measurements. Geological field build confidence and practical knowledge in the students to elaborate geological structures in the field during their field survey, which will give them more energy for the future.

Course Contents:

1. Field based exercises;
2. Identification of major rocks.
3. field stratigraphy,
4. Fossils,
5. Structures of Igneous Rocks
6. Structure of Sedimentary rocks
7. Relief features
8. Contours and its types
9. Regional and detailed mapping
10. Section measurement.
11. Basic geological mapping techniques.
12. Each field trip will be followed by report writing and Viva Voce / Evaluation

Recommended Texts:

1. Coe, A. L. (Ed.). (2010). *Geological field techniques*. Hoboken: John Wiley & Sons.
2. Lambert, D. (2000). *The field guide to geology*. New York: Infobase Publishing.

Suggested Readings:

1. Barnes, J. W., & Lisle, R. J. (2013). *Basic geological mapping*. Hoboken: John Wiley & Sons.
2. Lahee, F. H. (2000). *Field geology*. New York: McGraw-Hill.
3. Compton, R. R., & Compton, R. R. (2000). *Geology in the Field*. New York: Wiley.

M.F

GEOL - 6114	Geophysics	3(2-1)

Course Brief:

Geophysics is the branch of Earth sciences which explores and analyzes active processes of the Earth through physical measurement. The undergraduate and graduate programs are designed to provide a background of fundamentals in science, and courses to coordinate these fundamentals with the principles of geophysics. This course is designed to acquire the knowledge about the seismic waves, seismic refraction, gravity, magnetic and electrical prospecting.

Course Learning Objectives:

This course will demonstrate understanding of fundamental physics concepts such as thermodynamics, electricity, magnetism, work, and force in geophysics. This will help the students in learning the basic techniques in geophysics and the students will also work on the seismic images and interpretation of subsurface structures. This course will enable students to predict the characteristic geophysical signatures of different rock types and structures for a number of geophysical methods and choose appropriate geophysical techniques for a given geologic environment and problem

Course Contents:

1. Definition and relation of geophysics with other sciences
2. Classification and brief description of various branches of geophysics
3. Seismic reflection and refraction techniques
4. Geomagnetism
5. Geoelectricity
6. Tectonophysics
7. Gravimetry
8. Geothermy and geodesy
9. Geophysical data acquisition, processing and interpretation
10. Applications of geophysical techniques for exploration of mineral deposits
11. Oil, gas, subsurface water and engineering works
12. Introduction to earthquake seismology and geodynamics of earth

Recommended Texts:

1. Robinson, E.S., & Coruh, C. (2000), *Basic Exploration Geophysics*. Hoboken: John Wiley and Sons.
2. Burger, H. R., Sheehan, A. F., & Jones, C. H. (2000). *Introduction to applied geophysics: Exploring the shallow subsurface*. Manhattan: WW Norton.
3. Telford, W. M., Geldart, L. P., & Sheriff, R. E. (2000). Applied geophysics. Cambridge: Cambridge University Press.

Suggested Readings:

1. Dobrin, M.B. and Savit, C. H., (2000), *Introduction to geophysical prospecting*, New York: McGraw-Hill.
2. Sharma, P.V., (2000), *Geophysical methods in geology*. New York: Elsevier.
3. Kearey, P., and Brooks, M. (2000), *An introduction to geophysical exploration*. Oxford: John Wiley & Sons.
4. Robert J. Lillie, (2000), *Whole earth geophysics: an introductory textbook for geologists and geophysicists*. Upper Saddle River: Prentice Hall.

M.F

GEOL - 6115	Geochemistry	3(2-1)

Course Brief:

This is the sub discipline of geology which deals with the study of the chemical composition of the earth and its rocks and minerals. An element is material which has a particular kind of atom with specific electronic structure and nuclear charge, factors that determine their abundance in the rocks. Regarding distribution, it can only have direct evidence on the composition of the Earth's crust and indirect on the mantle and core.

Course Learning Objectives:

The course is designed to acquire the knowledge about the distribution of elements in minerals and rocks and their dispersion in different environments. This will help the students in learning the geochemical characteristic of various rocks and their role in mineral exploration. One of the goals of geochemistry is to determine the abundance of elements in nature, as this information is essential to hypotheses development about the origin and structure of our planet and the universe.

Course Contents:

1. Geochemistry of igneous, sedimentary and metamorphic rocks
2. Modal analysis for classification
3. Chemical characterization and identification of minerals
4. Classification and distribution of elements in the earth crust
5. Introduction to analytical geochemistry
6. Causes for geochemical diversity in the igneous rocks
7. Geochemical characteristics of igneous rocks as petrogenetic indicators
8. Processes which modify the composition of primary magmas
9. Geochemical characteristics of different magma series
10. Geothermometry and geobarometry
11. Metasomatic processes and environment.

Labs:

1. Characterization of igneous rocks on the basis of their (a) modal and (b) chemical composition
2. Calculation of normative composition from the major element chemistry of igneous rocks
3. The use of major and trace element composition of igneous rocks as a means to determine their paleotectonic setting
4. Graphical representation of metamorphic mineral parageneses (ACF and AKF diagrams)
5. Protolith of a variety of metamorphic rocks on the basis of their major and trace element geochemistry
6. The use of mineral chemical data for estimating pressure-temperature conditions of metamorphism.

Recommended Texts:s:

1. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
2. McSween, H. Y., Richardson, S. M., & Uhle, M. E. (2003). Geochemistry: Pathways and processes. Columbia University Press.

Suggested Readings:

1. Krauskopf, K. B., & Bird, D. K. (1982). Introduction to geochemistry (Vol. 72, No. 1). New York: McGraw-Hill.
2. Best, M. G. (2013). Igneous and metamorphic petrology. John Wiley & Sons.

M. F

GEOL - 6116	Petroleum Geology	3(2-1)

Course Brief:

This course is designed to acquire the 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. With the changing nature of hydrocarbon exploration and production, both conventional and unconventional hydrocarbons are considered. The key concepts of the origin and generation of hydrocarbons, reservoir rocks and subsurface reservoir structures (traps) are introduced, together with some of the key techniques used within the industry (e.g. reservoir geology, petrophysics and formation evaluation).

Course Learning Objectives:

This course will introduce students to the key issues surrounding being a geologist in the petroleum industry. Practical issues such as how hydrocarbon wells are drilled and how rocks are sampled in the subsurface are also considered. 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:

1. Introduction and history of hydrocarbon exploration
2. The nature and classification of petroleum hydrocarbons
3. Origin, migration and accumulation hydrocarbon
4. Traps, seal and cap rocks
5. Source rock-evaluation; Kerogene and its types
6. Reservoir rocks characterization, reservoir fluid, reservoir conditions and dynamics; tight reservoirs
7. Exploration petroleum cycle in Pakistan; prospect and exploration in frontiers areas
8. Introduction to drilling operations, well site geology and mud logging
9. Well failure/success analysis
10. Petroleum prospect risk analysis
11. Nonconventional hydrocarbons
12. Introduction to play fairways and petroleum system

Recommended Texts:

1. North, F.K., (2000). *Petroleum geology*. Boston: Allen and Unwin.
2. Selley, R. C., & Sonnenberg, S. A. (2014). *Elements of Petroleum Geology*. Cambridge: Academic Press.

Suggested Readings:

1. Bjorlykke, K. (2010), *Petroleum geoscience: from sedimentary environments to rock physics*. Amsterdam: Springer.
2. Levorsen, A. I. & Berry, F. A. (2000). *Geology of petroleum*. San Francisco: WH Freeman.
3. Hyne, N. J. (2012). Nontechnical guide to petroleum geology, exploration, drilling, and production. Tulsa: PennWell Books

M.F

GEOL - 6117	Engineering Geology	3(2-1)

Course Brief:

This course is a graduate course of engineering geology. This course is designed to acquire the knowledge about the rock mechanics and their role in the construction of huge structure. The construction of buildings, underground excavations, dams on different rock masses like igneous, sedimentary and metamorphic rocks requires the data of basic physical and geological and geotechnical parameters. So, this course will help the students in learning various techniques for the determination of physical and geotechnical parameters of soils and rocks for construction of buildings and foundations. The building code of Pakistan for the construction of various structures and buildings under various geological conditions is also included in this course. Lab work is also included to enhance the practical knowledge of students.

Course Learning Objectives:

This course enable students for how rocks work in construction. They will learn about different rock types and how they affect building. Discover methods to find facts about rocks and soil for building, and understand building codes in Pakistan. Also, explore solving common construction issues and get hands-on practice in the lab.

Course Contents:

1. Introduction to the engineering geology and its application
2. Weathering, physical and chemical
3. Earthquakes, causes and intensity scale
4. Rock mass classification
5. Geotechnical studies of rocks and soils
6. Geological factors and strength of rocks
7. Chemical and mechanical behavior of rocks
8. Geotechnical investigation; uses of sedimentary, igneous and metamorphic rocks as construction material
9. Building Code of Pakistan
10. Dam and tunnel engineering
11. Common engineering problems and their remedial measures

Lab. Work

1. Sieve analysis
2. Moisture, void ratios, porosity
3. Angle of repose, and other geotechnical properties of soils.
4. Uniaxial and Triaxial Testing; tensile, compressive and shear tests of rocks.

Recommended Texts:

1. Price, D. G. (2008). *Engineering geology: principles and practice*. Amsterdam: Springer Science & Business Media.
2. Bell, F. G. (2004). *Engineering geology and construction*. Boca Raton: CRC Press.

Suggested Readings:

1. Bell, F. G. (2016). *Fundamentals of engineering geology*. Amsterdam: Elsevier.
2. Beavis, F. C. (1985). *Rock weathering. Engineering Geology*. Melbourne: Blackwell Scientific.

M.F M

CHAIRMAN
Department of Earth Sciences

GEOL - 6118	Hydrogeology	3(3-0)

Course Brief:

This course is a graduate course. One of the elective advance level courses in the group of specialization in Engineering Geology is Hydrology. 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 also how to maintain its purity for meeting the present demand as well as the demand of the further generation. The process of installation of tube wells, its techniques, designing and developments. Flow-net analysis using pumping tests.

Course Learning Objectives:

Students will gain a wide understanding of hydrological processes and phenomena, including but not limited to groundwater. Other associated topics taught will equip them the critical interrelationships of groundwater with surface water hydrology and vegetation, amongst others. After completing these courses, the students will be able to carry out their independent research on the site development for water issues.

Course Contents:

1. The hydrologic cycle
2. Aquifer system and types
3. Occurrence and movement of groundwater
4. Hydrological properties of rocks and their measurements
5. Fluctuation of groundwater levels and causes
6. Recharge and discharge of ground water
7. Groundwater exploration by geological, hydro-geological and geo-physical methods and remote sensing techniques
8. Well hydraulics
9. Tube well drilling techniques, designing, development
10. Flow-net analysis and pumping tests, water logging and causes of water table declination

Recommended Texts:

1. Davie, T. (2008). *Fundamentals of hydrology*. London: Routledge.
2. Hiscock, K. M. (2009). *Hydrogeology: principles and practice*. Hoboken: John Wiley & Sons.

Suggested Readings:

1. Todd, D. K., & Mays, L. W. (2005). *Groundwater hydrology*. Hoboken: Welly.
2. Prickett, T. A., & Lonnquist, C. G. (1971). Selected digital computer techniques for groundwater resource evaluation. Bulletin (Illinois State Water Survey) no. 55.
3. Franklin, J. A., & Dusseault, M. B. (1989). *Rock engineering*. New York: McGraw-Hill.

M.F

GEOL - 6119	Geology of Pakistan	3(3-0)

Course Brief:

This course is designed to acquire the knowledge about the tectono-stratigraphy of Pakistan with special emphasis on the tectonic elements and minerals and fuel deposits. It is the study which describes the Mineral exploration and its exploitation, exploration and development Oil and Gas resources, Metallic and non-metallic mineral resources, suitable aggregate study for construction materials, dams side studies, earthquake studies and mega Infrastructure related. It also describes about the various tectonics elements for collisional, extensional and transform plate boundary setting. From the formation of mighty Himalayas, it includes the detail tectonosedimentary, metamorphic and deformation mechanism. It will also focuses on the occurrences of Active Seismic Zones of Pakistan and earthquake seismology scenario.

Course Learning Objectives:

This will help the students to learn about the interaction of regional plates and blocks such as Indian Plate, Arabian Plate, Karakoram Plate, and Afghan Block through geological times and their influence on the stratigraphy and mineral deposits of Pakistan. The core objective of this subject is to provide the detail Geological and Tectonics Setting of Pakistan by introducing the Geodynamcis setting of Pakistan.

Course Contents:

1. Physiographic and tectonic divisions of Indo Pak Plate and its descriptions.
2. Geology and stratigraphy of the Indian plate, Karakoram plate.
3. Afghan block and Arabian plate.
4. Waziristan , Kohistan, Chagai and Ras Koh magmatic Arcs.
5. Sedimentary basins of Pakistan.
6. Makran subduction complex.
7. Chaman transform zone, arcs, oroclines and suture zones.
8. Tertiary Himalayan and pre-Himalayan orogenic events.
9. Late Precambrian to Early Cambrian Hazaran orogeny.
10. Regional metamorphism (Himalayan and pre-Himalayan).
11. Main episodes of magmatism and their relations to tectonics.
12. Economic mineral and fuel deposits of Pakistan.

Recommended Texts:

1. Kazmi, A. H., & Jan, M. Q (1997). *Geology and tectonics of Pakistan.* Karachi: Graphic publishers.
2. Bender, F.K. & Raza, H.A. (1997). *Geology of Pakistan.* Berlin: Oxford University Press.

Suggested Readings:

1. Farah, A., Abbas, G., De Jong, K. A., & Lawrence, R. D. (1984). Evolution of the lithosphere in Pakistan. Tectonophysics, 105(1-4), 207-227.
2. Searle, M. (2013). *Colliding continents: a geological exploration of the Himalaya, Karakoram and Tibet.* Oxford: Oxford University Press.
3. Kazmi, A. H., & Abbasi, I. A. (2008). *Stratigraphy & historical geology of Pakistan* . Peshawar: National Centre of Excellence in Geology.

m.f

CHAIRMAN

GEOL - 6120	Geological Fieldwork- III	2(0-2)

Course Brief:

This course is designed to understand the geological mapping techniques in the field. This will help the students in learning the use of field equipment and data acquisition and preparation of geological maps and cross-sections. This course will help the students to get knowledge about various structures, features and other processes occurred in the field. The main goal of this subject is to acquire the fundamental geological field skill of mapping. The course emphasizes the basic skills essential to identify rocks according to different aspects, correlation & features also to locate yourself in the field and make essential field observations and measurements. Geological field build confidence and practical knowledge in the students to elaborate geological structures in the field during their field survey, which will give them more energy for the future. As geology is the subject of field and to explore the earth which is not possible without field work.

Course Learning Objectives:

The students will be able to carry out observation and plotting of geological information on topographic sheet. They will be able to study of geomorphic features in field and measurement of stratigraphic sections. Independently carry out recognition of structural features and study of fossils, primary and secondary structures. This geological fieldwork exercise will enable students to describe various features sedimentary, igneous and metamorphic rocks

Course Contents:

1. Field based exercises
2. Topographic sheets and its utilization in field.
3. Observation and plotting of geological information on topographic sheet.
4. Study of geomorphic features.
5. Measurement of stratigraphic sections.
6. Recognition of structural features.
7. Study of fossils
8. Study of primary and secondary geological structures.
9. Field description of sedimentary, igneous and metamorphic rocks.
10. Report writing based on geological mapping of an assigned area and fieldwork Viva Voce and Evaluation.

Recommended Texts:

1. Coe, A. L. (Ed.). (2010). *Geological field techniques*. Hoboken: John Wiley & Sons.
2. Lambert, D. (2000). *The field guide to geology*. New York: Infobase Publishing.

Suggested Readings:

1. Barnes, J. W., & Lisle, R. J. (2013). *Basic geological mapping*. Hoboken: John Wiley & Sons.
2. Lahee, F. H. (2000). *Field geology*. New York: McGraw-Hill.
3. Compton, R. R., & Compton, R. R. (2000). *Geology in the Field* . New York: Wiley.

M.F

GEOL - 6121	Sequence Stratigraphy	3(2-1)

Course Brief:

This course is designed to acquire the knowledge about various types of stratigraphic sequences and their relation with the sea level changes. This will help the students to learn about the formation of various sedimentary rock sequences during geologic time. Within the course basic concepts, principles and methods in sequence stratigraphy are presented, including how sequences can be subdivided into genetic units and which processes controls the sequence development through time. The principles are illustrated with examples and students may participate the methods during geological fieldwork in outcrops. Students can describe and analyze sedimentary successions with focus on interpretation of sedimentary environments and sequence stratigraphy.

Course Learning Objectives:

The goal of the course is to introduce the students to sequence stratigraphy and show how sequence stratigraphy can be applied to better understand how sedimentary successions are structured in a temporal-spatial perspective and which controls play part in this structure. They may identify genetically related units and their intervening discontinuity surfaces. And can assess which control is instrumental for the stacking and geometry of sedimentary sequences.

Course Contents:

1. Sequence Stratigraphy – An Overview, Historical Development of Sequence Stratigraphy, Sequence Stratigraphic Approach
2. Methods of Sequence Stratigraphic Analysis, Introduction, Facies Analysis: Outcrops, Core and Modern Analogies, Well Logs, Seismic, Accommodation and Shoreline Shift, Allogenic Controls on Sedimentation, Sediment Supply and Energy Flux, Sediment Accommodation, Shoreline Trajectories.
3. Stratigraphic Surfaces, Types of Stratal Terminations, Sequence Stratigraphic Surfaces
4. System Tracts including HST, FSST, LST, TST, RST
5. Sequence Models: Types of Stratigraphic Sequences, Parasequences in Fluvial System, Parasequences in Coastal to Shallow Water Clastic System
6. Time attribute of Sequence Stratigraphic Surfaces
7. Hierarchy of Sequences and Sequences Boundaries
8. Discussions and Conclusions, Future Directions.

Recommended Texts:

1. Catuneanu, O. (2000). *Principles of sequence stratigraphy*. Amsterdam: Elsevier.
2. Miall, A. D. (2010). *The geology of stratigraphic sequences*. New York Springer Science & Business Media.

Suggested Readings:

1. Slatt, R. M. (2006). *Stratigraphic reservoir characterization for petroleum geologists geophysicists, and engineers*. Amsterdam: Elsevier.
2. Emery, D. and Myers, K.J., (2000). *Sequence Stratigraphy*. Oxford: Blackwell.
3. Embry, A. F. (2009). *Practical sequence stratigraphy*. Alberta: Canadian Society of Petroleum Geologists.

M. F

GEOL-6122	Scientific Writing and Research Methods	3(3-0)

Course Brief:

This course introduces students to the fundamentals of scientific writing and the systematic approach to conducting research. It covers the principles of effective academic communication, research design, data collection, analysis, and interpretation. Emphasis is placed on writing research proposals, reports, and scientific papers, as well as developing skills for critical thinking, ethical research practices, and literature review. The course prepares students to plan and execute independent research projects and to communicate scientific findings clearly and professionally, both in written and oral formats.

Course Learning Objectives:

By the end of this course, students will be able to understand and apply key concepts in scientific research and communication. They will learn to develop research questions, design studies, conduct literature reviews, and analyze and present results in scientifically appropriate formats. Students will gain practical experience in writing abstracts, proposals, and full-length papers, while adhering to ethical standards and proper citation practices. The course aims to strengthen students' abilities to communicate their research effectively and engage in scholarly discourse across scientific disciplines.

Course Contents:

1. Introduction to scientific research and academic writing
2. Types of scientific research: qualitative, quantitative, and mixed methods
3. Formulating research questions, hypotheses, and objectives
4. Literature review techniques and reference management tools
5. Research design and methodology: experimental and observational studies
6. Data collection methods: surveys, experiments, fieldwork, secondary data
7. Introduction to basic statistics and data analysis techniques
8. Ethical considerations in research: plagiarism, consent, integrity
9. Structure of scientific documents: IMRAD (Introduction, Methods, Results, and Discussion)
10. Writing research proposals and project plans
11. Drafting abstracts, literature reviews, and methodology sections
12. Preparing and presenting research posters and oral presentations
13. Peer review process and responding to reviewer feedback
14. Citation styles and reference formatting (APA, MLA, Chicago, etc.)
15. Publication process and open-access platforms in scientific research

Recommended Texts:

1. Creswell, J.W., & Creswell, J.D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (5th ed.). SAGE Publications.
2. Alley, M. (2018). *The Craft of Scientific Writing* (4th ed.). Springer.
3. Hofmann, A.H. (2016). *Scientific Writing and Communication: Papers, Proposals, and Presentations* (3rd ed.). Oxford University Press.
4. Pechenik, J.A. (2016). *A Short Guide to Writing About Biology* (9th ed.). Pearson.

Suggested Readings:

1. Turabian, K.L. (2018). *A Manual for Writers of Research Papers, Theses, and Dissertations* (9th ed.). University of Chicago Press.
2. Silva, P. (2007). *How to Write a Lot: A Practical Guide to Productive Academic Writing*. APA LifeTools.

M.F

GEOL - 6123	Geological Fieldwork IV	2(0-2)

Course Brief:

This Geological fieldwork IV is designed for final-year undergraduate students to synthesize and apply geological knowledge in a real-world setting. The course comprises two integral components:

1. **Lithostructural Mapping** – Students will carry out detailed lithostructural mapping of a designated area at a 1:10,000 scale, applying skills in rock identification, structural measurements, and geospatial documentation.
2. **Specialization-Oriented Field Work** – Students will conduct focused field investigations aligned with their chosen areas of specialization (e.g., Sedimentology, Structural Geology, Economic Geology, Engineering Geology, Hydrogeology, Petroleum Geology, etc.). The data collected will directly contribute to their final-year thesis projects.

The course aims to build core competencies in field observation, data recording, spatial reasoning, and professional reporting.

Course Learning Objectives:

This course aims to develop students' advanced field skills through detailed lithostructural mapping and specialization-based fieldwork. Students will learn to identify rock units, measure structural features, and produce geological maps and cross-sections at a 1:10,000 scale. In the second part, they will conduct focused field investigations in their chosen specialization—Engineering Geology, Geophysics, or Mineralogy—collecting data directly related to their thesis research. The course also emphasizes field documentation, scientific interpretation, teamwork, and professional reporting practices..

Course Contents:

Part I – Lithostructural Mapping:

- Selection and reconnaissance of field area.
- Lithological unit identification and boundaries.
- Measurement and analysis of structural features (e.g., bedding, folds, faults, joints).
- Preparation of field notes, geological maps, and cross-sections.
- Report writing and geological interpretation.

Part II – Specialization-Based Field Work:

- Planning and execution of a specialization-specific field study.
- Data collection methods specific to each specialization (e.g., sedimentary facies analysis, ore body sampling, hydrogeological surveys, geotechnical profiling, reservoir characterization, etc.).
- Compilation of field data relevant to thesis objectives.
- Preliminary analysis and interpretation.
- Integration of field findings into thesis framework.

Recommended Texts:

1. Lisle, R.J., Brabham, P., & Barnes, J.W. (2019). *Basic Geological Mapping*, 6th Edition. Wiley-Blackwell.
2. Butler, R.W.H. & Bond, C.E. (2022). *Techniques and Applications of Structural Geology*. Cambridge University Press.
3. Norbury, D. (2021). *Soil and Rock Description in Engineering Practice*, 2nd Edition. Whittles Publishing.
4. Milsom, J. & Eriksen, A. (2018). *Field Geophysics*, 5th Edition. Wiley-Blackwell.
5. Rollinson, H.R. & Pease, V. (2021). *Using Geochemical Data: Evaluation, Presentation, Interpretation*, 2nd Edition. Routledge.

Suggested Readings:

1. Barker, R. & Dixon, G. (2021). *Field Hydrogeology*, 4th Edition. Wiley-Blackwell.
2. Sharma, P.V. (2019). *Environmental and Engineering Geophysics*, Reprint Edition. Cambridge University Press.
3. Nesse, W.D. (2021). Introduction to Mineralogy, 3rd Edition. Oxford University Press.

M.F

GEOL-6124	AI and Computational Geology	3(1-2)

Course Brief:

AI and Computational Geology explores the integration of artificial intelligence (AI), machine learning (ML), and advanced computational methods in the study of geological processes and Earth systems. This interdisciplinary course introduces students to the application of data-driven models, geostatistical tools, and algorithms for solving complex geological problems. Topics include data preprocessing, pattern recognition, predictive modeling, and image classification for geological mapping, resource estimation, and hazard assessment. Through case studies and hands-on exercises, students will gain practical experience using AI and computational tools to analyze large geological datasets, automate interpretation, and enhance decision-making in geoscience and energy sectors.

Course Learning Objectives:

This course aims to equip students with foundational knowledge and practical skills in applying AI and computational techniques to geoscientific problems. By the end of the course, students will be able to preprocess and interpret geoscience data, apply supervised and unsupervised learning algorithms, and develop models for classification, regression, and clustering of geological features. Students will understand the capabilities and limitations of AI in geological workflows and will be prepared to use computational approaches for exploration, modeling, and environmental monitoring.

Course Contents:

1. Introduction to computational geology and AI concepts
2. Overview of geoscience data types and sources
3. Fundamentals of machine learning: supervised, unsupervised, and reinforcement learning
4. Data preprocessing and feature engineering in geological datasets
5. Regression and classification models for reservoir and lithology prediction
6. Clustering and dimensionality reduction techniques in mineral exploration
7. Neural networks and deep learning for seismic and image interpretation
8. Remote sensing and image classification using AI techniques
9. Geostatistical modeling and simulation using AI-enhanced tools
10. Time-series forecasting for geohazards and environmental monitoring
11. Natural language processing (NLP) for automated report generation in geology
12. AI in geospatial analysis and GIS integration
13. Model evaluation, validation, and uncertainty analysis in geological applications
14. Case studies: mineral exploration, seismic interpretation, carbon storage, groundwater modeling
15. Ethical considerations and limitations of AI in geoscience

Recommended Texts:

1. Libraries, J. (2023). *Machine Learning and AI Applications in Geosciences*. Elsevier.
2. Karpatne, A., Ebert-Uphoff, I., Ravela, S., Babaie, H.A., & Kumar, V. (2018). *Machine Learning for the Geosciences: Challenges and Opportunities*. IEEE Transactions on Knowledge and Data Engineering.
3. Libraries, J. (2022). *Artificial Intelligence in Earth Science: Theory and Practice*. Springer.
4. Libraries, J. (2020). *Python Machine Learning for Geological Applications*. Wiley.
5. Libraries, J. (2021). *Computational Geosciences with Python: An Introduction to Modeling, Machine Learning, and Data Analysis*. Springer.

Suggested Readings:

1. Libraries, J. (2020). *Geostatistics for Environmental and Geotechnical Applications*. CRC Press.
2. Libraries, J. (2019). *Practical Machine Learning in Python for Earth Scientists*. O'Reilly.
3. Journals: *Computers & Geosciences, Journal of Geophysical Research: Solid Earth, Geoscience Frontiers, Environmental Modelling & Software, Earth Science Informatics, Remote Sensing, IEEE Geoscience and Remote Sensing Letters.*

m.f

Mandatory Elective Courses

Specialization: Mineralogy

GEOL-6130	Analytical Techniques in Mineralogy	3(3-0)

Course Brief:

This course introduces students to the modern analytical tools and techniques used in the identification and characterization of minerals. Emphasis is placed on both qualitative and quantitative approaches, helping students understand mineral structure, composition, and properties using instrumental methods. The course bridges theory with hands-on applications relevant to academic research and industry.

Course Learning Objectives:

- Understand the principles behind key analytical techniques used in mineralogy.
- Prepare mineral samples for instrumental analysis.
- Select appropriate analytical tools for specific mineralogical problems.
- Interpret analytical data and relate them to mineral composition and structure.
- Apply multiple techniques in an integrated manner to solve geological questions.

Course Contents:

- Introduction to Analytical Methods in Mineralogy
- Optical Microscopy
- X-Ray Diffraction (XRD)
- Scanning Electron Microscopy (SEM)
- Electron Microprobe Analysis (EMPA)
- X-Ray Fluorescence (XRF)
- Fourier Transform Infrared Spectroscopy (FTIR) and Raman Spectroscop
- Thermal Analysis (TGA, DTA, DSC)
- Case Studies and Applications

Recommended Texts:

1. Introduction to Mineralogy" by William D. Nesse – Chapters on optical mineralogy and XRD.
2. "Modern Analytical Geochemistry" by Robin Gill – Covers a wide range of analytical methods.

Suggested Readings:

3. Quantitative Mineral Analysis" by P.J. Potts – Detailed treatment of EMPA, XRF, and other methods.
4. "Practical Guide to Optical Mineralogy" by R.P. Richards and B. Dyar – For microscopy basics.

m.f

GEOL-6131	Applied Mineralogy-Petrology	3(3-0)

Course Brief:

Mineralogy and petrology are two closely related fields within the realm of geology, but they focus on different aspects of the Earth's materials. Both mineralogy and petrology are fundamental to understanding the Earth's composition, history, and processes, and they play crucial roles in fields such as geology, environmental science, materials science, and even archaeology.

Course Learning Objectives:

As mineralogy is the sub discipline of geology which deals with the study of minerals. So the course is designed to acquire the knowledge about the physical and optical properties of various rock forming minerals and related phase diagrams. This will help the students in learning how various silicate and non-silicate minerals can be identified and how these are formed during different P-T conditions. The composition of igneous rocks and minerals can be determined via a variety of methods of varying ease, cost, and complexity. The study of sedimentary rocks will help the students to understand the classification and depositional system of the sedimentary rock as well as the provenance of sediments and sedimentary structures. By studying of metamorphic petrology students will get familiar with metamorphic processes and the resulting textures and structures in the rocks. Petrogenetic processes such as recrystallization, continuous and discontinuous reactions, mixed volatile reactions and deformation are addressed.

Course Contents:

1. Introduction to mineralogy and crystallography
2. Classification of minerals
3. physical and optical properties of the common silicate and non-silicate mineral group
4. introduction to X-Ray diffractometry and universal stage and their application.
5. Tectonism-magmatism relationship
6. Origin, transportation and deposition of sediments
7. Texture of sedimentary rocks and their statistical parameters
8. Classification and description of sedimentary rocks
9. Types, grades, zones and facies of metamorphism
10. Metamorphic diffusion and differentiation
11. Metamorphism in relation to plate tectonics
12. Study of textures and structures of metamorphic rocks.

Recommended Texts:

1. Pettijohn, F. J., Potter, P. E., & Siever, R. (2012). *Sand and sandstone*. Springer Science & Business Media.
2. Blackburn, W. H., & Dennen, W. H. (1994). *Principles of mineralogy*. WCB/McGraw-Hill.
3. Best, Myron G. Igneous and metamorphic petrology. John Wiley & Sons, 2013.

Suggested Readings:

1. Wilson, B. M. (2007). *Igneous petrogenesis a global tectonic approach*. Springer Science & Business Media..
2. Blatt, H., Tracy, R., & Owens, B. (2006). *Petrology: igneous, sedimentary, and metamorphic*. Macmillan.

M.F

GEOL-6132	Clay Mineralogy and Soil Chemistry	3(3-0)

Course Brief:

This course provides an introduction to the fundamental concepts of clay mineralogy and soil chemistry, focusing on the structure, classification, and properties of clay minerals and their role in soil systems. Students will explore the geochemical processes that govern soil formation, mineral-soil interactions, nutrient cycling, and contaminant mobility.

Course Learning Objectives:

1. Classify clay minerals and understand their structural differences.
2. Explain the role of clay minerals in soil formation and behavior.
3. Apply analytical techniques to identify clay minerals.
4. Evaluate soil chemical properties, including nutrient availability and contaminant mobility.
5. Recognize the importance of clay minerals in industrial and environmental contexts.

Course Contents:

1. Introduction to Clay Minerals
2. Classification and Structure of Clay Minerals
3. Clay Mineral Formation and Weathering Processes
4. Identification Techniques (X-ray diffraction (XRD), SEM, and thermal analysis)
5. Cation Exchange Capacity (CEC) and Surface Chemistry
    - Clay-water interactions
    - Adsorption and desorption of nutrients and pollutants
6. Soil Chemistry Fundamentals
    - Soil pH, buffering, redox reactions
    - Organic matter and nutrient cycling
7. Soil Colloids and Ion Exchange Reactions
8. Clay Minerals in Environmental and Industrial Applications

Recommended Texts:

1. Introduction to Clay Minerals: Chemistry, Origins, Uses and Environmental Significance" by Velde, B.
2. Soil Chemistry" by Daniel G. Strawn, Hinrich L. Bohn, and George A. O'Connor.

Suggested Readings:

3. Clay Mineralogy" by Ralph E. Grim – Classic text covering structure and identification.
4. Soils: Genesis and Geomorphology" by Randall J. Schaetzl and Sharon Anderson – Useful for soil processes and formation.

M.F

GEOL-6133	Crystal Chemistry and Mineral Structures	3(3-0)

Course Brief:

This course explores the principles of crystal chemistry and the structural organization of minerals at the atomic level. Students will learn how atomic arrangement, bonding, and chemical composition determine mineral properties and stability. The course focuses on crystallographic systems, symmetry, unit cells, coordination geometry, and solid-solution mechanisms in minerals—laying the foundation for understanding advanced mineralogical and geochemical processes.

Course Learning Objectives:

- Understand the fundamental atomic arrangements in minerals.
- Interpret crystallographic data and describe mineral symmetry.
- Apply crystal chemical principles to explain mineral properties.
- Analyze structural variations in silicate and non-silicate minerals.
- Understand how crystal chemistry impacts geologic processes.

Course Contents:

1. Introduction to Crystal Chemistry
2. Importance and scopeAtomic bonding in minerals (ionic, covalent, metallic, van der Waals)
3. Crystallographic Concepts
4. Ionic Radii and Coordination Numbers
5. **Silicate Structures**
6. Structural classification of silicates
7. Tectosilicates, inosilicates, phyllosilicates, etc.
8. **Substitution and Solid Solution in Minerals**
9. Isomorphism, coupled substitution, and zoning
10. Polymorphism and Polytypism
11. Crystal Defects and Order–Disorder Phenomena
12. X-ray Crystallography in Mineral Structure Determination
13. Applications in Petrology and Geochemistry

Recommended Texts:

1. Introduction to Mineralogy" by William D. Nesse – Chapters on crystal chemistry and structure.
2. "Structure and Bonding in Crystalline Materials" by Gregory S. Rohrer – Focus on bonding and structure relationships.

Suggested Readings:

3. Minerals: Their Constitution and Origin" by Hans-Rudolf Wenk and Andrei Bulakh – Good for visualizing mineral structures.
4. "Crystallography and Crystal Chemistry" by F. Donald Bloss – Classic reference.

M.F

GEOL-6134	Gemology	3(3-0)

Course Brief:

This course introduces the science of gemology "the study of gemstones", including their identification, classification, properties, and origins. Students will learn about natural and synthetic gems, their formation, optical and physical characteristics, and the methods used in their evaluation and certification. The course integrates mineralogical principles with practical gem-testing techniques relevant to jewelry, trade, and scientific applications.

Course Learning Objectives:

- Identify and describe the physical and optical properties of gemstones.
- Understand the geological origins and formation conditions of gems.
- Distinguish between natural, synthetic, and treated gemstones.
- Apply standard gemological tools for gemstone testing and evaluation.
- Recognize ethical issues and market standards related to gemstone trade.

Course Contents:

1. **Introduction to Gemology** (Definition, history, and scope of gemology)
2. Gemstone classification and market overview
3. **Formation and Occurrence of Gemstones**
4. Geological environments of gem formation
5. Primary and secondary gem deposits
6. **Physical and Optical Properties of Gemstones**
7. **Gem Identification Techniques**
8. **Synthetic and Treated Gemstones**
9. Common gemstone treatments and enhancements
10. **Gemstone Cutting and Grading**
11. **Major Gem Varieties and Their Mineral Groups**

Recommended Texts:

1. Gemology" by Cornelius S. Hurlbut and Robert C. Kammerling – Comprehensive introduction.
2. "Gems" by Cally Hall (DK Eyewitness Books) – Excellent visual guide.

Suggested Readings:

1. Gemmology" by Peter G. Read – Practical techniques and theory.
2. "Field Guide to Rocks and Minerals" by Frederick H. Pough – Useful for field identification.

M.F

GEOL-6135	Geochemistry	3(3-0)

Course Brief:

This is the sub discipline of geology which deals with the study of the chemical composition of the earth and its rocks and minerals. This course is designed to acquire the knowledge about the distribution of elements in minerals and rocks and their dispersion in different environments. This will help the students in learning the geochemical characteristic of various rocks and their role in mineral exploration. One of the goals of geochemistry is to determine the abundance of elements in nature, as this information is essential to hypotheses development about the origin and structure of our planet and the universe. An element is material which has a particular kind of atom with specific electronic structure and nuclear charge, factors that determine their abundance in the rocks. Regarding distribution, it can only have direct evidence on the composition of the Earth's crust and indirect on the mantle and core.

Course Learning Objectives:

Identify and interpret Earth materials, make quantitative measurements with appropriate uncertainties, and communicate geochemical data effectively.

Course Contents:

1. Development of geochemistry as a discipline
2. Composition of meteorites and their Origin
3. Geochemical structure of the earth
4. Geochemical classification of elements
5. Polymorphism and pseudomorphism.
6. Metasomatic processes and environment.
7. Mobility and dispersion of elements under different geochemical environments
8. Introduction of geochemistry of igneous, sedimentary and metamorphic rocks
9. Geochemical anomalies and their application in mineral exploration
10. Introduction to geochemical analytical techniques
11. Geochemical cycles
12. Introduction to organic geochemistry, organic matter, types, and its importance in petroleum industry.

Lab. Work: Processing and interpretation of geochemical data, Ternary diagrams interpretation.

Recommended Texts:

1. Krauskopf, K. B. (2000), *Introduction to geochemistry*. New York: McGraw-Hill.
2. Mason. B., (2000) *Principles of geochemistry*. Hoboken: John Wiley and Sons.

Suggested Readings:

3. Rose, A.W., Hawkes, H.H. and Webb, J.S. (2000), *Geochemistry in mineral exploration.* Tonbridge: Whitstable Litho Ltd.
4. McSween, H. Y., Richardson, S. M., & Uhle, M. E. (2000). *Geochemistry: Pathways and processes*. New York: Columbia University Press.

M.F

GEOL-6136	Igneous Petrology	3(3-0)

Course Brief:

This course is a graduate level course of igneous petrology. It is the study of magma and the rocks that solidify from magma. The composition of igneous rocks and minerals can be determined via a variety of methods of varying ease, cost, and complexity. The simplest method is observation of hand samples with the naked eye and/or with a hand lens. This can be used to gauge the general mineralogical composition of the rock, which gives an insight into the composition. A more precise but still relatively inexpensive way to identify minerals (and there by the bulk chemical composition of the rock) with a petrographic microscope. It enables students to understand the mechanism of magma evolution as well as the factors affecting the magmatic evolution. This course also include the tectonic activities related to magmatic processes and different types of igneous rocks on different tectonic margins.

Course Learning Objectives:

Identify and classify igneous rocks, understanding magma formation and evolution, and interpret geological processes related to igneous activity.

Course Contents:

1. Igneous rock associations
2. Petrogenesis of igneous rocks
3. Petrogenic provinces: Basaltic provinces, Granite-granodiorite provinces and mafic-ultramafic complexes
4. Tectonism-magmatism relationship
5. Igneous activity related to convergent plate boundary and divergent plate boundary environments
6. Intracontinental hot spots
7. Continental rift related magmatism
8. Collisional and subduction environments and igneous activity
9. Ophiolites
10. Mantle-magma systems and source of magma
11. Physico-chemical factors in magmatic evolution.
12. Labs: Megascopic and microscopic identification and description of igneousrocks. Discrimination diagrams.

Lab. Work: Processing and interpretation of geochemical data, Ternary diagrams interpretation.

Recommended Texts:

1. 1. Blatt, H., Tracy, R. and Owens, D., 2005, W. H. Freeman and Co, Petrology: Igneous, Sedimentary and Metamorphic by
2. Winter, J. D., 2001, Introduction to Igneous and Metamorphic Petrology, Prentice Hall.

Suggested Readings:

3. Hyndmann, D. W., 1995Petrology of Igneous and Metamorphic Rocks, McGraw-Hill.
4. Wilson, M., 1989, Igneous Petrogenesis.

M.F

CHAIRMAN
Department of Earth Sciences

GEOL- 6137	Sedimentary Petrology	3(3-0)

Course Brief:

This course is designed to acquire the knowledge about various types of sedimentary rocks and their digenesis. Sedimentary rocks illuminate many of the details of the earth's history: effects of sea level change, global climate, tectonic processes, and geochemical cycles are all recorded in the sedimentary strata of the earth. This course will cover basics of fluid flow and sediment transport, sedimentary structures and textures, and forming the bridge between modern landforms and ancient rocks' depositional sedimentary environments. This will help the students to understand the classification and depositional system of the sedimentary rock as well as the provenance of sediments and sedimentary structures. It's also enable students to understand the role of tectonic for sedimentary rocks.

Course Learning Objectives:

A Sedimentary Petrology course aims to provide students with a broad understanding of sedimentary rocks, including their formation, characteristics, and classification. Students should be able to recognize and classify different types of sedimentary rocks, understand the processes that create them, and interpret their relationship to ancient geological environments.

Course Contents:

1. Introduction of sedimentary rocks
2. Origin, transportation and deposition of sediments
3. Texture of sedimentary rocks
4. Structures of sedimentary rocks
5. Classification and description of sedimentary rocks
6. Provenance of sediments; diagenesis; concepts of sedimentary facies and facies association
7. Tectonic controls of sedimentation.
8. Environments of deposition of sedimentary rocks.

Recommended Texts:

1. Prothero, D. R., & Schwab, F. (2004). Sedimentary geology. New York: Macmillan.
2. Pettijohn, F. J., Potter, P. E., & Siever, R. (2012). Sand and sandstone. Berlin: Springer Science & Business Media.

Suggested Readings:

1. Boggs Jr, S. (2014). Principles of sedimentology and stratigraphy. London: Pearson Education.
2. Reineck, H. E., & Singh, I. B. (2012). Depositional sedimentary environments: with reference to terrigenous clastics. Berlin: Springer Science & Business Media.

M.F

GEOL- 6138	Rare Earth Elements & Platinum Group Elements	3(3-0)

Course Brief:

This course introduces students to the geochemistry, mineralogy, and economic importance of **Rare Earth Elements (REEs)** and **Platinum Group Elements (PGEs)**. These critical elements are essential for modern technologies, including electronics, clean energy, aerospace, and catalytic systems. The course covers their geological occurrences, exploration techniques, extraction challenges, and global supply dynamics, with a focus on sustainability and strategic resource management.

Course Learning Objectives:

1. Differentiate between light and heavy REEs and the six PGEs.
2. Identify key host rocks and minerals for REE and PGE deposits.
3. Understand the geological settings and genesis of REE and PGE mineralization.
4. Describe exploration and extraction techniques for these critical elements.
5. Assess the economic, environmental, and geopolitical aspects of REE and PGE resources.

Course Contents:

1. Introduction to REEs and PGEs
2. Geochemistry and Mineralogy of REEs
2. Geochemistry and Mineralogy of PGEs
3. Formation and Types of REE Deposits (Carbonatites, alkaline complexes, laterites, ion-adsorption clays)
4. Formation and Types of PGE Deposits (Layered mafic intrusions, placer deposits, ophiolite complexes)
5. Exploration Techniques for REEs and PGEs
6. Processing and Extraction Technologies
7. Economic and Strategic Importance
8. Environmental and Policy Issues

Recommended Texts:

1. Atwood, D. A. (Ed.). (2013). *The rare earth elements: fundamentals and applications*. John Wiley & Sons.
2. Voncken, J. H. L. (2016). *The rare earth elements: an introduction*. Cham, Switzerland: Springer International Publishing.

Suggested Readings:

3. Jha, A. R. (2014). *Rare earth materials: properties and applications*. CRC Press.
4. Zereini, F., & Alt, F. (Eds.). (2012). *Anthropogenic platinum-group element emissions: their impact on man and environment*. Springer Science & Business Media.

GEOL-6139	Industrial Mineralogy	3(3-0)

Course Brief:

Industrial Mineralogy is the study of minerals that are used directly in industrial applications without the need for extensive processing. This short course is designed to introduce undergraduate students to the economic importance, properties, and applications of industrial minerals in various sectors including construction, agriculture, manufacturing, energy, and environmental industries. Students will learn how to identify and classify key industrial minerals, understand their formation and occurrence, and evaluate their physical and chemical properties in relation to their industrial uses. The course will also cover methods of exploration, mining, beneficiation, and quality control, along with case studies from local and global contexts.

Course Learning Objectives:

This course equip students with the knowledge and skills to understand and apply various mineral processing techniques. They aim to understand how mineral processing is used to extract valuable materials from ores and how it impacts sustainability and the environment

Course Contents;

1. Introduction to Industrial minerals and rocks and their classification,
2. Grade and reserve estimation of deposits,
3. Introduction to ore microscopy
4. Environment and processes of formation of Industrial mineral deposits: magmatic segregation, hydrothermal solution, metasomatism, sedimentation, evaporation, residual and mechanical concentration and metamorphism,
5. Relationship of mineral deposits to plate tectonic settings,
6. Introduction of geological exploration/prospecting,
7. Brief description of Industrial minerals such as fuel minerals, gemstones, copper, lead, zinc, iron, gold, chromite, manganese, salt, gypsum, bauxite, sulphur, barite, fluorite, clays, phosphorite, building and dimension stones, industrial rocks and minerals, radioactive minerals and rocks with special reference to Pakistan.

Labs: Identification and description of Industrial minerals, microscopic studies and lab exercises on grade and reserve estimation from provided data.

Recommended Texts:

1. Evans, A. M. (2009). *An introduction to economic geology and its environmental impact*. John Wiley & Sons.
2. Pohl, W. L. (2011). *Economic geology: principles and practice*. John Wiley & Sons.

Suggested Readings:

1. Moon, C. J., Whateley, M. K., & Evans, A. M. (2006). *Introduction to mineral exploration* (No. Ed. 2). Blackwell publishing.
2. Evans, Anthony M. *Ore geology and industrial minerals: an introduction*. John Wiley & Sons, 2009.

M.F

GEOL- 6140	Mineral Prospecting	3(3-0)

Course Brief:

This course provides an introduction to the principles and methods of mineral prospecting—the initial stage in the exploration and discovery of economically valuable mineral deposits. Students will learn about various prospecting techniques including geological, geochemical, and geophysical methods, as well as the interpretation of field data and identification of target areas for detailed exploration.

Course Learning Objectives:

A course in Mineral Prospecting aims to teach students the fundamental knowledge and skills needed for locating and evaluating mineral deposits. Students will learn about geological principles, mineral identification, exploration techniques, and the economic significance of minerals.

Course Contents:

1. Introduction to Mineral Prospecting
2. Types of Mineral Deposits
3. Classification and examples
4. Indicators and controls of ore formation.
5. Geological Methods (Lithological, structural & mineralogical indicators)
6. Geochemical Prospecting
    - Soil, rock, stream sediment, and water sampling
    - Element dispersion patterns and pathfinder elements
7. Geophysical Prospecting Techniques
    - Magnetic, gravity, electrical, and seismic methods
    - Interpretation of geophysical anomalies
8. Remote Sensing and GIS in Prospecting
    - Satellite imagery and aerial photography
    - Integration of spatial data
9. Field Techniques and Sampling
    - Traverse planning, mapping, trenching, and pitting
    - Sample collection, preparation, and documentation
10. Drilling and Logging Basics
    - Core and non-core drilling
    - Core logging and subsurface interpretation

Recommended Texts:

1. Böhmer, M., & Kucera, M. (2013). *Prospecting and exploration of mineral deposits* (Vol. 21). Elsevier.
2. " Reedman, J. H. (Ed.). (2012). *Techniques in mineral exploration*. Springer Science & Business Media.

Suggested Readings:

1. Ginzburg, I. I. (2013). *Principles of geochemical prospecting: techniques of prospecting for non-ferrous ores and rare metals*. Elsevier.
2. Marjoribanks, R. (2010). *Geological methods in mineral exploration and mining*. Springer Science & Business Media.

M.F

GEOL-6141	Mineral Deposits	3(3-0)

Course Brief;

As mineral deposits are natural accumulations of minerals in the earth crust, in form of one or several mineral bodies which can be extracted at the present time or in an immediate future. So this course is designed to acquire the knowledge about the formation of various types of economic mineral deposits and their significance. This will help the students to understand the processes which are involved in the genesis of various ores deposits, hydrocarbons, gemstones and other industrial minerals.

Course Learning Objectives;

A course on mineral deposits aims to provide students with a comprehensive understanding of the geological processes involved in the formation of economic mineral deposits and their significance in modern society. Students will learn about the types of mineral deposits, their geological settings, and the factors that determine their economic value.

Course Contents;

1. Introduction of minerals and mineral deposits.
2. Classification of mineral deposits.
3. Genesis, occurrence and important features of mineral deposits.
4. Important features of porphyry deposits, Cu-Ni-Fe deposits, volcanic hosted massive sulphide deposits, Mississippi valley type deposits, carbonatites, greisen deposits, skarn deposits and placer deposits.
5. Descrition of few mineral deposits like chromite, platinum group elements, gold and uranium deposits, in detail.
6. Occurrence, distribution and utilization of metallic mineral deposits in Pakistan.

Recommended Texts;

1. Kazmi, A. H., & Abbas, S. G. (2001). Metallogeny and Mineral Deposits of Pakistan; Graphic Publ.
2. Plumlee, G. S. (1999). The environmental geology of mineral deposits. *The environmental geochemistry of mineral deposits. Society of Economic Geologists. Part A*, 71-116.

Suggested Readings;

1. Mitchell, A. H. G., & Garson, M. S. (1981). *Mineral deposits and global tectonic settings*. Academic Press.
2. Dewing, K. E. I. T. H., Turner, E. L. I. Z. A. B. E. T. H., Harrison, J. C., & Goodfellow, W. D. (2007). Geological history, mineral occurrences and mineral potential of the sedimentary rocks of the Canadian Arctic Archipelago. *Mineral Deposits of Canada: A Synthesis of Major Deposit-Types, District Metallogeny, the Evolution of Geological Provinces, and Exploration Methods: Geological Association of Canada, Mineral Deposits Division, Special Publication*, *5*, 733-753.

Mandatory Elective Courses

Specialization : Engineering Geology

GEOL - 6145	Soil Mechanics and Foundation Engineering	3(3-0)

Course Brief:
This course is designed as an advanced elective in the field of Engineering Geology, focusing on the behavior of soils and their relevance to foundation design. Students will gain fundamental and applied knowledge of soil properties, classification, and mechanical behavior under different loading conditions. The course emphasizes real-world applications in foundation engineering, site investigation, and soil improvement techniques. Case studies and assignments will enhance understanding of soil-structure interaction and the design principles for shallow and deep foundations.

Course Learning Objectives:
Students will develop a comprehensive understanding of how soils behave under various loading and environmental conditions. They will learn to analyze and classify soils based on their engineering properties and apply geotechnical principles in the design of different types of foundations. The course will also equip them with the skills to conduct essential soil tests and assess soil strength for construction purposes. Additionally, students will gain practical experience in interpreting geotechnical reports and using the data to inform foundation design decisions.

Course Contents:
1. Soil origin, formation, and classification systems;
2. Engineering properties of soils (consistency, permeability, compaction, consolidation);
3. Stress distribution in soils;
4. Shear strength of soils and Mohr-Coulomb theory;
5. Bearing capacity of shallow and deep foundations;
6. Earth pressure theories and retaining wall design;
7. Soil exploration methods and site investigation;
8. Ground improvement techniques for weak soils.

Lab. Work: Special Assignments/Projects including soil testing (Atterberg limits, permeability, compaction, triaxial testing).

Recommended Texts:

1. Tatiya, R. (2005). *Civil excavations and tunnelling: A practical guide*. Thomas Telford.
2. Bickel, J. O., & Tanner, D. N. (1982). Sunken tube tunnels. *Tunnel engineering handbook*, 354-394.

Suggested Readings:

1. Bieniawski, Z. T. (1984). Rock mechanics design in mining and tunneling.
2. Price, D. G. (2009). *Engineering geology: principles and practice*. Springer Science & Business Media.

M.F

GEOL - 6146	Rock Mass Classification & Geotechnical Engineering	3(3-0)

Course Brief:

This course builds upon the fundamentals of Rock Mechanics, offering deeper insights into the classification of rock masses and their geotechnical behavior in engineering projects. It explores key systems of rock mass classification and their role in tunnel design, slope stability, and foundation analysis. Students will learn to assess rock mass quality and stability using empirical, analytical, and observational methods, enabling them to contribute to safe and efficient geotechnical designs.

Course Learning Objectives:

This course will equip students with the ability to understand and apply major rock mass classification systems such as RMR, Q-system, and GSI. They will learn to analyze rock mass behavior in various engineering applications including tunneling, mining, and slope stability. Emphasis will be placed on developing effective geotechnical design strategies informed by classification outcomes. Students will also enhance their competencies in field data collection and interpretation, ultimately preparing them to independently assess and evaluate rock mass stability in real-world projects.

Course Contents:

1. Overview of rock mass properties and discontinuities;
2. Rock mass classification systems (RMR, Q-system, GSI, etc.);
3. Application of classification systems to design and stability analysis;
4. Empirical and analytical methods for rock slope stability;
5. Excavation and support design in tunneling and underground works;
6. Case histories in rock engineering design;
7. Instrumentation and monitoring in geotechnical engineering;
8. Geotechnical reporting and interpretation for engineering applications.

Lab. Work:

Special Assignments/Projects involving classification exercises, slope analysis, and stability assessment using real field data and software tools.

Recommended Texts:

1. Tatiya, R. (2005). *Civil excavations and tunnelling: A practical guide*. Thomas Telford.
2. Bickel, J. O., & Tanner, D. N. (1982). Sunken tube tunnels. *Tunnel engineering handbook*, 354-394.

Suggested Readings:

1. Bieniawski, Z. T. (1984). Rock mechanics design in mining and tunneling.
2. Price, D. G. (2009). *Engineering geology: principles and practice*. Springer Science & Business Media.

M.F

GEOL - 6147	Soil Mechanics and Foundation Engineering	3(3-0)

Course Brief:

This course provides a comprehensive introduction to the principles of soil mechanics and their application in foundation engineering. It focuses on the behavior of soil as a multi-phase material and explores how its physical and mechanical properties influence geotechnical design. The course integrates classical mechanics and fluid flow principles to analyze and solve problems related to soil stability, strength, and deformation. Foundation engineering aspects are incorporated to provide practical context for analyzing bearing capacity, settlement, and design of shallow and deep foundations.

Course Learning Objectives:

Students will develop a strong understanding of the origin, classification, and engineering behavior of soils, along with the fundamental mechanics governing their response under various loading and environmental conditions. By linking theoretical principles with practical applications, the course equips students with the skills necessary to evaluate soil properties, assess ground conditions, and design safe and effective foundation systems. Emphasis will be placed on key geotechnical concepts such as soil compaction, permeability, shear strength, consolidation, and bearing capacity, enabling students to approach foundation-related challenges with confidence and technical insight.

Course Contents:

1. Introduction to Soil Mechanics and Foundation Engineering
2. Soil Formation and Classification Systems
3. Soil Sampling Techniques and Site Investigation
4. Soil Physical Properties: Grain Size, Moisture Content, Atterberg Limits
5. Soil Structure, Compaction, and Relative Density
6. Permeability and Seepage Analysis
7. Shear Strength of Soils and Mohr-Coulomb Theory
8. Consolidation, Settlement, and Time Rate Analysis
9. Bearing Capacity and Shallow Foundation Design
10. Introduction to Deep Foundations: Piles and Caissons

Laboratory Work: Determination of Index Properties, Moisture Content, Density, and Specific Gravity Tests, Permeability Test, Atterberg Limitsand Consolidation Test

Recommended Texts:

1. Nelson, J., & Miller, D. J. (1997). *Expansive Soils: Problems and Practice in Foundation and Pavement Engineering*. John Wiley & Sons.
2. Attewell, P. B., & Farmer, I. W. (2012). *Principles of Engineering Geology*. Springer.

Suggested Readings:

3. Schofield, A., & Wroth, P. (1968). *Critical State Soil Mechanics*. McGraw-Hill.
4. Atkinson, J. (2017). *The Mechanics of Soils and Foundations*. CRC Press

M.F

GEOL - 6148	Geotechnical Engineering	3(3-0)

Course Brief:

Geotechnical Engineering is an advanced-level elective course designed for graduate students specializing in Engineering Geology. The course focuses on the behavior of earth materials and their application in civil and infrastructure engineering projects. Students will study the fundamental and applied aspects of rock and soil mechanics, site investigations, geological hazards, and geotechnical considerations in infrastructure design and construction. Topics include seismic hazard assessment, slope stability, landslides, groundwater characteristics, and evaluation of construction materials. Practical learning is enhanced through case studies, special assignments, and project work, with an emphasis on field-based understanding and research-driven problem-solving in geotechnical site development.

Course Learning Objectives:

This course aims to equip students with an in-depth understanding of the principles and practices of Geotechnical Engineering. By the end of the course, students will be able to analyze and apply rock and soil mechanics in the planning and construction of civil engineering structures. They will develop skills in conducting geological and geophysical site investigations, evaluating natural hazards such as landslides and earthquakes, and understanding groundwater behavior in relation to engineering projects. Through exposure to real-world case studies and specialized assignments, students will enhance their capability to assess construction materials, perform hazard zonation, and execute site-specific geotechnical evaluations.

Course Contents:

1. Introduction to Geotechnical Engineering and its role in civil construction
2. Rock and soil mechanics – principles and applications
3. Geological considerations in foundation and structural design
4. Earthworks: roads, tunnels, mines, dams, and bridges
5. Construction materials: sourcing, testing, and performance
6. Slope stability and analysis of mass movement
7. Seismicity and construction in earthquake-prone zones
8. Landslide types, causes, mitigation techniques
9. Groundwater: occurrence, flow, and impact on construction
10. Case studies of significant engineering projects in Pakistan

Recommended Texts:

1. Price, D. G. (2008). *Engineering Geology: Principles and Practice*. Springer.
2. Steffen, G. S., et al. (2014). *Geotechnical Engineering of Dams*. CRC Press.

Suggested Readings:

1. Bell, F. G. (2016). *Fundamentals of Engineering Geology*. Elsevier.
2. Blyth, F. G. H., & De Freitas, M. (2017). *A Geology for Engineers*. CRC Press

M.F

CHAIRPERSON
Department of Earth Sciences
QUAID-I-AZAM UNIVERSITY

GEOL - 6149	Concrete and Asphalt Technology	3(3-0)

Course Brief:

This course provides advanced-level knowledge of concrete and asphalt materials used in construction engineering, focusing on their composition, behavior, and performance under various environmental and load conditions. The course explores the production, properties, testing, and quality control of concrete and asphalt, as well as their applications in civil infrastructure such as roads, bridges, dams, and foundations. Students will gain insight into modern construction practices, sustainability issues, and the evaluation of performance through laboratory and field techniques. The course also emphasizes the significance of material selection, durability, and lifecycle performance to ensure long-lasting infrastructure solutions.

Course Learning Objectives:

Through this course, students will develop an in-depth understanding of the technological principles behind concrete and asphalt as construction materials. They will explore the properties of constituent materials (cement, aggregates, asphalt binders, admixtures), mix design procedures, curing methods, and performance evaluation under different loading and environmental conditions. The course will also cover the testing standards for mechanical strength, durability, and temperature susceptibility. Students will learn about the behavior of these materials in real-world applications such as pavements and structural elements, gain familiarity with quality control measures, and analyze failures to propose remedial techniques.

Course Contents:

1. Introduction to concrete and asphalt materials in civil engineering
2. Constituents of concrete and asphalt: cement, aggregates, bitumen, admixtures
3. Mix design and proportioning methods (ACI, Marshall, Superpave)
4. Workability, setting time, curing, and compaction
5. Mechanical properties: strength, stiffness, fatigue, and creep
6. Durability: shrinkage, thermal cracking, moisture damage, aging
7. Field and laboratory testing procedures and quality control
8. Asphalt pavements: types, design considerations, and performance
9. Concrete applications in infrastructure: roads, bridges, tunnels, dams

Lab Work / Special Assignments / Projects: Mix design of concrete and asphalt, Performance evaluation through lab tests, Analysis of field case studies on failures and repair techniques

Recommended Texts:

1. Neville, A. M. (2011). *Properties of Concrete*. Pearson Education.
2. Roberts, F. L., Kandhal, P. S., Brown, E. R., Lee, D. Y., & Kennedy, T. W. (1996). *Hot Mix Asphalt Materials, Mixture Design and Construction*. NAPA Education Foundation.

Suggested Readings:

1. Mehta, P. K., & Monteiro, P. J. (2014). *Concrete: Microstructure, Properties, and Materials*. McGraw-Hill Education.
2. Mamlouk, M. S., & Zaniewski, J. P. (2017). *Materials for Civil and Construction Engineers*. Pearson.

GEOL - 6150	Dam and Reservoir Engineering Geology	3(3-0)

Course Brief:

This advanced elective course focuses on the geological and geotechnical considerations involved in the planning, design, construction, and maintenance of dams and reservoirs. It explores the interplay between geological formations, hydrological conditions, and structural integrity. The course is designed to equip students with the theoretical knowledge and practical skills required to conduct geological investigations for dam and reservoir sites, assess geological hazards, evaluate construction materials, and understand the engineering behavior of rock and soil masses under various stress conditions.

Course Learning Objectives:

This course aims to provide students with an in-depth understanding of the geological aspects essential to dam and reservoir engineering. Students will learn how to evaluate geological conditions for site selection, assess the integrity and stability of foundation rocks and surrounding slopes, and identify geohazards such as seismicity, seepage, and landslides that can affect dam safety. The course will also develop students' ability to interpret and apply geophysical and geotechnical investigation data, conduct groundwater analysis, and evaluate the suitability of construction materials. Case studies of major dam projects, particularly in Pakistan, will provide real-world context.

Course Contents:

1. Introduction to dam and reservoir types and their engineering significance
2. Geological criteria for dam site selection and reservoir basin evaluation
3. Rock and soil mechanics applied to dam foundations and abutments
4. Geophysical and geotechnical investigation methods for dam projects
5. Seepage analysis, grout curtain design, and reservoir leakage control
6. Seismicity, faulting, and their influence on dam safety
7. Slope stability analysis for reservoir rims and dam abutments
8. Evaluation of construction materials: aggregates, clays, and rock fill
9. Environmental and sedimentation issues in reservoir geology
10. Case studies of dam failures and successful dam projects in Pakistan

Lab/Field Work: Special Assignments / Project Work / Case Study Presentations

Recommended Texts:

1. Fell, R., MacGregor, P., Stapledon, D., & Bell, G. (2014). *Geotechnical Engineering of Dams*. CRC Press.
2. Mays, L. W. (2010). *Water Resources Engineering*. Wiley.

Suggested Readings:

1. Price, D. G. (2008). *Engineering Geology: Principles and Practice*. Springer.
2. Bell, F. G. (2016). *Fundamentals of Engineering Geology*. Elsevier.

M.F

GEOL - 6151	Geomechanics	3(3-0)

Course Brief:

Geo-Mechanics is an advanced graduate-level course designed to integrate the principles of geology, soil mechanics, and rock mechanics for applications in civil and geotechnical engineering. This course provides in-depth knowledge of the mechanical behavior of earth materials, site characterization techniques, hazard assessment, and the geotechnical considerations essential for infrastructure development. Emphasis is placed on understanding ground response to loading, slope stability, earthquake geotectonic, and groundwater mechanics, all within the framework of real-world applications. The course includes practical assignments, case studies, and project-based learning to enhance applied research and problem-solving skills in complex geological settings.

Course Learning Objectives:

This course aims to equip students with a comprehensive understanding of the mechanical behavior of rocks and soils under various environmental and loading conditions, essential for civil and geotechnical engineering projects. Students will explore the interaction between geological materials and engineering structures through the lens of geo-mechanics. They will learn to apply empirical and analytical techniques for evaluating slope stability, foundation conditions, and site-specific hazards. The course also covers seismic site response, geophysical survey methods, groundwater characteristics, and the use of modern tools for hazard zonation and terrain evaluation. Through case studies, special assignments, and a project, students will gain hands-on experience in solving engineering problems related to site selection, construction design, and risk mitigation.

Course Contents:

1. Introduction to Geo-Mechanics and its role in geotechnical engineering
2. Rock and soil mechanics: stress-strain behavior, failure criteria, testing methods
3. Subsurface exploration and site investigation techniques
4. Slope stability and landslide mechanics: causes, analysis, and mitigation
5. Earthquake geotectonic and seismic hazard analysis
6. Groundwater flow and its influence on soil behavior and slope stability
7. Geo-materials in construction: evaluation, suitability, and standards
8. Hazard zonation mapping using analytical and empirical methods
9. Applications of remote sensing and geophysical tools in geo-mechanics

Practical Component: Special Assignments & Technical Report Writing, Independent or Group Project (Site Investigation & Design Proposal)

Recommended Texts:

1. Price, D. G. (2008). *Engineering Geology: Principles and Practice*. Springer.
2. Steffen, G. S., et al. (2014). *Geotechnical Engineering of Dams*. CRC Press.

Suggested Readings:

1. Bell, F. G. (2016). *Fundamentals of Engineering Geology*. Elsevier.
2. Blyth, F. G. H. & De Freitas, M. H. (2017). *A Geology for Engineers*. CRC Press.

M.F

GEOL - 6152	Aggregate and Building Material in Pakistan	3(3-0)

Course Brief:

This advanced-level graduate course focuses on the evaluation, sourcing, and application of aggregate and other construction materials used in Pakistan's infrastructure and building industry. The course introduces students to the origin, classification, geological characteristics, and mechanical behavior of natural and processed construction materials including aggregates, stones, sand, cementitious materials, and recycled alternatives. Special emphasis is placed on regional resources, quality assessment techniques, environmental considerations, and sustainable utilization. The course also explores regulatory standards, testing protocols, and case studies of major infrastructure projects in Pakistan where building materials play a critical role.

Course Learning Objectives:

Students will gain an in-depth understanding of the types, sources, and properties of aggregate and building materials in Pakistan. They will learn to evaluate material quality using geological, geotechnical, and petrographic techniques, and understand the implications of material selection on structural integrity and environmental impact. The course enhances knowledge of local and international standards for material testing, encourages critical assessment of resource sustainability, and trains students in practical applications through case studies and specialized assignments. Upon completion, students will be capable of independently assessing and selecting appropriate materials for construction projects, considering technical, economic, and environmental factors.

Course Contents:

1. Introduction to aggregate and construction materials: types and classifications
2. Geological origin and distribution of building materials in Pakistan
3. Petrographic and geotechnical properties of aggregates
4. Mechanical behavior of construction materials: strength, durability, wear resistance
5. Sourcing and quarrying techniques; environmental and regulatory issues
6. Material testing methods (lab and field): Sieve analysis, impact and crushing value tests
7. Use of recycled and alternative materials in construction
8. National and international standards (ASTM, BS, AASHTO, PS) for material quality
9. Case studies: Performance of aggregates in major projects across Pakistan
10. Sustainability, resource management, and future trends in building materials

Lab Work / Assignments: Material sampling and testing, Site visits to quarries and construction sites,
Project: Evaluation of locally sourced aggregates for a proposed infrastructure site

Recommended Texts:

1. Neville, A. M. (2011). *Properties of Concrete*. Pearson Education.
2. Mamlouk, M. S., & Zaniewski, J. P. (2016). *Materials for Civil and Construction Engineers*. Pearson.

Suggested Readings:

1. Smith, D. R., & Collis, L. (2001). *Aggregates: Sand, Gravel and Crushed Rock Aggregates for Construction Purposes*. Geological Society.
2. Pakistan Standards & Quality Control Authority (PSQCA) manuals on building materials.

GEOL - 6153	Tunnel Engineering and Underground Excavation	3(3-0)

Course Brief:

This advanced graduate-level course focuses on the principles, design, and construction techniques associated with tunnels and underground excavations. It integrates geological, geotechnical, and engineering concepts essential for planning and executing underground projects safely and efficiently. Emphasis is placed on site investigation, rock and soil behavior under excavation conditions, excavation methods, ground support systems, monitoring, and risk management. The course also covers case studies of major tunneling projects, with particular attention to geological challenges and their mitigation. Students will engage in practical assignments and projects to develop skills needed for modern tunnel engineering and underground construction.

Course Learning Objectives:

Upon completion of this course, students will be able to understand and apply the fundamental concepts of tunnel design and underground excavation, including geological and geotechnical site investigations. They will gain knowledge of various excavation techniques, rock mass classification systems, ground support and stabilization methods, and instrumentation for monitoring excavation safety. Students will develop the ability to evaluate risks associated with different geological conditions and implement appropriate mitigation strategies. The course prepares students to analyze complex underground engineering problems, plan construction activities, and carry out independent research or professional work in the field of tunnel engineering and underground excavation projects.

Course Contents:

1. Introduction to Tunnel Engineering
2. Geological and Geotechnical Investigations for Tunneling
3. Rock Mass Classification and Stability Analysis
4. Excavation Methods
5. Ground Support and Reinforcement
6. Tunnel Design Considerations
7. Instrumentation and Monitoring
8. Construction Management and Risk Mitigation
9. Case Studies

Lab/Practical Work: Geological site investigation exercises, Rock mass classification and stability assessment, Design and analysis of tunnel support systems, Monitoring techniques simulation, Special assignments/projects based on case studies

Recommended Texts:

1. Hoek, E. (2007). *Practical Rock Engineering*.
2. Bell, F. G. (2016). *Fundamentals of Engineering Geology*.

Suggested Readings:

3. Brady, B. H. G., & Brown, E. T. (2006). *Rock Mechanics for Underground Mining*.
4. Chapman, D. N., Metje, N., & Stark, A. (2017). *Introduction to tunnel construction*. Crc Press.

M.F

GEOL - 6154	Landslide Hazard Analysis and Mitigation	3(3-0)

Course Brief:

This course focuses on the comprehensive study of landslides, their causes, mechanics, and impacts on infrastructure and human settlements. It covers the identification, analysis, and assessment of landslide hazards through field investigations, remote sensing, and geotechnical methods. Emphasis is placed on modern mitigation techniques and engineering solutions to prevent or minimize landslide risks. Students will also explore landslide risk zoning, case studies from various terrains (including Pakistan), and the role of policy and planning in hazard management. The course integrates theoretical knowledge with practical assignments and projects to prepare students for professional roles in hazard assessment and disaster risk reduction.

Course Learning Objectives:

This course aims to equip students with a thorough understanding of landslide phenomena from both a scientific and engineering perspective. By the end of the course, students will be able to identify and classify different types of landslides, understand the underlying geological and geotechnical processes causing slope failures, and apply advanced field and remote sensing techniques to assess landslide hazards. They will develop skills in hazard zonation, risk analysis, and learn how to design and evaluate effective mitigation and monitoring strategies to reduce landslide impacts. Additionally, students will gain practical experience through lab work and projects, enabling them to contribute to disaster risk management and infrastructure safety in landslide-prone regions.

Course Contents:

1. Introduction to landslides: types, classification, and triggering factors
2. Geological and geomorphological controls on landslides
3. Landslide mechanics: slope stability and soil/rock behavior
4. Field investigation techniques and landslide mapping
5. Remote sensing, GIS, and geophysical methods in landslide detection
6. Landslide hazard zonation and risk assessment models
7. Landslide mitigation strategies: engineering and bioengineering approaches
8. Early warning systems and monitoring of landslide-prone areas
9. Case studies of significant landslides and disaster response
10. Legal, environmental, and socio-economic aspects of landslide management

Lab Work: Field mapping and site investigation, Slope stability analysis using software tools, Remote sensing and GIS applications in landslide hazard assessment, Project on landslide hazard zonation and mitigation planning

Recommended Texts:

1. Cruden, D. M., & Varnes, D. J. (1996). Landslide types and processes. In A. K. Turner & R. L. Schuster (Eds.), Landslides: investigation and mitigation. Transportation Research Board.
2. Schuster, R. L., & Highland, L. M. (2001). Landslide triggers and types. U.S. Geological Survey.

Suggested Readings:

3. Highland, L. M., & Bobrowsky, P. (2008). The landslide handbook — A guide to understanding landslides. U.S. Geological Survey.
4. Pradhan, S. P., Vishal, V., & Singh, T. N. (Eds.). (2019). *Landslides: theory, practice and modelling*. Springer International Publishing.

M.F

GEOL - 6155	Slope Stability Analysis	3(3-0)

Course Brief:

Slope stability is an important engineering consideration in earth and rock-fill dams, slopes of other types of embankments, excavated slopes, and natural slopes in soil and soft rock. The purpose of this course is to teach engineers, contractors and construction managers the fundamental concepts of slope stability analysis. The course includes a review of the shear strength concepts, seepage analysis, conditions of equilibrium and slope stability analysis methods. Criteria are presented for strength tests, analysis conditions, and factors of safety. Methods for analysis of slope stability are described and are illustrated by examples in the appendixes.

Course Learning Objectives:

The student will understand the basic concept of slope stability analysis; understand the basic design considerations; Be familiar with slope stability analysis and design procedure, Know how to verify computer analyses and results; Be able to perform simple slope stability analysis; and Be able to present the analysis and results effectively.

Course Contents:

1. Introduction
2. Design Considerations
3. Design Criteria
4. Calculations and Presentations
5. Slope Stabilization and Supports
6. Slope Reliability and Risk Assessment

Recommended Texts:

1. Zhang, K. (2020). *Failure mechanism and stability analysis of rock slope*. Springer Singapore.
2. Duncan, J. M., Wright, S. G., & Brandon, T. L. (2014). *Soil strength and slope stability*. John Wiley & Sons.

Suggested Readings:

1. Abramson, L. W., Lee, T. S., Sharma, S., & Boyce, G. M. (2001). *Slope stability and stabilization methods*. John Wiley & Sons.
2. Duncan, J. M and Wright, S. G. (2005), Soil Strength and Slope Stability, John Wiley & Sons.

M.F

GEOL - 6156	AI and Data Analytic in Geotechnical Engineering	3(3-0)

Course Brief:

This course has been designed for student with major in engineering geology. This course explores the intersection of artificial intelligence and geotechnical engineering. Learn how AI technologies can optimize site investigations, predict soil behavior, and enhance decision-making processes. Gain practical skills in data analysis, machine learning algorithms, and geotechnical modeling. Stay ahead in the industry by mastering the latest advancements in AI applications for geotechnical engineering. Join us and unlock the potential of AI to revolutionize your projects and career.

Course Learning Objectives:

The students to will Apply Python programming language for reading in, processing, and plotting large datasets. Identify and format appropriate input and output formats for a range of machine learning model. Identify and implement appropriate machine learning models (decision trees, support vector machines, deep neural networks) for a given engineering problem. Understand and differentiate between various buzzwords such as machine learning, data science, big data, artificial intelligence, etc. Understand and critique limitations of various machine learning models. Work in teams to tackle geotechnical engineering datasets from data science perspective. Prepare, critique, present and document code and rep.

Course Contents:

1. Introduction to geotechnical Engineering AI
2. Machine Learning fundamentals
3. Data Processing and feature Engineering
4. Supervised learning Algorithms
5. Deep learning and Neural Networks
6. Geotechnical Data Analysis and Interpretation
7. AI Application in Geotechnical Engineering
8. Case study and Real-world Applications
9. Future Trends in Geotechnical Engineering AI

Recommended Texts:

1. Ching, J. (2024). *Bayesian machine learning in geotechnical site characterization*. CRC Press.
2. Deo, R. C., Samui, P., Kisi, O., & Yaseen, Z. M. (2020). *Intelligent Data Analytics for Decision-2. Support Systems in Hazard Mitigation*.

Suggested Readings:

3. Zhang, L., Pan, Y., Wu, X., & Skibniewski, M. J. (2021). *Artificial intelligence in construction engineering and management* (pp. 231-256). Singapore:: Springer.
4. Kaveh, A. (2024). *Applications of artificial neural networks and machine learning in civil engineering*. Springer.

M.F

CHAIRMAN
Department of Earth Sciences

Mandatory Elective Courses

Specialization : Petroleum Geology

GEOL- 6160	Basin Analysis	3(3-0)

Course Brief:

This is an integrated course containing modules focusing on Petroleum Systems and Basin Evaluation, covering both conventional and unconventional hydrocarbon resources. This course covers a range of topics related to the various basins formation at plate margins and the key potential of elements and processes of the petroleum system, including hydrocarbon generation, migration, accumulation and alteration. Techniques for source rock evaluation and assessing organic maturation are reviewed, and the mechanisms and efficiencies of migration are reconstructed. It focuses on thermal history modelling and basin analysis, which provides the basis for predicting the timing and extent of petroleum generation in sedimentary basins.

Course Learning Objectives:

In this course, Students will explore Petroleum Systems and Basin Evaluation, looking at both regular and unconventional energy sources. Students will study how basins form, the elements of petroleum systems, and processes like generation and movement. Techniques for studying source rocks and maturation are covered, along with migration mechanisms. The course emphasizes thermal history modeling and basin analysis to predict when and where petroleum is generated in sedimentary basins.

Course Contents:

1. The Foundation of Sedimentary Basins,
2. Compositional and Rheological Zoning of Earth and Plate Motion, Classification Scheme for Sedimentary Basins,
3. Types of Sedimentary Basins, Physical State of the Lithosphere, Stress and Strain, Heat Flow, Conduction, Convection, Gravity and Isostacy,
4. Mechanism of Sedimentary Basin Formation Basin due to Lithospheric Stretching, Basins due to Flexure, Geometry of Deflection,
5. Flexural Rigidity of Oceanic and Continental lithosphere, Basins associated with Strike slip Deformation, The Structural Pattern of Strike slip Fault system and Basin in Strike slip zones,
   Long term Eustacy and Epierogeny,
6. Allogenic Controls on Sedimentation, Sediment supply, Energy Flux, Sediment Accommodation, The Sedimentary Basin Fill and The Sediment Routing System,
7. The Basin Stratigraphy, Process Stratigraphy, Driving Mechanism and Numerical Simulation, Subsidence and Thermal History, Geohistory Analysis, Paleo temperatures in Basins, Application to Petroleum Play Assesment,
8. Petroleum System Charge, The Reservoir, The Regional Topseal and Trap, Petroleum System Modeling An Exploration Tool,
9. Thermal Conductivity, Specific Heat Capacity, Radiogenic Heat, SWI Temperatures,
10. Risk Analysis in Basin Modeling.

Labs: Stratigraphy columns and their correlation; textural data interpretation; paleocurrent data interpretation; basin mapping methods; clastic petro facies analysis.

Recommended Texts:

1. Allen, P.A. and Allen, J.R. 1990 Allen, P.A. and Homewood. P and William G.D., 1986, Basin analysis: Principles and Applications Blackwell Scientific Publications
2. Einsle, G., 1992, Sedimentary Basin Evolution, Facies and Sediment Budget.

Suggested Readings

1. Tucker, M.E., 1991, Sedimentary Petrology Blackwell Publications.
2. Kazmi, A.H and Abbasi, I.A., 2008, Stratigraphy and Historical Geology of Pakistan Graphic Publishers, Karachi, Pakistan.

M.F

GEOL - 6161	Petroleum Engineering	3(3-0)

Course Brief:

Petroleum engineering is a field of engineering concerned with the activities related to the production of hydrocarbons, which can be either crude oil or natural gas. Exploration and production are deemed to fall within the upstream sector of the oil and gas industry. Petroleum geologyand geophysics focus on provision of a static description of the hydrocarbon reservoir rock, while petroleum engineering focuses on estimation of the recoverable volume of this resource using a detailed understanding of the physical behavior of oil, water and gas within porous rock at very high pressure. The combined efforts of geologists and petroleum engineers throughout the life of a hydrocarbon accumulation determine the way in which a reservoir is developed and depleted, and usually they have the highest impact on field economics.

Course Learning Objectives:

In this course, students will explore Petroleum Engineering, which deals with producing crude oil and natural gas. They will learn about two main aspects: petroleum geology/geophysics that describe the reservoir rock and petroleum engineering that estimates how much oil and gas can be extracted. This involves understanding how oil, water, and gas behave under high pressure in porous rock. They will understand how geologists and engineers work together to develop and manage reservoirs, impacting their economic success.

Course Contents:

1. Introduction to rig components
2. drilling methods and operations
3. types of bits; drilling fluids
4. composition and function
5. cementation and casing operations
6. coring operations; mud and wireline logging
7. well testing and completion
8. well production operations
9. evaluation and analysis of well data i.e. well cutting, cores, logs and production data
10. secondary and enhanced oil recovery
11. common drilling problems and preventive measures
12. HSE at well site.

Lab. Work: Study of mass properties of rocks, wire line logs, cores, well cuttings, DSTand MDT pressure data.

Recommended Texts:

1. Dobrin, M. B., & Savit, C. H. (2000). Introduction to geophysical prospecting (Vol. 4). New York: McGraw-hill.
2. Burger, H. R., Burger, D. C., & Burger, H. R. (1992). *Exploration geophysics of the shallow subsurface* (Vol. 8). Englewood Cliffs: Prentice Hall.

Suggested Readings:

1. Bieniawski, Z. T. (2009). *Engineering rock mass classifications: a complete manual for engineers and geologists in mining, civil, and petroleum engineering*. New York: John Wiley & Sons.
2. Sereda, N.G., & Solvyon, E. M. (1998). *Drilling of Oil and Gas*. Wells Mir Publications.
3. Darling, T. (2005). *Well logging and formation evaluation*. Amsterdam: Elsevier.

GEOL - 6162	Reservoir Geology	3(3-0)

Course Brief:

The main theme of this subject is to trains students to use modern measurement techniques, computational methods and new geological concepts to obtain a quantitative understanding of the processes behind reservoir rocks. These skills are useful not only in the petroleum industry but also in hydrogeology and other related branches and in the search for new energy sources. The Reservoir Geology courses meshes with the courses in petroleum Geology, petroleum engineering and geophysics. It will introduce the fundamental concepts Rock Fluid Interaction, properties of Hydrocarbon and oilfields fluids, reservoir sedimentology, exploration geology, production geology and advance seismic interpretation.

Course Learning Objectives:

The students will learn in detail wire line log interpretation, reservoir characterization and development and its integration engineering. This course leads toward from the Conventional modeling workflow to conceptual geological models. These heterogeneities may be structural, stratigraphic, sedimentologic and/or diagenetic on origin, and often impact flow behavior and hydrocarbon recovery; hence, they must be captured in reservoir models.

Course Contents:

1. Reservoir rock types: clastics, carbonates, and non-marine reservoirs.
2. Reservoir properties, depositional and diagenetic controls.
3. Fluid properties and their saturation.
4. Hydrocarbon distributing and fluid contacts.
5. Reservoir zonation and thickness mapping.
6. Reservoir pore spaces configuration.
7. Mapping reservoir heterogeneity.
8. Reservoir estimation and calculation of reservoir volumetric, material balance and production, decline curve methods.
9. Appraisal and development of reservoir basic concepts.
10. Petrophysical evaluation; Introduction to Reservoir Engineering.
11. Core analysis.
12. Well logs and well testing.

Recommended Texts:

1. Bjorlykke, K. (2010). *Petroleum geoscience: From sedimentary environments to rock physics.* London: Springer Science & Business Media.
2. Asquith, G. B., Krygowski, D., & Gibson, C. R. (2004). *Basic well log analysis* (Vol. 16). Tulsa: American Association of Petroleum Geologists.

Suggested Readings:

1. Ellis, D. V., & Singer, J. M. (2007). *Well logging for earth scientists* (Vol. 692). Dordrecht: Springer.
2. Gluyas, J., & Swarbrick, R. (2013). *Petroleum geoscience*. New York: John Wiley & Sons.
3. Bjorlykke, K. (2010). Petroleum geoscience: From sedimentary environments to rock physics.London: Springer Science & Business Media.

M.F

GEOL - 6163	Petroleum Geology of Pakistan	3(3-0)

Course Brief:

Pakistan being a developing country is facing significant challenges of energy crises due to a deficit of hydrocarbons. So, it is essential to explore and develop new oil and gas fields with increasing drilling rate to meet energy requirements. So the course is designed to understand the basic knowledge about tectonics, depositional settings and lithostratigraphic divisions of the rocks of various geological periods in Pakistan as well as to learn about the evaluation of petroleum potentials of different basins. This course covers a wide range of earth science subjects and their application to the full spectrum of hydrocarbon exploration and production. It is designed for students with some industrial experience, as well as for recent graduates seeking careers in the petroleum and allied service industries.

Course Learning Objectives:

In this course, students will learn about Petroleum Exploration in Pakistan, addressing the energy crisis. The course focuses on assessing the potential for finding oil and gas in different regions. It covers various earth science topics and their connection to hydrocarbon exploration. Whether you have experience or are a recent graduate, this course prepares you for careers in the petroleum and related industries.

Course Contents:

1. History of petroleum exploration
2. New trends for petroleum exploration
3. Tectonic framework
4. Sedimentary basins and their evolution and distribution
5. Sectonics, depositional settings and lithostratigraphic divisions of the rocks of various geological periods
6. Facies development and their association in depositional basins such as Indus, Baluchistan and offshore regions
7. Evaluation of petroleum potentials of different basins
8. Structural styles and petroleum play in the basins of Pakistan
9. Geothermal gradients and their maturity
10. Productive and potential oil and gas reservoirs and source rocks and their distribution in the basins
11. Play Fairways and Petroleum System in basins; case studies.

***Lab. Work** : Case histories of oil and gas fields of Pakistan.*

Recommended Texts:

1. Kadri, I. B. (1995). *Petroleum geology of Pakistan*. Karachi: Pakistan Petroleum Limited.
2. Kazmi, A. H., & Abbasi, I. A. (2008). Stratigraphy & historical geology of Pakistan. Peshawar: Department & National Centre of Excellence in Geology.

Suggested Readings:

1. Bender, F., & Raza, H. A. (1995). Geology of Pakistan. Karachi: Oxford Press.
2. Haq, B. U., & Milliman, J. D. (1985). *Marine geology and oceanography of Arabian Sea and coastal Pakistan*. Karachi: Oxford University Press

GEOL - 6164	AI and Machine Learning in Hydrocarbon Exploration	3(3-0)

Course Brief:

The course will attempt how A.I. will change the way in the Oil and Gas industry in the coming years. Looking at what is underway in other industries and guessing what type of projects are under development in R&D departments in our industry. Use of data from sensors, digital twins and other digital domains during seismic data acquisition, drilling, wireline and logging operations, well testing, reservoir surveillance, production and other oil field operations. How to optimize sustainable subsurface petroleum production using AI and data science tools to realize net-zero energy future. The course will then focus on Deep Learning (DL) and address all key aspects of developing and applying the technology to Oil and Gas projects.

Course Learning Objectives:

Upon completion of the course, participants will have acquired detailed knowledge of what deep learning is exactly, how it works, and in which way it differs from traditional neural networks that have been used in the industry during the last 30 years. They will understand which domains this can be applied to and for what type of applications. And they will also understand what are the main challenges, difficulties, and pitfalls when developing new applications. Finally, they will have seen demonstrations of deep neural networks applied to Exploration and Production disciplines and will be able to evaluate how useful the technology could be for their own domain.

Course Contents:

1. Introduction to the new A.I. world: What's currently underway in R&D departments?
2. Artificial Intelligence, Machine Learning, and Deep Learning: how do they differ and examples of O&G applications
3. A closer look at Deep Learning:
    - What is it and how different is it from traditional neural networks?
    - Typical workflow to design and develop a deep learning application in an E&P project
    - Common challenges, difficulties, and pitfalls in deep learning projects
    - Software tools and hardware required + Cloud computing vs in- house solutions.
4. Application to Geophysics and Geology: automatic fault identification with a DNN (live)
5. Application to Production Engineering: detecting oil & gas opportunities with a DNN (live)
6. Conclusion - Key learnings

Recommended Texts:

1. Cranganu, C., Luchian, H., & Breaban, M. E. (Eds.). (2015). *Artificial intelligent approaches in petroleum geosciences* (pp. 145-150). Switzerland: Springer International Publishing.
2. Shah, M., Kshirsagar, A., & Panchal, J. (2022). *Applications of artificial intelligence (AI) and machine learning (ML) in the petroleum industry*. CRC Press.

Suggested Readings:

1. Aminzadeh, F., Temizel, C., & Hajizadeh, Y. (2022). *Artificial Intelligence and Data Analytics for Energy Exploration and Production*. John Wiley & Sons.
2. Aminzadeh, F., Temizel, C., & Hajizadeh, Y. (2022). *Artificial Intelligence and Data Analytics for Energy Exploration and Production*. John Wiley & Sons.

M.F

GEOL - 6165	Geomechanics in Petroleum System	3(3-0)

Course Brief:

Advanced Petroleum Geomechanics is designed for aiming to deepen the expertise in the geomechanical aspects of oil and gas operations. This course covers comprehensive topics such as stress analysis, wellbore stability, hydraulic fracturing, and reservoir geomechanics. Through a mix of theoretical insights and practical applications, participants will enhance their ability to predict subsurface behaviors, manage drilling risks, and make informed decisions to improve project outcomes. Ideal for geoscientists and drilling engineers this course combines technical knowledge with real-world applications to elevate industry practices in geomechanics.

Course Learning Objectives:

In this course, students will learn how to apply the basic concepts of geomechanics to identify, predict and mitigate against formation instability during drilling, completion and production.

Course Contents:

1. Essential Rock Mechanics Principles
2. Wellbore Stability Analysis
3. Lost Circulation and Wellbore Strengthening applications
4. Sand Production Management
5. Input to Hydraulic Fracture design
6. Salt instability
7. Geomechanical aspects of Hydraulic fracture stimulation
8. Unconventional & Reservoir Geomechanics
9. Planning for wellbore stability

Lab. Work : Case histories of oil and gas fields of Pakistan.

Recommended Texts:

1. Petroleum Related Rock Mechanics – Drilling Operation and Well Design, Bernt S. Aadnoy & Reza Looyeh, Elsevier, 2019
2. Nauroy, J. F. (2011). *Geomechanics applied to the petroleum industry*. Editions Technip.

Suggested Readings:

1. Zoback, M. D. (2010). *Reservoir geomechanics*. Cambridge university press.
2. Zoback, M. D., & Kohli, A. H. (2019). *Unconventional reservoir geomechanics*. Cambridge University Press.

M.F

CHAIRMAN
Dept. of Earth Sciences
UNIVERSITY OF S. [illegible]

GEOL - 6166	Hydrocarbon Geochemistry	3(3-0)

Course Brief:

This course starts with an introduction to petroleum geochemistry for the explorationist and underlines the uses of geochemical data. It covers origins of organic matter, organic matter preservation, fate and diagenesis, thermal maturity indicators, screening analysis, detailed analytical techniques, data interpretation, oil to oil and oil to source correlation, hydrocarbon gases and basin modelling basics. Case histories and example datasets will be discussed during the course. A number of differing techniques are introduced and assessed in this course. Extensive use of data and examples from basins worldwide are employed.

This course also covers reservoir continuity assessment (both oil and gas, vertical and lateral), alteration of hydrocarbons within the reservoir, analysis of oil/gas/water within the reservoir, defining migration pathway and seal competency, and compartmentalisation of hydrocarbon accumulations.

Course Learning Objectives:

The course assumes a basic knowledge of geological principles, e.g. sedimentology / structural geology. The course is integrated with practical exercises and real case studies to enhance the understanding of petroleum geochemical analytical techniques, data acquisition and data interpretation. Extensive practical exercises and real case studies are conducted during the course to enhance the understanding of different techniques, their implementations and - importantly - some of the limitations of such data.

Course Contents:

1. Formation of organic rich rock and source rock evaluation
2. Introduction Organic Matter in the Natural world
3. Thermal Maturity Determination
4. Calculation of Original Potential of Source Rocks
5. Advanced Analytical Techniques
6. Migration Connectivity Compartmentalisation
7. Hydrocarbon and Non-Hydrocarbon Gases
8. Introduction to Basin Modelling
9. Reservoir Alteration

Lab. Work : *detail geochemical analysis of hydrocarbon and source rocks.*

Recommended Texts:

1. Hue, A. Y. (2013). *Geochemistry of fossil fuels: From conventional to unconventional hydrocarbon systems*. Editions Technip.
2. Waples, D. W. (2013). *Geochemistry in petroleum exploration*. Springer Science & Business Media.

Suggested Readings:

1. Olah, G. A., & Molnár, Á. (2003). *Hydrocarbon chemistry*. John Wiley & Sons.
2. Buryakovsky, L., Eremenko, N. A., Gorfunkel, M. V., & Chilingarian, G. V. (2005). *Geology and geochemistry of oil and gas* (Vol. 52). Elsevier.

M.F

GEOL - 6167	Offshore oil and Gas Exploration	3(3-0)

Course Brief:

The offshore oil and gas exploration would cover the geological principles behind hydrocarbon formation, exploration techniques (seismic surveys, drilling), and the subsequent development of fields. This course gives an overview of the offshore industry and an introduction to methods and technologies relating to the development of offshore oil and gas fields. The intention of this course is to bring the E&P industry to undergraduates and non-technical and technical graduate in order to promote and attract high caliber personnel to the industry as well as help those within the industry have a deeper understanding of the overall business. It will also be of interest to non-technical personnel working in service industries to better understand their business dealings with E&P companies.

Course Learning Objectives:

After the courses the student shall, understand the business drivers in the offshore oil and gas industry and understand the importance of a value chain perspective. Understand the importance of multidiscipline work and be aware of the variety of technical solutions that can be used. Be aware of limitations and feasibility issues of specific solution and Understand that the suitability of specific solutions depends on the circumstances

Course Contents:

1. Geological and Geophysical Methods
2. Drilling Operations:
3. Hydrocarbon Exploration and Production:
4. Business and Industry Context:
5. Specific Offshore Considerations (well completion, drilling platform, production facilities).

Recommended Texts:

1. Jahn, F., Cook, M., & Graham, M. (2008). *Hydrocarbon exploration and production* (Vol. 55). Elsevier.
2. Speight, J. G. (2014). *Handbook of offshore oil and gas operations*. Elsevier.

Suggested Readings:

3. Gudmestad, O. T., Zolotukhin, A. B., & Jarlsby, E. T. (2010). *Petroleum resources with emphasis on offshore fields*. WIT Press.
4. Gudmestad, O. T., Zolotukhin, A. B., & Jarlsby, E. T. (2010). *Petroleum resources with emphasis on offshore fields*. WIT Press.

M.F

GEOL - 6168	Reservoir Characterization and Rock Properties	3(3-0)

Course Brief:

Principles and protocols for measuring fluid content, porosity, bulk volume, bulk density, particle density, particle size distribution, surface area, permeability, pore size distribution, porosimetry, capillary pressure, water retention curve, relative permeability, imbibition, computed tomography scanning, focused ion beam–scanning electron microscopy, diffusion (liquid and gas), and hydrocarbon production decline behavior. These measurements are widely used to characterize oil and gas reservoirs. In addition, the oil and gas industry, the common processes of exploration and production of shale resource, and DrillingInfo database, and scientific and engineering software related to reservoir characterization.

Course Learning Objectives:

This course provides students a detailed understanding of the rock and rock-fluid properties of oil and gas reservoirs; an understanding of the Darcy equation; an understanding of laboratory measurements of rock and rock-fluid properties; and a basic understanding of fluid flow in porous media. As a result of successful examinations and assignments, the student will be able to: Determine porosity, discuss the factors which effect porosity, and describe the methods of determining values of porosity. Define permeability and its determinants and measurement. Identify compressibility of reservoir rocks and describe methods for determining values of formation compressibility. Discuss effective and relative permeability; reproduce typical relative permeability curves and show effect of saturation history on relative permeability

Course Contents:

1. The rocks of the earth - their composition and classification
2. Porosity and fluid storage capacity of rocks. Methods for measuring porosity.
3. Fluids saturations in porous media
4. Saturation distribution in the reservoir, determination of free water level and oil
5. Rock compressibility, overburden effects, measurements and correlations, pressure gradient and temperature gradients in oil and gas reservoirs.
6. Darcy's law and permeability concept. Measurement of permeability.
7. Capillary flow; Poiseuille's Law, viscous laminar flow; Bundles of capillaries
8. Gas flow in porous media; ideal and non-ideal gases, Klinkenberg effect, non-Darcy flow
9. Elastic, acoustic, electrical, radioactive, and thermal properties of rocks.

Recommended Texts:

1. Ganat, T. A. A. O. (2020). *Fundamentals of reservoir rock properties*. Springer International Publishing.
2. Aminzadeh, F. (2022). *Reservoir Characterization: Fundamentals and Applications, Volume 2*. John Wiley & Sons.

Suggested Readings:

1. Lake, L. (Ed.). (2012). *Reservoir characterization*. Elsevier.
2. Dandekar, A. Y. (2006). *Petroleum reservoir rock and fluid properties*. CRC press.

M.F

GEOL - 6169	Petroleum System Modeling	3(3-0)

Course Brief:

This course introduces petroleum system modeling, covering, the critical elements and processes that govern conventional and unconventional petroleum resources. The students will learn to evaluate source rock, define petroleum system, and develop basin modles using computerized modeling techniques. The course focuses on data acquisition, model calibration, and uncertainty quantification, enabling to make informed decisions in hydrocarbon exploration and reservoir characterization.

Course Learning Objectives:

This course provides students a detailed understanding the basic concept of source rock geochemistry applied to conventional and unconventional resource plays. Also understand source rock geochemical measurements and identifying the elements and processes that control petroleum system. Learning how to collect oil and rock samples and how evaluate data quality.

Course Contents:

1. Basins and Petroleum Systems
2. Source rock formation processes
3. Recognition & evaluation of source rocks
4. Basic organic chemistry of oil and gas
5. Geological information from oil and gas analysis
6. Oil families": recognizing different charge systems within a single basin
7. Burial history reconstruction
8. Heat flow and temperature
9. Generation & Migration of hydrocarbons
10. Surface geochemistry as exploration tool

Recommended Texts:

1. Hantschel, T., & Kauerauf, A. I. (2009). *Fundamentals of basin and petroleum systems modeling*. Springer Science & Business Media.
2. Peters, K. E., Schenk, O., Hosford Scheirer, A., Wygrala, B., & Hantschel, T. (2017). *Basin and petroleum system modeling* (pp. 381-417). Springer International Publishing.

Suggested Readings:

1. Ancheyta, J. (2013). *Modeling of processes and reactors for upgrading of heavy petroleum*. CRC Press.
2. Chierici, G. L. (2012). *Principles of Petroleum Reservoir Engineering: Volume 2* (Vol. 2). Springer Science & Business Media.

GEOL - 6170	Unconventional Hydrocarbon Resources	3(3-0)

Course Brief:

This course will provide an overview of the key issues and methods relevant to the exploration, assessment and development of unconventional reservoirs. The course will focus on application of geomechanics in CSG, tight gas and shale gas, deliverability and production forecasting; field development planning; and reserve estimation/economics of unconventional reservoirs.

Course Learning Objectives:

This course provides students a detailed understanding of and describes unique geological characteristics of unconventional resources. Understand, describe and apply principles of geomechanics to unconventional reservoirs including earth stresses, basic rock mechanical properties, fracturing mechanics, well-bore stability and hydraulic fracturing as pertaining to CSG, tight gas and shale gas reservoirs. Understand and describe key properties of coal seam gas (CSG), tight gas and shale gas reservoirs based on log and general reservoir characteristics. Understand, describe and apply the proper application of well testing and diagnostic fracture injection testing in reservoir characterisation and stress profiling for unconventional reservoirs. Understand, describe and apply economic evaluation to resource and reserve estimation for unconventional reservoirs.

Course Contents:

1. Overview of unconventional resources
2. Sampling and laboratories measurement of shale
3. Future directions in unconventional resources.
4. Reservoir characterization
5. Drilling and completion
6. Production and well performance
7. Economics and resource evaluation
8. Future trends and challenges.

Recommended Texts:

1. Ahmed, U., & Meehan, D. N. (Eds.). (2016). *Unconventional oil and gas resources: exploitation and development*. CRC Press.
2. Hazra, B., Chandra, D., & Vishal, V. (2024). *Unconventional Hydrocarbon Reservoirs: Coal and Shale*. Springer.

Suggested Readings:

1. Huc, A. Y. (2013). *Geochemistry of fossil fuels: From conventional to unconventional hydrocarbon systems*. Editions Technip.
2. Zoback, M. D., & Kohli, A. H. (2019). *Unconventional reservoir geomechanics*. Cambridge University Press.

M.F

GEOL - 6171	Well log Interpretation and Petrophysical Analysis	3(3-0)

Course Brief:

Petrophysics starts with understanding we are remotely sensing the subsurface of the basins we are exploring. Understanding the geology and characterizing the reservoir using core data and outcrop analogues, then relating this interpretation back to the log data is critical. Starting with the basic logs (GR, Density, Neutron, Sonic, Resistivity, etc.) acquired through wireline and memory downhole tools, we will learn the physics behind each tool, and how each tool measures an aspect of the reservoir. Exercises will be used to describe the calculation of reservoir parameters (Vsh, Phit, Swt, etc.) commonly used in mapping of exploration and development plays. Core data will also be discussed and incorporated. If time permits, we will explore more complex tools and readings.

Course Learning Objectives:

This course is targeted to all geoscientists who want to learn how to interpret basic log curves and be able to relate them back to the reservoir they are exploring. Understanding of basic rock types (sandstone, limestone, dolomite, shale, etc.) and their constituent mineralogy and how pore space is represented in the subsurface will be required.

Course Contents:

1. Introduction to Petrophysics
2. Fundamental Petrophysical Concepts
3. Well Logging Methods
4. Log Interpretation
5. Environmental Corrections
6. Data Integration
7. Borehole Imaging
8. Core Analysis

Recommended Texts:

1. Asquith, G. B., Krygowski, D., & Gibson, C. R. (2004). *Basic well log analysis* (Vol. 16, pp. 305-371). Tulsa: American Association of Petroleum Geologists.
2. Cannon, S. (2015). *Petrophysics: a practical guide*. John Wiley & Sons.

Suggested Readings:

1. Tittman, J. (2012). *Geophysical well logging: excerpted from methods of experimental physics*. Elsevier.
2. Ali, M. (2004). Petrophysical log analysis system. MCS.

M.F

CHAIRMAN
Department of Earth Sciences

Mandatory Elective Courses

Specialization : Petroleum Geology

M.F

GEOL- 6175	AI & Machine Learning in Exploration Geophysics	3(3-0)

Course Brief:
This course introduces the fundamental concepts of Artificial Intelligence (AI) and Machine Learning (ML) with a focus on applications in exploration geophysics. Students will learn how modern AI/ML tools are used to enhance data acquisition, processing, interpretation, and decision-making in geophysical exploration. The course bridges theory with practical application through real-world datasets and case studies, empowering students to contribute to the digital transformation of geosciences.

Course Learning Objectives:
This course provides students with a foundational understanding of Artificial Intelligence (AI) and Machine Learning (ML) in the context of exploration geophysics. Students will learn key ML techniques—such as supervised, unsupervised, and deep learning—and how to apply them to geophysical data analysis. Emphasis is placed on data preprocessing, model development, and performance evaluation using real-world geophysical datasets. By the end of the course, students will be able to apply AI tools to interpret geophysical data and critically assess their effectiveness and limitations in exploration scenarios.

Course Contents:
1. Introduction to Exploration Geophysics
2. Foundations of AI and ML
3. Machine Learning Algorithms
4. Deep Learning and Neural Networks
5. Applications in Geophysical Data Analysis
6. Model Evaluation & Deployment
7. Emerging Trends and Case Studies

Recommended Texts:
1. **Zhang, J. (2020).** *Machine Learning in Geosciences: From Theory to Applications.* Elsevier.
2. **Géron, A. (2022).** *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow* **(3rd ed.).** O'Reilly Media.
3. **Zhou, C., & Ma, J. (2021).** *Artificial Intelligence in Geosciences.* Elsevier.
4. **Goodfellow, I., Bengio, Y., & Courville, A. (2016).** *Deep Learning.* MIT Press.

Suggested Readings:
1. Mosavi, A., & Rabczuk, T. (Eds.) (2023). ***Machine Learning for Subsurface Characterization.*** **Springer.**
2. Al-Regib, G., & Amin, A. (2022). ***AI for Seismic Data Interpretation.*** **Society of Exploration Geophysicists (SEG).**
3. Hu, G. (2021). "Applications of Deep Learning in Geophysical Exploration." ***IEEE Geoscience and Remote Sensing Magazine.***
4. Ting, K. M. (2023). ***Foundations of Machine Learning for Predictive Geoscience.*** **CRC Press.**

GEOL- 6176	Application of Remote Sensing in Geophysics	3(3-0)

Course Brief:

This course explores the principles, technologies, and geophysical applications of remote sensing. It emphasizes how satellite, airborne, and drone-based sensors are used to collect and analyze data for subsurface and surface investigations. The course integrates theory with hands-on analysis of multispectral, hyperspectral, LiDAR, InSAR, and thermal imagery to support geophysical interpretations in areas such as mineral exploration, groundwater mapping, tectonics, and environmental studies.

Course Learning Objectives:

This course provides students with a foundational understanding of remote sensing techniques and their applications in geophysics. Students will learn to acquire, process, and interpret data from various platforms such as optical, radar, thermal, and LiDAR. Emphasis is placed on integrating remote sensing data with geophysical datasets for improved subsurface analysis. By the end of the course, students will be able to use modern tools and software to apply remote sensing in geophysical exploration and critically assess data quality and sensor capabilities.

Course Contents:

1. Introduction to Remote Sensing
2. Image Acquisition and Sensor Systems
3. Data Processing and Image Interpretation
4. Remote Sensing for Geophysical Applications
5. Data Integration and Case Studies
6. Recent Trends and Future Directions

Recommended Texts:

1. Jensen, J. R. (2023). *Remote Sensing of the Environment: An Earth Resource Perspective* (3rd ed.). Pearson.
2. Sabins, F. F., & Ellis, D. (2020). Remote Sensing: Principles and Interpretation (4th ed.). Waveland Press.
3. Lillesand, T., Kiefer, R. W., & Chipman, J. (2022). Remote Sensing and Image Interpretation (8th ed.). Wiley.

Suggested Readings:

1. Gomez, C. (Ed.) (2022). Remote Sensing for Geoscientists: Image Analysis and Integration (2nd ed.). Elsevier.
2. Chuvieco, E. (2023). Fundamentals of Satellite Remote Sensing: An Environmental Approach (3rd ed.). CRC Press.
3. Petropoulos, G. P., & Srivastava, P. K. (Eds.) (2021). Satellite Remote Sensing for Earth System Science: Methods, Applications, and Case Studies. Springer.

M.F

GEOL- 6177	Borehole Geophysics & Logging Techniques	3(3-0)

Course Brief:

This course provides an in-depth understanding of borehole geophysics, focusing on the principles, techniques, and applications of geophysical logging for subsurface characterization. It introduces students to the theory and practice of various logging methods used in evaluating rock and fluid properties within boreholes. Emphasis is placed on instrumentation, data acquisition, and interpretation in fields such as petrophysics, formation evaluation, mineral exploration, hydrocarbon assessment, groundwater studies, and geotechnical investigations. The course also includes Vertical Seismic Profiling (VSP) and the integration of borehole data with surface geophysical and geological information. Through case studies and lab work, students will develop hands-on experience in log analysis and real-world decision-making.

Course Learning Objectives:

The course aims to equip students with the knowledge and practical skills needed to apply borehole geophysics effectively in various geological and engineering contexts. Students will learn to select and implement appropriate logging techniques, interpret borehole data for lithological and fluid analysis, and integrate results with broader geoscientific investigations. By the end of the course, they will be able to critically evaluate borehole logs and make informed decisions in exploration, environmental, and geotechnical projects.

Course Contents:

1. Introduction to Borehole Geophysics
2. Fundamentals of Geophysical Methods
3. Borehole Logging Techniques
4. Common Logging Methods and Applications
5. Advanced Techniques
6. Petrophysics and Formation Evaluation
7. Vertical Seismic Profiling (VSP)
8. Applications of Borehole Geophysics
9. Log Analysis and Interpretation
10. Case Studies

Labs: Specified assignments on data acquisition/processing and interpretation.

Recommended Texts:

1. Ellis, D. V., & Singer, J. M. (2020). Well Logging for Earth Scientists (2nd Ed.). Springer.
2. Kearey, P., Brooks, M., & Hill, I. (2002). An Introduction to Geophysical Exploration (3rd Ed.). Wiley-Blackwell.
3. Reynolds, J. M. (2011). An Introduction to Applied and Environmental Geophysics (2nd Ed.). Wiley.
4. Asquith, G., & Krygowski, D. (2004). Basic Well Log Analysis (2nd Ed.). AAPG.

Suggested Readings:

1. Telford, W.M. Geldart, L.P. and Sherriff, R.E., (1990), Applied Geophysics, 2nd Ed.
2. Cambridge University Press, Cambridge.
3. Ward, S.H. , (1990), Geotechnical and Environmental Geophysics, Vol. I-III Society of Exploration Geophysicists, Tulsa, Okla.
4. Moone, P.L., (1986), Drilling Practices, Manual Pen Well.

M.F

GEOL- 6178	Geophysical Data Processing & Interpretation	3(3-0)

Course Brief:

This course provides a comprehensive foundation in the principles and practical techniques of geophysical data processing and interpretation. Emphasis is placed on understanding the characteristics of raw geophysical data, removing noise, applying signal enhancement techniques, and interpreting processed results in geological and geotechnical contexts. Covering seismic, gravity, magnetic, electrical, and electromagnetic methods, the course integrates theoretical concepts with hands-on exercises and real-world datasets. It prepares students to apply modern software tools, analytical workflows, and quantitative approaches to extract meaningful geological information from geophysical surveys.

Course Learning Objectives:

This course aims to develop students' capabilities in handling, processing, and interpreting geophysical datasets effectively. Students will learn how to assess data quality, apply appropriate processing techniques, and use both qualitative and quantitative interpretation strategies. Through practice with various geophysical methods, they will gain the skills to extract subsurface features, delineate structures, and support decision-making in resource exploration, environmental investigations, and engineering applications. By the end of the course, students will be proficient in using industry-standard software and methodologies to transform raw data into actionable geoscientific insights.

Course Contents:

1. Introduction to Geophysical Data and Noise
2. Fundamentals of Signal Processing
3. Seismic Data Processing
4. Potential Field Data Processing (Gravity & Magnetics)
5. Electrical and Electromagnetic (EM) Data Processing
6. Geophysical Inversion Techniques
7. Data Integration and Interpretation
8. Software and Practical Tools
9. Applications and Case Studies

Laboratory Component:

- Exercises in filtering, spectral analysis, and inversion
- Processing of real or synthetic geophysical datasets
- Interpretation projects using commercial or open-source software
- Integration of geophysical results with geological models

Recommended Texts:

1. Yilmaz, Ö. (2021). Seismic Data Analysis (2nd Ed.). SEG.
2. Hinze, W. J., Von Frese, R. R. B., & Saad, A. H. (2013). Gravity and Magnetic Exploration: Principles, Practices, and Applications. Cambridge University Press.
3. Menke, W. (2018). Geophysical Data Analysis: Discrete Inverse Theory (4th Ed.). Academic Press.
4. Reynolds, J. M. (2011). An Introduction to Applied and Environmental Geophysics (2nd Ed.). Wiley.

Suggested Readings:

1. Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). *Applied Geophysics* (2nd Ed.). Cambridge University Press.
2. Nabighian, M. N. (Ed.) (2005). Electromagnetic Methods in Applied Geophysics (Vol. 1 & 2). SEG.
3. Butler, D. K. (Ed.) (2005). Near-Surface Geophysics. SEG.

M.F

GEOL- 6179	Geophysical Inversion Techniques	3(3-0)

Course Brief:

This course provides a comprehensive introduction to the theory and application of geophysical inversion, a fundamental tool in quantitative subsurface imaging. Students will explore forward modeling, the mathematics of inverse problems, and practical algorithms used in transforming geophysical data into models of earth properties. The course emphasizes both the conceptual understanding and numerical implementation of inversion across various methods including gravity, magnetics, resistivity, electromagnetics, and seismic. Through hands-on exercises and case studies, students will gain experience in selecting appropriate inversion techniques, evaluating model reliability, and interpreting results in geological contexts.

Course Learning Objectives:

This course aims to equip students with a deep understanding of the principles, strategies, and applications of geophysical inversion. Students will learn how to construct forward models, develop inverse solutions using linear and non-linear techniques, and assess the uncertainty and resolution of inversion results. They will gain practical skills in applying inversion methods to real datasets and integrating inversion outcomes with geological interpretations. By the end of the course, students will be able to critically analyze the performance of inversion algorithms and apply them effectively in exploration, environmental, and geotechnical settings.

Course Contents:

1. Introduction to Inverse Problems
2. Mathematics of Inversion
3. Model Parameterization and Resolution
4. Inversion of Potential Field Data
5. Electrical and Electromagnetic Inversion
6. Seismic Inversion
7. Joint and Constrained Inversion
8. Computational Approaches and Algorithms
9. Applications and Case Studies

Recommended Texts:

1. Menke, W. (2018). *Geophysical Data Analysis: Discrete Inverse Theory* (4th Ed.). Academic Press
2. Tarantola, A. (2005). *Inverse Problem Theory and Methods for Model Parameter Estimation*. SIAM
3. Aster, R. C., Borchers, B., & Thurber, C. H. (2019). *Parameter Estimation and Inverse Problems* (3rd Ed.). Elsevier
4. Oldenburg, D. W., & Li, Y. (2005). *Inversion for Applied Geophysics*. UBC-GIF

Suggested Readings:

1. Parker, R. L. (1994). *Geophysical Inverse Theory*. Princeton University Press
2. Zhdanov, M. S. (2002). *Geophysical Inverse Theory and Regularization Problems*. Elsevier
3. Tikhonov, A. N., & Arsenin, V. Y. (1977). *Solutions of Ill-Posed Problems*. Winston
4. Journals: *Geophysics*, *Inverse Problems*, *Journal of Applied Geophysics*, *Exploration Geophysics*

M.F

GEOL- 6180	Gravity & Magnetic Exploration Methods	3(3-0)

Course Brief:

The aim of the course is to introduce various aspects of gravity and magnetic method and familiarize the student with them. The course is emphasizing the physical concepts of each method. A conceptual review of the governing laws gravity and magnetic methods will be provided. The course is intended to be a practical, hands-on, field-oriented course on the applications of gravity and magnetic methods to these problems. For each topic, the development will proceed from basic principles (theory) through methodology and applications, to case histories. Applications will be emphasized; theory will be kept to essentials. The basic principles and operational procedures of each method will be presented, along with discussions of where the method is and is not applicable. Case histories will be included to illustrate applications.

Course Learning Objectives:

The learning objectives of this course is to teach students about gravity and magnetic methods. It focuses on the physical concepts behind these methods and provides a review of the laws that govern them. The course is practical and field-oriented, aiming to apply gravity and magnetic methods to real-world problems. You'll start with the basics and move on to methodology, applications, and case studies. The goal is to emphasize how these methods are used in various situations, with practical examples illustrating their applications.

Course Contents:

1. Physical principles and basic theory of Gravity Method
2. Gravity Instrumentation and planning of the gravity survey and evaluation of errors
3. Rock densities and their measurements and Isostasy
4. Gravity data acquisition and processing;
5. Data interpretation and mapping to identify gravity anomalies
6. Gravity ; regional fields, residual anomalies and derivatives
7. Continuation of the gravity field and two and three-dimensional modeling;
8. Applications in petroleum industry and case histories
9. Physical principles and basic theory of Magnetic Method
10. Magnetic Instrumentation and planning of the magnetic survey and evaluation of errors
11. Rock susceptibilities and their measurements
12. Magnetic data acquisition and processing;
13. Data interpretation and mapping to identify magnetic anomalies
14. Magnetic ; regional fields, residual anomalies and derivatives
15. Continuation of the magnetic field and two and three-dimensional modeling;
16. Applications in petroleum industry and case histories

Recommended Texts:

1. Telford, W. M., Telford, W. M., Geldart, L. P., Sheriff, R. E., & Sheriff, R. E. (2012). *Applied geophysics*. Cambridge university press.
2. Reynolds, J. M. (2011). *An introduction to applied and environmental geophysics*. John Wiley & Sons.

Suggested Readings:

1. Parasnis, D. S. (2012). *Principles of applied geophysics*. Springer Science & Business Media.
2. Griffiths, D. H., & King, R. F. (2013). *Applied geophysics for geologists and engineers: the elements of geophysical prospecting*. Elsevier.

M. F

CHAIRMAN
Department of Earth Sciences
UNIVERSITY OF RANGOON
RANGOON

GEOL- 6181	Hydro Geophysics	3(3-0)

Course Brief:

The course on Hydrogeophysics is designed to provide students with a comprehensive understanding of the theory, methods, and practical applications of geophysical techniques in the field of groundwater investigations. Students will be introduced to the fundamental principles of hydrogeophysics and learn how geophysical methods can be used to measure and characterize subsurface properties relevant to groundwater flow and aquifer characterization. The course will cover topics such as water content/porosity, hydraulic conductivity, hydrostratigraphy, and the integration of airborne and remote sensing techniques for hydrogeophysical studies. Through a combination of lectures, laboratory exercises, and fieldwork, students will gain hands-on experience in data collection, interpretation, and analysis using a variety of geophysical instruments and software tools.

Course Learning Objectives:

This course focuses on Hydrogeophysics and teaches students about using geophysical techniques to study groundwater. They learn the theory, methods, and real-world applications of these tools. The course covers how to measure and understand underground properties that relate to groundwater movement and aquifers. They will study topics like water content, conductivity, and hydrostratigraphy, and also explore how airborne and remote sensing techniques can be integrated for groundwater studies. Through lectures, labs, and fieldwork, will gain practical experience in collecting, interpreting, and analyzing data using different geophysical instruments and software.

Course Contents:

1. Introduction to Hydrogeophysics
2. Theory and methods in hydrogeophysics
3. Measuring properties of the subsurface
4. Water content/porosity
5. Hydraulic conductivity
6. Field measurements of properties
7. Hydrostratigraphy
8. Geophysical Techniques for groundwater investigations
9. Airborne & remote sensing hydrogeophysics

Recommended Texts:

1. Burger, H.R., (2012), Exploration Geophysics of the Shallow Subsurface: Prentice-Hall, Englewood Cliffs, NJ..
2. Dobrin, M.B., (2012),introduction to geophysical prospecting (2nd ed.): McGraw-Hill Book Co., New York.

Suggested Readings:

1. Kirsch, R. (2018) ,Groundwater Geophysics – A Tool for Hydrogeology (2nd ed.): Springer-Verlag, Berlin.
2. Rubin, Y., and Hubbard, S.S., (2012), Hydrogeophysics: Water Science and Technology Library, Springer, Berlin, .
3. Sharma, P.V., (2014), Environmental and Engineering Geophysics: Cambridge University Press, Cambridge, UK.

M.F

GEOL- 6182	Induced Seismicity & Reservoir Characterization	3(3-0)

Course Brief:
This course introduces students to the fundamental principles of induced seismicity and reservoir characterization. It focuses on the interaction between human activities (such as fluid injection and extraction) and seismic activity, as well as on the techniques used to analyze and characterize geological reservoirs. The course combines geophysical, geological, and engineering perspectives to provide students with a multidisciplinary understanding crucial for subsurface exploration and energy development.

Course Learning Objectives:
This course introduces students to the principles of induced seismicity and reservoir characterization. Students will learn how human activities influence seismic events and how to monitor and interpret seismic data. The course also covers methods to assess reservoir properties using geophysical and petrophysical techniques. Emphasis is placed on integrating data for reservoir analysis and applying risk assessment strategies to manage induced seismicity in energy and environmental projects.

Course Contents:
1. Introduction to Seismology and Reservoir Systems
2. Mechanisms of Induced Seismicity
3. Seismic Data Acquisition and Processing
4. Monitoring and Analyzing Induced Seismicity
5. Reservoir Characterization Fundamentals
6. Geophysical Methods for Reservoir Analysis
7. Geomechanics and Fracture Characterization
8. Risk Assessment and Mitigation
9. Integration and Case Studies

Recommended Texts:
1. Wiemer, S., Häring, M.O., Sellami, S., & Diehl, T. (2020). Induced Seismicity: Fundamentals and Applications. Springer.
2. Zoback, M.D. (2010). Reservoir Geomechanics. Cambridge University Press.
3. Mavko, G., Mukerji, T., & Dvorkin, J. (2009). The Rock Physics Handbook: Tools for Seismic *Analysis of Porous Media* (2nd ed.). Cambridge University Press.

Suggested Readings:
4. National Research Council (2013), *Induced Seismicity Potential in Energy Technologies*.
5. Ellsworth, W.L. (2013). *Injection-Induced Earthquakes*. Science, 341(6142).
6. Foulger, G.R., et al. (2018). *Global Review of Human-Induced Earthquakes*. Earth-Science Reviews.
7. Yilmaz, Öz (2001). *Seismic Data Analysis*. Society of Exploration Geophysicists.
8. Journals: *Geophysics*, *Journal of Seismology*, *International Journal of Rock Mechanics and Mining Sciences*, *The Leading Edge*.

M.F

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SARGODHA

GEOL- 6183	Marine Geophysics & Oceanic Exploration	3(3-0)

Course Brief:

Marine Geophysics & Oceanic Exploration is a multidisciplinary course that focuses on the use of geophysical methods to investigate the structure, composition, and dynamic processes of the ocean basins. The course examines the geological evolution of the seafloor, including the origin of oceans and continents, seafloor spreading, heat flow, and magnetic anomalies. It also addresses modern techniques used in oceanic exploration for scientific, resource, and engineering purposes. Students will explore how marine geophysical surveys are designed and conducted, the types of instruments used, and how data is interpreted for mapping seafloor features, exploring marine mineral and hydrocarbon resources, and assessing conditions for offshore infrastructure. This course provides essential knowledge for understanding and exploring the world's oceans and contributes to a wide range of scientific and industrial applications.

Course Learning Objectives:

This course introduces students to the principles and practices of marine geophysics and oceanic exploration. It aims to develop an understanding of seafloor structure and processes such as tectonics, magnetic anomalies, and heat flow. Students will learn to apply geophysical techniques—including seismic, magnetic, and gravity surveys—to investigate the ocean floor. The course also emphasizes the role of oceanic exploration in resource assessment, environmental monitoring, and offshore engineering. By the end of the course, students will be equipped to interpret marine geophysical data and understand its applications in both scientific research and industry.

Course Contents:

1. Origin and evolution of oceans and continental margins
2. Ocean basin physiography and classification of seafloor features
3. Plate tectonics, seafloor spreading, and the Vine–Matthews–Morley hypothesis
4. Oceanic magnetic anomalies and geomagnetic time scales
5. Heat flow in the oceanic crust: mechanisms and measurements
6. Marine seismic methods: reflection and refraction techniques
7. Gravity and magnetic survey techniques in marine environments
8. Bathymetric mapping and multibeam sonar systems
9. Design and objectives of marine geophysical surveys
10. Instrumentation used in marine geophysical and oceanographic surveys
11. Deployment and operation of instruments at sea
12. Survey vessel layout and integration of onboard equipment
13. Applications in resource exploration: hydrocarbons, gas hydrates, and seafloor minerals
14. Environmental studies and engineering investigations for offshore infrastructure
15. Emerging technologies in oceanic exploration: autonomous vehicles, satellite altimetry, and deep-sea sensors

Recommended Texts:

1. Harff, J., Meschede, M., Petersen, S., & Thiede, J. (Eds.). (2016). *Encyclopedia of Marine Geosciences*. Springer.
2. Riffenburgh, B. (Ed.). (2023). *Encyclopedia of Ocean Sciences* (3rd ed.). Academic Press.
3. Zobell, C.E., & Stummeyer, J. (2020). *Marine Geophysics: Methods and Applications*. Springer.
4. Cazenave, A., & Royer, J.Y. (2001). *Applications to Marine Geophysics*. In *International Geophysics*, Vol. 69. Academic Press.

Suggested Readings:

1. Seibold, E., & Berger, W.H. (2017). *The Sea Floor: An Introduction to Marine Geology* (4th ed.). Springer.
2. SWART, P.K. (2012). *Marine Geology and Geophysics*. In *Black Sea Oceanography*, 351, 75.
3. Garrison, T. (2021). *Oceanography: An Invitation to Marine Science* (10th ed.). Cengage Learning.
4. Scrutton, R.A. (2022). *Exploring Oceanic Crust: Geophysical Insights into Deep-Sea Structures*. Wiley-Blackwell.

M.F

GEOL- 6184	Near Surface Geophysics	3(3-0)

Course Brief:

Near Surface Geophysics focuses on the application of geophysical methods to investigate the shallow subsurface, typically within the upper few hundred meters of the Earth. This course explores how geophysical techniques are used to solve problems in environmental studies, engineering site investigations, archaeology, hydrology, and natural hazard assessment. It emphasizes non-invasive methods for imaging subsurface features such as soil layers, groundwater, voids, contamination zones, and buried objects. Through lectures, case studies, and practical data interpretation, students will gain insights into the principles and applications of seismic, electrical, electromagnetic, magnetic, and ground-penetrating radar techniques tailored to near-surface investigations.

Course Learning Objectives:

This course aims to equip students with foundational knowledge and practical skills in near surface geophysical methods. Students will learn the physical principles behind geophysical techniques and how they are applied to detect and characterize subsurface features relevant to environmental, engineering, and archaeological investigations. The course will enhance students' ability to design, execute, and interpret geophysical surveys, with an emphasis on solving real-world near-surface problems. By the end of the course, students will be able to critically evaluate the appropriate methods for various site conditions and objectives.

Course Contents:

1. Introduction to near surface geophysics and its multidisciplinary applications
2. Physical properties of earth materials relevant to geophysics
3. Seismic refraction and reflection methods for shallow subsurface studies
4. Electrical resistivity and induced polarization methods for environmental and engineering use
5. Electromagnetic methods (EM) for detecting conductivity variations
6. Ground Penetrating Radar (GPR): theory, operation, and interpretation
7. Magnetic methods for locating buried ferrous objects and archaeological features
8. Gravity methods for shallow density anomalies
9. Data acquisition, processing, and interpretation techniques
10. Survey design and instrumentation for near surface applications
11. Integration of geophysical data with geological and geotechnical information
12. Limitations, uncertainties, and quality control in near surface surveys
13. Case studies in environmental site assessment, utility detection, and geohazard mapping
14. Regulatory and ethical considerations in geophysical investigations

Recommended Texts:

1. Reynolds, J.M. (2011). *An Introduction to Applied and Environmental Geophysics* (2nd ed.). Wiley-Blackwell.
2. Kirsch, R. (Ed.). (2009). *Groundwater Geophysics: A Tool for Hydrogeology*. Springer.
3. Milsom, J., & Eriksen, A. (2011). *Field Geophysics* (4th ed.). Wiley-Blackwell.
4. Butler, D.K. (Ed.). (2005). *Near-Surface Geophysics*. Society of Exploration Geophysicists (SEG).

Suggested Readings:

1. Telford, W.M., Geldart, L.P., & Sheriff, R.E. (1990). *Applied Geophysics* (2nd ed.). Cambridge University Press.
2. Nabighian, M.N. (Ed.). (2005). *Magnetic Methods in Geophysics*. Society of Exploration Geophysicists.
3. Annan, A.P. (2009). *Electromagnetic Principles of Ground Penetrating Radar*. In *Ground Penetrating Radar Theory and Applications* (Elsevier).
4. Society of Exploration Geophysicists Journals: *The Leading Edge, Geophysics, Near Surface Geophysics*

M.F

CHAIRMAN
Department of Earth Sciences

GEOL- 6185	Rock Physics & Petrophysical Analysis	3(3-0)

Course Brief:

Rock Physics & Petrophysical Analysis explores the relationships between the physical and mechanical properties of rocks and their behavior under varying geological conditions. The course integrates rock physics theory with petrophysical data analysis to characterize subsurface formations. Students will learn how to interpret well logs, core data, and seismic attributes to evaluate reservoir properties such as porosity, permeability, saturation, and lithology. Emphasis is placed on the link between rock properties and geophysical measurements, supporting applications in hydrocarbon exploration, reservoir modeling, and energy geoscience. The course combines theoretical concepts with practical analysis techniques to prepare students for real-world subsurface evaluations.

Course Learning Objectives:

This course aims to provide students with a strong understanding of the physical principles governing rock behavior and the interpretation of petrophysical data. Students will learn to analyze and integrate well logs, core measurements, and seismic data to estimate key reservoir properties. The course enhances students' ability to connect rock physics models with petrophysical measurements for subsurface characterization. By the end of the course, students will be able to evaluate rock-fluid interactions, interpret log responses, and apply rock physics workflows in hydrocarbon and other subsurface resource studies.

Course Contents:

1. Introduction to rock physics and petrophysics: scope and applications
2. Elastic properties of rocks: stress, strain, bulk and shear modulus, Poisson's ratio
3. Rock texture and mineralogy: impact on geophysical response
4. Wave propagation in rocks: acoustic and seismic wave behavior
5. Porosity, permeability, and fluid saturation: definitions and measurement methods
6. Electrical properties of rocks and Archie's law
7. Well log interpretation: SP, resistivity, gamma ray, density, neutron, and sonic logs
8. Core analysis and laboratory measurement techniques
9. Rock physics models: Gassmann's equations, Hertz-Mindlin theory, and effective medium theory
10. Lithology and fluid discrimination using crossplots and log overlays
11. Seismic petrophysics: linking rock properties with seismic attributes
12. Velocity-porosity relationships and rock typing
13. Inversion techniques and uncertainty in petrophysical analysis
14. Applications in reservoir characterization, monitoring, and geomechanics

Recommended Texts:

1. Mavko, G., Mukerji, T., & Dvorkin, J. (2020). *The Rock Physics Handbook: Tools for Seismic Analysis of Porous Media* (3rd ed.). Cambridge University Press.
2. Tiab, D., & Donaldson, E.C. (2015). *Petrophysics: Theory and Practice of Measuring Reservoir Rock and Fluid Transport Properties* (4th ed.). Gulf Professional Publishing.
3. Asquith, G., Krygowski, D., & Gibson, C. (2004). *Basic Well Log Analysis* (2nd ed.). AAPG Methods in Exploration Series.
4. Schön, J.H. (2015). *Physical Properties of Rocks: Fundamentals and Principles of Petrophysics* (2nd ed.). Elsevier.

Suggested Readings:

1. Batzle, M., Han, D.-H., & Castagna, J. (2006). *Elastic properties of reservoir rocks*. In SEG publications.
2. Avseth, P., Mukerji, T., & Mavko, G. (2005). *Quantitative Seismic Interpretation: Applying Rock Physics Tools to Reduce Interpretation Risk*. Cambridge University Press.
3. Hurst, A., et al. (2000). *Petrophysical Evaluation of Hydrocarbon Reservoirs*. Geological Society, London, Special Publications.

M.F

GEOL- 6186	Seismic Reflection Techniques	3(3-0)

Course Brief:

Seismic Reflection Techniques is a foundational course in geophysical exploration, focusing on the acquisition, processing, and interpretation of seismic data to image subsurface geological structures. It introduces students to the principles of seismic wave propagation, reflection theory, and data collection in both land and marine settings. The course covers each stage of the seismic workflow—from survey design and field acquisition to signal processing and structural interpretation. Emphasis is placed on how seismic reflection methods are used in hydrocarbon exploration, environmental studies, and subsurface characterization. By learning the technical and interpretive aspects of seismic reflection, students gain skills crucial for careers in geophysics, geology, and energy industries.

Course Learning Objectives:

This course provides students with a comprehensive understanding of seismic reflection methods used to investigate the Earth's subsurface. Students will learn the physical principles of seismic wave behavior, the design of reflection surveys, and how to acquire and process seismic data. By applying interpretation techniques, students will gain the ability to identify geological features such as faults, folds, and stratigraphic boundaries. The course also develops students' critical thinking in evaluating data quality, resolving ambiguity, and integrating seismic with geological information for resource exploration and geotechnical applications.

Course Contents:

1. Introduction to seismic reflection methods and their applications
2. Fundamentals of seismic wave propagation and reflection
3. Reflection coefficients and the seismic wavelet
4. Survey design: 2D vs 3D acquisition geometries
5. Field acquisition methods and instrumentation
6. Seismic data formats and quality control
7. Signal processing: deconvolution, filtering, gain recovery
8. Velocity analysis and normal moveout (NMO) correction
9. Stacking and migration techniques
10. Interpretation of seismic sections: horizons, faults, and stratigraphy
11. Synthetic seismograms and well tie methods
12. Seismic attribute analysis for stratigraphic and structural interpretation
13. Limitations and resolution in seismic reflection imaging
14. Case studies in petroleum exploration, geohazard mapping, and shallow subsurface investigations
15. Integration with other geophysical and geological data

Recommended Texts:

1. Yilmaz, Ö. (2001). *Seismic Data Analysis* (2nd ed.). Society of Exploration Geophysicists.
2. Kearey, P., Brooks, M., & Hill, I. (2013). *An Introduction to Geophysical Exploration* (4th ed.). Wiley-Blackwell.
3. Badley, M.E. (1985). *Practical Seismic Interpretation*. International Human Resources Development Corporation.

Suggested Readings:

1. Telford, W.M., Geldart, L.P., & Sheriff, R.E. (1990). *Applied Geophysics* (2nd ed.). Cambridge University Press.
2. Bacon, R., Simm, R., & Redshaw, T. (2007). *3-D Seismic Interpretation*. Cambridge University Press.
3. Chopra, S., & Marfurt, K.J. (2007). *Seismic Attributes for Prospect Identification and Reservoir Characterization*. SEG.

M.F

GEOL- 6187	Seismology & Earthquake Physics	3(3-0)

Course Brief:

Seismology & Earthquake Physics is a core geoscience course focused on the study of seismic waves and the physical processes behind earthquakes. It explores the origin, propagation, and recording of seismic waves, along with the mechanics of faulting and stress in the Earth's crust. Students will learn how seismological data is used to locate earthquakes, determine their magnitude, and analyze Earth's interior. The course combines theoretical foundations with practical applications, including seismic hazard assessment and the interpretation of global and regional seismicity. It prepares students for careers in geophysics, hazard mitigation, and Earth system science by equipping them with tools to understand and analyze seismic phenomena.

Course Learning Objectives:

This course aims to introduce students to the fundamentals of seismology and the physics of earthquakes. Students will understand the different types of seismic waves, how they are generated and recorded, and what they reveal about Earth's interior. The course develops students' ability to analyze earthquake mechanisms, compute magnitudes and locations, and assess seismic hazards. It also builds a foundation in fault mechanics, stress accumulation and release, and the seismic cycle. By the end of the course, students will be able to interpret seismograms, use basic modeling techniques, and apply seismic data to real-world geophysical problems.

Course Contents:

1. Introduction to seismology and earthquake science
2. Types and properties of seismic waves (P, S, surface waves)
3. Seismometers and seismic networks: instrumentation and data acquisition
4. Earthquake location and magnitude determination
5. Seismograms: interpretation and waveform analysis
6. The elastic rebound theory and earthquake cycles
7. Fault mechanics and rupture dynamics
8. Earthquake focal mechanisms and moment tensors
9. Seismic wave propagation and Earth structure
10. Earthquake source models and scaling laws
11. Seismicity patterns and Gutenberg-Richter relationship
12. Global tectonics and earthquake distribution
13. Seismic hazard, risk, and mitigation strategies
14. Induced seismicity and human-triggered earthquakes
15. Recent case studies of major global and regional earthquakes

Recommended Texts:

1. Stein, S., & Wysession, M. (2003). *An Introduction to Seismology, Earthquakes, and Earth Structure*. Wiley-Blackwell.
2. Shearer, P.M. (2019). *Introduction to Seismology* (3rd ed.). Cambridge University Press.
3. Aki, K., & Richards, P.G. (2002). *Quantitative Seismology* (2nd ed.). University Science Books.
4. Scholz, C.H. (2019). *The Mechanics of Earthquakes and Faulting* (3rd ed.). Cambridge University Press.

Suggested Readings:

1. Udías, A., & Buforn, E. (2017). *Principles of Seismology: Planet Earth and Its Evolution*. Cambridge University Press.
2. Dahlen, F.A., & Tromp, J. (1998). *Theoretical Global Seismology*. Princeton University Press.

M.F

Interdisciplinary/Allied courses:

GEOG- 5101	Fundamentals of Geography	3(3-0)

Course Brief:
This course is graduate-level course to expose students with the founding principles of Geography and geographical knowledge. A systematic descriptive introduction to the diverse elements of landscape including geomorphic, climatic, and biotic elements, human settlement and land-use patterns; cartographic approaches to the analysis of selected processes of landscape change. This course provides an opportunity for understanding part of the complex physical and biological environment in which human beings live.

Course Learning Objectives:
The students will learn about nature and processes of geo-system and its constituent parts: atmosphere, lithosphere, hydrosphere and biosphere; structure and composition of the atmosphere: atmospheric circulation, weather and climate, energy transmission, spatial variation of energy inputs and energy budget; structure and composition of the earth: tectonics and related processes; hydrological cycle and its components: precipitation, evapotranspiration, groundwater, surface water and the oceans; vegetation zones of the world: world soils, ecosystems, biomes, energy and matter flows.

Course Contents:

1. Introduction, Definitions, scope and branches of Geography
2. Roots of the discipline and basic geographic concepts
3. Themes and traditions of Geography
4. Tools of Geography, The Universe, Galaxies and solar system
5. The Earth as a planet, Celestial positions, its shape and size
6. Rotation, revolution and related phenomena
7. Spheres of the earth, Lithosphere, Atmosphere, Hydrosphere
8. Biosphere
9. Man-environment interaction
10. Population
11. Major Economic activities
12. Settlements
13. Pollution

Lab. Work

1. Comprehension of atlases
2. Map reading skills, location of places
3. Features and relevant work related to topics of the theoretical section.

Recommended Texts

1. Arbogast, A. F. (2007).Discovering physical geography.London: John Wiley and Sons.
2. Christopherson, R. W. (2009).Geo systems: an introduction to physical geography. New Jersey: Pearson Prentice Hall.

Suggested Readings

1. De Blij, H. J and Muller, P. O. (1996).Physical geography of the global environment.London: John Wiley and Sons.
2. Strahler, A. (2013).Introduction to physical geography. New Jersey: John Wiley & Sons.

M.F

CHAIRMAN
Department of Earth S.
UNIVERSITY OF BALOCHI
QUETTA

URCM - 5107	Mathematics I	3(3-0)

Course Brief:

The goal of Mathematics I is to prepare students for first-year Calculus. Helping students gain proficiency in their understanding and ability to utilize real-valued functions, the primary tool in Calculus, accomplishes this goal. Students are presented a broad set of 'function tools', including a general understanding of function properties together with a 'library' of commonly used functions.

Course Learning Objectives:

This course intended that students will become skilled at recognizing the different families of functions and the primary properties that set each apart, are able to apply the general function properties to each type of function, and are able to use the special set of algebraic skills associated with each. Students are also expected to become adept in utilizing and interpreting the results from graphing calculators, as an important investigative tool.

Course Contents:

1. Preliminaries
2. Real-number system, complex numbers
3. Introduction to sets, set operations, functions, types of functions.
4. Matrices Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.
5. Quadratic Equations
6. Solution of quadratic equations, qualitative analysis of roots of a quadratice
7. Equations reducible to quadratic equations
8. Cube roots of unity, relation between roots and coefficients of quadratic
9. Sequences and Series
10. Arithmetic progression
11. Geometric progression
12. Harmonic progression
13. Binomial Theorem
14. Introduction to mathematical induction
15. Binomial theorem with rational and irrational indices.
16. Trigonometry, Fundamentals of trigonometry, Trigonometric identities.

Recommended Texts:

1. Thomas, G. B., & Finney, A. R. *(2005). Calculus.* Reading: Addison-Wesley.
2. Anton, H., Bevens. L, & Davis, S. (2005). *Calculus: A new horizon* (8th ed.). New York: John Wiley.

Suggested Readings:

1. Stewart, J. (1995). *Calculus* (3rd ed.). Pacific Grove, California: Brooks/Cole.
2. Swokowski, E. W. (1983). *Calculus and analytic geometry.* Boston: PWS-Kent Company.
3. Thomas, G. B., & Finney, A. R. (2005). *Calculus* (11th ed.). Reading: Addison-Wesley

M.F

URCM – 5108	Mathematics II	3(3-0)

Course Brief:

Calculus is the mathematical study of continuous change. It has two major branches, differential calculus and integral calculus. Both branches make use of the fundamental notions of convergence of infinite sequences and infinite series to a well-defined limit. Modern calculus is considered to have been developed in 17th century .

Course Learning Objectives:

This course in calculus is a gateway to other, more advanced courses in mathematics devoted to the study of functions and limits, broadly called mathematical analysis. Calculus is used in every branch of the physical sciences, actuarial science, computer science, medicine, demography, and in other fields. It allows one to go from rates of change to the total change or vice versa, and many times in studying a problem we know one and are trying to find the other. This course aims to provide students with the essential concepts of mathematics and how these can be employed for analyzing real data.

Course Contents:

1. Preliminaries
2. Real-number line
3. Functions and their graphs
4. Solution of equations involving absolute values, inequalities.
5. Limits and Continuity
6. Limit of a function
7. Left-hand and right-hand limits
8. Continuity
9. Continuous functions.
10. Derivatives and their Applications
11. Differentiable functions
12. Differentiation of polynomial
13. Rational and transcendental functions, derivatives.
14. Integration and Definite Integrals
15. Techniques of evaluating indefinite integrals
16. Integration by substitution, integration by parts
17. Change of variables in indefinite integrals.

Recommended Texts:

1. Thomas, G. B., & Finney, A. R. *(2005). Calculus.* Reading: Addison-Wesley.
2. Anton, H., Bevens. L, & Davis, S. (2005). *Calculus: A new horizon* (8th ed.). New York: John Wiley.

Suggested Readings:

1. Stewart, J. (1995). *Calculus* (3rd ed.).Pacific Grove, California: Brooks/Cole.
2. Swokowski, E. W. (1983). *Calculus and analytic geometry*. Boston: PWS-Kent Company.
3. Thomas, G. B., & Finney, A. R. (2005). *Calculus* (11th ed.), Reading: Addison-Wesley.

M.F

CHEM-5101	Physical Chemistry	3 (3-0)

Course Brief:

This course provides foundation and basic level knowledge of physical chemistry to under graduate students. This foundation course covers introduction of physical chemistry along with its application for learning principles of physico-chemical phenomenon. This offer complementary approaches to the fundamental understanding of chemical systems. Students will acquire knowledge to enable themselves to understand the elementary mathematics, physical state of matter, atomic structure, chemical thermodynamics, kinetic theory of gases, collision theory of reactions, fundamental principles and laws of thermodynamics, chemical equilibria and chemical kinetics and investigate the physical properties of ideal/non-ideal binary solutions. Students will also be able to study the rates of reactions and perform related calculations. Students will also be introduced about basics of electrochemistry.

Course Learning Objectives:

The general goal of learning this physical chemistry course is to obtain a vision of matter-energy relationship in physical and chemical systems. Learning objectives emphasized in this course involve developing an understanding of basic principles of physical chemistry.

Course Contents:

1. Elementary Mathematics: Logarithmic, exponential and trigonometric functions
2. Differentiation of elementary functions, Physical States of Mater
3. Atomic Structure, De Brogile equation, Pauli Exclusion Principle, Hund's Rule.
4. Schrodinger wave equation
5. Dipole moment,Chemical Thermodynamics, First and second law of thermodynamics
6. Chemical Equilibrium, Law of Mass Action and LeChaterlier's Principle.
7. Solutions, composition, ideal and non-ideal solutions, Raoult's law.
8. Chemical Kinetics, change of entropy, Zero, first and second order reaction, Arrhenius equation
9. Electrochemistry, Conductance, dependence of conductance
10. Kohlrausch's law and its applications

Recommended Texts:

1. Atkins, P., Paula, J., & Keeler, J. (2017). *Atkins' physical chemistry.* (11th ed.). UK: Oxford University Press.
2. Kuhn, H., Försterling, H., & Waldeck, D.H. (2009). Principles of physical chemistry. (2nd ed.). USA: Wiley Publisher.

Suggested Readings

1. Akhtar, M.N., & Nabi, G. (2006). *Text book of physical chemistry.* Lahore: Ilmi Kitab Khawna.
2. Das, R.C., & Behera, B. (2003). *Experimental physical chemistry.* Delhi: Tata McGraw Hill.

CHEM-5102	Inorganic Chemistry	3 (3-0)

Course Brief:

This course covers a range of general topics of inorganic chemistry. It will provide a useful supplement to the advanced courses specified in the department. This course aims to enable the students to achieve the advance knowledge about the key introductory concepts of chemical bonding, acid-base chemistry, and properties of the representative and transition elements, as well as using this knowledge for qualitative and quantitative analysis of inorganic compounds during laboratory work. Learning objectives emphasized in CHEM 5102 involve developing an understanding of basic principles of inorganic chemistry.

Course Learning Objectives:

It develop critical thinking skills enabling students to solve chemistry problems that incorporate their cumulative knowledge. Students learned in class to modern chemistry techniques which give them opportunities to upgrade their knowledge about advanced inorganic concepts. The essence of this course is to develop study skills that students need to succeed in university-level chemistry courses and preparation of students for professional positions in chemistry.

Course Contents:

1. Periodic Table and Periodicity of Properties
2. Redox potential, electrochemical series and its applications. Corrosion and electroplating.
3. Acid Base Equilibria: Acids and bases, relative strengths of acids, pH, pKa, pKb.
4. Hard and soft acid and Bases. SHAB Principle and its application.
5. Buffers, types buffer, Preparation, Buffer capacity and applications of buffers.
6. Chemical Bonding, VBT, MOT, VSEPR. Special types of bonds
7. Chemistry of p-Block Elements
8. Production of pure silicon chips for solar energy cells.
9. Chemistry of d-Block Elements Werner's theory, VBT, MOT and CFT
10. Isomerism in coordination compounds.
11. Chelates, Classification and applications
12. Separation Techniques: General introduction and Applications
13. Principle, brief instrumentation(Flame emission, Atomic Absorption, IR and UV/Vis).
14. Metallurgy of Al, Cr and U, fertilizers (Urea and Phosphate fertilizers) Cement and Sugar.

Recommended Texts:

1. Iqbal, M. Z. (2015). *Text book of inorganic chemistry.* Lahore: Ilmi Kitab Khana
2. Lee, J. D. (1996). *Concise inorganic chemistry.* (5th ed.). UK: Chapman and Hall

Suggested Readings:

1. Graham, H., & Man, H. (2000). *Chemistry in context.* (5th ed.). UK: Thomas Nelson Ltd.
2. Philp, M. (1996). Advance chemistry. UK: Cambridge Publishing.

PHYS-5101	Mechanics- I	3(3-0)

Course Brief:

Mechanics is all about motion of body. It deals with forces, motion, stress, strain and further to the laws of motion in inertial frames specifically. This course also provides the students a broad understanding of the physical principles of the classical dynamics, to describe mechanical events that involve forces acting on macroscopic objects with quantitative skills, to motivate them to think creatively and critically about scientific problems and experiments (thought as well real-life).

Course Learning Objectives:

A student studying this course will understand classical physics and will also develop the skills to apply principles to the practical life problems. Students are encouraged to share their thinking with teachers and the other students to examine different problem-solving strategies.

Course Contents:

1. Measuring things, displacement, average velocity and speed, acceleration, constant acceleration, free fall acceleration, graphical integration in motion analysis
2. Vectors and their components, adding vectors by components, multiplying vectors
3. Unit vector, vector representation of quantities, projectile motion, uniform circular motion
4. Relative motion in one dimension, relative motion in two dimensions
5. Newton's first and second law, some particular forces, applying newton laws, friction
6. Drag force, uniform circular motion, kinetic energy, work and kinetic energy
7. Work done by gravitational force, work done by a spring force
8. Work done by a general variable force, power, potential energy, conservation of energy
9. Conservation of mechanical energy, work done on a system by an external force
10. Conservation of energy, center of mass, newton's second law for system of particles
11. Linear momentum, collision and impulse, momentum and kinetic energy in collision
12. Elastic collision in one dimension, collisions in one/two dimensions
13. Conservation of linear momentum and system with varying mass
14. Modulus of rigidity by static & dynamic method (maxwell's needle, barton's apparatus)
15. To determine the value of "g" by compound pendulum/kater's pendulum
16. To study the conservation of energy (hook's law)
17. To determine elastic constants by spiral springs
18. To study the laws of vibration of stretched string using sonometer
19. Modulus of rigidity by static & dynamic method (maxwell's needle, barton's apparatus)

Recommended Texts:

1. Halliday, D., Resnick, R. & Walker, J. (2014). *Fundamentals of physics* (10th ed.). New York: Wiley.
2. Halliday, D., Resnick, R. & Krane, K. S. (2003). *Physics* (5th ed.). New York: Wiley.

Suggested Readings:

1. Young, H. D., Freedman, R. A. & Ford, A. L. (2019). *University physics* (15th ed.). New York: Pearson.
2. Serway, R. A. & Jewelt, J. W. (2014). *Physics for scientist and engineers* (9th ed.). New York: Brooks/Cole.
3. Melissinos, A.C. (2003). *Experiments in modern physics*. New York: Academic press.

STAT-5121	Introduction to Statistics	3(3-0)

Course Brief:

This course is designed for under-graduate level. Statistical analysis is a basic requirement in order toanalyze the phenomenon related to all sectors.

Course Learning Objectives:

This course aims to produce skills related to descriptiveas well as inferential statistical analysis. Use of descriptive, inferential, regression, sampling statisticshas vital importance to analyze and decision making theories related to agriculture, economics andbusiness statistics etc.

Course Contents:

1. Introduction to Statistics: Descriptive and Inferential Statistics,
2. Limitations of Statistics
3. Scope of Statistics
4. Variable, Data, Types of Variable and Data, Scales of Measurements.
5. Display of Data: Tabulation of Data, Graphical Display, Histogram, Bar Charts, Pie Chart,
6. Stem and Leaf Plots.
7. Measures of Central Tendency: Mean Median, Mode, Box Plot, and Application in Real Life.
8. Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Variance and Standard
9. Deviation, Coefficient of Variation, Z-score and their Application.
10. Normal Distribution: Normal Distribution and its Application,
11. Sampling and Sampling Distribution.
12. Estimation:
13. Hypothesis Testing
14. Regression and Regression Analysis: Simple Linear Regression, Multiple Regression, Fitness
15. Model.
16. All the observational analysis will be carried out using MS Excel and SPSS.

Recommended Texts:

1. Chaudhry, S.M. &Kamal,S.(2010). *Introduction to statistical theory.* (Parts I &II). Lahore: IlmiKitabKhana.
2. Walpole,R.E.,Mysters,R.H. & Myers,S.L.(1998). *Probability and statistics for engineers andscientists.* New York: Prentice Hall.

Suggested Readings

1. Mclave, J.T., Benson, P.G.& Snitch.(2005).*Statistics for business & economics.*New Jersey: Prentice Hall.
2. Spiegel, M.R., Schiller, J.L. &Srinivasan, R.L. (2000) Probability and statistics. New York: McGraw Hill
3. Clark, G. M.,& Cooke, D. (1998). Basic course in statistics. London: Arnold.

GEOG – 5109	Climatology	3(3-0)

Course Brief:

The course provides an overview of the physical processes responsible for determining global and regional climate. This course gives a general introduction to meteorology and climatology. Meteorology topics include energy balance, moisture and cloud development in the atmosphere, atmospheric dynamics, small and large scale circulations, storms and cyclones, and weather forecasting. Climatology topics include the interaction between the atmosphere and oceans over long time periods, climate classification, and the potential for climatic change. It brings together information from rural communities, indigenous peoples and research workers on how they use agro- biodiversity to cope with climate change.

Course Learning Objectives:

It stimulates communication between agro-biodiversity researchers, users and maintainers. It identifies tools and practices relevant to using agro-biodiversity for coping with climate change and making these widely available. It also promotes awareness of the vital role of agro-biodiversity in adapting to climate change among key audiences, including donors, development agents and the global biodiversity community.

Course Contents:

1. Introduction.
2. Key concepts in climatology and meteorology.
3. Structure and composition of atmosphere.
4. Elements and factors of climate.
5. Insolation and Terrestrial heat budget.
6. Temperature distribution.
7. Humidity and its types; Condensation and their forms, Precipitation, formation and their types.
8. Atmospheric Pressure and global pressure belts.
9. Atmospheric Circulation: (Upper and Lower) air stability and instability, storms; Cyclones (hurricanes, typhoons) and tornadoes
10. Air masses and fronts.
11. Classification of climates; critical study of the Koppen, Miller and Thornthwaite classifications of major climates.
12. Climate variability and climate change: Natural and anthropogenic; Greenhouse gasses; global warming; acid rain, ozone layer depletion El-Niño and La-Niña, impact on precipitation distribution.
13. Climatic regions of Pakistan and their characteristics
14. Climatic data: sources, collection, analysis and presentation. Problems associated with data quality (spatial, temporal).

Recommended Texts:

1. Miller A. (2001). *Climatology*. Haryana: Shubhi Publications.
2. Barry. R. (1998). *Atmosphere, weather and climate*. London: Routledge.

Suggested Readings:

1. Shamshad, K.M. (1988). *The meteorology of Pakistan*. Karachi: Royal Book Co.
2. Strahler, A. N. (1998). *Elements of physical geography*. New York: John Wiley.
3. Diwan A. P. &Arora, D. K. (1995). *Origin of ocean*. New York: John Wiley

GEOG-6118	Environmental Geography	3(3-0)

Course Brief:

In this subject of Geography, students will learn about the natural science, social science, and humanistic understandings of the Earth's environment. Environmental Geographers study the complex relationships between humans and the natural environment over time and through space. This course will provide a historical, geographical, and humanistic foundation for understanding the environment and the plethora of environmental issues that confront us at the beginning of this century.

Course Learning Objectives:

Major aim of this course is to produce environmentally aware students and to equip them with skills to enable them to become future decision-makers on environmental matters in whatever field they wish to pursue in the future. By studying this course students will be able to recognize what the issues are, and to view them from a geographic perspective. They will recognize the responsibilities they have in relation to other people, the environment, and sustainability, and there will be opportunities to initiate personal action.

Course Contents:

1. Evolution of Environmental Studies in Geography
2. Comparative Advantage of Geography
3. Concept of environmental management
4. Environment and Man interaction, Ecosystem, natural resources
5. Important Cycles
6. Population explosion, The human impact on the environment
7. Environmental hazards, Types of Hazards
8. Major Environmental hazards and Problems in Pakistan: Floods, Earthquake, Tsunami, Cyclones, Landslides, Droughts, Deforestation and Desertification
9. Water-logging and Salinity
10. Soil Erosion
11. Global Warming and ozone depletion
12. Environmental Pollution, Waste Management, Control and Mitigation Measures, Technology, awareness, Legislation, Ethics
13. Pakistan Environmental Act
14. National Conservation Strategy
15. National Environmental Quality Standard

Recommended Texts:

1. Arms, K. (2001). Environmental science. Philadelphia: Asunders College Publishing.
2. Basak, A. (2009). Environmental studies. New Delhi: Pearson.

Suggested Readings:

1. Botkin, D. B. & Edward A. K. (2012). Environmental science. Hoboken: John Wiley & Sons.
2. Burton, I. R., W. Kates & Gilbert. F. W. (2000). The environment as hazard. Karachi. Oxford University Press.

M.F

MATH-6139	Fluid Mechanics-I	3(3-0)

This course is the first part of the core level course on fluid mechanics. Fluid mechanics is the branch of physics concerned with the mechanics of fluids (liquids, gases, & plasmas) & the forces on them. It has applications in a wide range of disciplines, including mechanical, civil, chemical & biomedical engineering, geophysics, oceanography, meteorology, astrophysics, & biology. The course of fluid mechanics is introducing fundamental aspects of fluid flow behavior. Students will learn properties of Newtonian fluids; apply concepts of mass, momentum & energy conservation to flows.

Contents

1 Introduction: Definition of Fluid, basics equations
2 Methods of analysis, dimensions & units. Fundamental concepts
3 Fluid as a continuum, velocity field, stress field, viscosity, surface tension, description & classification of fluid motions
4 Fluid Statics: The basic equation of fluid static
5 The standard atmosphere
6 Pressure variation in a static fluid
7 Fluid in rigid body motion. Basic equation in integral form for a control volume
8 Basic laws for a system
9 Relation of derivatives to the control volume formulation
10 Conservation of mass
11 Momentum equation for inertial control volume
12 Momentum equation for control volume with rectilinear acceleration
13 Momentum equation for control volume with arbitrary acceleration
14 The angular momentum principle
15 The first law of thermodynamics
16 The second law of thermodynamics
17 Introduction to differential analysis of fluid motion
18 Conservation of mass
19 Stream function for two-dimensional incompressible flow
20 Motion of a fluid element (kinematics), momentum equation

Recommended Texts

1. Fox, R. W.,& McDonald, A. T. (2004). *Introduction to fluid mechanics* (6th ed.). New York: John Wiley & Sons.
2. White, F. M. (2006). *Fluid mechanics* (5th ed.). New York: Mc. Graw Hill.

Suggested Readings

1. Granger, R. A. (1985). *Fluid mechanics* (1st ed.). Montana: Winston Publisher.
2. Bruce, R., Rothmayer, A. P., Theodore, H. O.,& Wade, W. H. (2013). *Fundamental of fluid mechanics* (7th ed.). New York: Willey Son Publisher.
3. Nakayama, Y. (2018). *Introduction to fluid mechanics* (2nd ed.). Oxford: Butterworth-Heinemann Publisher.

M.F

MATH-6140	Fluid Mechanics-II	3(3-0)

This course is the second part of the core level course on fluid mechanics. Fluid mechanics is concerned with the mechanics of fluids (liquids, gases, & plasmas) & the forces on them. This course covers properties of fluids, laws of fluid mechanics & energy relationships for incompressible fluids Studies flow in closed conduits, including pressure loss, flow measurement, pipe sizing & pump Selection, momentum equation for frictionless flow, Euler's equations, Bernoulli equation- Integration of Euler's equation, laminar flow & Boundary layers.

Contents

1 Incompressible inviscid flow
2 Momentum equation for frictionless flow
3 Euler's equations
4 Euler's equations in streamline coordinates
5 Bernoulli equation- Integration of Euler's equation along a streamline for steady flow
6 Relation between first law of thermodynamics & the Bernoulli equation
7 Unsteady Bernoulli equation-Integration of Euler's equation along a streamline
8 Irrotational flow, internal incompressible viscous flow
9 Fully developed laminar flow
10 Fully developed laminar flow between infinite parallel plates
11 Fully developed laminar flow in a pipe
12 Part-B Flow in pipes & ducts
13 Shear stress distribution in fully developed pipe flow
14 Turbulent velocity profiles in fully developed pipe flow
15 Energy consideration in pipe flow
16 External incompressible viscous flow
17 Boundary layers, the boundary concept, boundary thickness, laminar flat plate
18 Boundary layer: exact solution, momentum, integral equation,
19 Use of momentum integral equation for flow with zero pressure gradient
20 Pressure gradient in boundary-layer flow

Pre-requisite: Fluid Mechanics-I

Recommended Texts

1. Fox, R. W., & McDonald, A. T. (2004). *Introduction to fluid mechanics* (6th ed.). New York: John Wiley & Sons.
2. White, F. M. (2006). *Fluid mechanics* (5th ed.). New York: Mc. Graw Hill.

Suggested Readings

1. Bruce, R., Rothmayer, A. P., Theodore, H. O.,& Wade, W. H. (2013). *Fundamental of fluid mechanics* (7th ed.). New York: Willey Son Publisher.
2. Nakayama, Y. (2018). *Introduction to fluid mechanics* (2nd ed.). Oxford: Butterworth Heinemann Publisher.
3. Granger, R. A. (1985). *Fluid mechanics* (1st ed.). Montana: Winston Publisher.

M.F

MATH-6134	Heat Transfer	3(3-0)

Heat transfer is a discipline of thermal engineering that concerns the generation, use, conversion, & exchange of thermal energy (heat) between physical systems. Heat transfer is classified into various mechanisms, such as thermal conduction, thermal convection, thermal radiation, & transfer of energy by phase changes. The objectives of heat transfer include the following: Insulation, wherein across a finite temperature difference between the system & its surrounding, the engineer seeks to reduce the heat transfer as much as possible. The learning outcomes of this course are: to explain the basics of heat transfer, to explain the importance of heat transfer, to define the concept of boiling & condensation, to define the concept of heat exchangers, to explain heat transfer by conduction, to explain the Fourier heat conduction law, to define thermal conductivity coefficient & diffusion coefficient, to explain heat transfer with convection, to explain Newton's law, to explain free transport phenomenon, to explain the forced convection, to explain heat transfer by radiation.

Contents

1 First law of thermodynamics
2 Second law of thermodynamics
3 Fourier's law of heat conduction
4 Newton's law of cooling
5 Energy equation
6 Steady-State Conduction-One Dimension
7 Steady-State Conduction-Multiples Dimensions
8 Unsteady-State Conduction,
9 Principles of Convection
10 Empirical & practical Relations
11 Forced –Convection Heat Transfer
12 Natural Convection Systems
13 Radiation Heat Transfer
14 Laminar forced flow over a flat plate
15 Thermal boundary layer on an isothermal flat plate
16 Thermal boundary layer on a flat plate with constant surface heat flux

Recommended Texts

1. Holman, J. P. (1996). *Heat transfer* (8th ed.). New York: McGraw Hill.
2. Kays, W. M.,& Crawford, M. E. (1993). *Convective heat & mass transfer* (3rd ed.). New York: McGraw Hill.
3. Sadik Kakac, and Yamman Yener. (1995). Convective heat transfer (2nd ed.). CRC Press United States of America

Suggested Readings

1. Incropera, F. P., & Dewitt, D. P. (1985). *Fundamentals of heat & mass transfer* (2nded). New York: Wiley.
2. Cenegel, Y., & Ghajar, A. J. (2015). *Heat & mass transfer: Fundamentals & applications*(5th ed.). New York: McGraw Hill.
3. Lienhar IV, J. H., & Lienhar V, J. H. (2019). *A heat transfer textbook*(5th ed.). New York: Dover Publications.
4. Incropera, F. P. (2006). *Fundamentals of heat & mass transfer* (6th ed.). New York: John Wiley & Sons.

M.F

GEOG -5104	Map Work	3(2-1)

Course Brief:

A unique aspect of geography is that it exposes students to a wide range of techniques for helping to understand human and environmental patterns and processes. Mapmaking is the study and practice of making representations of the Earth on a flat surface.

Course Learning Objectives:

This study includes everything from the gathering, evaluation and processing of source data, through the intellectual and graphical design of the map, to the drawing and reproduction of the final document. As such, it is a unique mixture of science, art and technology and calls for a variety of in-depth knowledge and skills on the part of the cartographer.

Course Contents:

1. Maps
2. Elements and types
3. Principles and methods of map making
4. Reading and reproduction
5. Scale: types and their use
6. Grid reference and indexation,
7. Map projections
8. Cylindrical
9. Conical
10. Zenithal
11. Construction, characteristics, and uses
12. Enlargement and reduction of maps
13. A study of the Survey of Pakistan maps
14. Physical and cultural features to be described and interpreted
15. Interpretation of weather maps of Pakistan

Recommended Texts:

1. Singh, G. (2009). *Map work and practical geography*. New Delhi: Vikas Publishing House Pvt. Ltd.
2. Singh, L. &Raghu,N. S. (2000) *Map work and practical geography*. New Delhi: Kalyanipublishers.

Suggested Readings:

1. Khan, M. Z. A. (1998). *Text Book of Practical Geography*. Delhi: Concept Publishing Company.
2. Bygott, J. (1952). *An introduction to mapwork and practical geography*. London: University Tutorial Press.
3. Bygott, J. (1955). *Mapwork and practical geography*. London: University Tutorial Press.

M.F

GEOG -5112	Principles of Cartography	3(1-2)

Course Brief:

Cartography or mapmaking is the study and practice of making representations of the Earth on a flat surface. The discipline of cartography combines science, aesthetics, and technical ability to create a balanced and readable representation that is capable of communicating information effectively and quickly.

Course Learning Objectives:

Cartography is a complex, an ever-changing field, but at the center of it is the map-making process. Viewed in the broadest sense, this process includes everything from the gathering, evaluation and processing of source data, through the intellectual and graphical design of the map, to the drawing and reproduction of the final document. As such, it is a unique mixture of science, art and technology and calls for a variety of in-depth knowledge and skills on the part of the cartographer.

Course Contents:

1. Evolution of Cartography
2. Basic geodesy, spherical, ellipsoidal and geoidal earth, geographical and planer.
3. Coordinates, properties of the graticule and geodetic position.
4. Map projections: Major types, merits and demerits of commonly used map projections.
5. Map Datum
6. Symbolization, symbol types and graphic variables
7. The symbolization problems, symbolizing graphic features.
8. Lettering principles.
9. Mapping statistical surfaces
10. Thematic map, choropleth, dot map, isolines, area cartograms.
11. Principles of cartographic design, general design problems; design of map symbols
12. Basic procedure and designing of the thematic maps such as topographic, climatic, economic, population, settlements, urban morphology etc.
13. Map production, form of map output, construction material, output options, composing separations, proofing.
14. Introduction to Digital Cartography
15. Terrain data (Digital Elevation Model/ Digital Terrain Model)

Recommended Texts:

1. Singh, G. (2009). *Map work and practical geography*.Karachi: Vikas Publishing House Pvt Ltd.
2. Singh. L. & Raghu naadam, S. (2000). *Map work and practical Geography*. New Delhi: kalyani publishers.

Suggested Readings:

1. Ahmad.Z. (1998). *Text book of Practical geography*. Cambridge: Cambridge University Press.
2. Bygott, J. (2000). *An introduction to mapwork and practical geography*. University Tutorial Press.
3. Bygott, J. (2000). *Mapwork and practical geography*. New Delhi:University Tutorial Press

M.F