UNIVERSITY OF SARGODHA

Office of the Registrar

No. SU/CE 5852
Dated: 11/11/20

Ref: SU/Acad/902
November/ 10 /2020

Notification

The Academic Council in its meeting held on 18.06.2020 has approved the following recommendations made by the Board of Faculty of Sciences in its meeting held on 03.06.2020. The Syndicate in its meeting held on 27.0 2020 has also endorsed the decision of Academic Council:

1. Revised scheme of studies of BS Geology under Semester / Term System from session 2019 (Annex-'A')
2. Revised scheme of studies of MS Geology under Semester / Term System from session 2019 (Annex-'B')
3. Revised scheme of studies of BS Geography under Semester / Term System from session 2019 (Annex-'C')
4. Revised scheme of studies of MS/MPhil Geography under Semester / Term System from session 2020 (Annex-'D')
5. Revised scheme of studies of M.Sc Geography under Semester / Term System from session 2019 (Annex-'E')

Muhammad Farooq
Deputy Registrar (Acad)
10/11/2020

For action!!
11/11/2020

Distribution:

- Chairman, Department of Earth Sciences
- Director, Sub-Campus Bhakkar
- Controller of Examinations
- Principals of all affiliated colleges (concerned)
- Web-Developer *(for uploading on university web-site)*

C.C:

- Focal Person, Faculty of Sciences
- Deputy Registrar (Affiliation)
- Deputy Registrar (Registration)
- Secretary to the Vice-Chancellor
- P.A to Registrar

ADA(CB)
11/11/2020

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REVISED SCHEME OF STUDIES & CURRICULUM
BS GEOLOGY
(Semester / Term System)
(2019)

DEPARTMENT OF EARTH SCIENCES
UNIVERSITY OF SARGODHA
SARGODHA

Revised Scheme of Study For 4-Years BS in Geology w.e.f. Fall 2019
Total Credit Hours: 136

Year-I

Semester - I

Course Code	Course Title	Credit Hour
CHEM-5101	Physical Chemistry	3(3+0)
URCE-5101	Grammar	3(3+0)
GEOL-5101	Introduction to Geology	3(3+0)
URCM-5107	Mathematics I	3(3+0)
PHYS-5101	Mechanics I	3(3+0)
URCI-5105	Islamic Studies	2(2+0)
Total:-	17	

Semester - II

Course Code	Course Title	Credit Hour
CHEM-5102	Inorganic Chemistry	3(3+0)
URCE-5102	Language Comprehension & Presentation Skills	3(3+0)
GEOL-5102	Geomorphology	3(3+0)
URCM-5108	Mathematics II	3(3+0)
PHYS-5103	Mechanics II	3(3+0)
GEOL-5103	Geological Fieldwork- I	3(0+3)
Total:	18	

Year-II

Semester - III

Course Code	Course Title	Credit Hour
URCI-5109	Introduction to information & Communication Technologies	3(3+0)
URCP-5106	Pakistan Studies	3(2+0)
GEOL-5104	Introduction to Paleontology	3(2+1)
GEOL-5105	Stratigraphy	3(2+1)
GEOL-5106	Geostatistics	3(2+1)
GEOL-5107	Mineralogy	3(2+1)
Total:	17	

Semester - IV

Course Code	Course Title	Credit Hour
URCE-5103	Academic Writing	3(3+0)
BUSB-5104	Introduction to Management	3(3+0)
GEOL-5108	Petrography	3(2+1)
GEOL-5109	Igneous Petrology	3(2+1)
GEOL-5110	Structural Geology	3(2+1)
GEOL-5111	Geological Fieldwork-II	3(0+3)
Total:	18	

Year-III

Semester - V

Course Code	Course Title	Credit Hour
GEOL-6112	Geotectonics	3(2+1)
GEOL-6113	Sedimentology	3(2+1)
GEOL-6114	Geophysics	3(2+1)
GEOL-6115	Field Geology	3(3+0)
GEOL-6116	Micropalaeontology	3(2+1)
GEOL-6117	Introduction to GIS and RS	3(2+1)
Total:-	18	

Semester - VI

Course Code	Course Title	Credit Hour
GEOL-6118	Sequence Stratigraphy	3(2+1)
GEOL-6119	Geochemistry	3(2+1)
GEOL-6120	Petroleum Geology	3(2+1)
GEOL-6121	Engineering Geology	3(2+1)
GEOL-6122	Metamorphic Petrology	3(2+1)
GEOL-6123	Geological Fieldwork – III	3(0+3)
Total:	18	

Year- IV

Semester - VII

Course Code	Course Title	Credit Hour
GEOL-6124	Geology of Pakistan	3(3+0)
GEOL-6125	Economic Geology	3(2+1)
GEOL-6126	Environmental Geology	3(2+1)
GEOL-6127	Hydrogeology	3(2+1)
*GEOL- 61--	(Elective course)	3(3+0)
*GEOL- 61--	(Elective Course)	3(3+0)
Total:-	18	

Semester - VIII

Course Code	Course Title	Credit Hour
*GEOL- 61--	(Elective Course)	3(3+0)
*GEOL-61--	(Elective Course)	3(3+0)
GEOL-6190	Thesis	6(0+6)
Total:-	12	

* Students should select the subject from their Specialization list according to respective code as notified by the chairman depending upon available resources.

*** List of Groups and Elective Courses**

Groups	Course Code	Course Title	Credit Hour
Group-I Mineralogy and Petrology	GEOL- 6130	Geochemistry II	3(3+0)
	GEOL-6131	Igneous Petrogenesis	3(3+0)
	GEOL- 6132	Metamorphic Petrology-II	3(3+0)
	GEOL-6133	Sedimentary Petrology-II	3(3+0)
	GEOL- 6134	Mineralogy II	3(3+0)
Group-II Engineering Geology	GEOL- 6135	Rock Mechanics	3(3+0)
	GEOL- 6136	Soil Mechanics	3(3+0)
	GEOL- 6137	Seismotectonics	3(3+0)
	GEOL- 6138	Engineering Geology II	3(3+0)
Group-III Petroleum Geosciences	GEOL- 6139	Sequence Stratigraphy II	3(3+0)
	GEOL- 6140	Petroleum Engineering	3(3+0)
	GEOL- 6141	Reservoir Geology	3(3+0)
	GEOL- 6142	Petroleum Geology of Pakistan	3(3+0)
	GEOL- 6143	Organic Geochemistry	3(3+0)
	GEOL-6144	Geological and Geophysical Software Applications	3(3+0)
	GEOL- 6145	Logging and Log Interpretation	3(3+0)
	GEOL- 5146	Seismic Interpretation	3(3+0)
	GEOL- 6147	Basin Modeling	3(3+0)
Group-IV Applied Geophysics	GEOL- 6148	Seismic Stratigraphy	3(3+0)
	GEOL- 6149	Earthquake Seismology	3(3+0)
	GEOL- 6150	Geomagnetism and Paleomagnetism	3(3+0)
	GEOL- 6151	Electrical and Radiometric Exploration Methods	3(3+0)
	GEOL- 6152	Bore-Hole Geophysics	3(3+0)
	GEOL- 6153	Seismic prospecting	3(3+0)
	GEOL- 6154	Gravity and Magnetic Methods	3(3+0)
	GEOL- 6155	Rock Physics	3(3+0)

GEOL - 5101 **Introduction to Geology** **3(3+0)**

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. 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.

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.

URCE-5101 **Grammar** **3(3+0)**

The course introduces the students to the underlying rules to acquire and use language in academic context. The course aims at developing grammatical competence of the learners to use grammatical structures in context in order to make the experience of learning English more meaningful enabling the students to meet their real life communication needs. The objectives of the course are to, reinforce the basics of grammar, understand the basic meaningful units of language, and introduce the functional aspects of grammatical categories and to comprehend language use by practically working on the grammatical aspects of language in academic settings. After studying the course, students would be able to use the language efficiently in academic and real life situations and integrate the basic language skills in speaking and writing. The students would be able to work in a competitive environment at higher education level to cater with the long term learners' needs.

Contents

1. Parts of speech
2. Noun and its types
3. Pronoun and its types
4. Adjective and its types
5. [illegible] its types
6. Adverb and its types
7. Prepositions and its types
8. Conjunction and its types
9. Phrases and its different types
10. [illegible] different types
11. Sentence, parts of sentence and types of sentence
12. Synthesis of sentence, Conditional sentences, Voices
13. Narration
14. Punctuation
15. Common grammatical errors and their corrections

Recommended Texts

1. Eastwood, J. (2011). *A basic English grammar*. Oxford: Oxford University Press.
2. Swan, M. (2018). *Practical English usage* (8th ed.). Oxford: Oxford University Press.

Suggested Readings

1. Thomson, A. J., & Martinet, A. V. (1986). *A practical English grammar*. Oxford: Oxford University Press.
2. Biber, D., Johansson, S., Leech, G., Conrad, S., Finegan, E., & Quirk, R. (1999). *Longman grammar of spoken and written English*. Harlow Essex: MIT Press.
3. Hunston, S., & Francis, G. (2000). *Pattern grammar: A corpus-driven approach to the lexical grammar of English*. Amsterdam: John Benjamins.

URCM – 5107 **Mathematics I** **3(3+0)**

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. It is intended that students 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.

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. I., & 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.

URCI-5105 **Islamic Studies** **2(2+0)**

Islamic Studies engages in the study of Islam as a textual tradition inscribed in the fundamental sources of Islam; Qur'an 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 bases of Islam in fields that include Qur'anic studies, Hadith and Seerah of Prophet Muhammad (PBUH), Islamic philosophy, and Islamic law, culture and theology through the textual study of Qur'an and Sunnah. Islamic Studies is the academic study of Islam and Islamic culture. It majorly comprises of the importance of life and that after death. It is one of the best systems of education, which makes an ethical groomed person with the qualities which he/she should have as a human being. The basic sources of the Islamic Studies are the Holy Qur'an and Sunnah or Hadith of the Holy Prophet Muhammad ﷺ. The learning of the Qur'an and Sunnah guides the Muslims to live peacefully.

Contents

1. Study of the Qur'an (Introduction to the Qur'an, Selected verses from *Surah Al-Baqarah, Al-Furqan, Al-Ahzab, Al-Mu'minoon, Al-An'am, Al-Hujurat, Al-Saff*)
2. Study of the Hadith (Introduction to Hadith literature, Selected Ahadith (Text and Translation)
3. Introduction to Qur'anic Studies
4. Basic Concepts of Qur'an
5. History of Quran
6. Basic Concepts of Hadith
7. History of Hadith
8. Kinds of Hadith
9. Uloom –ul-Hadith
10. Sunnah & Hadith
11. Seerat ul-Nabi (PBUH), necessity and importance of Seerat, role of Seerah in the development of personality, Pact of Madinah, Khutbah Hajjat al-Wada' and ethical teachings of Prophet (PBUH).
12. Legal Position of Sunnah
13. Islamic Culture & Civilization
14. Characteristics of Islamic Culture & Civilization
15. Historical Development of Islamic Culture & Civilization
16. Comparative Religions and Contemporary Issues
17. Impact of Islamic civilization

Recommend Texts

1. Hassan, A. (1990). *Principles of Islamic jurisprudence*. New Dehli: Adam Publishers.
2. Zia-ul-Haq, M. (2001). *Introduction to al-Sharia al-Islamia*. Lahore: Aziz Publication.

Suggested Readings

1. Hameedullah, M. (1957). *Introduction to Islam*. Lahore: Sh M Ashraf Publisher.
2. Hameedullah, M. (1980). *Emergence of Islam*. New Dehli: Adam Publishers.
3. Hameedullah, M. (1942). *Muslim conduct of state*. Lahore: Sh M Ashraf Publisher.

GEOL - 5102 **Geomorphology** **3(3+0)**

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.

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. Moses, A. (2013). *Geomorphology*. London: Routledge.

URCE-5102 **Language Comprehension & Presentation Skills** **3(3+0)**

The course aims at developing linguistic competence by focusing on basic language skills in integration to make the use of language in context. It also aims at developing students' skills in reading and reading comprehension of written texts in various contexts. The course also provides assistance in developing students' vocabulary building skills as well as their critical thinking skills. The contents of the course are designed on the basis of these language skills: listening skills, pronunciation skills, comprehension skills and presentation skills. The students require a grasp of English language to comprehend texts as organic whole, to interact with reasonable ease in structured situations, and so comprehend and construct academic discourse. The course objectives are to enhance students' language skill management capacity, to comprehend text(s) in context, to respond to language in context, and to write structured response(s).

Contents

1 Listening skills, Listening to isolated sentences and speech extracts
2 Managing listening and overcoming barriers to listening
3 Expressing opinions (debating current events) and oral synthesis of thoughts and ideas
4 Pronunciation skills,
5 Recognizing phonemes, phonemic symbols and syllables, pronouncing words correctly
6 Understanding and practicing stress patterns and intonation patterns in simple sentences
7 Comprehension skills
8 Reading strategies, summarizing, sequencing, inferencing, comparing and contrasting
9 Drawing conclusions, self-questioning, problem-solving, relating background knowledge
10 Distinguishing between fact and opinion, finding the main idea, and supporting details
11 Text organizational patterns, investigating implied ideas, purpose and tone of the text
12 Critical reading, SQ3P method
13 Presentation skills, features of good presentations, different types of presentations
14 Different patterns of introducing a presentation, organizing arguments in a presentation
15 Tactics of maintaining interest of the audience, dealing with the questions of audience
16 Concluding a presentation, giving suggestions and recommendations

Recommended Texts

1 Mikulecky, B. S., & Jeffries, L. (2007). *Advanced reading power: Extensive reading, vocabulary building, comprehension skills, reading faster*. New York: Pearson.
2 Helgesen, M., & Brown, S. (2004). *Active listening: Building skills for understanding*. Cambridge: Cambridge University Press.

Suggested Readings

1 Roach, C. A., & Wyatt, N. (1988). *Successful listening*. New York: Harper & Row.
2 Horowitz, R., & Samuels, S. J. (1987). *Comprehending oral and written language*. San Diego: Academic Press.

URCM – 5108 **Mathematics II** **3(3+0)**

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 .A 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.

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. I., & 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.

GEOL - 5103 **Geological Fieldwork-I** **3(0+3)**

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. 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.

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.

URCI-5109 Introduction to Information & Communication Technologies 3 (3+0)

The course introduces students to information and communication technologies and their current applications in their respective areas. Objectives include basic understanding of computer software, hardware, and associated technologies. They can make use of technology to get maximum benefit related to their study domain. Students can learn how the Information and Communications systems can improve their work ability and productivity. How Internet technologies, E-Commerce applications and Mobile Computing can influence the businesses and workplace. At the end of semester students will get basic understanding of Computer Systems, Storage Devices, Operating systems, E-commerce , Data Networks, Databases, and associated technologies. They will also learn Microsoft Office tools that includes Word, Power Point, Excel. They will also learn Open office being used on other operating systems and platforms. Specific software's related to specialization areas are also part of course.. Course will also cover Computer Ethics and related Social media norms and cyber laws.

Contents

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

Recommended Texts

1. Vermaat, M. E. (2018). *Discovering computers: digital technology, data and devices.* Boston: Course Technology Press.

Suggested Readings

1. Timothy J. O'Leary & Linda I. (2017). *Computing essentials* (26th ed.). San Francisco: McGraw Hill.
2. Schneider, G. M., & Gersting, J. (2018). *Invitation to computer science.* Boston: Cengage Learning.

URCP-5106 **Pakistan Studies** **2(2+0)**

The course is designed to acquaint the students of BS Programs with the rationale of the creation of Pakistan. The students would be apprised of the emergence, growth and development of Muslim nationalism in South Asia and the struggle for freedom, which eventually led to the establishment of Pakistan. While highlighting the main objectives of national life, the course explains further the socio-economic, political and cultural aspects of Pakistan's endeavours to develop and progress in the contemporary world. For this purpose, the foreign policy objectives and Pakistan's foreign relations with neighbouring and other countries are also included. This curriculum has been developed to help students analyse the socio-political problems of Pakistan while highlighting various phases of its history before and after the partition and to develop a vision in them to become knowledgeable citizens of their homeland.

Contents

1. Contextualizing Pakistan Studies
2. Geography of Pakistan: Geo-Strategic Importance of Pakistan
3. Freedom Movement (1857-1947)
4. Pakistan Movement (1940-47)
5. Muslim Nationalism in South Asia
6. Two Nations Theory
7. Ideology of Pakistan
8. Initial Problems of Pakistan
9. Political and Constitutional Developments in Pakistan
10. Economy of Pakistan: Problems and Prospects
11. Society and Culture of Pakistan
12. Foreign Policy Objectives of Pakistan and Diplomatic Relations
13. Current and Contemporary Issues of Pakistan
14. Human Rights: Issues of Human Rights in Pakistan

Recommended Texts

1. Kazimi, M. R. (2007). *Pakistan studies.* Karachi: Oxford University Press.
2. Sheikh, J. A. (2004). *Pakistan's political economic and diplomatic dynamics.* Lahore: Kitabistan Paper Products.

Suggested Readings

1. Hayat, S. (2016). *Aspects of Pakistan movement.* Islamabad: National Institute of Historical and Cultural Research.
2. Kazimi, M. R (2009). *A concise history of Pakistan.* Karachi: Oxford University Press.
3. Talbot, Ian (1998). *Pakistan: A modern history.* London: Hurst and Company.

GEOL - 5104 **Introduction to Paleontology** **3(2+1)**

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. This 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.

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(2+1)**

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. This 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.

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. (1989). *Stratigraphy and economic geology of Central Salt Range*. Quetta: Geological Survey of Pakistan.

GEOL - 5107 **Mineralogy** **3(2+1)**

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. It presents 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.

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.

URCE-5103 **Academic Writing** **3 (3+0)**

Academic writing is a formal, structured and sophisticated writing tofulfill the requirements for a particular field of study. The course aims at providing understanding of 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 academic writing skills. The course would enable the students to develop argumentative writing techniques. The students would be able to the content logically to 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 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 Academic vocabulary
2 Quoting, summarizing and paraphrasing texts
3 Process of academic writing
4 Developing argument
5 Rhetoric: persuasion and identification
6 Elements of rhetoric: Text, author, audience, purposes, setting
7 Sentence structure: Accuracy, variation, appropriateness, and conciseness
8 Appropriate use of active and passive voice
9 Paragraph and essay writing
10 Organization and structure of paragraph and essay
11 Logical reasoning
12 Transitional devices (word, phrase and expressions)
13 Development of ideas in writing
14 Styles of documentation (MLA and APA)
15 In-text citations
16 Plagiarism and strategies for avoiding it

Recommended Texts

1 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.
2 Bailey, S. (2011). *Academic writing: A handbook for international students* (3rd ed.). New York: Routledge.

Suggested Readings

1 Craswell, 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.

BUSB - 5104 **Introduction to Management** **3(3+0)**

This is an introductory course about the management of organizations. It provides instructions on principles of management that have general applicability to all types of enterprises; basic management philosophy and decision making; principles involved in planning, organizing, leading, and controlling; and recent concepts in management. Have you ever wondered what qualities billionaire Warren Buffet, visionary Steve Jobs, or Jeff Bezos all have in common? After you finish studying business practices in this course, you may discover that you have some of the same qualities as other successful entrepreneurs. This course is designed as a survey course that will expose you to business terminology, concepts, and current business issues. The intent is to develop a viable business vocabulary, foster critical and analytical thinking, and refine your business decision-making skills. The course will also encourage the students to explore and inquire the applicability of western management principles and theories in local settings.

Contents

1. Introduction to management the management process
2. Importance of management for a business
3. Organizational theories, Nature and types of organizations
4. The organizational culture and the management
5. The external environment and the manager
6. The internal environment and the manager
7. The manager's role as decision maker
8. Decision making process, Type of decision making processes
9. Basics of strategic management
10. Organizational structure, types of organizational structure,
11. Human Resource Management
12. Important of human resource for a business
13. Motivation its theories, team work and group behavior,
14. Leadership and its characteristics, leadership style and behavior ,
15. The process of control, case of controlling

Recommended Texts

1. Robbins, S. P., Coulter, M., & Langton, N. (2007). *Fundamentals of management.* Upper Saddle River: Pearson Prentice Hall.

Suggested Readings

1. Hannaway, J. (1989). *Managers Managing: The Workings of an Administrative System.* London: Oxford University Press.
2. Eccles, R. G. & Nohria, N. (1992). *Beyond the Hype: Rediscovering the Essence of Management.* Boston: The Harvard Business School Press.

GEOL - 5108 **Petrography** **3(2+1)**

Petrography is a branch of petrology that focuses on detailed descriptions of rocks. Someone who studies petrography is called a petrographer. This course is designed to help the students to identify the minerals in sedimentary, igneous and metamorphic rocks using polarizing microscope and also classifying the rocks on the basis of rock texture and mineral composition. The mineral content and the textural relationships within the rock will be described in detail. The classification of rocks is based on the information acquired during the petrographic analysis. Petrographic descriptions start with the field notes at the outcrop and include macroscopic description of hand specimens. However, the most important tool for the petrographer is the petrographic microscope. The detailed analysis of minerals by optical mineralogy in thin section and the micro-texture and structure are critical to understanding the origin of the rock.

Contents

1. Introduction to polarizing microscope
2. Optical properties of opaque and non-opaque minerals in plane polarized light and under crossed nicol including metallic under reflected light
3. Description of optical properties of common rock forming minerals
4. Mineralogy and common texture of igneous, sedimentary and metamorphic rocks.

Lab. Work

1. Identification and description of common minerals
2. Study of rocks and minerals in thin section, texture and composition
3. Classification of rocks using different techniques, volume estimates and other elementary petrographic techniques.

Recommended Texts

1. MacKenzie, W. S., Adams, A. E., & Brodie, K. H. (2017). *Rocks and Minerals in Thin Section: A Colour Atlas*. Boca Raton: CRC Press.
2. Perkins, D., (2000), *Minerals in Thin Sections*. Upper Saddle River: Prentice Hall.

Suggested Readings

1. Klein, C. (2000). *Minerals and rocks: exercises in crystallography, mineralogy, and hand specimen petrology*. New York: Wiley.
2. Best, M. G. (2013). *Igneous and metamorphic petrology*. New York: John Wiley & Sons.
3. MacKenzie, W. S., & Guilford, C. (2014). *Atlas of the Rock-Forming Minerals in Thin Section*. London: Routledge.

GEOL – 5109 **Igneous Petrology** **3(2+1)**

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.

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.

Recommended Texts

1. Winter, J. D. (2014). *Principles of igneous and metamorphic petrology*. London: Pearson Education.
2. McBirney, A. R. (1993). *Igneous petrology*. Burlington: Jones & Bartlett learning.

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*. New York: Macmillan.
3. Winter, J. D. (2000). *An introduction to igneous and metamorphic petrology* . New Jersey: Prentice hall.

GEOL - 5110 **Structural Geology** **3(2+1)**

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. This curse 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.

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.

GEOL - 5111 **Geological Fieldwork-II** **3(0+3)**

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. 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.

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.

GEOL - 6112 **Geotectonics** **3(2+1)**

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. This 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.

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 - 6113 **Sedimentology** **3(2+1)**

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.

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.

GEOL - 6114 **Geophysics** **3(2+1)**

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. 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

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.

GEOL - 6115 **Field Geology** **3(3+0)**

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. 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.

Contents

1. Introduction of topographic and geological maps.
2. Methods and techniques of surface and subsurface geological mapping.
3. Introduction to instruments for geological mapping.
4. Interpretation of geological maps with reference to outcrop patterns.
5. Correlation techniques.
6. Field description of igneous, metamorphic.
7. Modes of geological illustration including structural contour, isopach and lithofacies maps, block and fence diagrams.
8. Scan line survey.
9. Preparation of geological maps and cross sections.
10. Awareness and compliance of Health and Safety Environment (HSE) particularly during geological work.
11. Structure of sedimentary rocks.
12. Regional and detailed mapping.

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.

GEOL - 6116 **Micropaleontology** **3(2+1)**

This course is designed to understand the micro-fossils found in geological formations and Tertiary biostratigraphy rock units in Pakistan. Micropaleontology is concerned with microfossils and nanno fossils, the study of which must, of necessity, be carried out using the light or electron microscope. To achieve this course, the microfossil must be studied in terms of morphology, structure, chemical and mineralogical composition and taxonomy to discover their origin and systematic affinities. The course is designed to acquire knowledge about the microfossils and micro-organisms and their role in interpretation of depositional environment. This will help the student to identify various types of microfossils and to understand their role in depositional systems of major sedimentary basins. Application of these microfossils in the field of oil-exploration, biostratigraphy, paleobiology and paleoclimatology is essential. This subject emphasizes on the microfossils that lived in or under sea water.Thus, interaction with the present-day physical, chemical and biological characteristics of the ocean water will be also addressed. 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.

Contents

1. Introduction to Micropaleontology and its applications
2. Detail classification of marine environments,
3. Genus Miscellanea, Assilina, Ranikothalia, Lockhartia
4. Nummulites, Discocylina, Orbitolites, Globotrucana
5. Introduction to Foraminifera, Bryozoa, Conodonts,
6. Algae, pollen and spores:
7. Microfossils and nanoplanktons;
8. Principles of Biostratigraphy and Biostratigraphic zones;
9. Biostratigraphic techniques and procedures;
10. Morphological and taxonomic studies of selected micro fossils
11. KT Boundary and its presence in Pakistan
12. Tertiary biostratigraphy with special reference to Pakistan

Recommended Texts

1. Saraswati, P. K., & Srinivasan, M. S. (2015). *Micropaleontology: principles and applications*. New York: Springer.
2. Brasier, M. D. (1980). *Microfossils*. London: G. Allen & Unwin.

Suggested Readings

1. Haq, B. U., & Boersma, A. (Eds.). (2000). *Introduction to marine micropaleontology*. New York: Elsevier.
2. McGowran, B (2000). *Biostratigraphy: microfossils and geological time*. Cambridge: Cambridge University Press.
3. Boggs Jr, S. (2014). *Principles of sedimentology and stratigraphy*. London: Pearson Education.

GEOL - 6117 **Introduction to GIS and RS** **3(2+1)**

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. 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.

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.). (2004). *Foundations of geographic information science*. Boca Raton: CRC Press.
2. DeMers, M. N. (2008). *Fundamentals of geographic information systems*. Hoboken: John Wiley & Sons.

GEOL - 6118 Sequence Stratigraphy 3(2+1)

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. 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. 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. 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.

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., (2000). *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.

GEOL - 6119 **Geochemistry** **3(2+1)**

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.

Contents

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

Lab. Work

1. Processing and interpretation of geochemical data
2. Ternary diagrams interpretation.

Recommended Texts

1. Krauskopf, K. B. (2000). *Introduction to geochemistr*. New York: McGraw-Hill.
2. Mason. B., (2000) *Principles of geochemistry*. Hoboken: John Wiley and Sons.
3. Beaumont, E.A. & Foster, N.H. (1988), *Geochemistry*. Texas: AAPG.

Suggested Readings

1. Rose, A.W., Hawkes, H.H. and Webb, J.S. (2000), *Geochemistry in mineral exploration*. Tonbridge: Whitstable Litho Ltd.
2. Henderson, P. (2000). *Inorganic geochemistry. organic photonics and photovoltaics*. Upper Saddle River: Prentice Hall.
3. McSween, H. Y., Richardson, S. M., & Uhle, M. E. (2000). *Geochemistry: Pathways and processes*. New York: Columbia University Press.

GEOL - 6120 **Petroleum Geology** **3(2+1)**

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. It introduces students to the key issues surrounding being a geologist in the petroleum industry. 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). 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.

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.

GEOL - 6121 **Engineering Geology** **3(2+1)**

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. The study of common problems during the construction of structures is also included in this course and will help the students to discuss about the various natural and man-made problems. Lab work is also included to enhance the practical knowledge of students.

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.

GEOL - 6122 **Metamorphic Petrology** **3(2+1)**

This course is designed to expose the students to the solid state transformation of pre-existing igneous, metamorphic and sedimentary rocks into metamorphic rocks. This course is a basic to advance introduction for the post graduate students in petrology. Geology is plagued by the problem of in accessibility; they see only the tiny fraction of the rocks that composes the Earth. During the processes of uplift and the erosion on the surface, but their exact place of origin is vague. As a result, a large proportion of our information about earth is indirectly coming from analysis of subsurface materials, geophysical studies, or experiments conducted at variable temperature and pressure. 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, and on the bulk composition in these environments. Metamorphism affects rocks in three ways; it changes their mineralogy, it changes their shape, and it can change their composition.

Contents

1. Introduction to metamorphism
2. Types, grades, zones and facies of metamorphism
3. Metamorphic diffusion and differentiation
4. Study of thermal and regional metamorphism of igneous, argillaceous, calcareous and arenaceous rocks
5. Metamorphism in relation to plate tectonics
6. Study of textures and structures of metamorphic rocks
7. Metamorphism and deformation; history and dating of metamorphic rocks
8. Differentiation between metamorphism and metasomatism
9. Paired metamorphic belts
10. Himalayan and pre-Himalayan metamorphism in Pakistan.

Lab. Work

1. Petrographic and hand specimen identification of metamorphic textures, structures, and metamorphic history of rocks.
2. ACF and AKF ternary diagrams and petrogenesis.

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: McGraw-Hill.

Suggested Readings

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.
3. Yardley, B. W., & Yardley, B. W. D. (1989). *An introduction to metamorphic petrology*. New York: McGraw-Hill.

GEOL - 6123 **Geological Fieldwork- III** **3(0+3)**

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. 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

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.

GEOL - 6124 **Geology of Pakistan** **3(3+0)**

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. 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. 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.

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.

GEOL - 6125 **Economic Geology** **3(2+1)**

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. Upon successful completion, students will have the knowledge and skills to recognize common ore minerals in hand samples and under the microscope demonstrate familiarity with a wide range of mineral deposits, including recognizing the overall geometry, zonation and alteration patterns associated with specific classes of metallic mineral deposits Relate overall geometry, zonation and alteration patterns of rock associations to specific classes of metallic mineral deposits. Evaluate different processes of element enrichment by fluids and melts to from ore bodies. Inform peer students and the wider public how understanding the formation of ore bodies is important in the current debates about global resources.

Contents

1. Introduction to economic minerals and rocks and their classification,
2. Grade and reserve estimation of deposits, Introduction to ore microscopy
3. Environment and processes of formation of economic mineral deposits: magmatic segregation, hydrothermal solution, metasomatism, sedimentation, evaporation, residual and mechanical concentration and metamorphism,
4. Relationship of mineral deposits to plate tectonic settings,
5. Introduction of geological exploration/prospecting,
6. Brief description of economic 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.

Lab. Work

Identification and description of economic 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.* Hoboken: John Wiley & Sons.
2. Pohl, W. L. (2011). *Economic geology: principles and practice*. Hoboken: John Wiley & Sons.

Suggested Readings

1. Moon, C. J., Whateley, M. K., & Evans, A. M. (2006). *Introduction to mineral exploration* (2nd ed.). Hoboken: Blackwell publishing.
2. Park Jr, C. F., & MacDiarmid, R. A. (1975). *Ore deposits*. San Francisco, Freeman.
3. Evans, Anthony M. (2009). Ore geology and industrial minerals: an introduction. Hoboken: John Wiley & Sons.

GEOL - 6126 **Environmental Geology** **3(2+1)**

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. This will help 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.

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 - 6127 **Hydrogeology** **3(2+1)**

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. You will gain a wide understanding of hydrological processes and phenomena, including but not limited to groundwater. Other associated topics teach you the critical interrelationships groundwater has 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 construction.

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.

GEOL - 6130 **Geochemistry II** **3(2+1)**

This is the sub discipline of geology which deals with the study of the chemical composition of the earth and its rocks and minerals. 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. 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.

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.

Lab. Work

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

Recommended Texts

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

Suggested Readings

1. Krauskopf, K. B., & Bird, D. K. (2007). *Introduction to geochemistry* (Vol. 72, No. 1). New York: McGraw-Hill.
2. Best, M. G. (2013). *Igneous and metamorphic petrology.* New York: John Wiley & Sons.

GEOL-6132 **Metamorphic Petrology II** **3(2+1)**

This course is a graduate level course of metamorphic petrology. It enables students to understand the mechanism and types of metamorphism as well as the factors that affect the process of metamorphism. 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 petrology covers the chemical and physical work done in natural systems in response to changing physical conditions. Petrogenetic processes such as recrystallization, continuous and discontinuous reactions, mixed volatile reactions and deformation are addressed. The principles of metamorphic petrology are then applied to a number of orogenic events through geologic time, and modern advances in research in metamorphic petrology are explored.

Contents

1. Basic characteristics of metamorphic reactions and role of fluids
2. Concept of iso-grades and iso-reaction grades
3. Very low grade and ocean floor metamorphism
4. Cataclastic metamorphism
5. Metamorphic facies series
6. P-T gradients
7. Mineralogical charactersistics of individual facies
8. Progress metamorphism of pelites, basic rocks and carbonates
9. High grade metamorphism, anatexis and migmatites
10. Tectonics of regional metamorphic belts
11. Paired metamorphic belts, Metamorphic structure of continental crust.

Lab. Work

1. Construction and interpretation of ACF and AKF diagrams
2. Petrographicstudy of various rocks suites
3. Mineral and mineral phase equilibria and P-T conditions.

Recommended Texts

1. Best, M. G. (2013). *Igneous and metamorphic petrology*. New York: John Wiley & Sons.
2. Vernon, R. H., Vernon, R. H., Vernon, R., & Clarke, G. L. (2008). *Principles of metamorphic petrology*. Cambridge: Cambridge University Press.

Suggested Readings

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.
3. Yardley, B. W., & Yardley, B. W. D. (1989). *An introduction to metamorphic petrology*. New York: John Wiley & Sons.

GEOL - 6134 **Mineralogy II** **3(2+1)**

This course is a graduate level course of Mineralogy. Advance mineralogy is a subject of geology specializing in the scientific study of the chemistry, crystal structure, and physical (including optical) properties of minerals and mineralized artifacts. So the course is designed to acquire the knowledge about the physical and optical properties of various rock forming minerals and to develop a relationship between the structure chemistry and properties of silicates, carbonates, oxides, sulphides, and phosphate. This will help the students in learning the mechanisms of mineral nucleation, crystal growth and importance of kinetics in mineral formation as well as by using different computer programs, they will be able to calculate mineralogical parameters.

Contents

1. Physical and chemical properties of mineral
2. Relationship between the structure chemistry and properties of Silicates, carbonates, oxides, sulphides, and Phosphate
3. Physical and chemical properties of minerals
4. Mechanisms of mineral nucleation and crystal growth
5. Importance of kinetics in mineral formation
6. Interpretation of mineral analysis
7. Recalculation of a mineral analysis in terms of fixed number of anions, and, where appropriate, cations
8. Measurement of mineral triple junction angles
9. Description of grain boundaries and their implication for the development of rock textures
10. Use of computer programs, including spreadsheets, to calculate mineralogical parameter
11. Triangular and X-Y plots
12. Related mineralogical information to the assessment and performance of industrial rocks and minerals.

Recommended Texts

1. Perkins, D. (1998). *Mineralogy. In the Beginning*. Upper Saddle River: Prentice Hall.
2. Deer, W. A. (2011). *Rock-forming minerals*. London: Geological Society of London.

Suggested Readings

1. Perkins, D., and Henke, K.R., 2000, Minerals in Thin Section. Upper Saddle River: Prentice Hall.
2. Philpotts, A. R. (1989) *Petrography of igneous and metamorphic rocks*. Upper Saddle River: Prentice Hall.
3. MacKenzie, W. S., & Guilford, C. (2014). *Atlas of the Rock-Forming Minerals in Thin Section*. London: Routledge.

GEOL - 6135 **Rock Mechanics** **3(2+1)**

This course is a graduate course. One of the elective advance level courses in the group of specialization in Engineering Geology is Rock Mechanics. The course will enable the students to fully understand the basic knowledge about the stress and strain. The behavior of rocks under different geological stress regimes. The measurement the in-situ stresses around the periphery of underground excavations. The qualities of rock masses are very important to be studied for the overall estimation of rock mass deformation and strength of the rocks. These current and hot topic of rock mechanics is also included in the outline of subject and will enhance the practical knowledge about the mechanics of rocks. For the completion of course, special assignments of testing of uniaxial and triaxial conditions are also included. After completing these courses, the students will be able to carry out their independent research on the site development for construction.

Contents

1. Fabric and mechanical nature of rocks;
2. Determination of rock quality for engineering purposes;
3. Stress strain behaviors of different rocks; rock mass strength. Theories of failure;
4. Types of fracture; rock deformation in compression;
5. Factors controlling mechanical behaviors of rocks; excavation methods in rocks;
6. Distribution of stresses around underground excavations;
7. Use of photo elasticity in rock mechanics.
8. Measurement of stresses in situ; wave propagation in rocks; dynamic models.

Lab. Work

Special Assignments/Projects

Recommended Texts

1. Brady, B. H., & Brown, E. T. (2013). *Rock mechanics: for underground mining*. Amsterdam: Springer science & business media.
2. Duncan, N. (2000). *Engineering Geology and Rock Mechanics*. London: Leonard Hill

Suggested Readings

1. Li, D., Hyslip, J., Sussmann, T., & Chrismer, S. (2002). *Railway geotechnics*. Boca Raton: CRC Press.
2. Franklin, J. A., & Dusseault, M. B. (1989). *Rock engineering*. Abingdon: Routledge.

GEOL – 6136 **Soil Mechanics** **3(2+1)**

Soil Mechanics is a sub discipline Engineering geology involving the study of soil, its behaviour and application as an engineering material. Soil Mechanics is the application of laws of mechanics and hydraulics to engineering problems dealing with sediments and other unconsolidated accumulations of solid particles, which are produced by the mechanical and chemical disintegration of rocks, regardless of whether or not they contain an admixture of organic constituents. Soil consists of a multiphase aggregation of solid particles, water, and air. This fundamental composition gives rise to unique engineering properties, and the description of its mechanical behavior requires some of the most classic principles of engineering mechanics.

Contents

1. Introduction
2. Concept of soil mechanics,
3. Soil formation
4. Classification,
5. survey and sampling with its important engineering properties like soil gradin
6. Moisture contents
7. Void ratios, density, permeability
8. Shearing strength, bearing capacity
9. Consolidation and settlements.

Lab. Work

1. Index properties of soil.
2. Determination of soil density, permeability,unconfined shearing and compressive strength of soil and Attenberg's limits.

Recommended Texts

1. Nelson, J., & Miller, D. J. (1997). *Expansive soils: problems and practice in foundation and pavement engineering*. New York: John Wiley & Sons. .
2. Attewell, P. B., & Farmer, I. W. (2012). *Principles of engineering geology*. Springer Science & Business Media.

Suggested Readings

1. Schofield, A., & Wroth, P. (1968). *Critical state soil mechanics*(Vol. 310). London: McGraw-Hill.
2. Atkinson, J. (2017). *The mechanics of soils and foundations*. Boca Raton: CRC Press

GEOL - 6138 **Engineering Geology II** **3(2+1)**

This course is a graduate course. One of the elective advance level courses in the group of specialization in Engineering Geology is Engineering Geology II. The courses will enable the students to fully understand (1) the rocks and soil mechanics and their role in construction industry, (2) the earthquake related seismicity and intensity, (3) the geological and geophysical surveys, (4) the infrastructure development and (5) the techniques for evaluation of building materials. (6) Hazard Zonation and assessment of rock masses using different techniques of empirical and analytical techniques. (7) Landslides and case studies of landslides. (8) Groundwater and characteristics of ground water. This special course also includes the project and special assignments. After completing these courses, the students will be able to carry out their independent research on the site development for construction.

Contents

1. Rock and soil mechanics and its application in civil engineering;
2. Study of geological factors in relation to the construction of buildings and foundations,
3. Roads, highways, excavation and tunneling, mine openings, dams and bridges;
4. Construction materials; slope stability analysis,
5. Hazard assessment, mass movement, their causes and prevention;
6. Application of geophysical methods for site investigation;
7. Construction in earth-quake zone; dams and their kinds geological investigations for selecting a site for a dam;
8. Landslides, classification, geometry, causes and preventive methods;
9. Ground water and character of ground water;
10. Case histories of important engineering projects (small and mega) in Pakistan.

Lab. Work
Special Assignments/Projects

Recommended Texts

1. Price, D. G. (2008). *Engineering geology: principles and practice*. London: Springer Science & Business Media.
2. Steffen, G. S., Candelaria, S. M., Stapledon, D., Bell, G., & Foster, M. (2014). *Geotechnical engineering of dams*. London: CRC press.

Suggested Readings

1. Bell, F. G. (2016). *Fundamentals of engineering geology*. Elsevier.
2. Beavis, F.C. (1985). *Engineering Geology*. Oxford: Blackwell Scientific.
3. Blyth, F. G. H., & De Freitas, M. (2017). *A geology for engineers*. London: CRC Press.

GEOL - 6140 **Petroleum Engineering** **3(2+1)**

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.

Contents

1. Introduction to rig components
2. drilling methods and operations
3. types of bits; drilling fluids
4. composition and functions
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 - 6141 **Reservoir Geology** **3(2+1)**

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. It will also focus on the 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.

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.

GEOL - 6142 Petroleum Geology of Pakistan 3(2+1)

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. his course covers a wide range of earth science subjects and their application to the full spectrum of hydrocarbon exploration and production. This course is a one-year, full-time multidisciplinary programme covering 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.

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 - 6149 **Earthquake Seismology** **3(2+1)**

The course explores the processes that cause earthquakes, as well as the methodologies used by seismologists to analyze seismograms, to measure source parameters, and to simulate the seismic wave impact at the Earth's surface. The main goals are to provide an overview of earthquake seismology for non-seismologists, to introduce undergraduate geoscience students to earthquake seismology. The course is designed to deliver basic knowledge of earthquake phenomena. Describe the main scales for measuring the size of an earthquake. To enable undergraduate students to develop understanding for the occurrence of earthquakes according to elastic rebound theory and distribution of different types of earthquakes with reference to Plate Tectonic. Explain the relationship between earthquakes and faults and fault plan solutions. Learn basic techniques to locate earthquake epicenters using P and S waves.

Contents

1. Mathematical analysis of seismological processes on the basis of elastic wave theory
2. Seismic waves and their analysis in earthquake seismology
3. Frequency, magnitude, energy of an earthquake and their relationship
4. Source parameters and their determination
5. Composite fault plane solutions of earthquakes and their determination
6. Geographical distribution of important earthquakes
7. Earthquakes and their relationship to the tectonics of the area.

Lab. Work

Specified problems on data processing, analysis, fault solutions and interpretation.

Recommended Texts

1. Shearer, P. M. (2019). *Introduction to seismology*. Cambridge: Cambridge university press.
2. James, D. E. (Ed.). (1989). *Encyclopedia of solid Earth geophysics*. London: Springer Science & Business Media.

Suggested Readings

1. Borr, M. H. P. (1982). *The Interior of the Earth: its Structure, Constitution and Evolution*. London: Edward Arnold.
2. Shearer, P. M. (2019). Introduction to seismology. Cambridge: Cambridge University Press.
3. Bullen, K. E., Bullen, K. E., & Bolt, B. A. (1985). *An introduction to the theory of seismology*. Cambridge: Cambridge university press.

GEOL – 6151 Electrical and Radiometric Exploration Methods 3(2+1)

The major objective of this course is to skill undergraduate students with basic principles of the electrical and radiometric exploration methods used in mineral exploration and energy resources. Describe the different electrical and electromagnetic methods and how they relate to electrical conductivity and dielectric permittivity the importance of optimal processing and display of these data and the strengths and limitations of the various methods. Students shall learn how to extract the maximum amount of geological information from the data, recognizing noise-related artifacts in interpretation products and how to deal with the ambiguity when interpreting electrical and radiometric data sets. Core topics include the basic principles of the main geophysical exploration methods used in mineral exploration including the importance of optimal processing and display of these data and the strengths and limitations of the various methods. Particular attention is paid to extracting the maximum amount of geological information from the data, recognising noise-related artifacts in interpretation products and how to deal with the ambiguity when interpreting geophysical datasets.

Contents

1. Fundamentals of current flow in the earth
2. Electrode arrangements and field procedures
3. Instruments; processing and interpretation of resistivity data
4. Field procedure, data acquisition and interpretation of self-potential
5. Induced polarization and electromagnetic methods;
6. Study of case histories.
7. Physical principles and basic theory of Radioactivity
8. Radioactivity of rocks
9. Radioactive dating methods
10. Field surveys and instruments for radiometric methods
11. Data processing and interpretation of radiometric surveys
12. Application of radiometric methods in exploration of minerals and energy resources

Recommended Texts

1. Dobrin, M. B., & Savit, C. H. (2000). *Introduction to geophysical prospecting* (Vol. 4). New York: McGraw-hill.
2. Nabighian, M. N. (Ed.). (1991). *Electromagnetic Methods in Applied Geophysics*. Volume 2, Application, Parts A and B. Amsterdam: Society of Exploration Geophysicists.

Suggested Readings

1. Kearey, P., Brooks, M., & Hill, I. (2013). *An introduction to geophysical exploration*. New York: John Wiley & Sons.
2. Robinson, E. S. and Coruh, C. (1988) *Basic Exploration Geophysics*. New York: John Wiley & Sons.

GEOL - 6153 **Seismic Prospecting** **3(2+1)**

The overall objective of this course is to introduce undergraduate students to seismic data acquisition, technical processing concepts and interpretation principles that form the basis for value added seismic applications in exploration of hydrocarbon and reservoir management. This course will provide practical understanding of seismic acquisition, processing and interpretation skill. Data examples and practical exercises will illustrate key concepts, practical issues, and pitfalls of acquisition and processing as they affect the interpretation of seismic data. The students will be introduced to seismic data interpretation to generate structural and stratigraphic sections using seismic and well data. The participant learns to answer these and related questions by gaining an understanding of the seismic system, its limitations and pitfalls, and by interpreting 2D and 3D seismic examples of structural and stratigraphic features associated with actively producing hydrocarbon areas.

Contents

1. Planning for 2D and 3D seismic surveys and concepts of recording parameters
2. Types of seismic surveys
3. Onshore and offshore seismic surveys
4. Methodology of seismic data acquisition
5. Seismic equipment
6. Types of seismic energy sources and recording equipment
7. Acquisition methods,
8. Quality control of data during acquisition and processing
9. Field processing,
10. Work flow for various basic and advanced processing techniques
11. Seismic mapping and interpretation of 2D and 3D seismic data
12. Well seismic (VSP)
13. Forward seismic Modeling
14. Ray tracing
15. Synthetic seismograms generation
16. AVO for lithology and DHI
17. Applications in Exploration and Production.

Recommended Texts

1. Burger, H. R., Burger, D. C., & Burger, H. R. (1992). *Exploration geophysics of the shallow subsurface* (Vol. 8). Englewood Cliffs: Prentice Hall.
2. Mares, S., & Tvrdý, M. (1984). *Introduction to applied geophysics*. London: Springer Science & Business Media.

Suggested Readings

1. Pal, S. K. (1998). *Statistics for Geoscientists Techniques and Applications*. Delhi: Concept Publishing Company.
2. Davis, J. C., & Sampson, R. J. (1986). *Statistics and data analysis in geology* (Vol. 646). New York: John Wiley & Sons.
3. Freeden, W., Nashed, M. Z., & Sonar, T. (Eds.). (2010). *Handbook of geomathematics*. London: Springer Science & Business Media.