CENTRAL UNIVERSITY OF PUNJAB

Ph.D. Geology Course work

Session - 2021-22 onwards

Department of Geology

School of Environment and Earth Sciences

Department of Geology
Central University of Punjab

Syllabus for Ph.D. Geology Course work: 2021-2022

Course Code	Course Title	Credit Hours			
		L	**T**	**P**	**Cr**
Semester – I					
EGS. 701	Research Methodology	4	0	0	4
EGS. 751	Research and Publication ethics	2	0	0	2
EGS .752	Teaching Assistantship	0	0	2	1
UNI.753	Curriculum, Pedagogy and Evaluation	1	0	0	1
Elective courses: Select any two of the specialized courses listed below					
EGS. 702	Stratigraphy and Paleontology	4	0	0	4
EGS. 703	Geochemistry and Isotope Geology	4	0	0	4
EGS. 704	Remote Sensing and GIS	4	0	0	4
EGS. 705	Igneous and Metamorphic petrology	4	0	0	4
EGS. 706	Geomorphology and Quaternary Geology	4	0	0	4
EGS. 707	Hydrogeology and Environmental Geology	4	0	0	4
EGS. 708	Structural and Engineering Geology	4	0	0	4
EGS. 709	Sedimentology and Sequence stratigraphy	4	0	0	4
	Total	**14**	**0**	**0**	**16**
Semester – II onwards					
Ph.D. Research work					

L: Lectures T: Tutorial P: Practical Cr: Credits

Semester – I

Course title: Research Methodology

Course code: EGS.701

L	T	P	Cr
4	0	0	4

Total Hours: 60

Learning Outcomes: Upon successful completion of this course, the student will be able to

- Choose and propose appropriate research methods according to their research aims and objectives
- aware the limitations of particular research methods
- justify knowledge of the selection of various instruments and sample preparation techniques for addressing specific research problem
- Develop skills in qualitative and quantitative data analysis and presentation
- design advanced critical thinking skills and enhanced writing skills

Unit–I: **20 Hours**

Concept and definition of Research: academic research, basic and fundamental research, applied research, theoretical, conventional and experimental research. Concepts and needs of research hypothesis. Objective processes and steps in research methodology; research proposal and concepts; developing research proposal in the frontier areas of geosciences; research approach and identifying gap areas from literature review; use of digital library, online resource; problem formulation and statement of research objectives; developing bibliography; ethical issues in conducting research and paper writing; concepts on plagiarism; ISSN and ISBN numbers; impact factors and citation index of research articles and assessing the quality of research articles.

Unit-II: **10 Hours**

Pre-field preparations: preparation of maps, survey of the study area through satellite imageries, Google earth, etc. Field mapping and documentation; procedure of sampling-grab sampling: random sampling, stratified random sampling, stratified profile sampling, lateral sampling, and sampling documentation. Introduction to field mapping and section measurement. Introduction on laboratory techniques of sample analysis and their limitations.

Unit-III: **15 Hours**

Application software: Spreadsheet applications, word processing applications, Microsoft excel, Presentation applications, Internet browsers, Reference

Management, and Image processing applications; studies of the application of software such as Arc GIS, Rock wares, Erdas, Sigma plot, Corel Draw etc.

Unit-IV: **15 Hours**

Experimental design and analysis: Sampling techniques, Sampling theory, Steps in sampling, Collection of data-types and methods. Diagrammatic representation of frequency distribution: histogram, frequency polygon, frequency curve, ogives, stem and leaf plot, pie chart. Measures of central tendency, dispersion (including box and whisker plot), skewness and kurtosis. Data on two attributes, independence and association of attributes in 2x2 tables.

Transactional Modes: Lecture, Project Method, Inquiry training, Seminar, Group discussion, Focused group discussion, Team teaching, Brain storming, Collaborative learning, Case analysis, Case study, Self-learning, Through SOLE (Self Organized Learning Environment).

Suggested reading:

1. Qualitative Research Methods for Social Sciences by Bruce, L. B. 2001, Allyn and Bacon, Boston.
2. Computer Applications in the Social Sciences by Edward, E.B., 1990, Temple University Press, Philadelphia.
3. Survey Methodology by Robert, M. B, et al., 2009, Wiley, New Jersey.
4. Research Design: Qualitative, Quantitative and Mixed Methods Approaches by John, W. C., 2011, Sage Publications, Thousand Oaks.
5. Principles of Writing Research Papers by Lester, James, D. and Lester Jr. J. D., 2007, Longman, New York.
6. Social Research Methods: A Reader by Seale C., 2004, Routledge, London.
7. An Introduction to Operating Systems: Concepts and Practice by Bhatt, Pramod Chandra P., 2nd edition, 2008, PHI Learning Pvt. Ltd., New Delhi.
8. Elementary Statistics for Geographers by Burt J.E. Barber. G.E. Rigby D. L., 2009, Guilford Press, New York.
9. Fundamentals of MS Office 2007 by Douglas, Gretchen and Mark Connell, 2nd edition, 2007, Kendall Hunt Publication Company, Dubuque.
10. MS Word for Dummies by Gookin, D. 2007, Wiley.
11. MS Excel for Dummies by Harvey, G. 2007, Wiley.
12. DOS: The Pocket Reference by Jamsa, Kris A., 1993, Berkeley: Osborne McGraw Hill.
13. DOS: The Easy Way: Complete Guide to Microsoft's MS-DOS by Murdock, Everett E., 1993, HOT Press, Easy Way Downloadable Books.

14. Database Management System by Narang R., 2006, PHI Learning Pvt. Ltd., New Delhi.
15. Fundamentals of Computers by Raja Raman V., 2003, PHI Learning Pvt. Ltd., New Delhi.
16. Analyzing talk and text. In N. Denzin and Y. Lincoln, eds. Handbook of Qua litative Research by Silverman D., 2000, Sage Publications, Thousand Oaks, CA.1993, Longman U.K.

Course title: Research and Publication ethics

Course code: EGS. 751

L	T	P	Cr
2	0	0	2

Total Hours: 30

Learning Outcomes: Upon successful completion of this course, the student will be able to

- Understand the basics of philosophy of science and ethics, research integrity, publication ethics.
- Identify research misconduct and predatory publications.
- Index and cite databases, open access publications, research and p metrics and plagiarism tools.

Unit-I: **8 Hours**

Philosophy and ethics: Introduction to philosophy: definition, nature and scope, concept, branches, Ethics: definition, moral philosophy, nature of moral judgments and relations.

Scientific conduct: Ethics with respect to science and research, Intellectual honest and research integrity, Scientific misconducts, falsification, fabrication, and plagiarism, Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data.

Unit-II: **7 Hours**

Publication ethics: definition, introduction and importance, Best practices/standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: definition and concept, problems that lead to unethical behavior and vice-versa, types, Violation of publication ethics, authorship and contributor ship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals.

Unit-III: **8 Hours**

Open access publishing: Open access publications and initiatives, SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies, Software tool to identify predatory publications developed by SPPU, Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

Publication misconduct

Group Discussions: Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad.

Software tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools.

Unit-IV: **7 Hours**

Databases and research metrics

Databases: Indexing databases, Citation databases: Web of Science, Scopus, etc.,

Research Metrics: Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score, Metrics: h-index, g index, i10 index, altimetric

Transactional Modes: Lecture, Project Method, Practices, Inquiry training, Seminar, Group discussion, Focused group discussion, Team teaching, Brain storming, Collaborative learning, Case analysis, Case study, Self-learning, Through SOLE (Self Organized Learning Environment).

Suggested reading:

1. Principles of Writing Research Papers by Lester, James, D. and Lester Jr. J. D., 2007, Longman, New York.
2. Analyzing talk and text. In N. Denzin and Y. Lincoln, eds. Handbook of Quali tative Research by Silverman D., 2000, Sage Publications, Thousand Oaks, CA.1993, Longman U.K.
3. Research Design: Qualitative, Quantitative and Mixed Methods Approaches by John, W. C., 2011, Sage Publications, Thousand Oaks.
4. Social Research Methods: A Reader by Seale C., 2004, Routledge, London.

Course Code: EGS.752

Course Title: TEACHING ASSISTANTSHIP

L	T	P	Credit
0	0	2	1

Total Hours: 30

Learning Outcome:

At the end of this skill development course, the scholars shall be able to

1. familiarize themselves with the pedagogical practices of effective class room delivery and knowledge evaluation system
2. manage large and small classes using appropriate pedagogical techniques for different types of content

Activities and Evaluation:

- The scholars shall attend Master degree classes of his/her supervisor to observe the various transaction modes that the supervisor follows in the class room delivery or transaction process one period per week.
- The scholars shall be assigned one period per week under the direct supervision of his/her supervisor to teach the Master degree students adopting appropriate teaching strategy(s).
- The scholars shall be involved in examination and evaluation system of the Master degree students such as preparation of questions, conduct of examination and preparation of results under the direction of the supervisor.
- At the end of the semester, the supervisor shall conduct an examination of teaching skills learned by the scholar as per the following evaluation criteria:
- The scholars shall be given a topic relevant to the Master degree course of the current semester as his/her specialization to prepare lessons and deliver in the class room before the master degree students for one hour (45 minutes teaching + 15 minutes interaction).
- The scholars shall be evaluated for a total of 50 marks comprising content knowledge (10 marks), explanation and demonstration skills (10 marks), communication skills (10 marks), teaching techniques employed (10 marks), and classroom interactions (10).

Department of Geology
Central University of Punjab

Course Code: UNI.753

Course Title: CURRICULUM, PEDAGOGY AND EVALUATION

L	T	P	Credit
1	0	0	1

Learning outcomes: **Total Hours: 15**

After completion of the course, scholars shall be able to:

- analyze the principles and bases of curriculum design and development
- examine the processes involved in curriculum development
- develop the skills of adopting innovative pedagogies and conducting students' assessment
- develop curriculum of a specific course/programme

Course Content

Unit I Bases and Principles of Curriculum **4 hours**

1. Curriculum: Concept and Principles of curriculum development, Foundations of Curriculum Development.
2. Types of Curriculum Designs- Subject centered, learner centered, experience centered and core curriculum. Designing local, national, regional and global specific curriculum. Choice Based Credit System and its implementation.

Unit II Curriculum Development **4 hours**

1. Process of Curriculum Development: Formulation of graduate attributes, course/learning outcomes, content selection, organization of content and learning experiences, transaction process.
2. Comparison among Interdisciplinary, multidisciplinary and trans-disciplinary approaches to curriculum.

Unit III Curriculum and Pedagogy **3 hours**

1. Conceptual understanding of Pedagogy.
2. Pedagogies: Peeragogy, Cybergogy and Heutagogy with special emphasis on Blended learning, Flipped learning, Dialogue, cooperative and collaborative learning
3. Three e- techniques: Moodle, Edmodo, Google classroom

Unit IV Learners' Assessment **4 hours**

1. Assessment Preparation: Concept, purpose, and principles of preparing objective and subjective questions.

2. Conducting Assessment: Modes of conducting assessment – offline and online; use of ICT in conducting assessments.
3. Evaluation: Formative and Summative assessments, Outcome based assessment, and scoring criteria.

Transaction Mode

Lecture, dialogue, peer group discussion, workshop

Evaluation criteria

There shall be an end term evaluation of the course for 50 marks for duration of 2 hours. The course coordinator shall conduct the evaluation.

Suggested Readings

- Allyn, B., Beane, J. A., Conrad, E. P., & Samuel J. A., (1986). Curriculum Planning and Development. Boston: Allyn & Bacon.
- Brady, L. (1995). Curriculum Development. Prentice Hall: Delhi. National Council of Educational Research and Training.
- Deng, Z. (2007). Knowing the subject matter of science curriculum, Journal of Curriculum Studies, 39(5), 503-535. https://doi.org/10.1080/00220270701305362
- Gronlund, N. E. & Linn, R. L. (2003). Measurement and Assessment in teaching.
- Singapore: Pearson Education
- McNeil, J. D. (1990). Curriculum: A Comprehensive Introduction, London: Scott,
- Foreman/Little
- Nehru, R. S. S. (2015). Principles of Curriculum. New Delhi: APH Publishing Corporation.
- Oliva, P. F. (2001). Developing the curriculum (Fifth Ed.). New York, NY: Longman
- Stein, J. and Graham, C. (2014). Essentials for Blended Learning: A Standards-Based Guide. New York, NY: Routledge.

Web Resources

- https://www.westernsydney.edu.au/__data/assets/pdf_file/0004/467095/Fundamentals_of_Blended_Learning.pdf
- https://www.uhd.edu/academics/university-college/centers-offices/teaching-learningexcellence/Pages/Principles-of-a-Flipped-Classroom.aspx

- http://leerwegdialoog.nl/wp-content/uploads/2018/06/180621-Article-The-BasicPrinciples-of-Dialogue-by-Renate-van-der-Veen-and-Olga-Plokhooij.pdf

Elective courses: Select any two of the specialized courses listed below

L	T	P	Cr
0	0	0	1

Course title: Paleontology and Stratigraphy

Course code: EGS.702

L	T	P	Cr
4	0	0	4

Total Hours: 60

Learning Outcomes: Upon successful completion of this course, the student will be able to:

•Identify certain fossils fauna.
•Experiment with the technique of fossil extraction and taxonomy.
•Elaborate the origin and evolutionary history of various fossils in time and space and its application in hydrocarbon exploration.
•Formulate the paleoclimatic, paleoenvironmental and paleobiogeographic history of the earth.

Unit-I: **15 Hours**

Basic principle, species concepts, speciation, mechanism of evolution and diversification, adaptation and functional morphology, taphonomic consideration. Types and classification of microfossils and their applications. Invertebrates, vertebrates and plant fossils of India. Cenozoic biostratigraphy and paleoecology.

Unit-II: **15 Hours**

Field and laboratory techniques in paleontology: sampling and processing techniques, preparation of samples for SEM, EDX, petrological studies, etc.Introduction to applied paleontology: Use of paleontological data in Stratigraphy, Paleoecology, Evolution, paleoclimate and sea level changes, climate, exploration, tectonics and Paleobiogeography.

Unit-III: **15 Hours**

Recent advances in stratigraphy, Principles of stratigraphy, stratigraphic sequences and depositional framework. Stratigraphy in relationship with other branches of geology. Need for stratigraphic correlation, Different correlation techniques and related methodologies, relationship with evolutionary history of life, statistical analysis.

Unit-IV: **15 Hours**

Geology and stratigraphy of some important sections of Archeans-Precambrian, Paleozoic, Gondwana, Mesozoic and Cenozoic deposits of India, their significances and major stratigraphic boundaries.

Transactional Modes: Lecture, Demonstration, Lecture cum demonstration, Project Method, Inquiry training, Seminar, Group discussion, Co-operative learning, Blended learning, Flipped learning, Team teaching, Brain storming, Mobile teaching, Collaborative learning, Problem solving, Self-learning, Case based study, Through SOLE (Self Organized Learning Environment).

Suggested reading:

1. Geology of India, Geological Society of India, Bangalore, by Ramakrishnan M. and Vaidyanathan R., 2008, Vol. 1 & 2, ISBN No: 978-81-85867-98-4.
2. Principles of Stratigraphy by Danbar, C.O. and Rodgers, J., 1957, John Wiley & Sons.
3. Precambrian Geology of India by Naqvi, S.M. and Rogers, J.J.W., 1987, Oxford University Press.
4. Vertebrate Palaeontology, by Michael Benton, 3rd edition, 2004, Wiley-Blackwell, ISBN: 9780632056378.
5. Microfossils, by Howard A. Armstrong, Martin D. Brasier, 2nd edition, Blackwell Publishing Ltd., ISBN: 9780632052790.
6. Principles of Invertebrate Paleontology by N. Shrock, 2nd edition, 2005, CBS Publisher;ISBN-13: 978-8123912189
7. Geology of India and Burma by Krishnan, M.S., 1982, C.B.S. Publishers & Distributors, Delhi.
8. A Manual of the Geology of India & Burma by Pascoe, E.H.1968. (Vols.I-IV) Govt. of India Press,
9. Fundamentals of historical geology and stratigraphy of India by Ravindra Kumar, 1998. NEW AGE, ISBN-13: 978-0852267455.
10. Stratigraphy: Principles and Methods by Schoch, Robert M., 1989, Van Nostrand Reinhold, New York.
11. Introduction to Stratigraphy and Paleontology, in Indian Ocean Geology and Biostratigraphy (eds. J.R. Heirtzler, H.M. Bolli, T.A. Davies, J.B.

Saunders and J.G. Sclater) by Bolli, H. M. and Saunders, J. B. 1977, American Geophysical Union, Washington, D. C.
12. Unlocking the Stratigraphic Record byDoyle, P. & Bennett. M.R. 1996, John Willey.
13. Bringing Fossils to Life: An Introduction to Paleobiology, by Donald R. Prothero, 2nd edition, 2003,McGraw-Hill Higher Education; ISBN-10:0073661708
14. Paleontology Invertebrate by Henry Wood 2004, 8th Edition, CBS Publication ISBN: 9788123-910802.

Course title: Geochemistry and isotope Geology

Course code: EGS.703

L	T	P	Cr
4	0	0	4

Total Hours: 60

Learning Outcomes: Upon successful completion of this course, the student will be able to

- Appraise behaviors of elements in the formation of primary and secondary rocks
- Formulate basics of isotope systematics and radioactive decay.
- Design the geochemical aspects for assessment of elements in and on Earth.
- Discuss the principles and applications of radiogenic isotope systematics to study geological processes and date rock-forming events.
- Adapt the principles and applications of stable isotope systematics.

Unit I: **15 Hours**

Recent trend in pure and applied geochemistry, geochemical data and their controls, analysis and analytical methods for the procurement of geochemical data. Sample preparation techniques, correlation, regression, principle component analysis.

Unit II: **15 Hours**

Use of major, traces, REE, PGEs, element data in rock classification and their significance in environment, provenance, climatic and tectonic settings.

Unit III: **15 Hours**

Principle of isotope geology. Principles, methods and applications Carbon, Oxygen, Sulphur isotopes and its use in geosciences. Fractionation of stable

isotopes in hydrologic cycle; Processes involve in stable isotopic studies in laboratory and data analysis.

Unit IV: **15 Hours**

Radiogenic isotopes and their application in geochronology and geochemistry. Principles, methods, applications and limitations of K-Ar, Ar-Ar, Rb-Sr, Sm-Nd, U-Th-Pb methods, etc. Radionuclide as tracer for geochemical process. Application of ^{10}Be and ^{26}Al to understand earth surface processes.

Transactional Modes: Lecture, Demonstration, Lecture cum demonstration, Project Method, Inquiry training, Seminar, Group discussion, Co-operative learning, Blended learning, Flipped learning, Team teaching, Brain storming, Mobile teaching, Collaborative learning, Problem solving, Self-learning, Case based study, Through SOLE (Self Organized Learning Environment).

Suggested reading:

1. Principles and applications of Geochemistry by Gunter Faure, 2nd edition, 1998, Prentice Hall.
2. Essentials of Geochemistry by John V. Walther, 2010, Jones and Bartlett Publication.
3. Geochemistry: Pathways and Processes by McSween, H.Y. Jr., Richardson, S.M. and Uhle M.E. 2003, Columbia Univ. Press.
4. Geochemistry, An introduction by Francis Albarede, 2003, Cambridge Univ. Press,
5. Jochen Hoefs, 2015. Stable isotope Geochemistry. Springer.
6. Claude Allegre, 2008. Isotope Geology. Cambridge University Press.
7. Radiogenic Isotope Geology by Dickin A.P. 2005, Cambridge University Press.
8. Introduction to Geochemistry by Mason, B. and Moore, C.B. 1991, Wiley Eastern.
9. Introduction to Geochemistry by Krauskopf K.B.,1967, McGraw Hill.
10. Geochemistry by William M. White, 1stEdition, 2013, Wiley-Blackwell.
11. Introduction to Geochemistry by Mason, B. and Moore C.B., 1991, Wiley Eastern.

Course title: Remote Sensing and GIS

Course Code: EGS.704

L	T	P	Cr
4	0	0	4

Total Hours: 60

Learning Outcome: Upon successful completion of this course, the student will be able to

- Develop utilization of satellite data in various applications such as geology, hydrogeology, climatology, forestry, town planning etc.
- Maximize digital image processing technique of satellite data for various applications such as land use/land cover, digital elevation model (DEM).

Unit-I: **15 Hours**

Concept of Remote Sensing and GPS: Fundamentals of Remote Sensing, Sensors; Active and passive remote sensing; Types of platform; Types of orbits (Geostationary, Polar, Sun-synchronous); Scanning Systems (Push broom and Whiskbroom); Types of Sensors; Data collection, Aerial Photography, Visual Image Interpretation, Digital image processing. Introduction to Global Positioning System (GPS); Satellite remote sensing; Types of Satellites.

Unit-II: **15 Hours**

Concepts of GIS: Elements of GIS; Map Projection; Data structures in GIS: Raster and Vector data; GIS software; Hierarchical, Network and relational data; Geo-relational and object-oriented vector data structure; Vector and Raster based analysis; Overlays operations; Map algebra; Network Analysis; Spatial analysis

Unit-III: **15 Hours**

Applications of Remote Sensing and GIS in Geology – 1: Thermal Infra-red remote sensing in geological studies; microwave remote sensing for geological applications; Applications of remote sensing - identification of rocks, geological surveys; volcanic eruptions, environmental geology; geobotany; event mapping and monitoring; geo-hazard mapping.

Unit-IV: **15 Hours**

Applications of Remote Sensing and GIS in Geology – 2: Applications of remote sensing- lithological mapping; mineral explorations, alteration zones mapping; surficial deposit/bedrock mapping; structural mapping; sand and gravel (aggregate) exploration/ exploitation; hydrocarbon exploration; sedimentation mapping and monitoring.

Transactional Modes: Lecture, Demonstration, Lecture cum demonstration, Project Method, Inquiry training, Seminar, Group discussion, Co-operative learning, Blended learning, Flipped learning, Team teaching, Brain storming, Mobile teaching, Collaborative learning, Problem solving, Self-learning, Case based study, Through SOLE (Self Organized Learning Environment).

Suggested reading:

1. Remote sensing and image interpretation byLillisand, T. M. and Keifer, R. W. 2007, John Willey and Sons, USA
2. Introduction to environmental remote sensing by Barrett, E. C. and Curtis, L. F. 1999, Chapman and Hall Publishers, USA.
3. Fundamentals of remote sensing by Joseph G. 2003, Universities Press, Hyderabad.
4. Introduction to geographic information systems by Chang, Kang-Taung2002, Tata McGraw-Hill, USA.
5. Methods of Environmental Impact Assessment by Morris, P. and Therivel, R. 2001, Spoon Press.
6. Remote Sensing: Principles and Interpretation by Sabbins Jr, F.F. 1986, WH Freeman & Co, New York.
7. Remote Sensing Geology by Gupta, R.P., 1990, Springer Verlag.
8. Trends in Geological Remote Sensing by Ramsay, S.M. 1996, Rawat Publishers, Jaipur.
9. Environmental impact assessment: Practical solutions to recurrent problems by Lawrence, D.P. 2003,John Wiley and Sons, New Delhi.
10. Introduction to Remote Sensing of the Environment by Richardson, B. F., Jr. ed. 1978, Kendall/Hunt Publishing Company. Dubuque, Iowa.
11. Aerial photography and Image Interpretation for Resource Management by Paine, D.P., 1981, John Wiley.
12. Principles and Applications of Photogeology by Pandey, S.N., 1987, Wiley Eastern, New Delhi.

Course title: Igneous and Metamorphic petrology

Course code: EGS.705

L	T	P	Cr
4	0	0	4

Total Hours: 60

Learning Outcome: Upon successful completion of this course, the student will beable to

- Evaluate key textural/micro structural features of igneous and metamorphic rocks and appreciate the significance of such features with regard to geological processes that have operated.
- Assess certain igneous and metamorphic rocks on the basis of their mineralogical and textural characteristics.
- Interpret phase diagrams relevant to igneous systems and petrogenic grids relevant to metamorphic systems on the basis of mineral assemblages recorded in the rock.
- Discuss the chemistry of certain igneous/metamorphic rocks and predict their environment(s) of formation.

Unit-I: **15 Hours**

Recent trend in pure and applied petrology including the recent development in recent methodology and instrumentation. Magmatic processes: concepts and models; classification of igneous rocks using multiple criteria; textures and structures in igneous rocks and their origin.

Unit-II: **15 Hours**

Petro genesis of crustal igneous rocks; petrography, chemistry of acid, basic and ultra- basic igneous rocks. Igneous rocks in different tectonic setting, origin of structures and textures in igneous rocks.

Unit-III: **15 Hours**

Metamorphic textures and structures, classical and advanced techniques for textural analysis, nucleation and growth of materials in magmatic and metamorphic systems; replacement textures and reaction rims and their roles in reconstructing P-T histories of metamorphism; tectonites, foliation, lineation; deformation Vs metamorphic growth, analysis of poly-deformed and polymetamorphic rocks; equilibrium of mineral assemblages and metamorphic phase rules and phase diagrams.

Unit-IV: **15 Hours**

Metamorphic reactions and thermodynamics of metamorphic reactions. Geothermometry and geobarometry. Calculating P-T-t path from zoned crystals. Review of experimental works in metamorphic mineral stabilities and recrystallization. Problems of regional metamorphism illustrated by Precambrian terrain and more recent orogenic belts.

Transactional Modes: Lecture, Demonstration, Lecture cum demonstration, Project Method, Inquiry training, Seminar, Group discussion, Co-operative learning, Blended learning, Flipped learning, Team teaching, Brain storming, Mobile teaching, Collaborative learning, Problem solving, Self-learning, Case based study, Through SOLE (Self Organized Learning Environment).

Suggested reading:

1. An introduction to Igneous and Metamorphic Petrology by Winter J.D., 2001, Prentice Hall.
2. Igneous Petrology by Bose, M.K., 1997, World Press, Kolkata.
3. Igneous and Metamorphic Petrology by Best Myron G., 2002, Blackwell Science.

4. The Interpretation of Igneous Rocks by Cox, K.G., Bell, J.D. and Pankhurst, R.J., 1993, Chapman& Hall, London.
5. Petrogenesis of Metamorphic Rocks by Bucher K. and Martin F., 7th revised edition 2002, Springer – Verlag.
6. Mineralogical Phase Equilibria and pressure – temperature – time Paths by Spear, F. S. 1993, Mineralogical Society of America.
7. Igneous Petrology byHall A., 1997, Longman.
8. Igneous Rocks: A Classification and Glossary of Terms by LeMaitre R.W., 2002, Cambridge University Press.
9. Igneous Petrology by McBirney, 1994, CBS Publishers, Delhi.
10. Principles of Igneous and Metamorphic Petrology by Phillpotts, A.R. 1994, Prentice Hall, India.
11. Modern Igneous Petrology by Sood M.K., 1982, Wiley-Interscience Publ., New York.
12. Principles of Igneous and Metamorphic Petrology by Phillpotts A.R. 1994, Prentice Hall.
13. An introduction to Metamorphic Petrology by Yardley, B.W.D. 1989, Longman Scientific & Technical, New York.
14. Equilibrium thermodynamics in Petrology: An Introduction by Powell, R. 1978, Harper & Row Publishers, London.

Course title: Geomorphology and Quaternary Geology

Course Code: EGS.706

L	T	P	Cr
4	0	0	4

Total Hours: 60

Learning Outcomes: Upon successful completion of this course, the student will be able to:

- Demonstrate the principal theories and models for landscape evolution.
- Assess the mode of formation, age and history of landforms in India.
- Distinguish landforms and their processes of formation in different climate zones and tectonic regimes.
- Develop relevant solution for elucidate geomorphologic problems in Quaternary period.

Unit-I: **15 Hours**

Geomorphology- principles, scope and aspects of research, certain field and laboratory techniques, advance mapping techniques of geomorphic features. Evolution of landforms and their climatic, structural and tectonic controls. Understanding of computer software involve in geomorphological studies.

Unit-II: **15 Hours**

Detail geomorphic features of fluvial, glacial, Aeolian and coastal deposition system and their response to climate and tectonics. Study of the physiography of India.

Unit-III: **15 Hours**

Quaternary climate, sedimentation, tectonics and stratigraphy. Quaternary geology of northwestern India, knowledge gaps and future prospects. Various techniques used in studying the quaternary records. Evolutions of major river system of India and their tectonic implications. Major issues on quaternary geology and sustainable development.

Unit-IV: **15 Hours**

Tectonic set up of India. Use of GPS and satellite image for tectonic study. Seismic wave, paleo-seismology, active fault, fault nucleation and propagation, earthquake-fault relationship in tectonic domains, extensional and compressional tectonic environment, and liquefaction induced paleo-seismic features and age determination of such features.

Transactional Modes: Lecture, Demonstration, Lecture cum demonstration, Project Method, Inquiry training, Seminar, Group discussion, Co-operative learning, Blended learning, Flipped learning, Team teaching, Brain storming, Mobile teaching, Collaborative learning, Problem solving, Self-learning, Case based study, Through SOLE (Self Organized Learning Environment).

Suggested reading:

1. Indian Geomorphology by Sharma, H.S. 1991, Concept Publishing Co. New Delhi. ISBN: 817022344X.
2. Applied Geomorphology: Theory and Practice by Allison R. J. 1st edition, 2002,
Wiley.
3. Tectonic Geomorphology by Douglas, W. B and Anderson, R. S., 2nd edition, 2011, Wiley-Blackwell, ISBN-13: 978-1444338867.
4. Geomorphology: The Mechanics and Chemistry of Landscapes by Anderson, R.S. and Anderson S. P., 1st edition, 2010, Cambridge University Press, ISBN-13: 978-0521519786.
5. Key Concepts in Geomorphology by Paul R. B. and David R. M.,2013, W. H. Freeman, ISBN-13: 978-1429238601
6. Geomorphology and Global Tectonics by Michael A.S. 2000, Wiley, ISBN: 978-

0471-971931.
7. Introduction to geomorphology by Kale V. S., &Gupta, A. 2001, Orient Longman, Bangalore.
8. Physical geography by Singh S., 2011, Prayag Pustak Bhavan, Allahabad.
9. An introduction to physical geography by Strahler A.N. & Strahler, 1996, John Wiley & Sons.

Course title: Hydrogeology and Environmental Geology

L	T	P	Cr
4	0	0	4

Course code: EGS.707

Total Hours: 60

Learning Outcomes: Upon successful completion of this course, the student will be able to

- Appraise the role of groundwater in hydrological cycle, groundwater flow pattern in different terrains.
- Estimate quantity and to assess quality aspects of groundwater for better management, characterizations of aquifers in terms of yield, categorization of groundwater for different uses.
- Formulate the evolution of water chemistry through hydrogeochemical processes across different terrains.
- Discuss the role of geologic processes in assessment of natural hazards
- Formulate the occurrence and formation of earth resources and significant environmental effects caused by their extraction, processing, and use;
- Predict the major sources of water, soil, and sediment pollution and methods for their management.

Unit-I: 15 Hours

System, concepts of hydraulic cycle; concepts and scopes of unit hydrograph and its applications, discharge rate. Factors that affect occurrence of groundwater – Climate, topography, geology; Exploration techniques - Integrated approach to groundwater prospecting: Role of toposheets and Remote sensing in groundwater exploration; Hydrochemical methods: surface and subsurface Geophysical methods, Tracer techniques, Exploratory Bore well programme, use of computer software in exploration of groundwater**.**

Unit-II: 15 Hours

Different processes and techniques of prospecting ground water; Modern methods of characterization and assessment techniques of groundwater qualities, modeling, groundwater management, etc.; Case study on the problem of groundwater pollution in India. Hydrological prospects in different rock

terrains for groundwater exploration. Controls of groundwater, ground water provinces of India.

Unit III: **15 Hours**

Palaeohydrology, estimation of paleo-flood discharge, erosion and sediment yields, sediment yield process and modeling. Environmental Health – Base-line data generation; Sampling-Sampling Procedures-Errors in sampling, Air, Water, Soil and Noise Sampling-Instrumentation-Analysis.

Units IV: **15 Hours**

Geological hazards such as earthquake, landslide, their cause, mitigations, land-use planning development; Use of remote sensing and GIS in environment studies. Environmental Impact Assessment (EIA), Environmental Management Plans (EMP)-REA & SEA; Environmental Legislation-National / International Standards Application of Remote Sensing and GIS in Environmental Management.

Transactional Modes: Lecture, Demonstration, Lecture cum demonstration, Project Method, Inquiry training, Seminar, Group discussion, Co-operative learning, Blended learning, Flipped learning, Team teaching, Brain storming, Mobile teaching, Collaborative learning, Problem solving, Self-learning, Case based study, Through SOLE (Self Organized Learning Environment).

Suggested readings:

1. Ground Water Hydrology by Todd D.K., 1988, John Wiley & Sons, New York.
2. Hydrogeology by Davies, S.N. and Dc-West, R.J.N. 1966, John Willey & Sons, NY.
3. Ground Water by Raghunath H.M. 1983, Wiley Eastern Ltd., Calcutta.
4. Environmental Geology by Lundgren, L. 1986, Prentice Hall Pvt. Ltd., New Delhi.
5. Geological Hazards by Bell F.G. 1999, Routledge, London.
6. Environmental Geology by Bermett M.R., & Doyle P., 1999, John Wiley & Sons, NY.
7. Environmental Geology by Keller, E.A.,1978, Bell and Howell, USA.
8. Ground Water and Wells by Driscoll F.G. 1988, UOP, Johnson Div. St. Paul. Min. USA.
9. Natural Hazards by Bryant E., 1985, Cambridge University Press. London.
10. Introduction to Environmental Toxicology by Landis W.G. and Yu M.H, 1999, Lewis Publ., London.

11. Environmental Assessment source Book (1991) Volume I, II & III Environment Department, The World Bank, Washington DC.

Course title: Structural Geology and Engineering Geology

L	T	P	Cr
4	0	0	4

Course code: EGS-708

Total Hours: 60

Learning Outcome: Upon successful completion of this course, the student will be able to

- Determine the geological structures of deformed continental regimes.
- Reconstruct the regional tectonic set up based on microstructural and petrofabric data.
- Design the relative timing of formation of structures, the kinematics of deformation and the progressive deformation histories at various tectonic regimes.
- Appraisal of structural geology in the mining and resource exploration environment.
- Understand the engineering properties of rock and soil materials, engineering geological investigations, slope stability, geological factors affecting the stability of a facility on and in the soil, engineering, stability and protection of underground facilities, etc.
- Classify soils and rocks, use of air photos and geological maps, engineering geological problems related to design and stability.
- Understand the importance of engineering geology related to technical issues during construction, and conduct basic engineering geological assessments and analyzes.

Unit-I: 15 Hours

Modern techniques of structural geology. Structural mapping of deformed terrains, small scale structures and their relationship with the large structures; Use of stereographic projection and their kinematic analysis; use of stereographic projection related structural softwares; strain calculation of fold, fault, joints, fracture, foliation, lineation and other deformed bodies, stress trajectory and calculation of deformation paths.

Unit-II: 15 Hours

Morphological characteristics of folds and faults in all scales and their kinematics interpretation**.** Overview of thrust-tectonics; shear zone geometry;

microstructural studies of deformation correlation. Relationship between the internal stress and external stress and resultant strain features in rocks including mathematical analysis and analog computer studies.

Unit III: **15 Hours**

Engineering geology in planning and development; soils and rocks properties for engineer proposed; engineering classification of soils; stress, strain and constitutive process, shear strength of soil; rock strength, properties and their measurement; basic concepts of rock mechanics.

Unit IV: **15 Hours**

Importance of geology in engineering projects; site investigation for various engineering projects such as dam, highways, bridges, tunnels, etc.; Rock mass failures their types and techniques for studying rock mass failures. Geological materials for construction purposes. Case study of major engineering projects of India.

Transactional Modes: Lecture, Demonstration, Lecture cum demonstration, Project Method, Inquiry training, Seminar, Group discussion, Co-operative learning, Blended learning, Flipped learning, Team teaching, Brain storming, Mobile teaching, Collaborative learning, Problem solving, Self-learning, Case based study, Through SOLE (Self Organized Learning Environment).

Suggested reading:

1. Basic Methods of Structural Geology by Stephen Marshak & Gautam Mitra, 1988, Prentice Hal.
2. Structural analysis of Metamorphic Tectonites by Turner, F.J. & Weiss, L.E. 1963, McGraw Hill.
3. Structural Geology: Fundamental and Modern Developments by Ghosh, S. K., 1993, Pergamon Press.
4. Fundamentals of Engineering Geology byBell, F.G., 1992, Aditya Books Pvt. Ltd. Indian Edition.
5. Principles of Engineering Geology by Krynine, D.H. & Judd, W.R., 1998, CBS Edition.
6. Geology in Engineering by Schultz, J.R. & Cleaves, A.B. 1951, John Willey & Sons, NY.
7. Surveying (Plane and Geodetic) by Roy Chowdhary K.P. 1987, Oxford & IBH Pub. Co., New Delhi.
8. Folding and fracturing of rocks by Ramsay J.G. 1967, McGraw Hill.
9. Text Book of Surveying, vol–I. by Shahani, P.B.,1978, Oxford & IBH Pub. Co., New Delhi.
10. Techniques of Modern Structural Geology. Vol. I. Strain Analysis by Ramsay, J.G. and Huber, M.I. 1983, Academic Press.

11. Techniques of Modern Structural Geology. Vol. II. Folds and Fractures by Ramsay, J.G. and Huber, M.I. 1987, Academic Press.

Course title: Sedimentology and Sequence Stratigraphy

Course code: EGS.709

L	T	P	Cr
4	0	0	4

Total Hours: 60

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

- Categorize the various sedimentary rocks and their mode of genesis in different depositional environment.
- Interpret the processes responsible for the deposition of the sediment and formation of sedimentary textures and structures.
- Construct the depositional environment of certain sedimentary rock based on recognition of facies associations, lithology, textures and structures.
- Formulate the sedimentary basin forming processes and its environmental and economic significance.
- Make up reasoning to construct one or more hypotheses for the paleogeographic and environmental histories that produced a series of strata.
- Appraise an understanding of stratigraphic sequence mapping and interpretation to a variety of data types typical to surface geological and subsurface geological analysis (i.e., outcrop, well log, seismic).

Unit-1: 15 Hours

Modern techniques and methods in sedimentological studies; sedimentary structures, textures and their significances; probability scale, anatomy of probability scale, software used for log probability plots; hydrodynamic conditions of depositions of sedimentary agents such as fluvial, Aeolian, glacial, oceanic agents, etc.

Unit-II: 15 Hours

Classification and petrography of important clastic and non-clastic rocks. Paleocurrent analysis. Heavy minerals for correlation and provenance determination, diagenetic process; facies and facies map; Geochemical plots in sedimentary rocks, their limitations.

Unit-III: 15 Hours

Understanding basin forming processes and basin architecture. Stratigraphic signature of a basin: sea level change, basin-floor wobbling, sedimentation rate and climate. Depositional facies, seismic facies seismic expression & configuration and log-based sequence, correlation sequence.

Unit-IV: 15 Hours

Stratigraphic principles and facies tracts carbonate sequence stratigraphy and drowning unconformity. Application of sequence stratigraphy to basin evolution and other allied science.

Transactional Modes: Lecture, Demonstration, Lecture cum demonstration, Project Method, Inquiry training, Seminar, Group discussion, Co-operative learning, Blended learning, Flipped learning, Team teaching, Brain storming, Mobile teaching, Collaborative learning, Problem solving, Self-learning, Case based study, Through SOLE (Self Organized Learning Environment).

Suggested readings:

1. Principles of sedimentology & stratigraphy by Sam Boggs Jr., 5th edition, 2011, Prentice Hall, ISBN-13: 978-0321643186.
2. Sedimentology and stratigraphy by Gary Nichols, 2nd edition, 2009, Wiley-Blackwell, ISBN: 978-1-4051-3592-4.
3. Sedimentary Basins by Einsele G., 1992, Springer Verlag.
4. Principle of sequence stratigraphy by Catunaenu O., 1st edition, 2006. Elsevier.
5. Carbonate Sedimentology by Tucker M.E. and Wright V.P., 1991, Publisher Wiley, ISBN 0632014725, 9780632014729.
6. Atlas of sedimentary rocks under the Microscope by Adams A. E.,MacKenzie W. S., Guilfor C.,1st edition, 1984, Prentice Hall, ISBN-13: 978-0582301184.
7. Sedimentary Geology by Donald R. Prothero, Fred Schwab,3rdedition, 2013, W. H. Freeman, ISBN-13: 978-1429231558.
8. Sedimentary Rocks in the Field: A Practical Guide (Geological Field Guide) by Maurice E. Tucker, 4th edition, 2011, Wiley-Blackwell, ISBN-13: 978-0470689165.
9. Principles of Sedimentary Basin Analysis by Miall A.D., 2000, Springer-Verlag.
10. Depositional Sedimentary Environments by Reineck H.E. and Singh I.B., 1980, Springer-Verlag.
11. Introduction to Sedimentology by Sengupta S., 1997, Oxford-IBH.