CENTRAL UNIVERSITY OF PUNJAB

Ph.D. Geology

Batch 2025 onwards

Department of Geology

School of Environment and Earth Sciences

Syllabus for Ph.D. Geology Course work

Course Code	Course Title	Credit Hours			
		L	T	P	Cr
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 one of the specialized courses listed below					
EGS. 711	Paleontology	4	0	0	4
EGS. 712	Stratigraphy	4	0	0	4
EGS. 713	Geochemistry	4	0	0	4
EGS. 714	Isotope Geology & Geochronology	4	0	0	4
EGS. 715	Remote Sensing	4	0	0	4
EGS. 716	Geographic Information Systems (GIS)	4	0	0	4
EGS. 717	Igneous petrology	4	0	0	4
EGS. 718	Metamorphic petrology	4	0	0	4
EGS. 719	Applied Geomorphology	4	0	0	4
EGS. 720	Quaternary Geology	4	0	0	4
EGS. 721	Hydrogeology	4	0	0	4
EGS. 722	Environmental Geology	4	0	0	4
EGS. 723	Structural Geology	4	0	0	4
EGS. 724	Engineering Geology	4	0	0	4
EGS. 725	Sedimentology	4	0	0	4
EGS. 726	Sequence stratigraphy	4	0	0	4
EGS. 727	Paleomagnetism	4	0	0	4
EGS. 728	Rock Magnetism	4	0	0	4
EGS. 729	Ore Geology	4	0	0	4
	Total	**11**	**0**	**2**	**12**

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

Course title: Research Methodology

Course code: EGS.701

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: Choose and propose appropriate research methods according to their research aims and objectives

CLO2: Aware the limitations of particular research methods

CLO3: Justify knowledge of the selection of various instruments and sample preparation techniques for addressing specific research problem

CLO4: Develop skills in qualitative and quantitative data analysis and presentation

CLO5: Design advanced critical thinking skills and enhanced writing skills

Unit/ Hours	Contents	Mapping with CLO
I/20	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.	CLO1
II/10	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.	CLO2 CLO3
III/15	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.	CLO4
IV/15	Experimental design and analysis: Sampling techniques, Sampling theory, Steps in sampling, Collection of data types and methods. Diagrammatic representation of frequency distribution:	CLO3 CLO4 CLO5

	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

L	T	P	Cr
2	0	0	2

ethics Course code: EGS. 751

Total Hours: 30

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

CLO1: Understand the basics of philosophy of science and ethics, research integrity, publication ethics.
CLO2: Identify research misconduct and predatory publications.
CLO3: Index and cite databases, open access publications, research and p metrics and plagiarism tools.

Unit/ Hours	Contents	Mapping with CLO
I/08	**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.	CLO1
II/07	**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.	CLO2
III/08	**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.	CLO3
IV/07	**Databases and research metrics**	CLO3

	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 Qualitative Research bySilverman 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 title: Teaching Assistantship

Course code: EGS. 752

L	T	P	Cr
0	0	2	1

Total Hours: 30

Course Learning Outcomes (CLO): At the end of this skill development course, the scholars shall be able to:

CLO1: Familiarize themselves with the pedagogical practices of effective class room delivery and knowledge evaluation system

CLO2: 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).

Course title: CURRICULUM, PEDAGOGY AND EVALUATION

Course code: UNI. 753

L	T	P	Cr
1	0	0	1

Total Hours: 15

Course Learning Outcomes (CLO): After completion of the course, scholars shall be able to:

CLO1: Analyze the principles and bases of curriculum design and development

CLO2: Examine the processes involved in curriculum development

CLO3: Develop the skills of adopting innovative pedagogies and conducting students' assessment

CLO4: Develop curriculum of a specific course/programme

Unit/ Hours	Contents	Mapping with CLO
I/04	**Bases and Principles of Curriculum** 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.	CLO1
II/04	**Curriculum Development** 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.	CLO2
III/03	**Curriculum and Pedagogy** 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	CLO3
IV/04	**Learners' Assessment** 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.	CLO4

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

Course title: Paleontology

L	T	P	Cr
4	0	0	4

Course code: EGS.711

Total Hours: 60

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

CLO1: Identify certain fossils fauna.
CLO2: Experiment with the technique of fossil extraction and taxonomy.
CLO3: Elaborate the origin and evolutionary history of various fossils in time and space and its application

Unit/ Hours	Contents	Mapping with CLO
I/15	Basic principle, species concepts, speciation, mechanism of evolution and diversification, adaptation and functional morphology, taphonomic consideration.	CLO1
II/15	Types and classification of microfossils and their applications. Invertebrates, vertebrates and plant fossils of India. Cenozoic biostratigraphy and paleoecology.	CLO1
III/15	Field and laboratory techniques in paleontology: sampling and processing techniques, preparation of samples for SEM, EDX, petrological studies, etc.	CLO2
IV/15	Introduction to applied paleontology: Use of paleontological data in Stratigraphy, Paleoecology, Evolution, paleoclimate and sea level changes, climate, exploration, tectonics and Paleobiogeography.	CLO3

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. Vertebrate Palaeontology, by Michael Benton, 3rd edition, 2004, Wiley-Blackwell, ISBN: 9780632056378.
3. Microfossils, by Howard A. Armstrong, Martin D. Brasier, 2nd edition, Blackwell Publishing Ltd., ISBN: 9780632052790.

4. Principles of Invertebrate Paleontology by N. Shrock, 2nd edition, 2005, CBS Publisher;ISBN-13: 978-8123912189
5. Geology of India and Burma by Krishnan, M.S., 1982, C.B.S. Publishers & Distributors, Delhi.
6. Fundamentals of historical geology and stratigraphy of India by Ravindra Kumar, 1998. NEW AGE, ISBN-13: 978-0852267455.
7. 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.
8. Bringing Fossils to Life: An Introduction to Paleobiology, by Donald R. Prothero, 2nd edition, 2003, McGraw-Hill Higher Education; ISBN-10:0073661708
9. Paleontology Invertebrate by Henry Wood 2004, 8thEdition, CBS Publication ISBN: 9788123-910802.
10. Bringing Fossils to Life: An Introduction to Paleobiology, by Donald R. Prothero, 2nd edition, 2003, McGraw-Hill Higher Education; ISBN-10:0073661708
11. Paleontology Invertebrate by Henry Wood 2004, 8thEdition, CBS Publication ISBN: 9788123-910802.

Course title: Stratigraphy

Course code: EGS.712

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: describe the rock successions and their interpretation in terms of a general time scale.

CLO2: correlate rock/rock succession globally.

CLO3: Formulate the paleoclimatic, paleoenvironmental and paleobiogeographic history of the earth.

Unit/ Hours	Contents	Mapping with CLO
I/15	Recent advances in stratigraphy, Principles of stratigraphy, stratigraphic sequences and depositional framework. Stratigraphy in relationship with other branches of geology.	CLO1
II/15	Need for stratigraphic correlation, Different correlation techniques and related methodologies, relationship with evolutionary history of life, statistical analysis.	CLO2
III/15	Geology and stratigraphy of some important sections of	CLO3

	Archeans-Precambrian deposits of India, their significances and major stratigraphic boundaries	CLO1
IV/15	Paleozoic, Gondwana, Mesozoic and Cenozoic deposits of India, their significances and major stratigraphic boundaries	CLO3 CLO1

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. Principles of Invertebrate Paleontology by N. Shrock, 2nd edition, 2005, CBS Publisher; ISBN-13: 978-8123912189
6. Geology of India and Burma by Krishnan, M.S., 1982, C.B.S. Publishers & Distributors, Delhi.
7. A Manual of the Geology of India & Burma by Pascoe, E.H.1968. (Vols.I- IV) Govt. of India Press,
8. Fundamentals of historical geology and stratigraphy of India by Ravindra Kumar, 1998. NEW AGE, ISBN-13: 978-0852267455.
9. Stratigraphy: Principles and Methods by Schoch, Robert M., 1989, Van Nostrand Reinhold, New York.
10. 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.
11. Unlocking the Stratigraphic Record by Doyle, P. & Bennett. M.R. 1996, John Willey.

Course title: Geochemistry

L	T	P	Cr
4	0	0	4

Course code: EGS.713

Total Hours: 60

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

CLO1: Appraise the behaviors of elements in the formation of primary and secondary rocks.

CLO2: Design the geochemical aspects for assessment of elements in and on Earth.

Unit/ Hours	Contents	Mapping with CLO
I/15	Recent trend in pure and applied geochemistry, geochemical data and their controls, analysis and analytical methods for the procurement of geochemical data	CLO1
II/15	Analytical techniques, Sample preparation techniques, Data validation and analysis, correlation, regression, principle component analysis	CLO1
III/15	Use of major, traces, REE, PGEs, element data in rock classification and their significance in petrogenesis and tectonic settings	CLO2
IV/15	Use of elemental geochemistry in environmental, provenance and climatic studies.	CLO2

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. Introduction to Geochemistry by Mason, B. and Moore, C.B. 1991, Wiley Eastern.
6. Introduction to Geochemistry by Krauskopf K.B.,1967, McGraw Hill.
7. Geochemistry by William M. White, 1st Edition, 2013, Wiley-Blackwell.

Course title: Isotope geochemistry and Geochronology

Course code: EGS.714

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: Appraise the behaviors of stable and radiogenic isotopes in the formation of primary and secondary rocks.

CLO2: Formulate the basics of isotope systematics and radioactive decay, and their application in Geochronology.

CLO3: Discuss the principles and applications of radiogenic isotope systematics to study geological processes and date rock-forming events.

CLO4: Adapt the principles and applications of stable isotope systematics.

Unit/ Hours	Contents	Mapping with CLO
I/15	Recent trend in stable- and isotope-geochemistry, isotope-geochemical data and their controls, analysis and analytical methods for the procurement of isotope-geochemical data. Sample preparation techniques, correlation, regression, principle component analysis.	CLO1
II/15	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.	CLO2
III/15	Principle of stable 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	CLO3 CLO4
IV/15	Use of stable- and isotope-geochemistry in petrogenesis, environment, source, climatic and tectonic settings. Application of ^{10}Be and ^{26}Al to understand earth surface processes	CLO3 CLO4

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. Jochen Hoefs, 2015. Stable isotope Geochemistry. Springer.
2. Claude Allegre, 2008. Isotope Geology. Cambridge University Press.

3. Dickin, A.P., 2005. *Radiogenic Isotope Geology*. Cambridge University Press.
4. Gunter Faure, 1986. *Principles of Isotope Geology*, Wiley.
5. Gunter Faure and Teresa M. M, 2004.*Isotopes: Principles and Applications*, Wiley.

Course title: Remote Sensing

Course Code: EGS.715

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: Develop utilization of satellite data in various applications such as geology, hydrogeology, climatology, forestry, town planning etc.

CLO2: Maximize digital image processing technique of satellite data for various applications such as land use/land cover, digital elevation model (DEM).

Unit/ Hours	Contents	Mapping with CLO
I/15	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.	CLO1
II/15	Concept of Remote Sensing and GPS: Introduction to Global Positioning System (GPS); Satellite remote sensing; Types of Satellites.	CLO1
III/15	Applications of Remote Sensing 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.	CLO1 CLO2
IV/15	Applications of Remote Sensing 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.	CLO1 CLO2

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 by Lillisand, 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. Methods of Environmental Impact Assessment by Morris, P. and Therivel, R. 2001, Spoon Press.
5. Remote Sensing: Principles and Interpretation by Sabbins Jr, F.F. 1986, WH Freeman & Co, New York.
6. Remote Sensing Geology by Gupta, R.P., 1990, Springer Verlag.
7. Trends in Geological Remote Sensing by Ramsay, S.M. 1996, Rawat Publishers, Jaipur.
8. Environmental impact assessment: Practical solutions to recurrent problems by Lawrence, D.P. 2003, John Wiley and Sons, New Delhi.
9. Introduction to Remote Sensing of the Environment by Richardson, B. F., Jr. ed. 1978, Kendall/Hunt Publishing Company. Dubuque, Iowa.
10. Aerial photography and Image Interpretation for Resource Management by Paine, D.P., 1981, John Wiley.
11. Principles and Applications of Photogeology by Pandey, S.N., 1987, Wiley Eastern, New Delhi.

Course title: Geographic Information System (GIS)

Course Code: EGS.716

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: Develop utilization of satellite data in various applications such as geology, hydrogeology, climatology, forestry, town planning etc.

CLO2: Maximize digital image processing technique of satellite data for various applications such as land use/land cover, digital elevation model (DEM).

Unit/ Hours	Contents	Mapping with CLO
I/15	Concepts of GIS-1: Elements of GIS; Map Projection; Data structures in GIS: Raster and Vector data; GIS software;	CLO1

	Hierarchical, Network and relational data.	
II/15	Concepts of GIS-: Geo-relational and object-oriented vector data structure; Vector and Raster based analysis; Overlays operations; Map algebra; Network Analysis; Spatial analysis.	CLO1
III/15	Applications of GIS in Geology – 1: Thermal Infra-red remote sensing in geological studies; microwave remote sensing for geological applications; Applications of GIS - geological surveys; volcanic eruptions, environmental geology; geobotany; event mapping and monitoring; geo-hazard mapping.	CLO1 CLO2
IV/15	Applications of GIS in Geology – 2: Applications of GIS- mineral explorations, alteration zones mapping; surficial deposit/bedrock mapping; structural mapping; sand and gravel (aggregate) exploration/ exploitation; hydrocarbon exploration; sedimentation mapping and monitoring.	CLO1 CLO2

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. Introduction to geographic information systems by Chang, Kang-Taung2002, Tata McGraw-Hill, USA.
2. Methods of Environmental Impact Assessment by Morris, P. and Therivel, R. 2001, Spoon Press.
3. Remote Sensing Geology by Gupta, R.P., 1990, Springer Verlag.
4. Trends in Geological Remote Sensing by Ramsay, S.M. 1996, Rawat Publishers, Jaipur.
5. Environmental impact assessment: Practical solutions to recurrent problems by Lawrence, D.P. 2003, John Wiley and Sons, New Delhi.

Course title: Igneous Petrology

L	T	P	Cr
4	0	0	4

Course code: EGS.717

Total Hours: 60

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

CLO1: Assess certain igneous rocks on the basis of their mineralogical and textural characteristics.

CLO2: Evaluate key textural/micro structural features of igneous rocks and appreciate the significance of such features with regard to geological processes that have operated.

CLO3: Describe petrogenesis of Igneous rocks.

CLO4: Discuss the chemistry of certain igneous rocks and predict their environment(s) of formation.

Unit/ Hours	Contents	Mapping with CLO
I/15	Recent trend in pure and applied Igneous petrology including the recent development in recent methodology and instrumentation.	CLO1 CLO2
II/15	Magmatic and allied processes: concepts and models; IUGS classification of igneous rocks using multiple criteria; textures, Modal and structures in igneous rocks and their origin.	CLO1 CLO2 CLO3
III/15	Petrogenesis of crustal igneous rocks; petrography, chemistry of acid, basic and ultra- basic igneous rocks.	CLO1 CLO3
IV/15	Igneous rocks in different tectonic setting, origin of structures and textures in igneous rocks and their geochemical characteristics.	CLO4

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. Mineralogical Phase Equilibria and pressure – temperature – time Paths by Spear, F. S. 1993, Mineralogical Society of America.
6. Igneous Petrology by Hall A., 1997, Longman.
7. Igneous Rocks: A Classification and Glossary of Terms by LeMaitre R.W., 2002, Cambridge University Press.
8. Igneous Petrology by McBirney, 1994, CBS Publishers, Delhi.
9. Principles of Igneous and Metamorphic Petrology by Phillpotts, A.R. 1994, Prentice Hall, India.
10. Modern Igneous Petrology by Sood M.K., 1982, Wiley-Interscience Publ., New York.
11. Equilibrium thermodynamics in Petrology: An Introduction by Powell, R. 1978, Harper & Row Publishers, London.

Course title: Metamorphic Petrology

L	T	P	Cr
4	0	0	4

Course code: EGS.718

Total Hours: 60

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

CLO1: Assess certain metamorphic rocks on the basis of their mineralogical and textural characteristics.

CLO2: Evaluate key textural/micro structural features of metamorphic rocks and appreciate the significance of such features with regard to geological processes that have operated.

CLO3: Interpret phase diagrams relevant to igneous systems and petrogenetic grids relevant to metamorphic systems on the basis of mineral assemblages recorded in the rock.

CLO4: Discuss the chemistry of certain metamorphic rocks and predict their environment(s) of formation.

Unit/ Hours	Contents	Mapping with CLO
I/15	Recent trend in pure and applied Metamorphic petrology including the recent development in recent methodology and instrumentation.	CLO1 CLO2
II/15	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.	CLO1 CLO3
III/15	metamorphic growth, analysis of poly-deformed and polymetamorphic rocks; equilibrium of mineral assemblages and metamorphic phase rules and phase diagrams.	CLO1 CLO3
IV/15	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.	CLO4

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 and Metamorphic Petrology by Best Myron G., 2002, Blackwell Science.
3. Petrogenesis of Metamorphic Rocks by Bucher K. and Martin F., 7th revised edition 2002, Springer – Verlag.
4. Mineralogical Phase Equilibria and pressure – temperature – time Paths by Spear, F. S. 1993, Mineralogical Society of America.
5. Principles of Igneous and Metamorphic Petrology by Phillpotts, A.R. 1994, Prentice Hall, India.
6. Principles of Igneous and Metamorphic Petrology by Phillpotts A.R. 1994, Prentice Hall.
7. An introduction to Metamorphic Petrology by Yardley, B.W.D. 1989, Longman Scientific & Technical, New York.
8. Equilibrium thermodynamics in Petrology: An Introduction by Powell, R. 1978, Harper & Row Publishers, London.

Course title: Applied Geomorphology

Course Code: EGS. 719

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: Demonstrate the principal theories and models for landscape evolution.

CLO2: Assess the mode of formation, age and history of landforms in India.

CLO3: Distinguish landforms and their processes of formation in different climate zones and tectonic regimes.

Unit/ Hours	Contents	Mapping with CLO
I/15	Geomorphology- principles, scope and aspects of research, certain field and laboratory techniques, advance mapping techniques of geomorphic features.	CLO1
II/15	Evolution of landforms and their climatic, structural and tectonic controls; Models of landform evolution, morphometric analysis, Understanding of computer software involve in geomorphological studies,	CLO1 CLO2
III/15	Detail geomorphic features of fluvial, glacial, Aeolian and coastal deposition system and their response to climate and tectonics; Study of the physiography of India	CLO2
IV/15	Tectonic set up of India; Use of GPS and satellite image for tectonic	CLO3

	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.	CLO4

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: Quaternary Geology

Course Code: EGS.720

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: Demonstrate the principal theories and models for Quaternary landscape evolution.

CLO2: Develop relevant solution for elucidate geomorphologic problems in

Quaternary period.

Unit/ Hours	Contents	Mapping with CLO
I/15	Introduction to Quaternary Geology; Quaternary landforms and their genesis; Neotectonics; characterization of glacial-interglacial cycles.	CLO1
II/15	Quaternary climate, sedimentation, tectonics and Stratigraphy; Quaternary geology of northwestern India.	CLO1 CLO2
III/15	knowledge gaps and future prospects; Various techniques used in studying the quaternary records.	CLO2
IV/15	Evolutions of major river system of India and their tectonic implications; Major issues on quaternary geology and sustainable development	CLO1 CLO2

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

Course code: EGS.721

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: Appraise the role of groundwater in hydrological cycle, groundwater flow pattern in different terrains.

CLO2: 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.

CLO3: Formulate the evolution of water chemistry through hydro-geochemical processes across different terrains.

CLO4: Formulate the occurrence and formation of earth resources and significant environmental effects caused by their extraction, processing, and use

CLO5: Predict the major sources of water, soil, and sediment pollution and methods for their management.

Unit/ Hours	Contents	Mapping with CLO
I/15	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	CLO1 CLO2
II/15	Exploration techniques: Integrated approach to groundwater prospecting: Role of toposheets and Remote sensing in groundwater exploration; surface and subsurface Geophysical methods.	CLO1 CLO2
III/15	Groundwater Quality: Quality criteria for different uses, graphical presentation of water quality data. Concept of hydrochemical facies; Groundwater pollution. Problem of Arsenic and fluoride and remedial measures for their treatment. Quality Problems in India.	CLO3 CLO5
IV/15	Water level fluctuations: Causative factors and their measurements. Artificial recharge of water - Recharging by surface water and rain water harvesting. Consumptive and conjunctive use of surface and ground water; problem of overexploitation; ground water legislation.	CLO2 CLO5

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. Ground Water and Wells by Driscoll F.G. 1988, UOP, Johnson Div. St. Paul. Min. USA.

Course title: Environmental Geology

Course code: EGS.722

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: Discuss the role of geologic processes in assessment of natural hazards

CLO2: Formulate the occurrence and formation of earth resources and significant environmental effects caused by their extraction, processing, and use

CLO3: Predict the major sources of water, soil, and sediment pollution and methods for their management.

Unit/ Hours	Contents	Mapping with CLO
I/15	Geological hazards such as earthquake, landslide, their cause, mitigations, land-use planning development.	CLO1 CLO2
II/15	Use of remote sensing and GIS in environment studies; Environmental Impact Assessment (EIA).	CLO2 CLO3
III/15	Application of Remote Sensing and GIS in Environmental Management.	CLO2 CLO3
IV/15	Environmental Management Plans (EMP)-REA & SEA; Environmental Legislation- National/International Standards.	CLO2 CLO3

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. Environmental Geology by Lundgren, L. 1986, Prentice Hall Pvt. Ltd., New Delhi.
2. Geological Hazards by Bell F.G. 1999, Routledge, London.
3. Environmental Geology by Bermett M.R., & Doyle P., 1999, John Wiley & Sons, NY.
4. Environmental Geology by Keller, E.A., 1978, Bell and Howell, USA.
5. Natural Hazards by Bryant E., 1985, Cambridge University Press. London.
6. Introduction to Environmental Toxicology by Landis W.G. and Yu M.H, 1999, Lewis Publ., London.
7. Environmental Assessment source Book (1991) Volume I, II & III Environment Department, The World Bank, Washington DC.

Course title: Structural Geology

Course code: EGS. 723

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: Determine the geological structures of deformed continental regimes.

CLO2: Reconstruct the regional tectonic set up based on microstructural and petrofabric data.

CLO3: Design the relative timing of formation of structures, the kinematics of deformation and the progressive deformation histories at various tectonic regimes.

Unit/ Hours	Contents	Mapping with CLO
I/15	Modern techniques of structural geology. Structural mapping of deformed terrains, small scale structures and their relationship with the large structures.	CLO1 CLO3
II/15	Use of stereographic projection and their kinematic analysis; use of stereographic projection related structural software; strain calculation of fold, fault, joints, fracture, foliation, lineation and other deformed bodies, stress trajectory and calculation of deformation paths.	CLO1 CLO3
III/15	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.	CLO1 CLO2
IV/15	Relationship between the internal stress and external stress and	CLO1

	resultant strain features in rocks including mathematical analysis and analog computer studies.	CLO2

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 Hall.
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. Folding and fracturing of rocks by Ramsay J.G. 1967, McGraw Hill.
5. Text Book of Surveying, vol–I. by Shahani, P.B., 1978, Oxford & IBH Pub. Co., New Delhi.
6. Techniques of Modern Structural Geology. Vol. I. Strain Analysis by Ramsay, J.G. and Huber, M.I. 1983, Academic Press.
7. Techniques of Modern Structural Geology. Vol. II. Folds and Fractures by Ramsay, J.G. and Huber, M.I. 1987, Academic Press.

Course title: Engineering Geology

Course code: EGS. 724

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: Appraisal of structural geology in the mining and resource exploration environment.

CLO2: 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.

CLO3: Classify soils and rocks, use of air photos and geological maps, engineering geological problems related to design and stability.

CLO4: Understand the importance of engineering geology related to technical issues during construction, and conduct basic engineering geological assessments and analyzes.

Unit/ Hours	Contents	Mapping with CLO
I/15	Engineering geology in planning and development; soils and rocks properties for engineer proposed.	CLO1 CLO2
II/15	Engineering classification of soils; stress, strain and constitutive process, shear strength of soil; rock strength, properties and their measurement; basic concepts of rock mechanics.	CLO1 CLO2
III/15	Importance of geology in engineering projects; site investigation for various engineering projects such as dam, highways, bridges, tunnels, etc.	CLO3 CLO4
IV/15	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.	CLO3 CLO4

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. Fundamentals of Engineering Geology by Bell, F.G., 1992, Aditya Books Pvt. Ltd. Indian Edition.
2. Principles of Engineering Geology by Krynine, D.H. & Judd, W.R., 1998, CBS Edition.
3. Geology in Engineering by Schultz, J.R. & Cleaves, A.B. 1951, John Willey & Sons, NY.
4. Surveying (Plane and Geodetic) by Roy Chowdhary K.P. 1987, Oxford & IBH Pub. Co., New Delhi.

Course title: Sedimentology

Course code: EGS.725

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: Categorize the various sedimentary rocks and their mode of genesis in different depositional environment.

CLO2: Interpret the processes responsible for the deposition of the sediment and formation of sedimentary textures and structures.

CLO3: Construct the depositional environment of certain sedimentary rock based on recognition of facies associations, lithology, textures and structures.

Unit/ Hours	Contents	Mapping with CLO
I/15	Modern techniques and methods in sedimentological studies; sedimentary structures, textures and their significances.	CLO1 CLO2
II/15	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.	CLO1 CLO2
III/15	Classification and petrography of important clastic and non-clastic rocks.	CLO3
IV/15	Paleocurrent analysis. Heavy minerals for correlation and provenance determination, diagenetic process; facies and facies map; Geochemical plots in sedimentary rocks, their limitations.	CLO3

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. Carbonate Sedimentology by Tucker M.E. and Wright V.P., 1991, Publisher Wiley, ISBN 0632014725, 9780632014729.
4. 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.
5. Sedimentary Geology by Donald R. Prothero, Fred Schwab,3rdedition, 2013, W. H. Freeman, ISBN-13: 978-1429231558.
6. Sedimentary Rocks in the Field: A Practical Guide (Geological Field Guide) by Maurice E. Tucker, 4th edition, 2011, Wiley-Blackwell, ISBN-13: 978-0470689165.
7. Introduction to Sedimentology by Sengupta S., 1997, Oxford-IBH.

Course title: Sequence Stratigraphy

Course code: EGS.726

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: Formulate the sedimentary basin forming processes and its environmental and economic significance.

CLO2: Make up reasoning to construct one or more hypotheses for the paleogeographic and environmental histories that produced a series of strata.

CLO3: 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/ Hours	Contents	Mapping with CLO
I/15	Understanding basin forming processes and basin architecture. Stratigraphic signature of a basin: sea level change, basin-floor wobbling, sedimentation rate and climate.	CLO1
II/15	Depositional facies, seismic facies seismic expression & configuration and log-based sequence, correlation sequence.	CLO1
III/15	Stratigraphic principles and facies tracts carbonate sequence stratigraphy and drowning unconformity.	CLO2 CLO3
IV/15	Application of sequence stratigraphy to basin evolution and other allied science.	CLO2 CLO3

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. Sedimentary Basins by Einsele G., 1992, Springer Verlag.
2. Principle of sequence stratigraphy by Catunaenu O., 1st edition, 2006. Elsevier.
3. Carbonate Sedimentology by Tucker M.E. and Wright V.P., 1991, Publisher Wiley, ISBN 0632014725, 9780632014729.
4. Sedimentary Geology by Donald R. Prothero, Fred Schwab,3rdedition, 2013, W. H. Freeman, ISBN-13: 978-1429231558.
5. Principles of Sedimentary Basin Analysis by Miall A.D., 2000, Springer-Verlag.

6. Depositional Sedimentary Environments by Reineck H.E. and Singh I.B., 1980, Springer-Verlag.

Course Title: Paleomagnetism

L	T	P	Credits
4	0	0	4

Course Code: EGS.727

Total Hours: 60

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

CLO1: Understand about Earth's Magnetic Field and how it has changed in recent and ancient time and their importance in earth sciences.

CLO2: Understand the basics of the paleomagnetic theory and be able to determine the position of paleomagnetic polarity direction of different geological formation.

Unit / Hour	Contents	Mapping with CLO
I /15	Introduction to Geomagnetism, Early Measurements of the Earth's Magnetic Field, Origin of the magnetic field, Geocentric Axial Dipole Model, The Present Geomagnetic Field, Geomagnetic Secular Variation.	CLO 1 CLO 2
II / 15	Magnetic Properties of Solids- Diamagnetism, Paramagnetism, Ferro-, Antiferro- and Ferrimagnetism, Domain theory- Single, Pseudo-single & multi domain grains, types of magnetic remanence- NRM, IRM, DRM, ChRM, VRM, TRM. Basics of Paleomagnetism, Historical works in Earth's Magnetic Field, Sampling methods.	CLO 1 CLO 2
III /15	Instruments and laboratory techniques, Alternating field Demagnetisation Thermal Demagnetisation, Identification of Magnetic Minerals, Curie Temperatures, Isothermal Remanent Magnetization, The Lowrie-Fuller Test, Hysteresis and Magnetic Grain Sizes.	CLO 1
IV /15	Introduction to magnetostratigraphy, Magnetic Field Reversals, Normal, Reverse & Intermediate magnetic polarity direction Geomagnetic Polarity Time Scale (GPTS), , Development of magnetostratigraphy, Criteria for magnetostratigraphic correlation, Geochronologic applications, Applications to paleogeography and Apparent Polar Wander Paths, Paleomagnetism and Plate Tectonics	CLO 2

Transactional Modes: Lecture, Demonstration, Tutorial, Problem solving, Tools used: PPT, Video, Animation, Whatsapp, Software Tool: Remasoft, Anisoft, Paleomag.

Suggested readings:

1. Robert F. Butler (1992); Paleomagnetism: Magnetic Domains to Geologic Terranes, Blackwell Science Inc.
2. Michael W Mc Elhinny and Philip L.Mc Fadden (2000), Paleomagnetism Continents and Oceans, Academic Press USA.
3. D. H. Tarling, 1983. Palaeomagnetism. Principles and Applications in Geology, Geophysics and Archaeology. ix + 379 pp. London, New York: Chapman & Hall.
4. Tauxe, Lisa. Essentials of Paleomagnetism, Berkeley: University of California Press, 2010. https://doi.org/10.1525/9780520946378

Course Title: Rock Magnetism

L	T	P	Credits
4	0	0	4

Course Code: EGS.728

Total Hours: 60

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

CLO1: Understand the basics of the Rock Magnetism and their applications.
CLO2: To understand the application of magnetic anisotropy. Interpret the directional signature and magnetic properties of rock and soil.
CLO3: Understand the basics of Environmental Magnetism, magnetic mineralogy and possible proxy for Environmental Magnetism in various geologic settings. Comprehend the basic of soil & rock magnetism and their role in Earth's Environment.

Unit / Hour	Contents	Mapping with CLO
I /15	Introduction and prospect of magnetic minerals, Magnetism and Pollution, Soil Magnetism,	CLO1
II /15	Introduction to the Anisotropy of Magnetic Susceptibility (AMS), Magnetic petrofabrics, Normal/ Invers fabric. The applications of AMS in Paleomagnetism, Rock magnetism, Structural Geology.	CLO1 CLO2
III /15	Magnetic minerals in the atmosphere, Identification of Magnetic Minerals, Curie Temperatures, Isothermal Remanent Magnetization, The LF Test, Hysteresis and Magnetic Grain Sizes.	CLO1 CLO3
IV /15	Laboratory instrumentation and methods in Rock, Soil & Environmental magnetism.	CLO 2 CLO 3

Transactional Modes: Lecture, Demonstration, Tutorial, Problem solving, Tools used: PPT, Video, Animation, Whatsapp, Software Tool: Remasoft, Anisoft, Paleomag.

Suggested readings:

1. Evans ME, Heller F (2003) Environmental magnetism. Principles and applications of enviromagnetics. Academic Press, Elsevier Science.
2. R.Thompson and F.Oldfield (1986), Environmental Magnetism, Allen and Unwin, London
3. O'Reilly (1984), Rock and Mineral Magnetism, Chapman & Hall, New York.
4. Neli Jordanova (2017), Soil Magnetism. Applications in Pedology, Environmental Science and Agriculture. Academic Press, Elsevier Science.
5. Michael W Mc Elhinny and Philip L.Mc Fadden (2000), Paleomagnetism Continents and Oceans, Academic Press USA.
7. Liu, Qingsong & Roberts, Andrew & Larrasoaña, Juan & Banerjee, Subir & Guyodo, Yohan & Tauxe, Lisa & Oldfield, Frank. (2012). Environmental Magnetism: Principles and Applications. Reviews of Geophysics. 10.1029/2012RG000393.
8. Tauxe, Lisa. Essentials of Paleomagnetism, Berkeley: University of California Press, 2010. https://doi.org/10.1525/9780520946378

Course title: Ore Geology

Course code: EGS-715

L	T	P	Cr
4	0	0	4

Total Hours: 60

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

CLO1: Identify the various textural patterns that are associated with the ore minerals along with the paragenetic sequences.

CLO2: Understand the overall geometry, zonation and alteration patterns of rock associations to specific classes of metallic mineral deposits.

CLO3: Improve their knowledge regarding the tectonic processes that are associated with the different ore deposit types.

CLO4: Explain the role of fluid inclusion studies in ore geology to identify nature, source and evolution of the mineralizing fluids.

CLO5: Understand the metallogenesis of various ore deposits and their exploration mechanism.

Unit/ Hours	Contents	Mapping with CLO
I/15	Textures associated with the ore minerals; time-relationship between ore minerals and host rocks; Wall rock alterations and their significance in ore localization.	CLO1 CLO2
II/15	Mode of occurrence of ore bodies – morphology and relationship of host rock; various controls on mineralization;	CLO2 CLO3

	Tectonic settings related to the various ore deposits.	
III/15	Classification and genesis of ore depositss: magmatic deposits: ores related to submarine volcanism, biochemical, chemical and clastic sedimentation; placers and residual concentration deposits; metamorphic deposits and hydrothermal ore deposits.	CLO2 CLO3
IV/15	Fluid Inclusion studies: concept of microthermo-barometry; evolution of mineralized fluid; applications in ore geology. Ore genesis and their implications in mineral exploration.	CLO4 CLO5

Suggested readings:

1. Robb, L., 2005.*Introduction to Ore-forming processes*, Blackwell Publ., Oxford.
2. Evans, A.M., 1992. *Ore geology and industrial minerals*, Blackwell Science.
3. Misra, K.C. 1999. *Understanding mineral deposits*, Kluwer Academic Publishers.
4. Sinha, R. K. and Sharma, N.L., 1970. *Mineral economics*, Oxford & IBH.
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