

**Centre for Geography and Geology
Central University of Punjab**

Syllabus for Ph.D. Course work Geology										
Course Code	Course Title	Credit Hours				% Weightage				E
		L	T	P	Cr	A	B	C	D	
Semester-I										
Core courses										
EGS. 701	Research Methodology	4	1	-	4	25	25	25	25	100
EGS.702	Computer application and statistical techniques	4	1	-	4	25	25	25	25	100
EGS. 703	Analytical techniques in Geology.	4	1	-	4	25	25	25	25	100
EGS. 704	Remote Sensing and GIS	4	1	-	4	25	25	25	25	100
Elective courses: Select any one of the specialized courses listed below										
EGS. 705	Stratigraphy and Paleontology	4	1	-	4	25	25	25	25	100
EGS.706	Geochemistry and Isotope Geology	4	1	-	4	25	25	25	25	100
EGS. 707	Igneous and Metamorphic petrology	4	1	-	4	25	25	25	25	100
EGS. 708	Geomorphology and Quaternary Geology	4	1	-	4	25	25	25	25	100
EGS. 709	Hydrogeology and Environmental Geology	4	1	-	4	25	25	25	25	100
EGS. 710	Structural and Engineering Geology	4	1	-	4	25	25	25	25	100
EGS. 711	Sedimentology and Sequence stratigraphy	4	1	-	4	25	25	25	25	100
EGS. 712	Economic geology and Environmental Geology	4	1	-	4	25	25	25	25	100
Fundamental Course: Compulsory										
EGS. 713	Project work, laboratory components, report writing and presentation	4	1	-	4	25	25	25	25	100
Semester-II.....										
EGS	Ph.D.									

Continuous Assessment: Based on Objective Type Tests Mid-Term Test-1: Based on Objective Type and Subjective Type Test	C: Mid-Term Test-2: Based on Objective Type and Subjective Type Test D: End-Term Exam (Final): Based on Objective Type Tests E: Total Marks
L: Lectures T: Tutorial P: Practical Cr: Credits	

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Core courses:

Title: Computer Applications and Statistical Techniques.	L	T	P	Cr	Marks
Course Code: EGS.701	4	1		4	100

Unit1: Fundamentals of computers: Parts of computers, Hardware, BIOS, Operating systems, Binary system, Logic gates and Boolean algebra Application software:Spreadsheet applications, word processing applications, Presentation applications, Internet browsers, Reference Management, and Image processing applications; studies of the application of softwares such as Map-info, Arc GIS, Rockwares, Erdas, etc.

Unit II: Computer Language: Basic DOS commands, Auto Hot Key scripting language, HTML and basic structure of a webpage, Designing websites. World Wide Web: Origin and concepts, Latency and bandwidth, Searching the internet, Advanced web-search using Boolean logic, Cloud computing.

Unit III: Experimental design and analysis: Sampling techniques, Sampling theory, Steps in sampling, Collection of data-types and methods. Comparing means of two or more groups: Student's t-test, Paired t-test, Mann-Whitney U-test, Wilcoxon signed-rank, One-way and two-way analysis of variance (ANOVA), Critical difference (CD), Least significant difference (LSD), Kruskal Wallis one-way ANOVA by ranks, Friedman two-Way ANOVA by ranks, χ^2 test.

Unit IV: Regression and correlation: Standard errors of regression coefficients, Comparing two regression lines, Pearson product-moment correlation coefficient, Spearman rank correlation coefficient, power and sampling size in correlation and regression.

Suggested reading:

1. Bhatt, Pramod Chandra P. An Introduction to Operating Systems: Concepts and Practice. Second edition, New Delhi: PHI Learning Pvt. Ltd., 2008.
2. Burt J.E. Barber. G.E. Rigby D.L. 2009. Elementary Statistics for Geographers, Guilford Press, 3. New York.
3. Date, C. J. 2000. An Introduction to Database Systems. Massachusetts: Addison-Wesley Longman, 7th edition.
4. David Cyganski, John, A. Orrand R.F. Vaz, 2000. Information Technology: Inside and Outside. New Jersey: Prentice Hall.
5. Douglas, Gretchen and Mark Connell, 2007. Fundamentals of MS Office 2007. 2nd edition, Dubuque: Kendall Hunt Publication Company.
6. Gookin, D. 2007. MS Word for Dummies. Wiley.
7. Harvey, G. 2007. MS Excel for Dummies. Wiley.

Further reading

1. Jamsa, Kris A. 1993. DOS: The Pocket Reference. Berkeley: Osborne McGraw-Hill, .
2. Murdock, Everett E. 1993. DOS The Easy Way: Complete Guide to Microsoft's MS DOS. H O T Press, Easy Way Downloadable Books.
3. Narang, R., 2006. Database Management System. New Delhi: PHI Learning Pvt. Ltd.,
4. Rajaraman, V. Fundamentals of Computers. New Delhi: PHI Learning Pvt. Ltd., 2003.Sanders, Donald H. Computers Today. Singapore: McGraw Hill Publishing, 198.
5. Silverman D. (2000). Analyzing talk and text. In N. Denzin and Y. Lincoln, eds. Handbook of Qualitative Research. Thousand Oaks, CA: Sage Publications, pp. 821-834.

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Course title: Research Methodology	L	T	P	Cr	Marks
Course code: EGS-702	4	1		4	100

Unit –I: 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 field of Geosciences.

Unit-II: Literature survey and review, research literatures and electronic media including internet, use of digital library, online resource; necessity of review of literatures. Research approach and identifying gap areas from literature review; problem formulation and statement of research objectives; Developing of bibliography.

Concepts on plagiarism, ISSN and ISBN numbers, impact factors and citation index of research articles and assessing the quality of research articles.

Unit-III: Pre-field preparations: preparation of maps, survey of the study area through satellite imageries, google earth, etc. Field mapping and documentation. Procedure of sampling-grap sampling, random sampling, stratified random sampling, stratified profile sampling, lateral sampling, sampling documentation. Introduction to field mapping and section measurement. Introduction on laboratory techniques of data analysis and their limitations.

Types of datas- primary and secondary datas. Source and authenticity of secondary datas.

Unit-III: Introduction on the techniques of data representation, documentation and representation tools, basic presentation structures, writing a scientific paper, developing arguments, abstract and summary writing and organizing thesis, project reports; formulation of research proposals. Scientific research funding organizations in India.

Suggested reading:

1. Bruce, L. B. 2001. Qualitative Research Methods for Social Sciences. Boston: Allyn and Bacon.
2. Edward, E.B.1990. Computer Applications in the Social Sciences. Philadelphia: Temple University Press.
3. Robert, M. B, et al 2009. Survey Methodology. New Jersey: Wiley.
4. Bryman, A. 2008. Social Research Methods. New York: Oxford University Press.
5. John, W. C. 2011. Research Design: Qualitative, Quantitative and Mixed Methods Approaches. Thousand Oaks: Sage Publications.
6. Lester, James, D. and Lester Jr. J. D. 2007. Principles of Writing Research Papers. New York: Longman.

Further reading:

7. Paul, F. 1975. Against Method: Outline of an Anarchist Theory of Knowledge. London: New Left Books.
8. Michel, F. 1980. Power/Knowledge: Selected Interviews and Other Writings, 1972-1977. Edited by Colin Gordon, New York: Vintage.
9. Thomas, K. 1996. The Structure of Scientific Revolutions. Chicago: University of Chicago Press.
10. Seale, C. 2004. Social Research Methods: A Reader. London: Routledge.

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Course title: Analytical techniques and recent trends in Geology.	L	T	P	Cr	Marks
Course code: EGS-703	4	1		4	100

Unit-I: Introduction to advanced laboratory techniques: Working principles and concepts of Differential Thermal Analysis (DTA), X-ray Diffractions (XRD), Scanning Electron Microscope (SEM), ICP MS, X-ray fluorescence (XRF), Energy-dispersive X-ray spectroscopy (EDS, EDX, or XEDS), Mass spectrometer, CT-scan tomography, Fission Track Dating, etc.

Unit-II: Techniques of sample preparation, applications and limitations of Differential Thermal Analysis (DTA), X-ray Diffractions (XRD), Scanning Electron Microscope (SEM), ICP MS, X-ray fluorescence (XRF), Energy-dispersive X-ray spectroscopy (EDS, EDX, or XEDS), Mass spectrometer, CT-scan tomography, Fission Track Dating, etc. in the field of geosciences.

Unit-III: Understanding of petrological and stereozoom microscopes. Identification of common rock forming minerals. Sample preparation techniques for petrological sections studies, geochemical and palaeontological studies. Review of literatures on the applications of advance laboratory techniques in geology.

Unit-IV: Thermobarometric study for mineral exploration. Integrative approach in geology and geophysics, sustainable development, current environmental issues related to soils, water, air, their causes and remedy; earth's climatic history and global warming.

Suggested reading:

1. Reed, S. J. B., 1990. Recent developments in geochemical microanalysis: Chemical Geology, v. 83, p. 1-9.
2. Cullity, B.D. 1978. Elements of X-ray Diffraction. Addison-Wesley Publishing Company.
3. Faure, G., 1986. Principles of isotope geology: John Wiley and Sons, Inc., New York, New York.
4. Goldstein, J., 1979. Introduction to Analytical Electron Microscopy: New York and London, Plenum Press.
5. Jenkins, Ron and Snyder, Robert L. 1996. Introduction to X-ray Powder Diffractometry, Vol. 138, Wiley Interscience, John Wiley & Sons, New York.
6. Reed, S. J. B., 1996, Electron Microprobe and Scanning Electron Microscopy in Geology: Cambridge, Cambridge University Press, 201 p.
7. Frank A. Settle, 1997. Handbook of Instrumental Techniques for Analytical Chemistry. Upper Saddle River, NJ : Prentice Hall PTR

Further reading:

8. Hoefs, J., 1987, Stable isotope geochemistry: Springer-Verlag, Berlin, Germany.
9. Potts, P. J., Bowles, J. F. W., Reed, S. J. B., and Cave, M. R., 1995, Microprobe Techniques in Earth Sciences: London, Chapman and Hall, 419 p.
10. Reed, S. J. B., 1993, Electron Microprobe Analysis: Cambridge, Cambridge University Press, 326 p.
11. Scott, V., and Love, G., 1983. Quantitative Electron-probe microanalysis: West Sussex, Ellis Horwood, 345 p.
12. Slavin, Morris, 1978, Atomic absorption spectroscopy: Chemical Analysis, v. 25, John Wiley and Sons, New York, NY, 187 p.

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Course title: Analytical techniques and recent trends in Geology.	L	T	P	Cr	Marks
Course Code: -704	4	1		4	100

Unit-I: Applications of Remote Sensing and GIS in Geology: Fundamentals of Remote Sensing, Sensors; Active and passive remote sensing; Types of platform; Types of orbits (Geostationary, Polar, Sun-synchronous); Scanning Systems (Pushbroom 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: Thermal Infra-red remote sensing in geological studies; microwave remote sensing for geological applications; Applications of remote sensing - identification of rocks, mineral explorations, geological surveys; alteration zones mapping; geomorphology applications, volcanic eruptions, surficial deposit / bedrock mapping; lithological mapping; structural mapping; sand and gravel (aggregate) exploration/ exploitation; hydrocarbon exploration; environmental geology; geobotany; sedimentation mapping and monitoring; event mapping and monitoring; geo-hazard mapping.

Unit-III: Concepts of GIS: Elements of GIS; Map Projection; Data structures in GIS: Raster and Vector data; GIS softwares; 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-IV: Applications of Remote Sensing and GIS in Geology: Thermal Infra-red remote sensing in geological studies; microwave remote sensing for geological applications; Applications of remote sensing-identification of rocks, mineral explorations, geological surveys; alteration zones mapping; geomorphology applications, volcanic eruptions, surficial deposit/bedrock mapping; lithological mapping; structural mapping; sand and gravel (aggregate) exploration/ exploitation; hydrocarbon exploration; environmental geology; geobotany; sedimentation mapping and monitoring; event mapping and monitoring; geo-hazard mapping.

Suggested reading:

1. Lillisand, T. M. and Keifer, R. W. 2007. Remote sensing and image interpretation. John Willey and Sons, USA
2. Barrett, E. C. and Curtis, L. F. 1999. Introduction to environmental remote sensing. Chapman and Hall Publishers, USA.
3. Joseph G. 2003. Fundamentals of remote sensing. Universities Press, Hyderabad.
4. Chang, Kang-Taung 2002. Introduction to geographic information systems, Tata McGraw-Hill, USA.
5. Morris, P. and Therivel, R. 2001. Methods of Environmental Impact Assessment. Spoon Press,.
6. Sabbins, Jr, F.F. 1986. Remote Sensing: Principles and Interpretation. New York: WH Freeman & Co.
7. Gupta, R.P., 1990: Remote Sensing Geology. Springer Verlag.

Further reading:

8. Ramasay, S.M. 1996. Trends in Geological Remote Sensing, Rawat Publishers, Jaipur.
9. Lawrence, D.P. 2003. Environmental impact assessment: Practical solutions to recurrent problems. New Delhi: John Wiley and Sons.

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10. Richason, B. F., Jr. ed. 1978. Introduction to Remote Sensing of the Environment. Kendall/Hunt. Publishing Company. Dubuque, Iowa.
11. Paine, D.P., 1981. Aerial photography and Image Interpretation for Resource Management. John Wiley.
12. Pandey, S.N., 1987. Principles and Applications of Photogeology. Wiley Eastern, New Delhi.

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

Course title: Paleontology and Stratigraphy	L	T	P	Cr	Marks
Course code: EGS-705	4	1	-	4	100

Unit-I: 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 palaeoecology.

Unit-II: Field and laboratory techniques in palaeontology: sampling and processing techniques, preparation of samples for SEM, EDX, petrological studies, etc.

Introduction to applied paleontology: Use of palaeontological datas in Stratigraphy, Palaeoecology, Evolution, palaeoclimate and sea level changes, climate, exploration, tectonics and Palaeobiogeography.

Unit-III: 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: Geology and stratigraphy of some important sections of Archaeans-Precambrian, Palaeozoic, Gondwana, Mesozoic and Cenozoic deposits of India, their significances and major stratigraphic boundaries.

Suggested reading:

1. Ramakrishnan, M. and Vaidyanathan, R. 2008. Geology of India, Geological Society of India, Bangalore, Vol. 1 & 2, ISBN No: 978-81-85867-98-4.
2. Danbar, C.O. and Rodgers, J. 1957. Principles of Stratigraphy. John Wiley & Sons.
3. Naqvi, S.M. and Rogers, J.J.W. 1987. Precambrian Geology of India. Oxford University Press.
4. Michael Benton, 2004. Vertebrate Palaeontology. 3rdEdition, 2004, Wiley-Blackwell, ISBN: 9780632056378.
5. Howard A. Armstrong, Martin D. Brasier, 2013. Microfossils. 2nd Edition, Blackwell Publishing Ltd., ISBN: 9780632052790.
6. Shrock, N. 2005. Principles of Invertebrate Paleontology, 2nd Edition, CBS Publisher. ISBN-13: 978-8123912189.

Further reading:

1. Krishnan, M.S. 1982. Geology of India and Burma. C.B.S. Publishers & Distributors, Delhi.
2. Pascoe, E.H. 1968. A Manual of the Geology of India & Burma (Vols. I-IV) Govt. of India Press,
3. Ravindra Kumar, 1998. Fundamentals of Historical Geology And Stratigraphy Of India by, NEW AGE, ISBN-13: 978-0852267455.

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4. Schoch, Robert, M. 1989. Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.
5. Bolli, H. M. and Saunders, J. B. 1977. 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), American Geophysical Union, Washington, D. C..
6. Doyle, P. & Bennett. M.R. 1996. Unlocking the Stratigraphic Record (John Willey).
7. Bringing Fossils to Life: An Introduction to Paleobiology, by Donald R. Prothero, 2nd Edition (2003), McGraw-Hill Higher Education; ISBN-10: 0073661708
8. Henry Wood 2004. Paleontology Invertebrate. 8th Edition, CBS Publication ISBN:9788123-910802.

Course title: Geochemistry and isotope Geology	L	T	P	Cr	Marks
Course code: EGS-706	4	1	-	4	100

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

Unit II: Use of major, traces, REE, PGEs, element datas in rock classification and their significance in environment, provenance, climatic and tectonic settings

Unit III: 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: 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. Radionuclie as tracer for geochemical process.

Suggested reading:

1. Gunter Faure 1998. Principles and applications of Geochemistry by: Prentice Hall, second edition.
2. John V. Walther 2010. Essentials of Geochemistry. Jones and Bartlett Publication.
3. McSween, H.Y. Jr., Richardson, S.M. and Uhle, M.E. 2003. Geochemistry: Pathways and Processes. Columbia Univ. Press.
4. Francis Albarede, 2003: Geochemistry, An introduction. Cambridge Univ. Press,
5. Jochen Hoefs, 2015. Stable isotope Geochemistry. Springer.
6. Claude Allegre, 2008. Isotope Geology. Cambridge Univ Press.

Further reading:

7. Dickin A.P. 2005. Radiogenic Isotope Geology. Cambridge Univ Press.
8. Mason, B. and Moore, C.B. 1991. Introduction to Geochemistry, Wiley Eastern.
9. Krauskopf, K.B. 1967. Introduction to Geochemistry. McGraw Hill.
10. William M. White, 2013. Geochemistry, 1st Edition, Wiley-Blackwell.
11. Mason, B. and Moore, C.B. 1991. Introduction to Geochemistry, Wiley Eastern.
12. Rollinson, H.R. 1993. Using geochemical data: Evaluation, Presentation, Interpretation. Longman U.K.

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Course title: Igneous and Metamorphic petrology	L	T	P	Cr	Marks
Course code: EGS-707	4	1	-	4	100

Unit -I: 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: Petrogenesis 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: 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 polydeformed and polymetamorphic rocks; equilibrium of mineral assemblages and metamorphic phase rules and phase diagrams.

Unit-IV: 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 recrystallisation.

Problems of regional metamorphism illustrated by precambrian terrain and more recent orogenic belts.

Suggested reading:

1. Winter, J.D. 2001. An introduction to Igneous and Metamorphic Petrology. Prentice Hall.
2. Bose, M.K., 1997. Igneous Petrology. World Press, Kolkata.
3. Best, Myron G., 2002. Igneous and Metamorphic Petrology. Blackwell Science.
4. Cox, K.G., Bell, J.D. and Pankhurst, R.J., 1993: The Interpretation of Igneous Rocks. Chapman & Hall, London.
5. Bucher, K. and Martin, F. 2002. Petrogenesis of Metamorphic Rocks. Springer – Verlag, 7th Revised Edition.
6. Spear, F. S. 1993. Mineralogical Phase Equilibria and pressure – temperature – time Paths. Mineralogical Society of America.

Further reading:

7. Hall, A. 1997. Igneous Petrology, Longman.
8. LeMaitre, R.W. 2002. Igneous Rocks: A Classification and Glossary of Terms. Cambridge University Press.
9. McBirney, 1994. Igneous Petrology, CBS Publishers, Delhi.
10. Phillpotts, A.R. 1994. Principles of Igneous and Metamorphic Petrology. Prentice Hall of India.
11. Sood, M.K. 1982: Modern Igneous Petrology. Wiley-Interscience Publ., New York.
12. Philpotts, A.R. 1994. Principles of Igneous and Metamorphic Petrology. Prentice Hall.
13. Yardley, B.W.D. 1989. An introduction to Metamorphic Petrology. Longman Scientific & Technical, New York.
14. Powell, R. 1978. Equilibrium thermodynamics in Petrology: An Introduction. Harper & Row Publishers, London.

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Course title: Geomorphology, Quaternary Geology and Siesmotectonics	L	T	P	Cr	Mark s
Course Code: EGS-708	4	1	-	4	100

Unit-I: 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 softwares involve in geomorphological studies.

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

Suggested reading:

- 1.Sharma, H.S. 1991. Indian Geomorphology. Concept Publishing Co. New Delhi. ISBN: 817022344X.
- 2.Allison R. J. 2002. Applied Geomorphology: Theory and Practice. Wiley, 1st edition.
- 3.Douglas, W. B and Anderson, R. S. 2011. Tectonic Geomorphology. Wiley-Blackwell; 2nd edition, ISBN-13: 978-1444338867.
- 4.Anderson, R.S. and Anderson, S. P. 2010. Geomorphology: The Mechanics and Chemistry of Landscapes. Cambridge University Press; 1 edition , ISBN-13: 978-0521519786.
- 5.Paul R. B. and David R. M. 2013. Key Concepts in Geomorphology. W. H. Freeman, ISBN-13: 978-1429238601
- 6.Michael, A.S. 2000. Geomorphology and Global Tectonics. Wiley, ISBN: 978-0-471-97193-1.

Further reading

- 1.Kale, V. S. and Gupta, A. 2001. Introduction to geomorphology. Orient Longman, Bangalore.
- 2.Singh, S. 2011. Physical geography, Prayag Pustak Bhavan, Allahabad.
- 3.Strahler, A.N. & Strahler 1996. An introduction to physical geography. John Wiley & Sons, UK.

Title of Course: Hydrogeology and Environmental Geology	L	T	P	Cr	Marks
Course code: EGS-709	4	1	-	4	100

Unit-I: 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 Borewell programme, use of computer software in exploration of groundwater.

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Unit-II: 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: Palaeohydrology, estimation of palaeo-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: Geological hazards such as earthquake, landslide, their cause, mitigations, landuse 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.

Suggested readings:

1. Todd, D.K. 1988. Ground Water Hydrology. John Wiley & Sons, New York.
2. Davies, S.N. and De-West, R.J.N. 1966. Hydrogeology. John Willey & Sons, New York.
3. Raghunath, H.M. 1983. Ground Water. Wiley Eastern Ltd., Calcutta.
4. Lundgren, L. 1986. Environmental Geology. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Bell, F.G. 1999. Geological Hazards, Routledge, London.
6. Bernett, M.R. and Doyle, P. 1999. Environmental Geology, John Wiley & Sons, N. York.
7. Keller, E.A. 1978. Environmental Geology, Bell and Howell, USA.

Further reading:

8. Driscoll, F.G. 1988. Ground Water and Wells. UOP, Johnson Div. St. Paul. Min. USA.
9. Bryant, E., 1985. Natural Hazards, Cambridge University Press. London.
10. Landis, W.G. and Yu, M.H, 1999. Introduction to Environmental Toxicology. Lewis Publ., London.
11. Environmental Assessment source Book (1991) Vo.I, II & III Environment Department, The World Bank, Washington DC.

Title of Course: Structural Geology and Engineering Geology	L	T	P	Cr	Marks
Course code: EGS-710	4	1	-	4	100

Unit-I: 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: 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.

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Unit III: 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: 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.

Suggested reading:

1. Stephen Marshak and Gautam Mitra, 1988. Basic Methods of Structural Geology. Prentice Hal.
2. Turner, F.J. and Weiss, L.E. 1963. Structural analysis of Metamorphic Tectonites. McGraw Hill.
3. Ghosh, S.K. 1993. Structural Geology: Fundamental and Modern Developments. Pergamon Press.
4. Bell, F.G., 1992: Fundamentals of Engineering Geology. Aditya Books Pvt. Ltd. Indian Edition.
5. Krynine, D.H. & Judd, W.R. 1998. Principles of Engineering Geology. CBS Edition.
6. Schultz, J.R. & Cleaves, A.B. 1951. Geology in Engineering. John Willey & Sons, New York.

Further reading:

7. Roy Chowdhary, K.P. 1987. Surveying (Plane and Geodetic). Oxford & IBH Pub. Co., New Delhi.
8. Ramsay, J.G. 1967. Folding and fracturing of rocks. McGraw Hill.
9. Shahani, P.B. 1978. Text Book of Surveying. vol. I. Oxford & IBH Pub. Co., New Delhi.
10. Ramsay, J.G. and Huber, M.I. 1983. Techniques of Modern Structural Geology. Vol. I. Strain Analysis. Academic Press.
11. Ramsay, J.G. and Huber, M.I. 1987. Techniques of Modern Structural Geology. Vol. II. Folds and Fractures. Academic Press.

Title of Course: Sedimentology and Sequence Stratigraphy	L	T	P	Cr	Marks
Course code: EGS-711	4	1	-	4	100

Unit-1: 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: Classification and petrography of important clastic and non-clastic rocks. Palaeocurrent analysis. Heavy minerals for correlation and provenance determination, diagenetic process; facies and facies map; Geochemical plots in sedimentary rocks, their limitations.

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

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Reference books: -

1. Sam Boggs Jr. 2011. Principles of sedimentology & stratigraphy. Prentice Hall; 5 edition, ISBN-13: 978-0321643186.
2. Gary Nichols, 2009. Sedimentology and stratigraphy. Wiley-Blackwell, 2nd edition, ISBN: 978-1-4051-3592-4.
3. Einsele, G. 1992: Sedimentary Basins. Springer Verlag.
4. Catunaenu, O. 2006. Principle of sequence stratigraphy. Elsevier, 1st edition.
5. Tucker, M.E. and Wright, V.P. 1991. Carbonate Sedimentology. Publisher Wiley, ISBN 0632014725, 9780632014729.
6. Adams, A. E. MacKenzie, W. S. Guilford, C. 1984. Atlas of sedimentary rocks under the Microscope. Prentice Hall; 1st edition, ISBN-13: 978-0582301184.

Further reading:

7. Donald R. Prothero, Fred Schwab, 2013. Sedimentary Geology. W. H. Freeman, 3rd Edition, ISBN-13: 978-1429231558.
8. Maurice E. Tucker, 2011. Sedimentary Rocks in the Field: A Practical Guide (Geological Field Guide). Wiley-Blackwell, 4th edition, ISBN-13: 978-0470689165.
9. Miall, A.D. 2000: Principles of Sedimentary Basin Analysis. Springer-Verlag.
10. Reineck, H.E. and Singh, I.B., 1980. Depositional Sedimentary Environments. Springer-Verlag.
11. Sengupta, S. 1997. Introduction to Sedimentology, Oxford-IBH.

Title of Course: Economic geology and Mineral exploration	L	T	P	Cr	Marks
Course code: EGS-712	4	1	-	4	100

Unit-I: Classification of Mineral deposits; Genesis of Ore forming minerals-Analysis- Microscopic techniques; Surface and Subsurface exploration- evaluation and categorization of reserves-UNFC; Beneficiation and conservation and conceptual plan for sustainable development. Principle and techniques of Fluid inclusions study in ore: assumptions, limitations and applications. Geothermometry, geobarometry and isotope studies in ore geology.

Unit-II: Fundamentals of coal petrology, peat, lignite, bituminous and anthracite coal. Microscopic constituents of coal. Origin, migration and entrapment of natural hydrocarbons. Characters of source and reservoir rocks. Structural, stratigraphic and mixed traps.

Unit-III: Economic geology of India: spatial and temporal distribution of mineral resources of India, Indian coal deposits, geographical and geological distributions of onshore and offshore petroliferous basins of India. Recent trend and techniques in ore and economic geology.

Unit-IV: Techniques of exploration: Geological, geophysical, geochemical and geobotanical methods of surface and sub-surface exploration on different scales; Sampling, assaying and evaluation of mineral deposits; methods of mineral deposit studies including ore microscopy; Methods of petroleum exploration- surface and subsurface exploration, gas hydrate and coal bed methane. Nuclear and Non-conventional source of energy.

Suggested reading:

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1. Evans, A.M. 1993. Ore Geology and Industrial Minerals. Blackwell.
2. Stanton, R.L. 1972. Ore Petrology. McGraw Hill.
3. Klemm, D.D. and Schneider, H.J. 1977. Time and Strata Bound Ore Deposits. Springer Verlag.
4. Guilbert, J.M. and Park, Jr. C.F. 1986. The Geology of Ore Deposits. Freeman.
5. Dobrin, M. B. 1988. Introduction to geophysical prospecting . McGraw-Hill Inc.,US; 4th Revised edition edition

Further reading:

6. Barnes, H.L. 1979. Geochemistry of Hydrothermal Ore Deposits. John Wiley.
7. Ramdohr, P. 1969. The Ore Minerals and their Intergrowths. Pergamon Press.

Fundamental Course: Compulsory

Title of Course: Project work, laboratory components, report writing and presentation	L	T	P	Cr	Marks
Course code: EGS-713	4	1	-	4	100

Project work will be assigned in a topic and should be carried out as per the recommendations of the respective guides. The credits of theory and analytical methods to be used by the candidates (decided by the Supervisor), practical training, review of literatures, depth of the methodology and hypothesis shall be decided by a departmental committee including the supervisor depending (Under the rule of the University) on the presentation of the candidate.