Course Structure & Syllabus

Choice Based Credit System (CBCS)

M.Sc. Applied Geology
Two Years (Four Semester Course)
w.e.f. Session 2020-Onwards

DEPARTMENT OF EARTH SCIENCES
SCHOOL OF EARTH & ENVIRONMENTAL SCIENCES
UNIVERSITY OF KASHMIR -19006

Program outcomes (POs)

After completing the MSc in Applied Geology, the students will be able to

- Develop a strong foundation in geosciences, gaining expertise in geological, geophysical, and geochemical methods to analyse and interpret Earth materials and processes.
- Acquire hands-on experience through local and national field training, mastering skills in geological mapping, mineral exploration, and identifying geological structures, rock types, and landforms.
- Address real-world challenges such as mineral exploration, disaster management, and environmental protection by applying field, lab, and data analysis techniques.
- Demonstrate problem-solving abilities through dissertation work, applying analytical, theoretical, or experimental approaches to geological problems and defending findings in public forums.
- Prepare for careers in academia, mineral exploration, geohazard assessment, and environmental consultancy, with the ability to publish research in reputable scientific journals.

Program Specific Outcomes (PSOs)

PSOs _1	**Advanced Geological Knowledge**	Students will develop a comprehensive expertise in core geological principles, processes, and methods. They will be able to apply this knowledge to understand Earth's materials, structures, and dynamic systems.
PSOs _2	**Research Aptitude**	Students will be able to develop a strong research aptitude by formulating geoscientific questions and applying appropriate methodologies. They will be able to identify, analyse, and interpret geological problems, such as stratigraphic correlations, tectonic processes, or mineralogical assessments, and draw meaningful conclusions based on data analysis.
PSOs _3	**Communication**	Students will be able to effectively communicate geological concepts, research findings, and interpretations to both the scientific community and the general public. They will be able to demonstrate proficiency in presenting data through technical reports, scientific publications, maps, and oral presentations.
PSOs _4	**Problem Solving**	Students will be able to apply geological knowledge and analytical skills to solve scientific and practical problems, such as evaluating natural hazards, resource exploration, environmental assessment, and geological mapping.
PSOs _5	**Individual and Team Work**	Students will be able to work effectively both independently and collaboratively in multidisciplinary teams and will contribute to field studies, laboratory analysis, and geoscientific projects by facilitating

		cooperative efforts and promoting teamwork in applied geology settings.
PSOs _6	**Investigation of Problems**	Students will be able to apply critical thinking and analytical skills to geoscientific research, including field studies, data analysis, and interpretation.
PSOs _7	**Modern Tool usage**	Students will be proficient in using modern geological tools, techniques, and software for mapping, remote sensing, and data analysis.
PSOs _8	**Science and Society**	Students will be able to apply reasoning to assess societal issues and fulfil professional responsibilities with awareness of their social impact.
PSOs _9	**Life-Long Learning**	Students will be able to continuously acquire new knowledge and skills, fostering adaptability and lifelong learning.
PSOs _10	**Ethics**	Students will be able to uphold ethical standards by identifying and avoiding misconduct, such as data fabrication, falsification, or plagiarism. They will be committed to objective, unbiased, and truthful practices in all aspects of their work.

Choice based Credit System (CBCS) Scheme and course structure for M.Sc. Applied Geology 1st semester effective from academic session 2020 and onwards

Course Code	Course Name	Paper Category	Credits
GL20101-CR	Structural Geology	Core	3
GL20102-CR	Palaeontology	Core	3
GL20103-CR	Crystallography &Mineralogy	Core	3
GL20104-CR	Geomorphology	Core	2
GLP20101-CR	Structural Geology Lab	Core	1
GLP20102-CR	Palaeontology Lab	Core	1
GLP20103-CR	Crystallography & Mineralogy Lab	Core	1
GL 20105-DCE	Field Training (compulsory)*	Elective (DCE)	2
GL20106-DCE	Environmental Geology	Elective (DCE)	3
GL20107-DCE	Petroleum and Coal Geology	Elective (DCE)	3
GL20108-GE	Frontiers in Earth Sciences	Elective (GE)	2
GL20109-OE	Earth System Science	Elective (OE)	2

Choice based Credit System (CBCS) Scheme and course structure for Applied Geology 2nd semester effective from academic session 2020 and onwards

Course Code	Course Name	Paper Category	Credits
GL20201-CR	Igneous Petrology	Core	3
GL20202-CR	Sedimentology	Core	3
GL20203-CR	Metamorphic Petrology	Core	3
GL20204-CR	Global Tectonics	Core	2
GLP20201-CR	Igneous Petrology Lab	Core	1
GLP20202-CR	Sedimentology Lab	Core	1
GLP20203-CR	Metamorphic Petrology Lab.	Core	1
GL20205-DCE	Field Training (compulsory)*	Elective (DCE)	2
GL20206-DCE	Natural Hazards	Elective (DCE)	3
GL20207-DCE	Himalayan Geology	Elective (DCE)	3
GL20208-DCE	Oceanography and Marine Geology	Elective (DCE)	3
GL20209-GE	Natural Resources of J&K	Elective (GE)	2
GL20210-OE	Life through Time	Elective (OE)	2

Choice based Credit System (CBCS) Scheme and course structure for M.Sc. Applied Geology 3rd semester effective from academic session 2020 and onwards

Course Code	Course Name	Paper Category	Credits
GL20301-CR	Geochemistry	Core	3
GL20302-CR	Hydrogeology	Core	3
GL20303-CR	Remote Sensing and GIS	Core	3
GL20304-CR	Stratigraphy	Core	2
GLP20301-CR	Geochemistry Lab	Core	1
GLP20302-CR	Hydrogeology Lab	Core	1
GLP20303 -CR	Remote Sensing and GIS Lab	Core	1
GL20305-DCE	Project Work-I (compulsory)*	Elective (DCE)	2
GL20306 -DCE	Geophysics	Elective (DCE)	3
GL20307-DCE	Ore Geology	Elective (DCE)	3
GL20308-DCE	Glaciology	Elective (DCE)	2
GL20309-GE	Indian Mineral Deposits	Elective (GE)	2
GL20310-OE	Precious stones	Elective (OE)	2

Choice based Credit System (CBCS) Scheme and course structure for M.Sc. Applied Geology 4th semester effective from academic session 2020 and onwards

Course Code	Course Name	Paper Category	Credits
GL20401-CR	Exploration& Mining Geology	Core	3
GL20402- CR	Quaternary Geology& Paleoclimate	Core	3
GL20403-CR	Sequence Stratigraphy &Basin Analysis	Core	2
GL20404- CR	Project work (Compulsory*)	Core	6
GL20405- DCE	Engineering Geology	Elective (DCE)	2
GL20406-DCE	Advanced Hydrogeology	Elective (DCE)	3
GL20407-DCE	Rock Deformation &Structural Analysis	Elective (DCE)	3
Gl20408-DCE	Medical Geology	Elective (DCE)	3
GL20409-DCE	Advanced Remote Sensing& GIS	Elective (DCE)	3
GL20410- GE	Natural Disasters	Elective (GE)	2
GL20411- OE	Earth Surface Processes	Elective (OE)	2

FIRST SEMESTER

Choice based Credit System (CBCS) Scheme and course structure for M.Sc. Applied Geology 1st semester effective from academic session 2020 and onwards.

COURSE CODE: GL20101 CR: STRUCTURAL GEOLOGY

Course Outcomes: The study of this course will strengthen student's knowledge concerning understanding the essentials of the structural dynamics of the earth. The student will gain knowledge of the geometry of the rock structures, and understand the mechanism of the evolution of rock structures and its application in the field. This course will help them to understand the concept of epeirogeny and orogeny necessary for mineral prospecting.

Unit-I

Concept of stress and strain. Behaviour of rocks under stress. Mohr circle representation of different stress states. Different criteria for failure and sliding. Geometry and mechanics of fracturing and conditions for reactivation of pre-existing discontinuities. Introduction to deformation mechanisms. Different types of deformation. Techniques of strain analysis. Particle paths and flow patterns. Simple shear, pure shear, sub-simple shear and super shear deformation and their respective particle paths. Progressive strain history. Different methods of strain estimation. Role of fluids in deformation processes

Unit-II

Fractures and Joints- their nomenclature, age relationship, origin and significance. Faults- types, and dynamics of faulting. Different types of shear zones. Geometry and analyses of brittle-ductile and ductile shear zones. Different types of rocks and structures within fault/shear-zones. Methods for displacement estimation in ductile shear zones. Transpression and transtension.

Unit-III

Linear and planar structures: classification and origin. Fold interference patterns. Sheath folds. Geometry and mechanics of development of folds, boudins, foliations and lineations. Interference patterns of superposed fold. Fault-related folding. Gravity induced structures. Principles and methods of structural analysis in areas of superposed folding.

COURSE CODE: GLP20101-CR: STRUCTURAL GEOLOGY LAB

Structural Geology: Preparation and interpretation of geological maps and sections. Exercises on Mohr circle. Different methods of strain estimation. Exercises of structural analysis in the areas of single phase and multiple phases of folding. Plotting and interpretation of petro-fabric data.

Books recommended:

1. Davis, G. H., Reynolds, S. J. and Kluth, C. F., 2011: Structural Geology of Rocks and Regions (3rd Ed). John Wiley and Sons Inc.
2. Davis, G. R., 1984: Structural Geology of Rocks and Region. John Wiley.
3. Fossen, H, 2010: Structural Geology (2nd Ed), Cambridge University Press.
4. Ghosh. S. K., 1995: Structural Geology Fundamentals of modem Developments. P. Press.
5. Hobbs, B. E., Means, W. D. & Williams, P. F., 1976: An Outline of Structural Geology. JW.
6. Lisle, R. J. and Leyshon, P. R., 2004: Stereographic projection techniques for geologists and civil engineers. Cambridge University Press.
7. Price, N. J. and Cosgrove, J., 1990: Analysis of geological structures. Cambridge University Press.

8. Raga, D. M., 2009: Structural Geology (4th Ed). Cambridge University Press.
9. Ramsay, J. G, 1967: Folding and Fracturing of Rocks. Mc Graw Hill.
10. Ramsay, J. G. and Huber, M. I., 1983: The techniques of modern structural geology, Vol. 1, Academic Press, London.
11. Ramsay, J. G. and Huber, M. I., 1983: The techniques of modern structural geology, Vol. 2, Academic Press, London.
12. Ramsay, J. G. and Huber, M. I., 2010: Modem Structural Geology. Academic Press. Ragan, D. M. Cambridge Univ. Press.
13. Ramsay, J. G. and Lisle, R. J., 2010: The techniques of modern structural geology, Vol. 2, Academic Press, London.
14. Twiss, R. J, and Moors, E. M., 1992. Structural Geology, W. H. Freeman and Company, New York.

COURSE CODE: GL20102-CR: PALAEONTOLOGY

Course outcomes: Understanding the principles of stratigraphy, correlation, and palaeontology will help students comprehend the changes that have taken place throughout Earth's history, connect those changes to their field observations, and comprehend the structure of India's stratigraphy. Students will also learn about various kinds of fossils and the reasons behind their extinction and evolution.

UNIT-I

Species concept and species problem in palaeontology; definition, origin, biologic and palaeontological methods of species determination. Precambrian fossil record. Major biotic events in the Phanerozoic; Taphonomy, modes of preservation of fossils types of fossil assemblages and their application in biostratigraphy and paleo-environmental interpretation. Modes of preservation of fossils and taphonomic considerations. Mass extinctions and their causes. Application of fossils in age determination and correlation.

UNIT-II

Theories on origin of life. Organic evolution – Punctuated Equilibrium and Phyletic Gradualism models. Micro-and macro-evolution, types of heterochrony in evolutionary lineages, application to bio chronology with Indian examples. Evolutionary trends and geological history of Ammonoidea and Trilobita. Classification of Brachiopoda and Bivalvia and their geological distribution. Collection and preparation of vertebrate fossils, vertebrate life through ages and landmarks in evolution. General account of the Gondwana vertebrates, Siwalik Mammals and possible causes of their extinction.

UNIT-III

Types of microfossils. Environmental significance of fossils and trace fossils. Use of microfossils in interpretation of sea floor tectonism. Application of micropaleontology in hydrocarbon exploration. Oxygen and Carbon isotope studies of microfossils and their use in paleo-oceanographic and paleoclimatic interpretation. Morphology of foraminifera and their geological applications. Origin and evolution of early vertebrates. Evolutionary trends in Equidae, Proboscidea and Hominidae. Paleoecology, Life habitats and various ecosystems, Paleobiogeography. Important invertebrate fossils, vertebrate fossils, plant fossils and microfossils in Indian stratigraphy.

COURSE CODE: GLP 20102-CR: PALAEONTOLOGY LAB

Study of the morphological characters of some important invertebrate fossils belonging to Brachiopoda, Bivalvia, Gastropoda, Ammonoidea, Trilobita, Echinoidea and corals. Determination of valves and dental formula of heterodont bivalves. Shell petrography of bivalves and brachiopods.

Books Recommended:

1. Clarkson, E.N.K., 1998: Invertebrate Palaeontology and Evolution.IV Ed.-Blackwell.
2. Stearn, C.W. & Carroll, R.L, 1989: Palaeontology-the Record of Life-John Wiley
3. Principles of Palaeontology by David M. Raup and Steven M. Stanley. CBS Publishers and Distributers.
4. Evolution of Vertebrates by E.H. Colbert. Wiley Eastern Ltd.

COURSE CODE: GL20103-CR: CRYSTALLOGRAPHY & MINERALOGY

Course outcomes: The course aims to provide students with an understanding of the fundamentals of mineralogy and crystallography, which contributes to their overall knowledge in geology. The course covers the morphology, symmetry, notations, normal crystal classes, and different crystallographic rules as they relate to the study of crystals. In addition, the course covers the physical, chemical, and optical properties of minerals. In thin sections and hand specimens, the students will be able to recognize common minerals that make rocks. Students will also learn about different mineral groups.

Unit-I

Crystallography: 32 crystals classes and description of the different normal classes. Different types of crystal projections – spherical and stereographic and their uses. Space Lattice and Symmetry of internal structures – 14 Bravais Lattice. Twinning and Twin Laws: common types of twins and their examples in minerals. Introduction to space group and reciprocal lattice. Lattice defects (point, line and planar). Historical development of X-ray Crystallography Bragg's Law and its derivation. X-rays in mineral science. Principles of X-ray crystallography and its application in X-ray-diffraction (XRD) and scanning electron microscopy.

Unit-II

Introduction to mineralogy: Properties associated with bond types (ionic size, radius ratio, coordination principle, coordination number). Transformation of minerals – polymorphism, polytypism, and polysomatism. Solid solution and exsolution. Electrical, magnetic and optical properties of minerals. Bonding and crystal structures of common oxides, sulphides, and silicates;(a) Nesosilicates- Olivine Group, Garnet Group, Aluminosilicate Group,(b) Cyclosilicates- Beryl, (c) Inosilicates-Pyroxene Group, Amphibole Group, (d) Phyllosilicates-Kaolinite Group, Serpentine Group, Pyrophyllite, Talc, Mica Group, Chlorite, (e) Tectosilicates: Feldspar Group, Cordierite

Unit-III

Concept and application of optical indicatrix. Interference phenomenon. Optical crystallography of uniaxial and biaxial crystals, Indicatrix, pleochroism, Interference figures, crystal orientation, 2V and 2E. Determinative methods in mineralogy: Refractive index (Colored Backeline variation method). Description and function of microscopic aids-compensation plates and wedges.

COURSE CODE: GLP 20103-CR: CRYSTALLOGRAPHY&MINERALOGY LAB

Mineralogy Identification of rock-forming minerals in hand specimens. Optical Mineralogy Determination of length fast and length-slow characters of minerals. Scheme of pleochroism and absorption of a given mineral in thin section. Determination of extinction angle and

composition of plagioclase. Study of interference figures of uniaxial and biaxial crystals, determination of optic signs. Representation of symmetry elements of crystals belonging to 32 classes of symmetry and study of their stereograms.

Books Recommended:

1. Berry & Mason, 1988: Mineralogy. CBS Pub.
2. Berry, L.G., Mason, B. and Dietrich, R.V. 1985: Mineralogy: Concepts, Descriptions and determinations. CBS Publishers.
3. Dana, E.S. and Ford, W.E. 2002: A text book of Mineralogy (Reprint).
4. De Jong, W.F., 1956: General Crystallography. Freeman, San Francisco.
5. Deer, W.A., Howie, R.A. & Zussman, J. 2013: An Introduction to the rock forming minerals, ELBS and Longman.
6. Deer, W.A., Howie, R.A. and Zussman, J., 1996: The Rock forming Minerals-Longman.
7. Gribble C.D., 2005: Rutley's elements of Mineralogy, Springer.
8. Hutchinson, C.S., 1974: Laboratory Handbook of Petrographic Techniques-John Wiley.
9. JAK Tareen TRN Kutty 2001: A Basic Course in Crystallography. University Press (India) limited.
10. Kerr, P. F., 1977: Optical Mineralogy. McGraw Hill.
11. Kerr, P.F.1977: Optical Mineralogy McGrew Hill.
12. Klein, C. and Hurlbut, Jr. C.S., 1993: Manual of Mineralogy-John Wiley.
13. Nesse, D.W., 1986: Optical Mineralogy, McGraw Hill.
14. Perkins, D., 2013: Mineralogy, Prentice Hall.
15. Phillips, F.C. 1963. An Introduction to Crystallography. Longmans, Green and Co Ltd, London.
16. Phillips, F.C.1971. Introduction to Crystallography. Longman Group Publication.
17. R.S. Sharma and Anurag Sharma (2013) Crystallography & Mineralogy: Concepts and Methods. Geological Society of India.
18. Phillips, Wm, R. and Griffen, D.T., 1996: Optical Mineralogy-CBS Edition.
19. Putnis, A., 2001: Introduction to mineral Science. Cambridge University Press.
20. Putnis, Andrew, 1992: Introduction to Mineral Sciences-Cambridge University Press.
21. Richard, V. G., 1997: Dana's new Mineralogy. John Wiley.
22. Spear, F.S. 1993: Mineralogical Phase Equilibria and Pressure-Temperature-Time paths Mineralogical Society of America Publ.
23. Winchell, A. N., 1968: Elements of optical mineralogy. Wiley Eastern Pvt Ltd.

COURSE CODE: GL20104-CR: GEOMORPHOLOGY

Course Outcomes: The study of this course will help students to understand basic concepts and significance of Geomorphology and will help them to understand processes and geomorphic agents behind the diverse array of geomorphic landforms. The application of geomorphic knowledge in mineral prospecting, hydrogeology, tunnel, dam, bridge and road construction, environmental studies, fault identification and river course dynamics are also part of this course.

UNIT-I

Overview of geomorphology: Basic concepts and significance of Geomorphology. Geomorphic processes and resulting landforms. Cycle of erosion, fluvial landforms and drainage patterns. Evolution of landforms in Aeolian, marine, glacial and karst landscapes. Geomorphological cycle. Morphometric analysis of basins. Introduction to tectonic geomorphology: Energetics, active tectonics and the models of landscape development, modern controversies in tectonic geomorphology. Application of Geomorphology in mineral prospecting, hydrogeology and environmental studies.

UNIT-II

Landform dating techniques: Relative – Clast seismic velocity method, Weathering rinds, Obsidian hydration rinds, Soil development and Carbonate coating method, Lichenometry;

Absolute – Tree rings, Luminescence dating. Geomorphic Expression of Faults. Geomorphic markers: linear and planer geomorphic markers. Palaeoseismology. Use of liquefaction-induced features for Palaeoseismic analysis. Holocene Deformation and Landscape Responses, Knickpoints, base level. Experimental Responses to Base-Level Lowering, Planform Changes: Geometry and Position, Stream-table Experiments, Examples of Tectonically Perturbed Fluvial Systems; Alluvial River response to active tectonics.

Books recommended:

1. Burbank, D. W. and Anderson, R.S., 2001: Tectonic Geomorphology Blackwell Sciences.
2. Easterbrook, Easterbrook, 1994: Surface Processes and Land Forms. Prentice Hall. McCalpin, J., 1996: Paleoseismology Academic Press.
3. Bloom, A. L. 2011: Geomorphology: A systematic analysis of Late Cenozoic Landforms 3rd Edition. Rawat Publications.
4. Gautam, A., 2015: Geomorphology 5th Edition. Sharda Pustak Bhavan Allahabad.
5. Halis, J.R. 1983: Applied Geomorphology.
6. Holmes, A. 1992: Holmes Principles of Physical Geology Edited by P. McL. D. Duff. Chapman and Hall, London.
7. Kale V S and Avijit Gupta 2010: Introduction to geomorphology. University Press.
8. Lowa Sharma, V. K., 1986: Geomorphology. Tata McGraw Hill.
9. Pitty, A. F, 1982: Nature of Geo-Morphology. University Paper Backs. Ritter, D. F., 1978: Process Geomorphology. Wm. C. Brown Publishers.
10. Sharma, H.S. 1990: Indian Geomorphology. Concept Publishing Co. New Delhi.
11. Siddhardha, K. 2016: The Earth's Dynamic Surface- A book of Geomorphology, Kitab Mahal.
12. Singh Savindra 2016: Geomorphology. Pravalika Publication Allahabad.
13. Small, R.J. 1978: Study of Landforms: A Textbook of geomorphology (2nd Edition), Cambridge University Press.
14. Summerfield M.A 2011: Geomorphology and Global Tectonics, Wiley India Pvt Ltd.
15. Thornbury, W.D. 2004: Principles of Geomorphology. 2nd edition CBS Publication.
16. Vishwas, S. K and Gupta, A., 2001: Introduction to Geomorphology Orient Longman.

COURSE CODE: GL20105-DCE: FIELD TRAINING

Geological Field Training shall be conducted on every alternate week in the valley.

COURSE CODE: GL20106-DCE: ENVIRONMENTAL GEOLOGY

Course Outcomes: The ability to recognize and control natural hazards and the environmental issues related to earthquakes, floods, landslides, volcanoes will be taught to the students. Using the knowledge of the past climate extremes the students will be able to understand find solutions to the future climate extremes. In addition, there are methods for controlling the use of natural resources including water, soil, and minerals, handling of nuclear waste, as well as techniques to prevent environmental damage.

UNIT-I

Environmental Geology: Introduction to environmental geology, fundamental concepts of environmental geosciences. Earth processes; endogenic and exogenic. Health Geochemistry: essential and toxic elements and radon emission. Environmental issues related to earthquakes, floods, landslides, volcanoes.

UNIT- II

Ozone hole depletion, ocean acidification, coral bleaching, sea level rise, eutrophication and acid rain; environmental impacts of urbanization, Geological investigations of nuclear waste disposal sites, mining and hydropower projects; water pollution, water logging and soil erosion; greenhouse gases and effect; cause and effects of global climate change. Proxies of climate

change (ice cores, tree rings, lake sediments, and speleothems). Environmental legislation.

UNIT-III

Planetary temperature and Stefan-Boltzmann equation, Earth's radiation budget, Negative and positive feedback mechanisms. Cenozoic climate extremes, Milankovitch cycle, Glacial and interglacial periods, records of paleotemperature in ice cores of glaciers, palaeo - temperature changes during the glacial ages, last ice age, causes of glaciation, Last Glacial Maximum, Little Ice Age. Biogeochemical cycle of carbon; Carbon Sequestration

Books Recommended:

1. Valdiya,K.S.,1987:EnvironmentalGeology-IndianContext-TataMcGrawHill.
2. Keller,E.A., 1978:EnvironmentalGeology–BellandHowell,USA.
3. Bryant, E., 1985: NaturalHazards-CambridgeUniversityPress.
4. Patwardhan, A.M., 1999: TheDynamicEarthSystem-PrenticeHall.
5. Subramanian, V., 2001: TextbookinEnvironmentalScience-NarosaInternational.
6. Bell, F.G., 1999: GeologicalHazards-Routledge,London.
7. Smith, K., 1992: EnvironmentalHazards-Routledge,London.

COURSE CODE: GL20107-DCE: PETROLEUM AND COAL GEOLOGY

Course outcomes: The course provides the student with essential and basic concepts of mineral exploration techniques and the art and science of mining of fossil fuels such as coal and petroleum. The students will be appraised about the formation of coal and origin, migration, and accumulation of petroleum.

Unit-I

Nature of petroleum: Chemical composition & physical properties of organic matter. Origin of petroleum; Biogenic and abiogenic theories on origin of petroleum. Source rocks and reservoir rocks. Amount, type and maturation of organic matter. Formation of source rock kerogens; diagenesis, ketagenesis and metagenesis. Evidences of migration. Primary and secondary migration; reservoir rocks-porosity, permeability and mechanics of fluid flow. Structural, stratigraphic and combination traps. Cap rocks and their properties. Formation of petroleum in relation to geological processes, temperature, time, and pressure. Timing of oil and gas generation.

UNIT-II

Definition, origin and different varieties of coal. Chemical characteristics of coal. Proximate and ultimate analysis of coal. Classification of coal in terms of rank, grade and type. Maturation concept; Physico-chemical coalification processes associated with rank change. Biochemical coalification; Concept of lithotype, maceral and micro-lithotype. Classification of macerals and microlithotypes. Organic petrological methods: vitrinite reflectance, optical properties of vitrinite and their Influence on measurements, relationship of reflectance to other optical properties. Geological and geographical distribution of coal deposits in India with emphasis on Gondwana coal fields of India.

Unit-III

Petroleum basins: Basin studies and basin analysis. Basin classification in plate tectonics. Fundamental types of petroliferous basin: Onshore and offshore petroliferous basins of India. Geology of productive oil fields of India, position of oil and gas in India, future prospects and the economic scenario.

Industrial application of coal: Coal carbonization, hydrogenation, liquification and gasification, underground coal gasification, coal bed methane. Elementary idea about generation of methane in coal beds, coal as a reservoir and coal bed methane exploration**.** Coal hazards and mitigation measures- Environmental impact of coal mining, acid mine drainage, mine subsidence, groundwater inundation, spontaneous combustion of coal, environmental impact of coal based power plants, disposal of coal ash.

Books recommended:

1. Guillemot, J., 1986: Oil and Gas Exploration Techniques. Additions Technip.
2. Glennie, K. W., 1998: Petroleum Geology of the North Sea. Blackwell Science.
3. Holson, G. D. and Tiratsoo, E.N., 1985: Introduction Petroleum Geology. Gulf Pub.
4. Houston, Keller, S. E., 1994: Mineral Resources, Economic and the Environment. McMillan College Pub.
5. Levarson, 1985: Geology of Petroleum. CBS Pub.
6. Landon, R. C., 1996: Principles of Petroleum Development Geology. Printice Hall.
7. North, F. K., 1985: Petroleum Geology. Allen &Unwin.
8. Salley, R. C., 1988. Elements of Petroleum Geology. Academic Press.
9. Tedesco, S. A., 1995: Surface Geochemistry in Petroleum Exploration. Chapman Hall.
10. Tissot, B. P. &Welte, D. H., 1984: Petroleum Formation and Occurrence, Springer Verlag.
11. Taylor, G.H., Teichmuller, M., Davis, A., Diessel, C.F.K., Littke, R. and Robert, P., 1998: Organic Petrology-GebruderBorntraeger, Stuttgart.
12. Chandra, D., Singh, R.M. and Singh, M.P., 2000: Textbook of Coal (Indian Context) -Tara Book Agency, Varanasi.
13. Singh, M.P., (Ed.), 1998: Coal and Organic Petrology-Hindustan Publ. Corp., New Delhi.
14. Stach, E., Mackowsky, M.T.H., Taylor, G.H., Chandra, D., Teichmuller, M. and Teichmuller, R., 1982:7.Stach's Text Book of Coal Petrology- GebruderBorntraeger, Stuttgart.

COURSE CODE: GL20108-GE: FRONTIERS IN EARTH SCIENCES

Course outcomes: This course is designed for students from the allied subjects. In this course the students will learn about the fundamental concepts like structure of the earth, various geospheres, geological time scale, fossils, minerals, past climate.

Unit-I

Introduction: Origin of Earth, Structure of earth. Crust, Mantle & Core.
Outer spheres: Atmosphere, hydrosphere, biosphere of the earth, Exogenous and endogenous process. Biogeochemical cycles - nitrogen cycle, carbon cycle and phosphorous cycle.

Unit-II

Geological Time Scale: Lithostratigraphic Units, Chronostratigraphic Unit and Biostratigraphic Unit. Geology as the history of Earth: (a) Fossils (b) Mineralogy and the texture; (c) Structures; (d) Palaeogeography (e) Paleoclimate.

Books recommended:

1. Holmes, A., 1996: Principles of Physical Geology, EUBS, Chapman.
2. Judson, S. and Kaufman, M. E., 1990: Physical Geology, Prentice Hall.
3. Press, F. and Seiver, R., 1989: The Earth, W. H. Freeman.

COURSE CODE: GL20109-OE: EARTH SYSTEM SCIENCE

Course outcomes: This course is designed for students from the allied as well as other subjects. In this course the students will learn about the basic definition of geology, its relation with other

subjects. The elementary idea about weathering, erosion, deposition, soils is also given in the course.

Unit-I

Introduction to Geology: Definition, branches and scope. Relationship of geology with other subjects, Interior of earth, Folds, faults and joints- definition and types.

Unit-II

Weathering: definition and types. Depositional and erosional features formed by rivers, glaciers and wind. Soils: formation and types.

Books recommended:

1. Ehlers and Blatt, 1999: Petrology, (Igneous, Sedimentary and Metamorphic). CBS Pub.
2. Einsele, G., 1992: Sedimentary Basins. Springer Verlag.
3. Friedman, G. M. and Sander, J. E., 1978: Principles of Sedimentology. John Wiley.
4. Twiss, R. J, and Moores, E. M., 1992. Structural Geology, W. H. Freeman and Company, New York.

SECOND SEMESTER

Choice based Credit System (CBCS) Scheme and course structure for M.Sc. Applied Geology 2nd semester effective from academic session 2020 and onwards.

COURSE CODE: GL20201-CR: IGNEOUS PETROLOGY

Course outcomes: After completion of this course, students will be able to: classify igneous rocks with the help of megascopic and microscopic studies of constituent minerals, structures and textures; understand the origin, geochemical evolution and diversity of igneous rocks; understand the magma generation with relation to plate tectonics; understand the tectono-magmatic evolution of large igneous provinces of the India and world. In addition, students acquire knowledge about the geochemical evolution of mantle through geological time and space. Students get the understanding of economic potential of various rock units such as ultramafic rocks (hosts of Platinum Group of elements, Ni, Cr, Co etc.), alkaline rocks (hosts of K, Na, etc.), kimberlites and lamproits (hosts of diamond), carbonatites (hosts of P, Nb, Ta, and rare earth elements), granitic rocks (hosts of U, Th etc.).

Unit-I

Introduction to igneous petrology: Magma-, Magma types and their evolution. Steady-state geotherms. Genesis, properties, emplacement and crystallization of magmas. Processes involving modification of primary magma (Assimilation Fractional crystallization). Effect of pressure and volatiles on melt equilibria, magmatic crystallization, differentiation, magma mixing, mingling immiscibility and partial melting. Thermal structure of the earth and melting of mantle. Introduction to mantle petrology and mantle heterogeneities.

Unit-II

Classification schemes of igneous rocks: IUGS and Chemical classification of igneous rocks, forms, structures and textures of igneous rocks. Petrology & petrogenesis of the following igneous rocks with suitable Indian examples: (a) Peridotites, komatiites, basaltic rocks, anorthosites, carbonatite and alkaline rocks. (b) Large igneous Provinces, Mafic dyke swarms and layered intrusive complexes. (d) Granitoids and pegmatites. Plate tectonics and magma generation

Unit-III

Phase Rule and Phase equilibrium - Unary, binary and ternary systems and their relations to magma genesis and crystallization. Interpretation of igneous textures in terms of rate of nucleation and crystal growth. Source and tectonic setting of different Magma Types: Intraplate magmatism, mantle plume, oceanic island Basaltic, granitic and alkaline magmas. Petrogenetic aspects of important rock suites of India, such as the Deccan Traps, layered intrusive complexes, anorthosites, carbonatites, charnockites, alkaline rocks, Kimberlites, ophiolites and granitoids.

COURSE CODE: GLP20201-CR: IGNEOUS PETROLOGY LAB

Megascopic and microscopic studies of acidic, basic and ultramafic igneous rocks. CIPW normative calculations based on geochemical data. Chemographic diagrams.

Books recommended:

1. Albert, J., 1967: Descriptive petrology of the Igneous Rocks. Mc-Graw Hill, New York.
2. Alexander, Mc. B., 1987: Igneous Petrology. Prentice Hall.
3. Barth, T. F. W., 1956: Theoretical Petrology. Mc-Graw Hill, New York.
4. Best, M. G., 1986: Igneous Petrology, CBS Pub.
5. Blatt H. & Tracy R.J. 1995. Petrology: Igneous, Sedimentary & Metamorphic. WHF & Co, New York.
6. Bose, M. K., 1997: Igneous Petrology. World Press.
7. Hall, A., 1988: Igneous petrology. ELBSI Longman.
8. Harker, A., 1944: Natural History of Igneous Rocks. McMillan Press.
9. Hatch & Wells, Text Book of Petrology. CBS Pub.
10. McBirney, A. R., 1993: Igneous Petrology. John Wiley.
11. Philpotts, A., 1992: Igneous and Metamorphic Petrology. Prentice Hall.
12. Shelley, D., 1995: Descriptive Petrology of the Igneous Rocks. Chapman & Hall.
13. Turner &Verhoogen, 1999: Igneous and Metamorphic Petrology. CBS Pub.
14. Winter, J.D. 2010: Principles of Igneous and Metamorphic Petrology: Pearson New
15. Philpotts, A., & Ague, J. 2009: Principles of Igneous and Metamorphic Petrology. Cambridge: Cambridge University Press.

COURSE CODE: GL20202-CR: SEDIMENTOLOGY

Course outcomes: The students will know the processes of sedimentation, lithification, diagenesis which converting loose sediments into consolidated sedimentary rocks. They will be able to describe with confidence sedimentary structure, texture and sedimentary processes of ore formation.

Unit-I

Origin of sedimentary rocks: Weathering; processes involved in sediment generation. Clastic, non-clastic and volcanoclastic sediments and their characteristics. Sedimentary textures, grain-size scale and sediment granulometry, primary sedimentary structures. Classification of sediments: Sandstone –Types of sandstones and their petrogenesis. Plate tectonics and

sandstones composition. Carbonates–classification, petrography and environment of deposition. Mudstones–classification and identification. Diagenesis of mudstones, sandstones and carbonate rocks.

Unit-II

Sedimentary processes: Introduction of fluid flow concepts and sediment transport, laminar and turbulent flow, Froud Number and Flow regime concept. Idealized sequence of structures in lower and upper flow regimes. Fluid and Sediment gravity flows; character of these deposits and their significance. Compositional maturity of sedimentary rocks. Scalar and Vector attributes; Palaeo-current analysis statistical techniques and interpretation.

Unit-III

Sedimentary facies: Concept and definition; Facies association; Walthers Law of Facies and application. Facies models and environmental reconstruction. Sedimentary environments: Lithologies, Structures and Vertical sequences formed in alluvial, Eolian, Glacial, Deltaic, Shallow marine and deep sea, field recognition, micromorphological features and paleoclimatic significance. Ichnofossils and their environmental significance Sedimentary cycles and Cyclothems. Formation and evolution of sedimentary basins. Carbonates: Chemistry, Types, Dunham and Folk classification. Carbonate diagenesis: sea floor, Meteoric and Deep burial. Types of carbonate platform; their geometry and depositional architecture.

COURSE CODE: GLP20202-CR: SEDIMENTOLOGY LAB

Megascopic and microscopic study of different types of sedimentary rocks and heavy mineral analysis. Paleocurrent analysis - collection of azimuthal data, graphical representation of data and determination of statistical parameters. Identification and study of common clastic sedimentary rocks viz. Quartz-arenite, Arkose, Litharenite, Greywacke etc. Study of carbonate rocks (Sparites and Micrites) Study of carbonate minerals (calcite, ferroan calcite, ferroan dolomite, aragonite & magnesite) by staining technique.

Books recommended:

1. Collinson, J. D, 1999: Sedimentary Structures. Springer Verlag.
2. Ehlers and Blatt, 1999: Petrology, (Igneous, Sedimentary and Metamorphic). CBS Pub.
3. Einsele, G., 1992: Sedimentary Basins. Springer Verlag.
4. Friedman, G. M. and Sander, J. E., 1978: Principles of Sedimentology. John Wiley.
5. Miall, A. D., 1999: Principles of Sedimentary Basin Analysis. Springer-Verlag.
6. Pettijohn, F. J., Potter, P.E. and Siever, R, 1990: Sand and Sandstone. Springer Verlag.
7. Reading, J. G. 1996: Sedimentary Environment and Facies. Black well.
8. Reineck, H. E. and Singh, I.B., 1975: Deposition Sedimentary Environment. Spring-Verlag.
9. Selley, R. C., 1976: Introduction of Sedimentology. Academic Press, London.
10. Sengupta, S., 1997: Introduction to Sedimentology. Oxford-IBH.
11. Boggs, S. Jr., 2011 Principles of sedimentology and stratigraphy. Fifth Edition PEARSON
12. James, N.P and Jones, B., 2016 Origin of Carbonate sedimentary rocks. Wiley.

COURSE CODE: GL20203-CR: METAMORPHIC PETROLOGY

Course outcomes: The course will help students understand the processes involved in metamorphic rock formation. Students will be able to understand the implications of various physico-chemical parameters in formulating the metamorphic history of rocks. It will further enhance their understanding of the P-T-t path associated with metamorphism and tectonic chemical zoning.

UNIT-I

Introduction to metamorphic petrology: Metamorphism and metamorphic processes; factor controlling metamorphism; role of fluids in metamorphism; types of metamorphism; Index minerals; Mineral assemblages; metamorphic differentiation. Metamorphic structures and textures. Mineralogical Phase rule of closed and open systems. Factors and processes of metamorphism. Claussius-Clapeyron equation and slopes of metamorphic reactions; heat flow, diffusion and mass transfer; Fourier's law of heat conduction. Fabric of metamorphic rocks, mylonite. Progressive and retrogressive metamorphism of pelitic, calcareous and basic rocks.

UNIT-II

Metamorphic facies: detailed description of each facies of low pressure, medium to high pressures and very high pressure. Characteristic metamorphic zones and subfacies (albite-epidote hornfels; hornblende- hornfels; pyroxene hornfels; sanidinite; greenschist; amphibolite; granulite; prehenite – pumpellite; glaucophane-lawsonite (blueschist); eclogite). Metamorphic textures. Nature of metamorphic reactions and pressure-temperature. Basic characteristics of metamorphic reactions, solid-solid reactions,dehydration reactions, decarbonisation and oxidation-reduction reactions. Mineralogical geothermo-barometry (applications and pitfalls).

UNIT-III

Conditions of metamorphism: isograds, iso-reaction grads. Roles of bulk rock and fluid compositions on the dispositions of isograds. Schrienemakers rule and construction of petrogeneticgrids; their application to petrological problems. Anatexis and origin of migmatites. Metamorphism and Tectonics; regional metamorphism and paired metamorphic belts. Metamorphic facies series. P-T-t paths and their implications. Ultra-high temperature, ultra-high pressure and ocean-floor metamorphism. Origin and significance of the compositional zoning.

COURSE CODE: GLP20203-CR: METAMORPHIC PETROLOGY LAB

A detailed study of textures in rock sections with reference to time relations between the phases of deformation and recrystallization of minerals. Calculation of ACF, AKF and AFM values from chemical and structural formulation of minerals and their graphical representation. Study of metamorphic rocks in thin sections belonging to different facies with emphasis on texture/structure, mineral composition, parent rock, metamorphic facies.

Books Recommended:

1. Turner, F.J., 1990: Metamorphic Petrology, McGraw Hill, New York.
2. Yardley, B.W. 1989: An Introduction to Metamorphic Petrology-Longman.
3. Bucher, K. and Frey, M.1994: Petrogenesis of Metamorphic Rocks-Springer Verlag.
4. Philipotts, A., 1992: Igneous and Metamorphic Petrology-Prentice Hall.
5. Best, M.G., 1986: Igneous Petrology-CBS Publ.
6. Kretz, R., 1994: Metamorphic Crystallization-John Wiley.
7. Bose, M.K., 1997: Igneous Petrology-World Press.
8. Perchuk, L.L. and Kushiro, I.1991: Physical Chemistry of Magmas-Springer Verlag.
9. Philpotts, A., & Ague, J. 2009: Principles of Igneous and Metamorphic Petrology. Cambridge: Cambridge University Press.

COURSE CODE: GL20204-CR: GLOBAL TECTONICS

Course outcomes: The course deals with geological structures resulting from the action of the tectonic forces on rocks. The student will gain knowledge of the geometry of the rock structures, and understand the mechanism of the evolution of rock structures and its application in continental reconfiguration. The students will also understand paleomagnetism, geological, geochemical and geophysical characteristics of earth, theories of the Earth and solar system etc.

Unit-I

Concept of super continents: Introduction to Gondwana Pangea and Rodinia their assembly and breakup. Geological evidences of Continental drift, Sea floor spreading. Lithospheric layers; composition and geophysical characteristics. Plate tectonics; concept, causes and examples. Different types of Plate boundaries and their geological, geochemical and geophysical characteristics. Tectonic features of extensional-, compressional-, and strike-slip-terrains and relevance to plate boundaries. The driving forces of plate motion. Interior of the earth: mechanical and compositional properties of earth's crust, mantle and core.

Unit-II

Geomagnetism: rock magnetization, reversals in the earth's magnetic field, polar wandering and Paleomagnetism. Mantle plumes and hot spots and general characteristics Hotpot tracks. Indian plate Himalayan orogeny and tectonic models and neotectonics. Seismicity in India. Different hypotheses on the origin of Earth and solar system; Evidence from astronomical observations, Cosmochemistry, meteorites, chondrites and achondrites. Early earth systems, Nature of early Geological records, Hadean and Archaean. Oldest terrestrial material. Oldest rocks in different cratons in India.

Books Recommended:

1. Condie, K.C., 2013: Plate tectonics & crustal evolution. Elsevier.
2. Condie, K.C., Plate Tectonics and Crustal Evolution, 2003.
3. Cox, A., 1996: Plate Tectonics. Blackwell.
4. Davies, G.F. 1977: Dynamic earth: Plates, plumes, and mantle convection. Cambridge University Press, Cambridge, 458 pp.
5. Kearey, P. and Vine, 2000: Global Tectonics. Black Well.
6. Kearey,P., Klepeis, K.A. and Vine, F. J., 2013. Global Tectonics.John Wiley & Sons Ltd. UK.
7. Moores, E. M. and Twiss, R. J., 2006. Tectonics, W.H. Freeman & Company,
8. Piper, J.D.A. 1987: Paleomagnetism and the continental Crust. New York, J. Wiley, 434 pp.
9. Valdiya, K.S., 2009: Aspects of Tectonics: Focus on South-Central Asia. Tata McGraw-Hill.

COURSE CODE: GL20205-DCE: FIELD TRAINING

Geological Field Training of 4 to 6 weeks shall be conducted at different parts of India.

Course outcomes: This course will impart the field knowledge of identifying various geological structures, rock types, mineral deposits, mapping skills, etc, necessary for mineral exploration, disaster management, environmental protection, etc. During this course students will be taken to various field sites across India so that they get a deep knowledge of the Geology of the country.

COURSE CODE: GL20206-DCE: NATURAL HAZARDS

Course outcomes: On the completion of the course, students will be able to comprehend the different kinds of natural hazards and disasters, their causes, and ways to map and mitigate their effects.

UNIT-I

Natural hazards: Concepts of environmental security. Neotectonics and seismic hazards assessment. Seismicity in India and significance of seismic hazard maps. Distribution, magnitude, intensity and geological effects of earthquakes. Sea level rise: impacts and risks. Desertification: causes, impact and assessment. Wasteland classification: mapping and reclamation. Air, water and noise pollution and their major causes.

UNIT-II

Principles of Disaster Management: Assessment of disaster vulnerability of a location and vulnerable groups. Preparedness and mitigation measures for various disasters. Disaster management with respect to earthquakes, flood and landslides. Water logging, problems of water logging due to indiscrete construction of canals, reservoirs, dams, water logging problem in India, Floods, causes of floods, flood hazard, management of floods. Application of remote sensing & GIS in natural hazards. Examples & case studies.

UNIT-III

Pollutants and contaminants: Behaviour of contaminants in environment; Point and non-point sources. Assessment and impact of contamination for surface and ground water quality due to industrialization and urbanization. Induced pollution, water quality criteria for different uses. Soil erosion by running water wind, soil deterioration by agricultural and engineering practices. Soil pollution and soil amendments, effects of fertilizers, pesticides and insecticides. Role of physical, chemical and biological parameters influencing environment. Riverine and marine environments and their important characteristics.

Books recommended:

1. Aki, K. and P.G. Richards., 2002: Quantitative Seismology, University Science Books, Sausalito, CA.
2. Bolt, B.A., 1992: Inside the Earth, W.H. Freeman, San Francisco.
3. Building safer cities, 2003: AlciraKreime, Margaret Arnold,Anee Carlin, New York United Nations Press.
4. Denis Smith,Steve Tombs.,2000: Risk management and Society-Eve Coles.
5. Iyer, H.M. and K. Hirahara (Eds.) (1993) Seismic Tomography Theory and Practice, Chapman & Hall, New York.
6. Landslides-Risk reduction. KyojiSassa, Paolo Canuti. 2008, Kluwer Academic Publishers.
7. Lay, T. and T.C. Wallace (1995) Modern Global Seismology, Academic Press, San Diego.
8. Natural Hazards and Human-Exacerabated disasters, Edgardo Latrubesse. National University of Colombia.

COURSE CODE: GL20207-DCE: HIMALAYAN GEOLOGY

Course outcomes: Upon completing this course, students are expected to have a comprehensive understanding of the region's geological framework, including the formation and ongoing evolution of the Himalayas due to the collision of the Indian and Eurasian plates. They will be familiar with the diverse rock types, stratigraphic sequences, and geomorphological processes that shape the landscape, including the roles of erosion, weathering, and glaciers. Students will develop a deep understanding of the seismic activity in the region, its associated hazards, and the implications for human settlements. The course will equip them with knowledge of natural hazards such as landslides and avalanches, and the

strategies for disaster risk management. Practical experience in fieldwork techniques and the ability to interpret geological data will further prepare students to analyse the region's geological history and dynamics, providing them with a solid foundation in understanding the complex interplay between geology, climate, and human activity in this unique region.

Unit-I

Introduction and classification of Himalayas: physiographic divisions of Himalaya, geological or tectonics sub divisions of Himalaya. Major longitudinal faults of Himalaya: Himalayan Frontal Fault, Main Boundary Thrust, Main Central Thrust, Tethyan Thrust, Indus Suture Thrust, Karakoram Fault, Main Himalayan Thrust, Tectonic history of India and origin and evolution of Himalaya.

Unit-II

Tectonic framework and geological features of Higher Himalayan crystalline, Lesser Himalayas, Tethys Himalayan succession and Indus and Shyok suture zone. Characteristics of Flysh& Molasse sediments of Himalaya.

Unit-III

The Fossiliferous horizons of Himalaya, Vertebrates of Siwalik, Vertebrates of non Siwalik and Plant fossils of Himalaya. Fuel and water resources of Himalaya. The metallogeny and plate tectonics of the Himalayas and its mineral deposits. Important Granitic bodies and associated mineralisation: Indus ophiolites and ophiolitic Melange in the Himalaya.

Books recommended:

1. Biyani, A.K., 2006: Dimensions of Himalayan Geology. Satish Serial Publishing House, New Delhi.
2. Condie, Kent. C., 1982. Plate Tectonics and Crystal Evolution Pergamon Press.
3. Gass I.G. et al 1982: Understanding the Earth. Artemis Press (Pvt.) Ltd. U.K.
4. Heim and Gansser, Central Himalaya.
5. Sharma, K. K., 1991: Geology and Geodynamic evolution of the Himalayan Collission Zone.
6. Sinha, A. K., Sassi, F. P. and Papinikolaou, D., 1997: Geodynamic domains in the Alpine- Himalayan.
7. Sinha, A.K., 1989: Geology of Higher Central Himalaya.
8. Tethys, Sinha, A.K., 1992: Himalayan Orogen and Global Tectonics.
9. Thakur, V. C. and Sharma, K. K., 1983: Geology of the Indus Suture Zone of Ladakh.
10. Thakur, V. C., 1992: Geology of Western Himalaya.
11. Windley B. 1973: The Evolving continents. John Wiley & Sons, New York.

COURSE CODE: GL20208-DCE: OCEANOGRAPHY & MARINE GEOLOGY

Course outcomes: To provide essential concepts of oceanography and to study the tectonics, geology, economic resources concerning the oceans. The course will also apprise students about the causes of sea level changes at its possible impacts on the coastal regions.

UNIT-I

Morphologic and tectonic domains of the ocean floor; structure, composition and mechanism of the formation of oceanic crust. Ocean margins and their significance. Ocean Circulation, Coriolis effect and Ekman spiral, convergence, divergence and upwelling, El Nino. Indian Ocean Dipole Thermohaline circulation and oceanic conveyor belt. Formation of Bottom waters; major water masses of the world's oceans. Mineral resources of the ocean including polymetallic nodules; Hydrocarbons beneath the sea floor; Marine gas hydrates and their economic potential. Marine pollution.

UNIT-II

Oceanic sediments: Factors controlling the deposition and distribution of oceanic sediments; geochronology of oceanic sediments, diagenetic changes in oxic and anoxic environments. Tectonic evolution of the ocean basins. Deep sea sediments and their relation to oceanic processes such as productivity, solution and dilution; sedimentation rates; Calcite and aragonite compensation depth. Methods and instruments for exploring the ocean floor. Marine stratigraphy, correlation and chronology.

UNIT- III

Palaeoceanography: approaches to paleoceanographic reconstructions; various proxy indicators for paleoceanographic interpretation. Paleoceanographic changes in relation to earth system history including impact of the oceans on climate change. Reconstruction of monsoon variability by using marine proxy records. Opening and closing of ocean gateways and their effect on circulation and climate during the Cenozoic. Sea level processes and Sea level changes. Methods of paleo-Sea Surface temperature quantifications.

Books Recommended:

1. Arnold. 2002: Quaternary Environmental Micropaleontology (Ed. Simon K. Haslett), Oxford Univ. Press, New York.
2. Kennett, J.P., 1982: Laboratory Excercises in Oceanography Marine Geology, Prentice Hall.
3. Seibold, E. and Berger, W.H., 1982: The Sea Floor, Springer-Verlag.
4. Shepard, F.P., 1963: Submarine Geology, Harper Row.
5. Komar, P.D., 1976: Beach processes and sedimentation, Prentice Hall.
6. Thurman, H.V., Trujillo, A.P., Abel, D.C. and McConnell, R., 1999. *Essentials of oceanography*. Upper Saddle River, NJ: Prentice Hall.

COURSE CODE: GL20209-GE: NATURAL RESOURCES OF J& K

Course outcomes: This course is meant for students from the sister departments of the school and will familiarise them with J&K's natural resources and assist them in discovering methods to preserve and responsibly utilizing them.

Unit-I

Ore minerals and gangue. Mineral deposit of Jammu and Kashmir. Distribution and uses of Marble, Granite, Basalt, Limestone and Slate in Kashmir. Economic mineral resources: Origin of petroleum. Reservoir and Source rocks – definition and types. Coal: definition, formation and classification of coal. Coal Petroleum prospecting in Kashmir.

Unit-II

Water resources: Rivers- types and major rivers of Kashmir. Glaciers- types and major glaciers of Kashmir. Lakes-types and major lakes of Kashmir. Springs-types and major springs of Kashmir. Ground water: concept and scope. Hydrological cycle and its components. Water quality standards for drinking purposes.

Books Recommended

1. Bamzai, P. N. K (1994), Culture and Political History of Kashmir (3 Vols. Set), M.D.
2. Publications, ISBN97881-85880-31-0.
3. Sir Walter Roper Lawrence (1895).The Valley of Kashmir. Asian Educational Services.
4. Raina A. N. (2002) Geography of Jammu & Kashmir State .RadhaKrishnanand& Co.
5. Qazi S.A. (2005).Systematic Geography of Jammu And Kashmir. APH Publishing, 2005.
6. Evan, A. M., 1983: Ore Geology and industrial Minerals. Blackwell.
7. Holson, G. D. and Tiratsoo, E. N., 1985: Introduction Petroleum Geology. Gulf Pub. Houston.
8. Jensen, M. L. and Bateman, A. M., 1981: Economic Mineral Deposits, John Wiley.
9. Keller, S. E., 1994: Mineral Resources, Economic and the Environment. McMillan College Pub

COURSE CODE: GL20210-OE: LIFE THROUGH TIME

Course outcomes: This open elective course offers students a vital understanding of the origin of life, evolutionary theories, and the role of fossils in geology. By exploring how life has evolved over time, students gain insights into the processes that have shaped Earth's biodiversity. The study of fossils, including their characteristics and conditions for fossilization, is crucial for reconstructing Earth's history and plays a significant role in stratigraphy, where fossils are key tools for dating rock layers. In the second unit, students will learn the fundamentals of stratigraphy, understanding these concepts is essential for interpreting the chronological order of rock layers and Earth's geological history. The study of the Karewas of Kashmir provides a regional focus, allowing students to apply these principles to a significant geological formation.

Unit-I

Origin of life through time, theories of evolution. Fossils, their characters, conditions necessary for fossilization; types of preservation and occurrence. Importance of fossils in stratigraphy.

Unit-II

Stratigraphy-definition and principles. Geological timescale. Stratigraphic correlation. Order of superposition. Karewas of Kashmir.

Books recommended

1. Arnold, C. A., 1947: An introduction to Paleobotany. McGraw - Hill Book Co.
2. Clerkson, E. N. K., 1998: Invertebrate Paleontology and evolution. Black Well
3. Dunbar, C. O, Rodger, J., 1957: Principles of stratigraphy. Wiley International.
4. Krishanan, M. S., 1968: Geology of India and Burma. HigginbothamsPvt. Ltd., Madras.
5. Kumar, R, 1998: Fundamentals of Historical Geology and Stratigraphy. Wiley Eastern Limited.

THIRD SEMESTER

Choice based Credit System (CBCS) Scheme and course structure for M.Sc. Applied Geology 3rd semester effective from academic session 2020 and onwards.

COURSE CODE: GL20301-CR: GEOCHEMISTRY

Course outcomes: After completion of this course, the student acquire the knowledge about the origin of the elements in the universe; differentiation of elements through crust, mantle, and core; behaviour of elements through various geochemical processes such as partial melting of rocks, crystallization of magma, chemical weathering of rocks, transportation and diagenesis of sediments. Students come to know about how elements redistribute within the different reservoirs or spheres of the Earth. Students will be able to understand the use of stable and radiogenic isotopes for the evaluation of genesis of rocks. Further, students get knowledge of various radiometric dating methods and which they can apply to date the rocks and minerals to understand the occurrence (age) of geological events through time.

Unit-I

Introduction to geochemistry: Origin of Earth, Differentiation and formation of core, mantle, crust, hydrosphere, atmosphere, Earth composition. Origin and abundance of elements in the solar system and in the Earth. Geochemical cycle of elements. Goldschmidt's classification of elements. Goldschmidt's rules for ionic substitution. Geochemical classification of elements: major elements, trace elements transition elements, compatible and incompatible elements, HFSE, LILE/LFSE, PGE, and REE. Concept of equilibrium. Entropy, enthalpy, Gibbs free energy and laws of thermodynamics. Chemical kinetics in geoscience and its applications: disequilibrium textures.

Unit-II

Concepts of partitioning and distribution coefficients of trace elements between solid and liquid phases vis-à-vis partial melting and magma generation. Utility of trace elements in petrogenesis of rocks. Distribution of REE in earth's mantle and crust. Interpretation of REE patterns. Sampling procedures and introduction to important analytical techniques used in geochemistry. Introduction to sedimentary geochemistry. Geochemical processes involved in rock weathering and soil formation. Mineral stability in Eh-Ph diagrams.

Unit-III

Radiogenic and cosmogenic isotope geochemistry: Stable isotope geochemistry (oxygen, hydrogen, carbon & sulphur) and its applications to geology. Radioactive decay law. Geochemistry of U and Th, their decay series, growth of daughter isotopes. U, Th, Pb methods of dating, U-Pb Concordia. Decay scheme of Sm-Nd, growth of daughter isotopes, geochemistry of Sm and Nd, age determination, CHUR, epsilon and model dates. Geochemistry of Rb, Sr, decay scheme and growth of daughter isotopes. Dating of minerals and whole rock, isochron dates, errorchrons, initial ratio. Principles and methodology of K-Ar dating.

COURSE CODE: GLP20301-CR: GEOCHEMISTRY LAB

Rock analyses (Rapid method of silicate analysis) Mineral formula calculations. Calculation of weathering indices in soil and sediments. Preparation of classificatory and variation diagrams and their interpretation; plotting of REE data and their interpretation.

Books Recommended:

1. Krauskopf, K.B., 1967: Introduction to Geochemistry-McGraw Hill.
2. Faure, G., 1986: Principles of Isotope Geology-John Wiley.
3. Hoefs, J., 1980: Stable isotope Geochemistry –Springer Verlag.
4. Marshal, C.P. and Fairbridge, R.W., 1999: Encyclopaedia of Geochemistry-Kluwer Academic.
6. Nordstrorm, D.K. and Munoz, J.L., 1986: Geochemical Thermodynamics-Blackwell.
7. Henderson, P., 1987: Inorganic Geochemistry-Pergamon Pres.

8. Hugh R. Rollinson. 1993: Using Geochemical Data: Evaluation, Presentation and Interpretation, Pearson Prentice Hall.
9. Mason, B. and Moore, C.B., 1991: Introduction to Geochemistry-Wiley Eastern.
10. Kula C Misra., 2012: Introduction to Geochemistry: Principles and Applications, Wiley-Blackwell.

COURSE CODE: GL20302-CR: HYDROGEOLOGY

Course outcomes: Students will have a comprehensive understanding of the physical, chemical, and biological processes that govern the movement, distribution, and quality of groundwater in various geological settings. They will be proficient in designing and conducting hydrogeological investigations, including groundwater modeling, aquifer testing, and the use of geophysical and geochemical techniques to assess groundwater resources. They will also be able to apply hydrogeological knowledge to address complex issues related to water resources management, including sustainable groundwater extraction, contamination remediation, and the impacts of climate change on groundwater systems. Students will be having better understanding of the ethical, environmental, and social implications of hydrogeological work, ensuring that their professional practices contribute to sustainable development and the protection of water resources.

Unit-I

An overview of hydrological cycle, aquifers, groundwater fluctuations, porosity, specific retention, specific yield, hydraulic conductivity, transmissivity, storage coefficient. Methods for estimation of aquifer parameters. Water table maps and flow net analysis; Differential equations for groundwater flow. Darcy's Law and its validity.

Unit-II

Surface and subsurface methods for groundwater exploration- geological and geophysical. Preparation of strata charts, design of tube well assembly and water well design criteria. Water level development and yield tests, well completion reports. Steady, unsteady and radial flow into a well; Concept of groundwater flow through dispersion and diffusion; pumping tests, slug tests for confined and unconfined aquifers; Determination of aquifer characteristics from pump-tests. Groundwater modeling techniques, data requirement.

Unit-III

Groundwater basin management methods: groundwater basin investigations and management practices; concepts of managed aquifer recharge and methods; Water logging –causes and remedial measures; Fresh and saltwater relationship in coastal areas. Hydrogeochemistry-physical and chemical constituents in groundwater (major ions and trace elements), water facies; Groundwater quality: sampling and analyses; Quality criteria for drinking, irrigation and industrial purposes. Pollution of groundwater. Groundwater and hydro-chemical provinces of India.

GLP20302-CR: HYDROGEOLOGY LAB

Delineation of hydrological boundaries on water-table contour maps and estimation of permeability. Preparation of isohytal maps, Theissen's polygonal method. Analysis of aquifer performance test data, Thiem's, Theis's and Jacob's method. Analysis of hydrographs and estimation of infiltration capacity. Study of geophysical well logs. Estimation of TDS using resistivity and SP logs. Plotting of groundwater provinces of India, Piper trilinear diagrams, US salinity diagrams

Books recommended:

1. Chow, V. T, 1988: Advances in Hydrosciences, McGraw Hill.
2. Fetter, C. W., 1990: Applied Hydrogeology. Merill Publishing.
3. Freeze, R. A. & Cherry, J. A., 1979: Ground Water. Prentice Hall.
4. Karanth, K. R., 1987: Groundwater Assessment-Development and Management. Tata McGraw Hill.
5. Raghunath, N. M., 1982: Ground Water. Wiley Eastern.
6. Ragunath, H. M., 1997: Hydrology, Principles, Analysis, Design. New Age Pub.
7. Roa, K. L., 1979: India's Water Wealth, Orient Blackswan.
8. Todd, D. K.., 1980: Groundwater Hydrogeology John Wiley.

COURSE CODE: GL20303-CR: REMOTE SENSING & GIS

Course outcomes: This course aims to cover the basic methods of remote sensing. The student will gain all the theoretical knowledge, information, and abilities necessary to use remotely sensed data for geological applications by the end of the course. This course aims to familiarize students with the fundamental concepts and methods of remote sensing, as well as the fundamental characteristics of electromagnetic radiation and how it interacts with matter. The student will have a thorough understanding of remote sensing, its applications, and the interpretation of geoscience data upon completion of this course.

Unit-I

Remote sensing: basic concepts, fundamentals, data sources, Types of scanners and image acquisition: History and scope of remote sensing, concepts of remote sensing, electromagnetic radiations, matter interactions with atmosphere and terrain atmospheric windows, spectral reflectance of vegetation, soils, minerals and rocks. Elements of visual image interpretation. Factors governing image interpretation, verification and validation of RS data (Ground Truthing).

Unit-II

Digital analysis of remote sensing data: Picture element and image statistics, Geometric and Radiometric Distortions, Pre-processing of satellite data (radiometric and geometrical corrections). Image enhancements techniques. Image filtering techniques. Spectral ratios and indices. Digital image classification: Supervised and unsupervised classification. Accuracy assessment: Sources of errors and measurement of map accuracy, kappa coefficient.

Unit-III

Remote sensing applications to geosciences: Earth sciences: Lithology and structure (faults, folds), Environmental: Land use and land cover changes, monitoring erosion, urbanization and deforestation. Survey: cadastral mapping, digital terrain models. Hydrology: hydrological modeling and ground water prospecting.

COURSE CODE: GLP20303-CR: REMOTE SENSING & GIS LAB

Remote Sensing in Geosciences: Tutorial on different modules of image processing software; Import and export of satellite data; Different image and remote sensing data formats; Familiarization with the earth surface features on the images; Preparation of satellite data for analysis like rotate, reflect, subset, layer addition; Pre-processing of satellite data like image registration, geo-correction, filtering, image enhancements, math operations; Image ratios and

other remote sensing and geological indices like SAVI; Lithologic, land use/land cover feature identification Familiarization with GIS software systems.

Books recommended:

1. Burrough, P.A., 2003: Principles of Geographic Information Systems. Oxford University Press.
2. Campbell, J., 2002: Introduction to Remote Sensing. Guilford Press, New York.
3. Demers, M. N., 1999: Fundamentals of Geographic Information Systems. John Wiley.
4. Jensen, J. R., 2004: Remote Sensing of the Environment. Prentice Hall, New Jersey.
5. John, A. Richards, 1993: Remote Sensing Digital Image Analysis. Springer-Verlag.
6. John, R. Jensen, 2000: Introductory Digital Image Processing, a Remote Sensing Perspective.
7. Lillesand, T. M. and Kiefer, R. W., 1987: Remote Sensing in Geology. John Wiley.
8. Lillesand, T. M. and Kiefer, R. W., 2002: Remote Sensing and Image Interpretation. PrenticeHall, New Jersey.
9. Sabbins, F. F., 1985: Remote Sensing - Principles and Applications. Freeman.
10. Wiley Rees, W. G., 2001: Physical Principles of Remote sensing. Cambridge University Press.

COURSE CODE: GL20304-CR: STRATIGRAPHY

Course outcomes: The appearance and evolution of life throughout geologic time, as well as the chronological arrangement of rocks, are all included in the study of stratigraphy. With an understanding of stratigraphic ideas and correlation, students will be able to relate their field observations to the changes that have occurred throughout Earth's history and comprehend the framework of India's stratigraphy.

Unit-1

Fundamental concepts of stratigraphic principles and correlation. Recent developments in stratigraphic classification. Code of stratigraphic nomenclature – Stratotypes, Global Boundary Stratotype Sections and Points (GSSP). Lithostratigraphic, chronostratigraphic and biostratigraphic subdivisions. Methods of stratigraphic correlation including Shaw's Graphic correlation. Concept of sequence stratigraphy. Phanerozoic stratigraphy of India with reference to the type areas– their correlation with equivalent formations in other regions. Precambrian stratigraphy (Dharwar craton, Eastern Ghat mobile belt; Southern Granulite belt and Singhbhum-Chotanagpur-Orissa belt); Proterozoic stratigraphy (Vindhyan, Chattisgarh, Cuddapah and Kurnool basins). Boundary problems in Indian Phanerozoic stratigraphy.

Unit-1I

Stratigraphy of the marine Palaeozoic rock formations of India. Classification, depositional characteristics, fauna and flora of Triassic, Jurassic and Cretaceous systems in principal basins of India. Classification, depositional characteristics, fauna and flora of the Palaeogene and Neogene systems in their type localities and their equivalents in India. Archean-Proterozoic; Proterozoic-Cambrian; Permian- Triassic and Cretaceous-Tertiary boundary problems in Indian subcontinent. Karewas of Kashmir and its paleoclimate history.

Books Recommended:

1. Boggs, S., 2001: Principles of Sedimentology and Stratigraphy, Prentice Hall.
2. Danbar, C.O. and Rodgers, J., 1957: Principles of Stratigraphy, John Viley and Sons.
3. Doyle, P. and Bennett. M.R., 1996: Unlocking the Stratigraphic Record, John Viley and Sons.
4. Krishnan,M.S. (1982): Geology of India and Burma, C.B.S. Publ. and Distributors, Delhi.
5. Naqvi, S.M. and Rogers, J.J.W., 1987: Precambrian Geology of India, Oxford University Press.
6. Pascoe, E.H., 1968: A Manual of the Geology of India and Burma (Vols.I-IV), Govt. of India Press, Delhi.
7. Pomerol, C., 1982: The Cenozoic Era? Tertiary and Quaternary, Ellis Harwood Ltd., Halsted Press.
8. Schoch, Robert, M., 1989: Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.

COURSE CODE: GL20305-DCE: PROJECT WORK-I

Term Work (compulsory)*

COURSE CODE: GL20306-DCE: GEOPHYSICS

Course outcome: The students will acquire skills to use various geophysical methods for exploration purposes. The geophysical techniques in the course include seismic, gravity, magnetic and electrical resistivity methods and their various applications.

Unit-I

Introduction to Geophysics: Geophysics; Energetics. Rock Magnetism: Columb's law for magnetic poles; magnetic fields of an electric current and inside a material; Magnetic Properties of rocks; geomagnetism and Paleomagnetism; Gravitation: Law of Universal Gravitation; gravitational acceleration; Equipotential Surface; centripetal and centrifugal acceleration; Figure of the earth; Gravitational potential of the spheroid earth; Normal gravity; Geoid.

Unit-II

Techniques of Seismology; origin and form of seismic waves; Earthquakes: Elastic rebound model; Focus epicenter and depth of earthquakes, locating earthquakes; Earthquake magnitude and frequency Earthquake focal mechanism and its analysis. Seismic reflection and refraction. Gravity: Principles and interpretation. Electric properties of earth. Heat transfer in earth: conduction; convection; radiation; Satellite geodesy.

Unit-III

Geoelectric and electromagnetic Methods, GPR. Gravity anomalies and their correction; Electromagnetic surveying; Electric conductivity in earth; Seismometer and its principles. Concepts and usage of corrections in geophysical data.

Books recommended:

1. Lowrie, W. (2007). Fundamentals of Geophysics (Second Ed.) Cambridge University Press, 381p.
2. Parasnis, D.S. (1975)-Principles of Applied Geophysics-Chapman and Hall.
3. Stanislave, M. (1984)-Introduction to Applied Geophysics-Reidel Publ.
4. Keller E. (1986). Investigation of active tectonics: use of surficial earth processes. In: Wallace, R.E. (Ed.).
5. Active Tectonics. Studies in Geophysics. Nat. Acad. Press, Washington, DC, p136-147.

COURSE CODE: GL20307-DCE: ORE GEOLOGY

Course outcomes: The students will get familiarized about the processes involved in the formation of various ore minerals. The students will be appraised about basic skills in prospecting, drilling and logging operations in mineral exploration. Besides, the students will also learn about the process involved in the formation of various deposits.

UNIT-I

Modern concepts of ore genesis: Spatial and temporal distribution of ore deposits and a global perspective. Comparison between Earth's evolutionary history and evolutionary trends in ore deposits. Ore deposits and plate tectonics. Mode of occurrence of ore bodies – morphology and relationship of host rocks. Textures of ores and their genetic significance

Unit-II

Different types of ore reserves, Mineral economics and its significance. National Mineral Policy. Geo-thermometry of ore deposits. Fluid inclusion in ores: Principles, assumptions, limitations and applications. Inversion points, exsolution textures and stable isotopes as indicators of depositional temperatures. Ores of mafic-ultramafic association- diamonds in kimberlite; REE in carbonatites; Ti-V ores; chromite and PGE; Ni ores; Cu, Pb-Zn. Ores of silicic igneous rocks, disseminated and stock work deposits, porphyry associations.

UNIT-III

Ores of sedimentary affiliation-chemical and clastic sedimentation; stratiform and strata bound ore deposits (Mn, Fe, non-ferrous ores), placers and paleo-placers. Ores of metamorphic affiliations-metamorphism of ores. Ores related to weathering and weathered surfaces laterite, bauxite. Contemporary ore-forming systems e.g., black smokers, mineralized crusts, Mn nodules. Mineralogy, genesis and important Indian distribution of ore minerals related to: Mn, Au, Sn, W and U.

Books Recommended:

1. Ore Microscopy and Ore Petrography – J.R. Craig and D.J. Vauhan, 1994. John Wiley and Sons, 434pp.
2. Ore Geology and Industrial Minerals – A.M. Evans, 2013. John Wiley and Sons, 400pp.
3. Metal deposits in relation to plate tectonics – F.J. Sawkins, 2013. Springer Science & Business Media, 461pp.
4. Ore Petrology – R.L. Stanton, 1972. McGraw-Hill, 713pp.
5. Economic Geology and Geotectonics – D.H. Tarling, 1981. John Wiley and Sons, 213pp.
6. Geochemistry of Hydrothermal Ore Deposits – H.L. Barnes (Ed), 1979. John Wiley and Sons, 798pp.
7. Time and Strata Bound Ore Deposits – D.D. Klemm and H.J. Schneider, 2012. Springer Science & Business Media, 446pp.
8. The Geology of Ore Deposits – J.M. Guilbert and C.F Park, Jr, 2007. Waveland Press, 985pp.
9. Elements of Mining 3rd Ed. - R.S. Lewis and G.B. Clarke, 1964. John Wiley and Sons, New York.
10. Ore genesis – A Holistic Approach – A. Mookherjee, 1999. Allied Publishers, 657pp.
11. Mining Geology II Ed. – H.E. McKinstry, 1962. Asia Publishing House.

COURSE CODE: GL20308-DCE: GLACIOLOGY

Course outcomes: The course glaciology is meant to make understand to the students the formation and dynamics of glaciers, their importance in maintaining stream flows and water supply as well as their preservation for perennial water supply.

Unit-I

Glaciers: Glacier Formation, glacier features and types. Movement of glaciers. Glacial deposits. Glacial and interglacial periods. Glacial landform. Last Glacial Maximum, Little Ice Age, Younger Dryas. Climate change and glaciers. Glaciers resources of the Antarctica, Greenland and the Himalayas. Glacier dynamics: ELA, AAR, velocity; Mass balance studies of glaciers; geological, photogrammetric, GPS/GPR mass balance.

Unit-II

Snow and glacier resources of the Himalayas. Climate change and glaciers. Snow hydrology, snowmelt runoff modeling. Black carbon deposition on glaciers and its impacts on melting, and other feedbacks. Impacts of changing Himalayan cryosphere on political stability in south Asia. Use of remote sensing for snow and glacier studies, glacier (snow cover, snow depth, snow water equivalence, snow density). Snow depletion curves.

Books recommended

1. Benn, D.I. and EvansJ A D., 1997. Glaciers and Glaciation.Woody's Books USA.

2. Bennett, M. R. and Glasser, N. F., 2000. Glacial Geology Ice Sheets and Landforms. Wiley Sharp.
3. Hubbard, B. and Glasser N. F. 2005. Field Techniques in Glaciology and Glacial Geomorphology. Wiley.
4. M., Richards, K. S. and Tranter M., 1998. Glacier Hyrology and Hydrochemistry. Wiley Allan, T. D.Satellite microwave remote sensing. Chichester, Ellis Hardwood.

COURSE CODE : GL20309-GE : INDIAN MINERAL DEPOSITS

Course outcomes: The course is for students outside the department but within the school. The course tries to impart basic skills related to mineral deposits found in India and will help to understand the processes of ore and mineral formation. Besides the students will learn methods of mineral exploration, sampling principle, estimation of reserves, ore dressing, etc.

Unit-I

Economic mineral resources: Metallogenic provinces and epoch in Indian subcontinent. An over view of various types of ore deposits and industrial minerals in India. Biotic resources, Metallic minerals, Non-metallic minerals, Minor minerals. Broad distribution of important minerals in India.

Unit- II

Mineralogy and genesis of major bauxite, iron ore and manganese deposits of India. Mineralogy and mode of occurrence of major copper, lead-zinc, chromite and tin deposits of India.

Books Recommended

1. Bamzai, P. N. K (1994), Culture and Political History of Kashmir (3 Vols. Set), M.D. Publications, ISBN 97881-85880-31-0.
2. Sir Walter Roper Lawrence (1895). The Valley of Kashmir. Asian Educational Services, 1895.
3. Raina A. N. (2002) Geography of Jammu & Kashmir State. Radha Krishan Anand & Co.
4. Qazi S.A. (2005). Systematic Geography of Jammu And Kashmir. APH Publishing, 2005.
5. Evan, A. M., 1983: Ore Geology and industrial Minerals. Blackwell.
6. Holson, G. D. and Tiratsoo, E. N., 1985: Introduction Petroleum Geology. Gulf Pub. Houston,
7. Jensen, M. L. and Bateman, A. M., 1981: Economic Mineral Deposits, John Wiley.
8. Keller, S. E., 1994: Mineral Resources, Economic and the Environment. McMillan College Pub.
9. Levarson, 1985: Geology of Petroleum. CBS Pub.
10. Prasad, U., 1996: Economic Geology. CBS Pub. N. Delhi.

COURSE CODE: GL20310-OE: PRECIOUS STONES

Course outcomes: The main goal is to provide students of various sister departments of the school with the knowledge and abilities necessary to succeed as gemmologists by familiarising them with the many terms used in the gem industry.

Unit-I

Gem and Gemstones. General characteristics and chemical composition of gemstones: Physical characteristics: Form, cleavage, fracture, hardness and specific gravity. Optical characteristics: colour, luster, play of colour, refractive index, reflectivity, pleochroism, dispersion.

Unit-II

Ore minerals and gangue, Gold, Thorium, Mica, Bauxite and Tungsten deposits their Properties and distribution in India. General idea of Manganese nodules, Placer & Residual deposits.

Books Recommended

1. Ore Geology and Industrial Minerals – A.M. Evans, 2013. John Wiley and Sons, 400pp.
2. Metal deposits in relation to plate tectonics – F.J. Sawkins, 2013. Springer Science & Business Media, 461pp.
3. Ore Petrology – R.L. Stanton, 1972. McGraw-Hill, 713pp.
4. Economic Geology and Geotectonics – D.H. Tarling, 1981. John Wiley and Sons, 213pp.
5. Geochemistry of Hydrothermal Ore Deposits – H.L. Barnes (Ed), 1979. John Wiley and Sons, 798pp.
6. Time and Strata Bound Ore Deposits – D.D. Klemm and H.J. Schneider, 2012. Springer Science & Business Media, 446pp.
7. The Geology of Ore Deposits – J.M. Guilbert and C.F Park, Jr, 2007. Waveland Press, 985pp Ore genesis – A Holistic Approach – A. Mookherjee, 1999. Allied Publishers, 657pp.
8. Phillips,Wm,R.andGriffen,D.T.,1996:OpticalMineralogy-CBSEdition
9. Hutchinson,C.S.,1974:LaboratoryHandbookofPetrographicTechniques-JohnWiley
10. Klein, C. and Hurlbut, Jr. C.S., 1993: Manual of Mineralogy-John Wiley

FOURTH SEMESTER

Choice based Credit System (CBCS) Scheme and course structure for M.Sc. Applied Geology 4th semester effective from academic session 2020 and onwards

COURSE CODE: GL20401-CR: EXPLORATION & MINING GEOLOGY

Course outcomes: During this course the students will understand Earth's structure and processes, that play a crucial role in identifying resource-rich areas through geological and

geophysical surveys and mapping. This foundational step sets the stage for exploration activities, ensuring the responsible extraction of minerals and metals.

Unit-I

General and Exploration geophysics- Different types of geophysical methods; Gravity, magnetic, Electrical, Seismic, radioactive- their principles and applications. Concepts and Usage of corrections in geophysical data. Role of geophysical data in explaining geodynamical features of the earth. Application of Geophysical methods - Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics. Geophysical field operations: Different types of surveys, grid and route surveys, profiling and sounding techniques.

Unit-II

Well logging: Open hole, cased hole and production logging; Electrical logs; lateral, latero, induction, temperature, S.P; porosity logs; sonic, density, neutron; natural gamma; determination of formation factor, porosity, permeability, density, water saturation, lithology; logging while drilling. Geophysical anomalies: geophysical, anomaly, regional and residual (local) anomalies, factors controlling anomaly, depth of exploration. Integrated geophysical methods - Ambiguities in geophysical interpretation, Planning and execution of geophysical surveys. Scales of survey.

Unit-III

Application of rock mechanics in mining. Planning, exploration and exploratory mining of surface and underground mineral deposits involving diamond drilling, shaft sinking, drifting, cross cutting, winzing, stoping, room and pillaring, top-slicing, sub-level caving and block caving. Types of drilling methods. Classification of mining methods. Mining Methods: Placer mining methods, open pit methods, Underground mining methods, Ocean bottom mining. Ventilation in underground mining: Purpose, types and arrangements of ventilation in underground mining. Mining hazards and safety measures. Mine inundation, fire and rock burst.

Books recommended:

1. An introduction to Geophysical Prospecting by Oobrin, M.B. and Savit, C.H., McGraw Hill, New Delhi, 1988.
2. Applied Geophysics by Telford W.M. Geldart L.P., Sheriff, R.E. and Keys D.A. Oxford and IBH Publishing Co. Pvt., Ltd. New Delhi, 1976.
3. Outlines of Geophysical Prospecting - A manual for geologists by Ramachandra Rao, M.B., Prasaranga, and University of Mysore Mysore 1975.
4. Ore Microscopy and Ore Petrography–J.R.Craig and D.J.Vauhan, 1994.JohnWiley and Sons, 434 pp.
5. Ore Geology and Industrial Minerals–A.M.Evans, 2013 .John Wiley and Sons, 400pp.
6. Ore Petrology–R.L.Stanton, 1972.McGraw-Hill, 713 pp.
7. Geochemistry of Hydrothermal Ore Deposits–H.L.Barnes (Ed), 1979.JohnWileyandSons, 798pp.
8. Time and Strata Bound Ore Deposits–D.D. Klemmand H.J. Schneider, 2012.Springer Science & Business Media,446pp.

COURSE CODE: GL20402-CR: QUATERNARYGEOLOGY & PALEOCLIMATE

Course outcomes: On the completion of this course students will be able to describe how the Earth's climate system works and summarize general atmosphere circulation patterns, ocean circulation patterns and climate oscillations such as the El Niño Southern Oscillation. Besides,

they will also be in a position to illustrate the Earths carbon cycle and quantitatively describe how addition of CO2 to the atmosphere due to burning of fossil fuels influences the climate.

Unit- I

Paleoclimatology, Paleoclimatic reconstruction. Reconstructing the climates of the Quaternary, definition of Quaternary. The Character of Quaternary. Quaternary Stratigraphy–Oxygen Isotope stratigraphy, biostratigraphy and magnetostratigraphy. Responses of geomorphic systems, sea level and tectonics during the Quaternary.

Unit-II

Quaternary dating methods: Radiocarbon, Cosmogenic radionuclide, Luminescence, and Relative dating methods. Quaternary Glaciation. Glaciation during times of enhanced/reduced atmospheric carbon dioxide. Glaciotectonic structures, landforms and processes. Glacial-interglacial cycles, eustatic changes, proxy indicators of paleoenvironmental/ paleoclimatic changes.

Unit-III

Quaternary stratigraphy of India–continental records (fluvial, glacial, aeolian, palaeosols and duricrust); marine records; continental-marine correlation of Quaternary record. Quaternary deposits of Kashmir. Plate tectonics and climate change, Variations of the earth's orbital parameters, **(**Milankovitch cycles); Application of pollens, loess-paleosols and phytoliths in Quaternary Stratigraphy.

Books Recommended:

1. Bigg, G., 1999: Ocean and Climate. Springer- Verlag.
2. Bradley, F., 2000: Paleoclimatology: Reconstructing Climates of the Quaternary. Springer- Verlag.
3. Maher and Thompson, 2000: Quaternary Climates, Environments and Magnetism. Cambridge University Press.
4. Williams, Durnkerley, Decker, Kershaw and Chhappell, 1998: Quaternary Environments. Wiley and Sons.
5. Dudeja D. (2011) Glaciostatic Pressure/Stress. In: Singh V.P., Singh P., Haritashya U.K. (eds) Encyclopedia of Snow, Ice and Glaciers. Encyclopedia of Earth Sciences Series. Springer, Dordrecht

COURSE CODE: GL20403-CR: SEQUENCE STRATIGRAPHY & BASIN ANALYSIS

Course outcomes: This course provides significant benefits to students by equipping them with critical skills and knowledge for careers in geology, particularly in fields like petroleum exploration, sedimentology, and basin analysis. Understanding sequence stratigraphy is essential for interpreting the deposition of sedimentary layers and predicting the location of natural resources like hydrocarbons. This course trains students to analyse base level changes, transgressions, regressions, and stratigraphic surfaces, all of which are crucial for identifying and evaluating potential hydrocarbon reservoirs. By mastering these concepts, students will be well-prepared for advanced roles in geology, such as in hydrocarbon exploration and basin analysis, making them highly competitive in both academic and industrial settings. The practical applications of the knowledge gained in this course will open up opportunities in research, exploration, and resource management.

UNIT-I

Sequence stratigraphy. Definitions and key concepts. Base level changes, Transgressions and regressions, T-R cycles. Stratigraphic surfaces: Stratal terminations, sequence stratigraphic surfaces. Unconformity and correlative conformity, Ravinement surface, Initial and maximum

flooding surface Systems Tracts: Lowstand, Transgressive, Highstand, Falling stage etc. Sequence Models: Depositional sequence (Type I, 11, Ill), Genetic stratigraphic sequence, Transgressive-Regressive sequence. Hierarchy of sequences and bounding surfaces. Application of sequence stratigraphy in hydrocarbon exploration. Concepts of event stratigraphy. Applications of biostratigraphy in sequence delineation.

UNIT-II

Evaluation of sedimentary basins: tectonics and sedimentation; craton facies, geosyncline and related facies. Basin subsidence and Geohistory analysis. Sedimentation pattern and depositional environment of selected un-deformed sedimentary basins of India representing Precambrian, Phenerozoic and contemporary basins. Volcanoclastic- formation and general characteristics, types of pyroclastic.

Books Recommended:

1. Allen, J.R.L., 1985: Principles of Physical Sedimentation-George Allen & Unwin.
2. Bhattacharya, A. and Chakraborti, C., 2000: Analysis of Sedimentary Successions-Oxford-IBH.
3. Boggs Sam Jr., 1995: Principles of Sedimentary and Stratigraphy-Prentice Hall.
4. Davis, R.A. Jr., 1992: Depositional System-Prentice Hall.
5. Einsele, G., 1992: Sedimentary Basins-Springer Verlag.
6. Miall, A.D., 2000: Principles of Sedimentary Basin Analysis-Springer Verlag.
7. Nichols, G., 1999: Sedimentology and Stratigraphy.Blackwell.
8. Pettijohn, F.J., Potter, P.E. and Siever, R., 1990: Sand and Sandstone-Springer Verlag.
9. Reading, H.G., 1996: Sedimentary Environment-Blackwell.
10. Reineck, H.E. and Singh, I.B., 1980: Depositional Sedimentary Environments-Springer Verlag.
11. .D. Emery, and K. Mayers 1996: Sequence Stratigraphy: Blackwell Publishers.
12. Principles of Sequence Stratigraphy Octavian cateneauau, 2006: Elsevier
13. P. A. Allen and J.R. Allen ,1990: Basin Analysis: Principles and Applications: Blackwell Publishing

COURSE CODE: GL20404-CR: PROJECT WORK

Course outcomes: Students are introduced to the specifics of scientific research in their third semester of an MSc degree, with the goal of fostering a culture of creativity and research at the postgraduate level and equipping them to conduct cross-cutting research in geoscience.

GL20404-CR: PROJECT WORK: Project work shall be discipline centric, and every student shall do the project work under the Supervision of a teacher. The Dissertation must be typed and be limited to 50-75 pages of A4 size. The project work must be evaluated by one external and one internal examiner followed by presentation of work and viva voce.

COURSE CODE: GL20405-DCE: ENGINEERING GEOLOGY

Course outcomes: The students will learn different geological considerations and environmental aspects of engineering projects, like tunnelling, road building, dam construction etc.

Unit-I

Principles of engineering geology: Development of Engineering Geology. Important Geo-engineering failures: Geological causes for mishaps and failures of engineering structures. Surface and sub-surface investigations for site selection Engineering properties and classification of rocks. Physical characteristics of building stones, concretes and other aggregates. Alkali aggregate reactions, artificial aggregate. Factors affecting engineering

properties of rocks. Rock stability tests. Engineering properties and classification of rocks: RQD, engineering classification of rock mass, Terzaghi's rock mass classification, coates, C-factor, Q-system and geochemical classification.

Unit-II

Engineering properties of soil, Atterberg limits, cohesive and non-cohesive soils. Quick clay, quick sand, thixotrophy, soil liquefaction and creep. Active faults, features of active faults, earthquakes and seismicity, seismic zones of India, Paleoseismic indicators. Mass movements with special emphasis on landslides and causes of hill slope instability. Geological investigations for construction of buildings, dams, reservoirs, bridges, highways, tunnels and coastal protection structures. Dam foundation rock problems. Tunnel alignment and transportation routes. Methods of tunnelling and various types of tunnel support. Remedial measures. Seismic design of buildings. Earthquakes and seismic zones of India. Case history of engineering projects and geological causes for failures of engineering structures and remedial measures

Books recommended:

1. Arms, K., 1990: Environmental Science. Saunders College Pub.
2. Bell, F. G., Engineering Properties of Soils and Rocks.
3. Bell, F. G., 1999: Geological Hazards their assessment, Avoidance & Mitigation. E&FN S. London.
4. Bell, F. G., 1999: Geological Hazards. Routledge, London.
5. Bieniawski, Z.T. 1989. Engineering rock mass classifications. New York: Wiley.
6. Bryant, E., 1985: Natural Hazards. Cambridge University Press.
7. Goodman, R. E., Engineering Geology.
8. Keller, E. A., 1978: Environmental Geology. Bell and Howell, USA.
9. Krynine, D. H. and Judd, W.R., 1998: Principles of Engineering Geology. CBS Pub.

COURSE CODE: GL20406-DCE: ADVANCED HYDROLOGY

Course outcomes: By the end of this course, students will be able to demonstrate a comprehensive understanding of advanced hydrogeological principles, including groundwater flow, aquifer properties, and subsurface water interactions, and apply these concepts to real-world scenarios. They will utilize mathematical models and computational tools to quantify and predict groundwater flow, contaminant transport, and aquifer responses under varying environmental conditions. Master advanced field and laboratory techniques for investigating hydrogeological systems, including well logging, aquifer testing, and the use of geophysical methods for subsurface characterization. Apply hydrogeological knowledge to design and evaluate sustainable groundwater management practices, considering both human needs and environmental impacts.

UNIT-I

Hydrographic analysis: Annual, seasonal and storm hydrographs; Water balance studies, determination of recharge by stream hydrograph, base flow separation and stable isotopes; Water level maps; groundwater-surface water interaction; Applications of Darcy's law, estimation of aquifer parameters with the help of pumping tests.

UNIT-II

Groundwater modelling and management: Groundwater budgets, artificial recharge, conjunctive use of surface and groundwater; Mathematical modelling: concept, boundary conditions, analytical and numerical methods of solution, MODFLOW- introduction, Indian case studies.

Unit -III

Environmental isotopes in hydrogeology: concept and applications; Stable isotopes: standards and measurements; oxygen-18 and deuterium in waters, carbonate, sulphate and nitrate, chloride, bromide, lithium and boron; strontium in water; radioisotopes: tritium, carbon-14, chlorine-36, Argon-39, Krypton; Isotope fractionation: Equilibrium and kinetic fractionation; isotope fractionation, enrichment and separation; Partitioning of isotopes through the hydrological cycle, Deuterium excess in meteoric waters, Precipitation and meteoric water line; Rainout and Rayleigh distillation; Temperature and altitude affects; Ice cores and paleotemperature.

Books recommended:

1. Chow, V. T., 1988: Advances in Hydrosciences, McGraw Hill.
2. Fetter, C. W., 1990: Applied Hydrogeology, Merill Publishing.
3. Freeze, R. A. & Cherry, J. A., 1979: Ground Water. Prentice Hall.
4. Karanth, K. R, 1987: Groundwater Assessment-Development and Management. Tata McGraw Hill.
5. Raghunath, N. M., 1982: Ground Water. Wiley Eastern.
6. Todd, D. K., 1980: Ground water Hydrogeology. John Wiley.
7. Walton, W. C., 1988: Ground Water Resources Evaluation. McGraw Hill.
8. Clark, I. D., Peter F., 1997: Environmental Isotopes in HydrogeologyCRC Press.

COURSE CODE: GL20407-DCE: ROCK DEFORMATION & STRUCTURAL ANALYSIS

Course outcomes: After completing this course students will have a broad understanding of the principles of stress and strain in rocks, differentiating between elastic, plastic, and brittle deformation under varying conditions. They will be able to identify and analyse geological structures such as folds, faults, and fractures, and understand the geometry and kinematics of deformed rocks. Students will develop skills in structural mapping, field observation, and laboratory techniques like thin section analysis and experimental deformation. The course also covers the application of structural geology to resource exploration, including the influence of structures on mineralization and hydrocarbon traps, as well as seismology and earthquake analysis, particularly the relationship between deformation, faulting, and seismic activity.

UNIT- I

Stress and strain relationship in rocks, principles and methods of stress and strain analysis and its application in deformed rocks. Classification and characteristic structure and textures of different types of faulted and folded rocks.

UNIT-II

Ductile shear zones: types, criteria for sense of shear and mechanism of development. Geometry and mechanism of development of different types of fault related folds and other structures in different tectonic regimes.

UNIT -III

Mechanics of rock fracturing: fracture initiation and propagation. Tectonites and their significance. Descriptive and geometric analysis of Tectonites. Stereographic and equal area projections for presenting different types of fabrics, and π and β diagrams.

Books recommended:

Davis, G.R., 1984: Structural Geology of Rocks and Region. John Wiley.
Ghosh. S. K., 1995: Structural Geology Fundamentals of Modem Developments. Pergamon Press.
Hobbs, B. E., Means, W. D. and Williams, P.F., 1976: An Outline of Structural Geology. John Wiley.
Lisle, R. J., 1988: Geological Strain Analysis. Pergamon.
Price, N. J. and Cosgrove, J. W., 1990: Analysis of Geological Structure. CambridgeUniv. Press.
Ramsay, J. G. and Huber, M. I., 1987: Modem Structural Geology, Vol. 1&/1. Academic Press.
Ramsay, J. G., 1967: Folding and fracturing of Rocks. McGraw Hill. ,
Turner, F. J. and Weiss, L. E., 1963: Structural Analysis of Metamorphic Tectonites. McGraw Hill.

COURSE CODE: GL20408-DCE: MEDICAL GEOLOGY

Course outcomes: On completion of the course the student will be able to understand the distribution of trace elements and its cyclic movement through the abiotic-biotic environment and their influence on human health, flora and fauna.

UNIT 1:

Definitions: Medical geology, Ecological health. Environmental epidemiology. History, evolution, and future prospects of medical geology. Geologic materials and processes and their role in human and ecological health. Relationship between public health and geologic processes.

UNIT II:

Effects of combustion of coal and other fuel materials, dust, heavy metals, volatile organic compounds, and pesticides on human and ecological health. Medical geology data source (maintained by WHO, CDC, USEPA, and others) and its use in medical geology research. Environmental geochemistry: natural and anthropogenic sources of chemical elements and compounds in the environment. Weathering and its control in mobilization of natural elements and compounds.

UNIT III:

Environmental Biology: Biological function, uptake and body response to elements. Geologic materials and nutrition. Principles of toxicology. Disease and well-being. Environmental and behavioural diseases. Major human diseases and mortality in modern time: Top ten killers and their significance. Climate change impacts on human and ecological health and its mitigation. Case histories of vector- and water-borne diseases.

Books recommended:

1. Essentials of Medical Geology, 2nd revised edition, 2013:OlleSelinus (Editor), Springer, 805 p.
2. Earth Materials and Health: Research Priorities for Earth Science and Public Health, 2007: Catherine Skinner (Chair), U.S. National Academy of Sciences. National Academies Press, Washington, DC; 188 p.

COURSE CODE: GL20409-DCE: ADVANCED REMOTE SENSING & GIS

Course outcomes: On course completion students will demonstrate a deep understanding and proficiency in applying advanced remote sensing techniques for the acquisition, analysis, and

interpretation of spatial data. They will be able to integrate various remote sensing technologies, including multispectral, hyperspectral, LiDAR, and radar data, to solve complex environmental, urban planning, and resource management challenges. Graduates will develop advanced skills in Geographic Information Systems, enabling them to design, implement, and manage complex GIS projects. They will be proficient in spatial data modelling, geospatial analysis, and the use of advanced GIS software and tools to analyse spatial relationships and patterns. Students will be capable of integrating remote sensing and GIS technologies with other scientific disciplines, such as environmental science, ecology, and urban studies. They will effectively collaborate with professionals from various fields to address multidisciplinary challenges and contribute to sustainable development goals.

UNIT I

Space borne remote sensing system and platforms: IRS, LANDSAT, SPOT, and IKONOS. Multispectral and hyper-spectral remote sensing, Geophysical Remote Sensing, Active Microwave remote sensing. Multivariate image statistics, Optical remote sensing data filters, radar speckle/noise removal techniques, image data formats (BSQ, BIP and BIL), image ratios, Georeferencing and mosaicing of satellite data, Image classification and accuracy estimation

UNIT II

Remote Sensing application: Geological mapping (lithology, structural mapping of faults, folds). Use of remote sensing data for snow and glacier mapping, change detection studies (deforestation), remote sensing for crustal deformation and hydrological analysis.

UNIT III

Geospatial data representation techniques, database management systems, Surface mapping and interpolation methods, Digital Elevation Model (DEM) and its development from point, contour and stereo-image data, raster and vector data analysis, Applications of GIS for drainage analysis and active tectonics, use of GIS for flood risk assessment and landslide hazard zonation.

Books recommended:

1. Burrough, P. A., 2003: Principles of Geographic Information Systems. Oxford University Press.
2. Campbell, J., 2002: Introduction to Remote Sensing. Guilford Press, New York.
3. Demers, M. N., 1999: Fundamentals of Geographic Information Systems. John Wiley.
4. Jensen, J. R., 2004: Remote Sensing of the Environment. Prentice Hall, New Jersey.
5. John, A., Richards, 1993: Remote Sensing Digital Image Analysis. Springer-Verlag.
6. John, R., Jensen, 2000: Introductory Digital Image Processing. A Remote Sensing Perspective.
7. Lillesand, T. M. and Kiefer, R W., 1987: Remote Sensing in Geology. John Wiley. Prentice Hall,
8. Lillesand, T. M. and Kiefer, RW, 2002: Remote Sensing and Image Interpretation, John Wiley.
9. Rees, W. G., 2001: Physical Principles of Remote sensing. Cambridge University Press.
10. Sabbins, F. F., 1985: Remote Sensing - Principles and Applications. Freeman.
11. Skidmore, A., 2002. Environmental modeling with GIS and Remote Sensing. Taylor& Francis,
12. London. Longley, D. A., Gordchild, M. F., Maguire, D. J. and Rhind, D. W., 2001: Geographic Information Systems and Science. John Wiley & Sons.

COURSE CODE: GL20410-GE: NATURAL DISASTERS

Course outcomes: After completing this course, the students will be able to assess risk factors based on geographical, environmental, and socio-economic aspects, understand the concepts of vulnerability and resilience, and learn strategies for disaster preparedness, including early warning systems and community education, as well as mitigation techniques like engineering solutions and land-use planning. The students will understand their personal and community responsibilities in promoting disaster preparedness and resilience and will be encouraged to engage in lifelong learning to stay updated on new research, technologies, and strategies, ultimately contributing to safer and more resilient communities.

UNIT I

Earthquake: definition, types, magnitude and intensity. Seismic waves: types. Seismographs and seismograms. Elastic rebound theory. Earthquake location: Focus, epicentre and hypocenter; Earthquake belts; Focal depth of earthquakes. Earthquake Prediction and precautionary measures. History of earthquakes in Kashmir.

UNIT II

Landslides: definition, classification, prevention measures/ methods. Landslide prone areas along Srinagar to Jammu national highway.

Floods: definition, classification, prevention and precautionary measures. History of floods in Kashmir. Coastal hazards, Hazards on Indian coasts, Cyclones and their mitigation methods.

Cloudburst: definition, types, causes, prediction, precautionary measures. Sea level rise: impacts and risks.

Books Recommended:

1. Geological Hazards-Routledge, London, by Bell, F.G., 1999.
2. Natural Hazards and Disastersby Donald Hyndman and David Hyndman, 2013.
3. Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes (3rd Edition)byEdward A. Keller and Duane E. DeVecchio, 2011.
4. Natural Hazards-Cambridge University Press, by Bryant, E., 1985.
5. The Disaster Diaries: How I Learned to Stop Worrying and Love the ApocalypsebySam Sheridan, 2013.
6. The Dynamic Earth System-Prentice Hall, by Patwardhan, A.M., 1999.

COURSE CODE: GL20411-OE: EARTH SURFACE PROCESSES

Course outcomes: After completing this course, students learn about various geological and geomorphologic processes that were/ are/ will be active in (past, present, and future) shaping the landforms of the Earth. Students will be able to understand the links between how surface processes affect our landforms and landscapes. Students will be able to examine the erosion, transportation, and depositional actions of major agents like rivers, glaciers, groundwater, and wind. Students understand the role of gravity in triggering landslides. Students will be able to examine the landslide-prone areas, causes, and mitigation measures of mass wasting.

UNIT I

Introduction to earth surface processes. Mass wasting: Definition, types, and factors affecting mass wasting. Geomorphic landforms created by wind. Topography of sea floor.

UNIT II

Geomorphic landforms created by river, glaciers, and groundwater. Erosional land forms created by rivers, glaciers and ground water.

Books Recommended:

1. Alien, P.A., 1997. Earth Surface Processes, Blackwell publishing.
2. Bloom, A.L., 1998. Geomorphology: A Systematic Analysis of Late Cenozoic Landforms, Pearson Education.
3. Bridge, J.S. and Demicco, R.V., 2008. Earth Surface Processes, Landforms and Sediment Deposits, Cambridge University Press.
4. Esterbrook, D.J., 1992. Surface Processes and Landforms, MacMillan Publ.
5. Kale, V.S. and Gupta A 2001 1ntoduction to Geomorphology, Orient Longman Ltd.
6. Leeder, M. and Perez-Arlucea M 2005 Physical processes in earth and environmental sciences, Blackwell' publishing.
7. Summerfield M A 1991Globle Geomorphology Prentice Hall.
8. Wllcock, P.R., Iverson R M (2003) Prediction in geomorphology ' AGU Publication.

General Instructions for the Candidates

1. The two year (4 semesters) PG programme is of 96 credit weightage i.e., 24 credits / semester (24x4=96).
2. A candidate has compulsorily to opt for 14 credits from the core component in each semester.
3. A candidate has to obtain a minimum of 8 credits (2-3 papers) from the Discipline Centric Electives (DCE) offered by his/her own Department.
4. A candidate has compulsorily to obtain a minimum of 2 credits from Generic Elective (GE) or Open Electives (OE) or a combination of both offered by the departments other than his/her own.
5. A candidate can earn more than the minimum required credits (i.e, more than 96 credits for four semester programme) which shall be counted towards the final result of the candidate.
6. Field Training (course code: **GL20105-DCE andGL20205-DCE)**are compulsory only for M.Sc. Applied Geology students. Every student of M.Sc. Applied Geology ought to opt for this course.
7. Term Work (compulsory)* (course code: **GL20305-DCE**) is compulsory only for M.Sc. Applied Geology students. Every student of M.Sc. Applied Geology ought to opt for this course