GOA UNIVERSITY
Taleigao Plateau, Goa 403 206

REVISED MINUTES

of the 9th Special Meeting of the

X ACADEMIC COUNCIL

Day & Date

Saturday, 30th July, 2022

Time

10.00 a.m.

Council Hall
Goa University

	2. The Course Codes for the PG programmes to be revised/changed. The Controller of Examination was requested to draw up a uniform pattern to be made applicable across all disciplines in consultation with a few Deans and the Chairpersons of the Boards of Studies. 3. The Chairperson, Board of Studies was requested to rework on the following Elective Courses giving more details: a) MMO-22-213 'Field Trip/Study Tour – Practical' b) MMO-22-214 'Internship' **(Action: Assistant Registrar Academic – PG)**
D 3.2	**Minutes of the Board of Studies in Marine Science meeting held on 28.04.2022.** The Academic Council approved the minutes of the Board of Studies in Marine Science meeting held on 28.04.2022 with the following suggestions: 1. The month and year mentioned in the heading of the Syllabus document to be corrected from September 2022 to August 2022. 2. The Course Codes for the PG programmes to be revised/changed. 3. Total Number of Credits indicated as a footnote to the Programme Structure to be deleted. **(Action: Assistant Registrar Academic – PG)**
D 3.3	**Minutes of the Board of Studies in Earth Science (Applied Geology) meeting held on 29.04.2022.** The Academic Council approved the minutes of the Board of Studies in Earth Science (Applied Geology) meeting held on 29.04.2022 with the following suggestions: 1. The number of hours to be assigned to each module in Courses. 2. Theory component of one credit to be included for the Practical Courses. 3. Course GLC-22-107 Geological Field Mapping to be offered as a new Theory Course. 4. Course Code: GLC-22-207 Geological Field Training to be included as a part of the Dissertation. **(Action: Assistant Registrar Academic – PG)**
D 3.4	**Minutes of the Board of Studies in Mathematics meeting held on 22.04.2022.** The Academic Council approved the minutes of the Board of Studies in Mathematics meeting held on 22.04.2022 with the following suggestions: 1. The Course Codes for the PG programmes to be revised/changed. 2. The word 'Optional Courses' to be replaced with 'Elective Courses'. 3. The Chairperson, Board of Studies was requested to resubmit the syllabus incorporating the suggestions. The Vice-Chancellor was authorized to approve the same on behalf of the Academic Council. The proposed syllabus for Semester III and Semester IV was deferred. **(Action: Assistant Registrar Academic – PG)**

X AC- 9 (Special)
30.07.2022

GOA UNIVERSITY
Taleigao Plateau, Goa 403 206

F I N A L U P D A T E D A G E N D A

For the 9th Special Meeting of the

X ACADEMIC COUNCIL

Day & Date

30th July, 2022

Time

10.00 a.m.

Venue
Conference Hall
Administration Block

	2. **Members of the BOS deliberated on the above matter and approved the syllabus with some minor corrections.** **Part B** i) Scheme of examinations at the under-graduate level.NIL ii) Panel of examiners for different examinations at the under – graduate level.NIL iii) Scheme of examinations at the post-graduate level. NIL iv) Panels of Examiners for different examinations at post-graduate level.NIL **Part C** i) Recommendations regarding preparation and publication of selection of reading material in any subject or group of subject or group of subjects and names of persons recommended for appointment to make the selection. **Part D** i) Recommendations regarding general academic requirements in the Department of University or affiliated Colleges. NIL **Part E** i) Recommendations of text books for the courses of study at the under-graduate Level.NIL ii) Recommendations of text books for the courses of study at Post-graduate level NIL **Part F** i) The declaration by the Chairman, that the minutes were read out by the Chairman at the meeting itself. **The Chairman read out the minutes of the meeting to all the members.** Sd/- Date: 28.04.2022 Signature of the Chairman Place: Goa University **Part G:** The remark of the Dean of Faculty 1) The minutes are in order. 2) The minutes may be placed before the Academic Council with remark, if any. 3) Approved syllabus at BOS held on 20.04.2018. Sd/- Date: 28/04/2022 Signature of the Dean Place: Goa University Dean SEOAS **(Back to Index)**
D 3.3	**Minutes of the Board of Studies in Earth Science (Applied Geology) meeting held on 29.04.2022.** **Part A**. i. Recommendations regarding courses of study in the subject or group of subjects at the undergraduate level:----- Nil ii. Recommendations regarding courses of study in the subject or group of subjects at the postgraduate level:

The Board approved M.Sc. (Applied Geology) program structure and the syllabus of Semester I and II.

Part B

i. Scheme of Examinations at undergraduate level: ---- Nil
ii. Panel of examiners for different examinations at the undergraduate level: ---- Nil
iii. Scheme of Examinations at postgraduate level: ----- Nil
iv. Panel of examiners for different examinations at post-graduate level: ---- Nil

Part C

i. Recommendations regarding preparation and publication of selection of reading material in the subject or group of subjects and the names of the persons recommended for appointment to make the selection: ---- Nil

Part D

i. Recommendations regarding general academic requirements in the Departments of University or affiliated colleges: ----- Nil
ii. Recommendations of the Academic Audit Committee and status there of: ----- Nil

Part E

i. Recommendations of the text books for the course of study at undergraduate level: **—----- Nil**
ii. Recommendations of the text books for the course of study at post graduate level: (**Annexure I refer page no. 92)**

Part F.

Important points for consideration/approval of Academic Council

i The important points/recommendations of BoS that require consideration/approval of Academic Council (points to be highlighted) as mentioned below **Approval of M.Sc. (Applied Geology) program structure and the syllabus of Semester I and II.**

ii The declaration by the chairman that the minutes were read out by the Chairman at the meeting itself.

Date:29.04.2022 Sd/-
Place: Taleigao Plateau Signature of the Chairman

Part G.

The Remarks of the Dean of the Faculty

i) The minutes are in order
ii) The minutes may be placed before the Academic Council with remarks if any.
iii) May be recommended for approval of Academic Council.
iv) Special remarks if any.

Date:29.04.2022 Sd/-
Place: Taleigao Plateau Signature of the Dean

D 3.3 Minutes of the Board of Studies in Earth Science (Applied Geology) meeting held on 29.04.2022.

Annexure I

M.Sc. in Applied Geology Program Structure and Syllabus
(With effect from academic year 2022-2023)
Semester I

Title of the Course: Principles of Mineralogy and Geochemistry
Course Code: GLC-22-101 **Number of Credits:** 03
Total Contact Hours: 45 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	This course addresses the concepts of crystal chemistry, mineralogy, geochemistry and isotope geology. Further it also provides an insight on the origin of the earth, distribution of elements, evolution of mineral and also to understand geological processes that are necessarily inaccessible to observe directly.	
Content:	**Module 1: Crystal chemistry:** Ionic radii, co-ordination of ions, Pauling's Rules, different types of chemical bonding, crystal growth, crystal defects, external and internal symmetry, XRD: powder and single crystal diffraction. Twinning, Polymorphism and pseudomorphism. Mineral stability and phase diagram, two	15 hours

	component eutectic systems, incongruent melting, solid solution system, exsolution. **Module 2: Mineralogy:** Mineral evolution, Biological-mineralogical interactions, Medical mineralogy. Composition, structure, Chemistry and paragenesis of the mineral groups: Olivine, Pyroxene, Amphibole, Mica, Feldspar, Garnet, Sulphide, Sulphate, Carbonate and Oxides. Optical mineralogy: Study of isotropic and anisotropic minerals under convergent light. Working principles of XRD, ICPMS, Spectroscopy, SEM, X-ray tomography. **Module 3: Geochemistry:** Introduction and scope of geochemistry, geochemical classification of elements, distribution and behaviour of major, trace elements and REE in igneous, sedimentary and metamorphic processes and products. Introduction to isotope geochemistry: Elements of nuclear systematics, introduction to isotopes and their properties. Introduction to Meteorites, origin, composition, classification and mineral constituents of meteorites.	15 hours 15 hours
Pedagogy:	Lectures/ tutorials/assignments/field study/discussion	
References/Readings	1. Deer, W. A., Howie, R. A., and Zussman, J. (1992). *An introduction to the rock-forming minerals.* 2nd ed. Harlow, Essex, England. New York, NY. Longman Scientific and Technical. 2. Klein, C., Hurlbut, C. S., and Dana, J. D. (1999). *Manual of mineralogy: (after James D. Dana)*. New York: J. Wiley. 3. Winchell, A. N. (1991). *Elements of optical mineralogy: An introduction to microscopic petrography*. New York. Wiley. 4. Nesse W. (2012*). Introduction to Optical Mineralogy.4th ed.* Oxford University Press 5. Kerr, P. F. (1977). *Optical mineralogy*. New York. McGraw-Hill Book Co. 6. Mason B., and Moore C.B. (1982). *Principles of geochemistry*. 4th ed. Chichester John Wiley 7. Krauskopf, K. B., and Bird, D. K. (1995). *Introduction to geochemistry*. New York. McGraw-Hill 8. Klein, C., and Dutrow, B. (2007). *Manual of mineral science*. New York. John Wiley and sons ltd 9. Mason, B., and Moore, C. B. (1982). *Principles of geochemistry*. New York. Wiley. 10. Walther, J. V. (2009). *Essentials of geochemistry*. Sudbury, Mass. Jones and Bartlett Publishers. 11. White, W. M. (2014). *Isotope Geochemistry*. Hoboken. Wiley. 12. Faure, G. (1986). *Principles of isotope geology. Second edition*. John Wiley and Sons Inc., New York, NY 13. Dyar, M. D., and Gunter, M. E. (2008). *Mineralogy and optical mineralogy*. Chantilly. Mineralogical Society of America.	

Learning outcomes	Provide a comprehensive understanding about the origin of earth as a whole with detail emphasis on elemental distribution, mantle processes and mineral evolution.	

Title of the Course: Practical of Principles of Mineralogy and Geochemistry
Course Code: GLC-22-102 **Number of Credits:** 1
Total Contact Hours: 30 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	This course deals with the megascopic and petrographic identification of minerals. And thereafter also deals with the use of instruments (Spectrophotometer, flame photometer) for analyses of different chemical constituents in water/soil/rocks.	
Content:	Observing and recording properties of representative minerals in hand specimens. Observation and recording of optical properties of rock forming minerals. Determination of different chemical constituents in water/soil/rock using flame photometer and spectrophotometer. Reading of plots/graphs. Numerical problems on partition coefficient, calculation of isotope ratios.	30 hours
Pedagogy:	Megascopic and microscopic identification of minerals/Demonstrations/Laboratory experiments/Plotting and Interpretations.	
References/Readings	1. Mackenzie, W. S. (2015). *Atlas of the rock-forming minerals in thin section*. Routledge. 2. Barker, A. J. (2017). *A key for identification of rock-forming minerals in thin section* 3. Deer, W. A., Howie, R. A., and Zussman, J. (1992). *An introduction to the rock-forming minerals.* 2nd ed. Harlow, Essex, England. New York, NY. Longman Scientific and Technical. 4. Khandpur, R. S. (2006). *Handbook of analytical instruments*. New York, N.Y. McGraw-Hill Education LL	
Learning outcomes	Technique to identify minerals using physical and optical properties and also to develop analytical skills to determine the concentrations of various chemical parameters in water/soil/rock.	

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Title of the Course: Structural Geology and Geotectonics
Course Code: GLC-22-103 **Number of Credits:** 03
Total Contact Hours: 45 **Effective from:** 2022–23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.

Objective:	To provide a conceptual understanding of deformation processes and mechanisms at different levels in the Earth's lithosphere and their effects at different scales from regional to microscopic. Students will also be introduced to plate tectonics and tectonic processes in the context of major tectonic features present in different tectonic environments.	
Content:	**Module 1: Introduction to Deformation and Rock Mechanics** Components of deformation, Strain in 1D, 2D and 3D, strain ellipsoid, Pure shear and simple shear, progressive deformation, strain analysis. Introduction to stress, deviatoric and mean stress, Mohr Circle diagram. Rheology: elastic, viscous and plastic deformation, rheologic stratification of the lithosphere. Deformation microstructures and mechanisms, recovery and recrystallization. Fractures: brittle deformation mechanisms, failure and fracture criteria, types of fractures and joints. **Module 2: Fault and Fold Mechanics** Faults: Characteristics of faults and fault planes, movement mechanisms, role of fluids, brittle versus ductile faults, mylonites, shear sense indicators, shear zone kinematics. Folds: Mechanisms of folding, kinematic models of folding, Ramsay's classification of folds, superposed folding, occurrence and recognition. Cleavage and foliations. Linear structures and their interpretation. An overview of structures in contractional and extensional regimes with field examples. **Module 3: Geotectonics** Fundamental concepts of Geotectonics, Isostasy and geoid. Continental drift, Sea floor spreading, paleomagnetism and Plate tectonics. Supercontinent cycles. Volcanic and seismic belts of the Earth. Major tectonic features in intraplate settings and at convergent, divergent and transform plate margins.	15 hours 15 hours 15 hours
Pedagogy	Lectures/ tutorials/ assignments/ self-study	
References/ Readings	1. Van der Pluijm, B.A. and Marshak, S. (2004). *Earth structure: an introduction to structural geology and tectonics*, W.W. Norton and Company Ltd. 2. Davis, G.H. and Reynolds, S.J. (1996). *Structural Geology of rocks and regions*, John Wiley and Sons. 3. Fossen, H. (2010). *Structural Geology*, Cambridge University Press. 4. Ghosh, S.K. (1993). *Structural Geology: Fundamentals, and modern developments*, Pergamon Press. 5. Passhier, C. and Trouw, R.A.J. (2005). *Microtectonics*. Springer, Berlin. 6. Pollard, D.D. and Fletcher, R.C. (2005). *Fundamentals of structural geology*, Cambridge University Press. 7. Ramsay, J.G and Huber, M.I. (1983). *Techniques of Modern Structural Geology: Vol. I and II*, Academic Press. 8. Ramsay, J.G. (1967). *Folding and Fracturing of Rocks*, McGraw-Hill Book Company, New York. 9. Twiss, R.J. and Moores, E.M. (2007). *Structural Geology*. Freeman. 10. Means, W. D., and Williams, P. F. (1976). *An outline of structural geology*. John Wiley.	

	11. Condie, K. C. (2013). *Plate tectonics and crustal evolution*. Elsevier. 12. Windley, B.F. (1996). *The evolving continents*. Oceanographic Literature Review, 8(43), 785. 13. Turcotte, D.L., and Schubert, G. (2002). *Geodynamics*. Cambridge University Press.
Learning outcomes	Students will acquire a comprehensive understanding of how rocks deform at different scales through brittle and ductile deformation and the tectonic processes responsible for the formation of the different tectonic features present within the Earth's lithosphere.

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Title of the Course: Practical of Structural Geology
Course Code: GLC-22-104 **Number of Credits:** 01
Total Contact Hours: 30 **Effective from:** 2022–23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	This course deals with solving geologic maps, structural problems and description of structural data in rocks.	
Content:	Completion of outcrops. Preparation and interpretation of geological maps and sections Structural problems concerning economic deposits Recording and plotting of the field data, stereographic projections. Petro-fabric analysis and study of deformed structures in hand specimens. Strain estimation from the data already collected from the field. Study and interpretation of structures from photographs and satellite imagery.	30 Hours
Pedagogy:	Demonstrations /Laboratory observations / Plotting and Interpretations	
References/ Readings	1. Rowland, S.M., Duebendorfer, E. and Schiefelbein, I.M. (2007). *Structural analysis and synthesis: a laboratory course in structural geology*, Blackwell Pub. 2. Davis, G.H. and Reynolds, S.J. (1996). *Structural Geology of rocks and regions*, John Wiley and Sons. Marshak, S., and Mitra, G. (1988). *Basic methods of Structural geology*. Prentice Hall.	
Learning outcomes	The students will be familiar with the common ways to measure and represent data from structurally deformed rocks and to solve structural maps and problems related to economic geology.	

Title of the Course: Igneous Petrology
Course Code: GLC-22-105 **Number of Credits:** 3
Total Contact Hours: 45 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	The main objective of this course is to get students acquainted with a wide range of igneous rocks and their corresponding geological settings.	
Content:	**Module 1:** Introduction to Magmas and Magmatic Processes; Process of formation and description of Textures and Structures of volcanic and plutonic rocks; Classification of igneous rocks: modal, chemical, quasi-chemical-schemes: their merits and demerits. Working principles of XRF, EPMA. **Module 2:** Composition of the mantle; Enriched- and Depleted-mantle and their characteristics; Magma generation: Heat source and the factors responsible to bring about melting, Fractional melting, Batch melting and Zone melting; Magmatic Evolution; Magmatic differentiation: crystal fractionation, gravitational differentiation, flowage differentiation, filter pressing, liquid immiscibility; Magmatic assimilation, Magma Mixing and contamination. **Module 3:** Magma Associations in relation to Plate Tectonics: continental flood basalts such as the Deccan Traps, Paranas, Karoo; Mid Ocean Ridge Basalts, Ocean Island basalts, Continental as well as ocean Arc magmatism; Alpine type intrusions and Ophiolites; Alkaline rocks- Nephelinites and Ijolites, Lamprophyres and Lamproites, Carbonatites and Kimberlites; Granites and Granitic rocks, I-type, S-type, A-type and M-type granites, anatexis and Granitization; Anorthosites. Continental Layered Intrusions: Mineralogical and Petrological characteristics with special reference to the Bushveld, Skaergaard, Stillwater Complexes.	15 hours 15 hours 15 hours
Pedagogy:	Lectures/ tutorials/ assignments/ self-study	
References/ Readings	1. Barker, F. (Ed.). (2013). *Trondhjemites, dacites, and related rocks*. Elsevier 2. Best and Christainsen (2002). *Igneous Petrology Daly: Petrology of Igneous Rocks*. 3. Dawson, J. B. (2012). *Kimberlites and their xenoliths* (Vol. 15). Springer Science and Business Media. 4. Middlemost, E. A. (1986). *Magmas and magmatic rocks: an introduction to igneous petrology*. 5. Moorhouse, W. W. (1959). *The study of rocks in thin sections: by WW Moorhouse*. Harper. 6. Wager, L. R., and Brown, G. M. (1967). *Layered igneous rocks*. WH Freeman. 7. Philpotts, A. R., and Ague, J. J. (2022). *Principles of igneous and metamorphic petrology*. Cambridge University Press. 8. Rock, N. M. (2013). *Lamprophyres*. Springer Science and Business Media. 9. Wilson, M. (Ed.). (1989). *Igneous petrogenesis*. Dordrecht: Springer Netherlands. 10. Williams, T., and Turner, F. J. Gilbert (1954): *Petrography*.	

	11. Winter, J. D. (2013). *Principles of igneous and metamorphic petrology*. Pearson education. Woolley, A. R. (2019, September). *Alkaline Rocks and Carbonatites of the World, Part 4: Antarctica, Asia and Europe (excluding the former USSR), Australasia and Oceanic Islands*. Geological Society of London.	
Learning outcomes	The students will develop skills, to identifying a wide range of igneous rocks, processes of formation and their corresponding geological settings.	

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Title of the Course: Practical of Igneous Petrology
Course Code: GLC-22-106 **Number of Credits:** 1
Total Contact Hours: 30 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	The main objective of this course is to get students acquainted with identification of rocks in hand specimens and petrographic thin section.	
Content:	Study of the textures and structures and identification of rocks in hand specimens. Characterization of the following suites of rocks from micro-sections: ultramafic rocks, mafic igneous rocks, intermediate rocks, granitic rocks and alkaline igneous rocks. CIPW normative calculations of minerals based on available compositional data using excel sheet. Applications of trace elements in igneous petrology, such as spider diagrams, REE distribution patterns and implications in deducing origin, source and evolution of magma, and tectonic diagrams-trace element ratio plots.	30 hours
Pedagogy:	It is a practical component and entire course is taught in the laboratory.	
References/ Readings	1. Howie, R. A., Zussman, J., and Deer, W. (1992). *An introduction to the rock-forming minerals* (p. 696). London, UK. Longman. 2. Nesse, W. D. (2012). *Introduction to mineralogy* (No. 549 NES). 3. Phillips, W. R., and Griffen, D. T. (1981). *Optical mineralogy: The nonopaque minerals*. 4. Turner, F. J., and Howel. and Gilbert William (Charles M.). (1965). *Petrography; an Introduction to the Study of Rocks in Thin Section*. Vakils, Feffer and Simons. 5. Hutchinson, C.S. (1974). *Laboratory handbook of petrographic techniques*. New York.	
Learning outcomes	The students will develop skills, to identifying minerals and other phases, to understand their geologic occurrence of the rocks and to infer the processes of formation and environmental conditions from the mineral assemblage, texture, and tectonic setting.	

Title of the Course: Geological Field Mapping
Course Code: GLC-22-107 **Number of Credits:** 4
Total Contact Hours: 60 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	The main objective of this course is to give students the hands on experience in the field to understand the lithology structure and their plates in Stratigraphy besides getting a thorough knowledge of field mapping.	
Pedagogy:	Lectures and on-field Training.	
References/ Readings	1. *Geology of Gujarat*, Mehr S.S., Geological Society of India, 1991. 2. *Geology of Karnataka*, Radharishnan B.P. and Vaidhyanadhan R., Geological Society of India. 1977. 3. *Geology of Rajasthan*, S. Sinha Roy. Geological Society of India.1991. 4. Geology of Rajasthan (North-West India-Precambriam to Recent) A.B Roy and S.R. Jakhar. Scientific Publishers, 2012. 5. *Geology of Andhra Pradesh*. P.K. Raman and V. N. Murty, Geological Society of India. 2012. 6. *Field Guide Book of Geology of Kutch (Kachchh) Basin, Gujarat, India*. 7. *Geology and Mineral Resources of Goa*. A.G. Dessai 8. *Geology of Maharashtra* Second Edition. G.G. Deshpande and Pitale U. L. Geological Society of India. 2012.	
Content:	The students will be taught the techniques of geological mapping, field data collection: recording the attitude of beds, foliation, lineation, joints and their analysis. Use of GPS, DGPS, GNSS for spatial data collection. Sampling of rocks, preparation of geological field report. The record of data will be maintained in a field-diary. This work will be carried out under the supervision of teachers who will accompany the students during the course of the field-traverse. There will be a viva-voce examination based on the field report.	60 hours
Learning outcomes	The students will be able to identify the rocks their structures, and prepare geological map and write a detail technical report of the area.	

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Title of the Course: Groundwater Geology
Course Code: GLO- 22-108 **Number of Credits:** 03
Total Contact Hours: 45 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.
Objective:	To understand occurrence and circulation of groundwater To study the functioning, methods and problems related to Groundwater.

Content:	**Module 1: Introduction:** Genetic classification of water, global distribution of water. Hydrologic cycle: Precipitation, runoff, infiltration and evapotranspiration. Historical developments in science of hydrogeology. Vertical distribution of sub surface water, classification of aquifers and confining layers, hydraulic properties of aquifers, water table fluctuations. Concepts of drainage and groundwater basins. Water table and piezometric surface. **Module 2: Well Hydraulics and well designs**: Theory of groundwater flow, Darcy's law, its validity and applications, determination of permeability in laboratory and in field. Types of wells, drilling methods, construction, design, development and maintenance of wells. Specific capacity and its determination steady and unsteady and radial flow conditions. Pumping tests-methods, data analysis and interpretations. Rainwater Harvesting and conservation. **Module 3: Groundwater Chemistry, Contamination and occurrence:** Groundwater Chemistry: Groundwater quality- physical, chemical, biological properties of water quality criteria for different uses, graphical presentation of water quality data. Groundwater contamination. Problems of arsenic and fluoride in India. Saline water intrusion and Sub-marine Groundwater Discharge (SGD) in coastal aquifers and its modelling. Classification of rocks with respect to their water bearing characteristics, aquifer modelling and groundwater provinces of India. Groundwater exploration techniques.	15 hours 15 hours 15 hours
Pedagogy:	Lectures / Assignments / Seminars/ Self-study	
References/ Readings	1. Mays, L. W., and Todd, D. K. (2005). *Groundwater Hydrology.* John Wily and Sons, Inc., Arizona State University, Third addition. 2. Fetter, C. W. (2018). *Applied hydrogeology*. Waveland Press. 3. Hiscock, K. M., and Bense, V. F. (2021). *Hydrogeology: principles and practice*. John Wiley and Sons. 4. Raghunath, H. M., and Raghunath, H. M. (2007). *Ground water*. New Age International (P) Limited Publishers. 5. Davis, S. N., and De Wiest, R. J. (1966). *Hydrogeology* New York: Wiley.	
Learning outcomes	The main outcome of the course is to understand and develop information with respect to occurrence and circulation of groundwater in nature and find ways for sustainable use of the same	

Title of the Course: Practical of Groundwater Geology (GLO- 22-108)
Course Code: GLO-22-109 **Number of Credits:** 01
Total Contact Hours: 30 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	To make use principles of groundwater movement and well hydraulics to solve problems related to groundwater flow and hydraulic parameters	
Content:	Exercises on Groundwater flownet construction and interpretations of equipotential line and groundwater flow direction, interaction between various surface water, movement of contaminants related to groundwater flow. Problem related to aquifer parameters such as hydraulic conductivity, transmissivity and specific yield. Analysis of aquifer test data; Theis method, Jacob-cooper method and chows method. Problem solving on groundwater recharge and groundwater volume. Problems related to wells under various aquifer conditions. Graphical plotting and interpretation of chemical quality data of waters: Hill piper diagram, Schoeller diagram,	30 hours
Pedagogy:	Lectures / Self-study	
References/ Readings	1. Mays, L. W., and Todd, D. K. (2005). *Groundwater Hydrology.* John Wily and Sons, Inc., Arizona State University, Third addition. 2. Raghunath, H. M., and Raghunath, H. M. (2007). *Ground water*. New Age International (P) Limited Publishers. Fetter, C. W. (2018). *Applied hydrogeology*. Waveland Press.	
Learning outcomes	The main outcome of the course is to understand movement of groundwater and solve problems related to aquifer parameters and groundwater contamination.	

Title of the Course: Marine Geology
Course Code: GLO -22-110 **Number of Credits:** 3
Total Contact Hours: 45 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	To provide a conceptual understanding of marine processes, landforms, marine minerals, methods of geo-physical surveys for sea-bed mapping and coastal zone management.	
Content:	**Module I** Introduction and scope of marine geology, coastal zone and coastline classifications, beach and beach landforms, oceanic profile and landform features, morphologic and tectonic domain of the ocean floor, origin of oceanic crust, marine sediment and classification, ocean tectonics. Coastal surveys including beach profiling, Exclusive Economic Zone, concept and causes of sea level changes and measurements, Holocene sea level curves and future projections, Introduction to paleo-beaches and paleo-	15 hours

	oceanography, coastal geomorphology and coastal tectonic framework of India. **Module II** Classification of marine mineral deposits, origin and depositional system of marine resources, beach placers, shelf deposits, phosphorites, gas hydrates, hydrocarbon deposits, sulphate deposits, hydro-thermal deposits, polymetallic nodules, reserves and economics of marine resources with special reference to India. Introduction to marine geophysics, methods of geophysical surveys for seabed mapping and mineral exploration; Introduction to marine geochemistry, laboratory methods for sample analyses; Introduction to isotope geology and geochronology. **Module III** Coastal zone management, coastal erosion and protection measures, coastal natural disasters and management, salt water intrusion and submarine ground water discharge, marine spatial planning, coastal zone regulation and acts, the law of the seas.	15 hours 15 hours
Pedagogy:	Lectures/ tutorials/assignments/field study/discussion	
References/Readings	1. Shepard, *Submarine Geology*, Third Edition. 2. Kuenen, P. *Marine Geology*, 2008, John Wiley. 3. Cuchlaine A.M.King, *Introduction to Marine Geology and Geomorphology* 4. M.J.Keen, *Introduction to Marine Geology*, Elsevier. 5. James Kennet, *Marine Geology*, 1982, Prentice Hall 6. Chester and Jickells, 2012, *Marine Geochemistry*, Wiley 7. Roy-Barman and Jeandel, 2016, *Marine Geochemistry*, Oxford University Press. 8. Jones, *Marine Geophysics*, 1999, John Wiley and Sons Inc	
Learning outcomes	At the end of the course the students will be able to explain the coastal processes and landforms, processes of mineral formation, identify the minerals and propose various coastal zone management remedial measures.	

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Title of the Course: Practical of Marine Geology (GLO-22-110)
Course Code: GLO -22-111 **Number of Credits:** 1
Total Contact Hours: 45 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	To provide a conceptual understanding of identification of marine minerals and preparing profiles of beaches, coastal landforms and ocean features.	
Content:	Study of marine minerals in hand specimen and under microscopy, identification of micro fossils, granolometric analysis, beach profile mapping and beach survey, preparation of coastal geomorphology map from satellite images, understanding the maps relating to of ocean morphometry, resources and tectonics.	30 hours
Pedagogy:	Lectures/ tutorials/assignments/field study/discussion	
References/Readings	1. Michael J. Kennish ***Practical Handbook of Marine Science, Fourth Edition,*** **CRC Press.** 2. Mackenzie, W. S. (2015). *Atlas of the rock-forming minerals in thin section*. Routledge.	
Learning outcomes	The students will be able to identify the marine minerals, micro-fossils and prepare profiles of beaches, coastal landforms and ocean features.	

M.Sc. in Applied Geology Program structure and syllabus
(with effect from Academic year 2022-2023)

Semester II

Course Code	Course Title	L-T-P (Hours/week)	Credits (s)	Page Number
GLC-22-201	Sedimentology	3-0-0	3	19-20
GLC-22-202	Practical of Sedimentology	0-0-2	1	21-22
GLC-22-203	Metamorphic Petrology	3-0-0	3	23-24
GLC-22-204	Practical of Metamorphic Petrology	0-0-2	1	25
GLC-22-205	Principles and Stratigraphy and Indian Geology	3-0-0	3	26-27
GLC-22-206	Practical of Principles and Stratigraphy and Indian Geology	0-0-2	1	28
GLC-22-207	Geological Field Training	4	4	29

GLO-22-208	Exploration Geophysics	3-0-0	3	30-31
GLO-22-209	Practical of Exploration Geophysics (GLO-22-208)	0-0-2	1	32
GLO -22-210	Economic Geology	3-0-0	3	33-34
GLO-22-211	Practical of Economic Geology (GLO -22-210)	0-0-2	1	35

Title of the Course: Sedimentology
Course Code: GLC-22-201 **Number of Credits:** 03
Total Contact Hours: 45 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	To understand the different processes operating in sediment formation, transportation and deposition. To impart a detailed knowledge of different types of sedimentary rocks, their origin and applications. To understand different types of depositional environments.	
Content:	**Module 1: Sedimentary processes** Introduction to sedimentology, distribution of sedimentary rocks in time and space and their applications. Weathering: Types and their products, soils and paleosols. Transportation and Deposition: Fundamentals of fluid flow, particle transport by fluid and by sediment gravity flows. Textures and structures of sedimentary rocks, their origin. **Module 2: Sedimentary rocks** Petrography, classification and provenance of: Terrigenous/clastic sedimentary rocks: Conglomerates, sandstones and mud rocks. Carbonate rocks: Limestones and dolomites. Evaporites, silicious, phosphatic, iron and manganese-rich sedimentary rocks. **Module 3: Depositional environments** Introduction and classification of: Terrestrial environment: fluvial system, eolian desert system, lacustrine system and glacial system. Marine environment: Deltaic system, beach and barriers island system, estuarine system, lagoonal system, tidal flat system; shelf and deep water environment.	15 hours 15 hours 15 hours
Pedagogy:	Lectures, Case studies, Discussions and Assignments.	
References/ Readings	1. Pettijohn, F. J. (1975). *Sedimentary rocks* (Vol. 3, p. 628). New York: Harper and Row. 2. Collinson, J. (2006). *Sedimentary structures*. Dunedin Academic Press Ltd.	

	3. Nichols, G. (2009). *Sedimentology and stratigraphy*. John Wiley and Sons. 4. Prothero, D.R. and Schwab, F. (2013). *Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy.* W.H. Freeman, 3rd Edition. 5. Selley, R. C. (2000). *Applied sedimentology*. Elsevier.2nd Edition. 6. Tucker, M. E. (2001). *Sedimentary petrology: an introduction to the origin of sedimentary rocks*. John Wiley and Sons. 3rd Edition. 7. Boggs, S. (2006). *Principles of sedimentology and stratigraphy*. Pearson Prentice Hall. 4th Edition. 8. Boggs Jr, S., and Boggs, S. (2009). *Petrology of sedimentary rocks*. Cambridge university press. 2nd Edition. 9. Greensmith, J. T. (1978). *Petrology of the sedimentary rocks*. Textbook of petrology Vol. 2.	
Learning outcomes	In this course a student will learn about: The concepts of sediment formation, and various processes involved in transportation and deposition. Thorough knowledge on textures and structures exhibited by sedimentary rocks. Detail understanding of the sedimentary rocks. Infer various depositional environments and origin of diverse rock types.	

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Title of the Course: Practical of Sedimentology
Course Code: GLC-22-202 **Number of Credits:** 01
Total Contact Hours: 30 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	To assess the grain size and grain size parameters by different methods. To identify and characterize sedimentary rocks at mega and microscopic scales. To study sedimentary textures, structures, and paleocurrent methods for environmental reconstructions.	
Content:	Granulometric analysis: Textural analyses of sediments, plotting of grain size data and statistical analyses and interpretation. Palaeocurrent analysis: Exercises using sets of directional data to understand spatial variation in vectorial data. Study of hand specimens: Megascopic identification of sedimentary rocks, observation of texture, structure and diagenetic changes; inferences on depositional environment. Study of thin sections: Microscopic identification of sedimentary rocks, observation of texture, minerology and diagenetic changes. Heavy mineral analysis.	30 hours
Pedagogy:	Lectures, problem solving, hands on experience in megascopic and microscopic identification of rocks and discussions.	

References/ Readings	1. Lindholm, R. (1987). *A practical approach to sedimentology*. Springer Science and Business Media. 2. Prothero, D.R. and Schwab, F. (2013). *Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy.* W.H. Freeman, 3rd Edition. 3. Selley, R. C. (2000). *Applied sedimentology*. Elsevier. 2nd Edition. 4. Tucker, M. E. (2001). *Sedimentary petrology: an introduction to the origin of sedimentary rocks*. John Wiley and Sons. 3rd Edition. 5. Boggs, S. (2006). *Principles of sedimentology and stratigraphy.* Pearson Prentice Hall. 4th Edition. 6. Boggs Jr, S., and Boggs, S. (2009). *Petrology of sedimentary rocks*. Cambridge University Press. 2nd Edition. 7. Tucker, M. E. (2011). *Sedimentary rocks in the field: a practical guide (Vol. 38).* John Wiley and Sons. Adams, A. E., MacKenzie, W. S., and Guilford, C. (2017). *Atlas of sedimentary rocks under the microscope*. Routledge.
Learning outcomes	Thorough knowledge on textures and structures exhibited by sedimentary rocks. Detail understanding of the sedimentary rocks. Interpretation of sedimentary processes based on the composition of the rock and sedimentary structures

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Title of the Course: Metamorphic Petrology
Course Code: GLC-22-203 **Number of Credits:** 03
Total Contact Hours: 45 **Effective from:** 2022–23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	To provide a conceptual understanding of metamorphism, and metamorphic rocks encompassing the chemical and physical transformations that take place in response to changing pressure, temperature, and chemical environments, including different petrogenetic processes involving mineral reactions and equilibrium thermodynamics.	
Content:	**Module 1: Introduction, Types, Facies and Textures of metamorphic rocks** Definitions, factors and conditions of metamorphism; pressure and temperature limits of metamorphism; Types of metamorphism - orogenic metamorphism, ocean-floor metamorphism, regional metamorphism, contact metamorphism, cataclastic metamorphism, hydrothermal metamorphism, other types of small-scale metamorphism. Facies and facies series; Zones of Metamorphism; Concept and origin of isograds; General characteristics of contact and regional metamorphic rocks; Classification and types of textures; Interpretation of porphyroblast–inclusion relations.	15 hours

	Module 2: Introduction to Elementary Thermodynamics Related to Mineral Science Concept of equilibrium in metamorphic systems; Gibbs phase rule and Mineralogical Phase Rule and their application in simple and complex systems. First law of thermodynamics, second law of thermodynamics-definition of entropy, third law of thermodynamics, thermodynamic equations, free energy of formation of minerals at any temperature and pressure, free energy surface in G–T–P–X space, free energy of ideal and non-ideal solutions, the regular solution model, equilibrium constant of a reaction and its relation with Gibbs free energy; Introduction to geothermobarometry.	15 hours
	Module 3: Metamorphic Reactions, Chemographic Projections and Progressive metamorphism in pelitic, carbonate and mafic rocks Different types of metamorphic reactions, reactions among solid-phase components, reactions involving volatiles as reacting species, controls of pressure, temperature and chemical compositions on the metamorphic reactions, time scale of metamorphism; ACF, AKF and AFM diagrams; Progressive metamorphism in pelitic, carbonate and mafic rocks; Metamorphism in the context of plate tectonics	15 hours
Pedagogy	Lectures/ tutorials/ assignments/ self-study	
References/ Readings	1. Winter, J. D. (2010). *An Introduction to Igneous and Metamorphic Petrology* (2nd Edition), Pearson Education, Inc. 2. Philpotts, A., and Ague, J. (2009). *Principles of Igneous and Metamorphic Petrology* (2nd ed.). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511813429. 3. Bucher, K., and Grapes, R. (2011). *Petrogenesis of Metamorphic Rocks* (8th Edition), Springer. 4. Best, M. (2002). *Igneous and metamorphic petrology* (2nd Edition). Blackwell Science Ltd. 5. Frost, R., and Frost, C., (2014). *Essentials of Igneous and Metamorphic Petrology.* Cambridge University Press, New York. 6. Vernon, R., (2018). *A Practical guide to Rock Microstructure* (2nd Ed.), Cambridge University Press, https://doi.org/10.1017/9781108654609. 7. Winkler, H.G.F., (1979). *Metamorphic petrogenesis* (5th Ed.). Springer-Verlag, New York. 8. Spear, F., (1993). *Metamorphic Phase Equilibria and Pressure-Temperature-Time paths*. Mineralogical Society of America, Washington, D.C.	
Learning outcomes	Students will acquire a comprehensive understanding of metamorphism and the thermodynamic principles related to metamorphic petrology, applicable to a number of orogenic events in time and space, especially different pressure-temperature conditions during orogenesis.	

Title of the Course: Practical of Metamorphic Petrology
Course Code: GLC-22-204 **Number of Credits:** 01
Total Contact Hours: 30 **Effective from:** 2022–23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	The main objective of this course is to get students acquainted with identification of metamorphic rocks in hand specimens and petrographic thin section and to identify fabric forming processes.	
Content:	Identification of typical metamorphic minerals in hand specimen and thin section. Description, identification and classification of commonly occurring metamorphic rocks in hand specimen and thin section. Description of fabrics and textures of common metamorphic rocks in hand specimen and thin section.	30 hours
Pedagogy:	It is a practical component and entire course is taught in the laboratory.	
References/ Readings	1. Yardley, B. W., MacKenzie, W. S., and Guilford, C. (1997). *Atlas of metamorphic rocks and their textures*. Longman. 2. Vernon, R. H. (2018). *A practical guide to rock microstructure*. Cambridge University Press. 3. Dana, E. S., and Ford, W. E. (1952). *Dana's textbook of mineralogy*. Wiley Easstern Limited 4. Winter, J. D. (2010). *An Introduction to Igneous and Metamorphic Petrology* (2nd Edition), Pearson Education, Inc. 5. Phillips W. R. and Griffen, D.T. (1981). *Optical Mineralogy: The Non-opaque Minerals*. W. H. Freeman and Co., Ltd. New York.	
Learning outcomes	The students will develop skills to identify metamorphic minerals and rocks, to understand their geologic occurrence and to infer the processes of formation and environmental conditions from the mineral assemblage, texture, and tectonic setting.	

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Title of the Course: Principles and Stratigraphy and Indian Geology
Course Code: GLC-22-205 **Number of Credits:** 03
Total Contact Hours: 45 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.
Objective:	To understand the stratigraphic principles by which standards in stratigraphy are developed. To understand deposition and emplacement of different stratigraphic units in India and its evolution through time.

Content:	**Module 1: Introduction:** Stratigraphic principles and their applications. Evolution of Stratigraphic column. Stratigraphic (Lithostratigrapic, Chronostratigraphic and Biostratigraphic) nomenclature and their inter-relationships. Palaeomagnetism and time correlation. Concepts of Magnetostratigraphy, Seismic stratigraphy, Chemostratigraphy and Event stratigraphy. **Module 2: Stratigraphy of India:** Cratons and mobile belts, Archaean-Proterozoic boundary. Important Proterozoic basins of India. Precambrian/Cambrian boundary, Palaeozoic rocks in Himalayas. Mesozoic of Peninsular and extra peninsular India. K-T boundary. Paleocene Eocene Thermal Maxima (PETM), Cenozoic successions, Quaternary and Holocene stratigraphy. **Module 3: Important Stratigraphic Units of India:** Stratigraphy of Gondwana Supergroup with special emphasis on fossils, climate and economic important minerals. Deccan Volcanic Province, its distribution and lithological characteristics. Siwalik: Classification, significant vertebrate fauna and its basin evolution. Geology of Goa.	15 hours 15 hours 15 hours
Pedagogy:	Lectures / Assignments / Seminars/ Self-study	
References/ Readings	1. Ramakrishnan, M., and Vaidyanadhan, R. (2010). Geology of India (vol. 1 and 2). *GSI Publications*, *2*(1). 2. Naqvi, S. M., and Rogers, J. J. W. (1987). *Precambrian geology of India*. Oxford University Press, USA. 3. Krumbein, W. C. (2013). *Stratigraphy and sedimentation*. aearpeman company. 4. Prothero, D. R., and Schwab, F. (2004). Sedimentary geology. Macmillan. 5. Boggs, S. (2012). Principles of sedimentology and stratigraphy. 6. Fetter, C. W. (2018). *Applied hydrogeology*. Waveland Press. Salvador, A. (Ed.). (1994). International stratigraphic guide: a guide to stratigraphic classification, terminology, and procedure (No. 30). Geological Society of America	
Learning outcomes	The main outcome of the course is to provide a detailed understanding of stratigraphic principles, units and its correlation. It also gives knowledge of various stratigraphic units of India.	

Title of the Course: Practical of Principles and Stratigraphy and Indian Geology
Course Code: GLC-22-206 **Number of Credits:** 01
Total Contact Hours: 30 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.
Objective:	To make use of stratigraphic principles in correlation with different stratigraphic units and to understand the location and distribution of different stratigraphic units in India.

Content:	Study of rocks in hand specimens from Indian stratigraphic horizons and type localities. Exercises on stratigraphic classification and correlation. Preparation of stratigraphic range charts. Study of geological map of India and identification of major stratigraphic units. Locating/drawing of stratigraphic units in outline map of Goa and India.	30 hours
Pedagogy:	Lectures / Seminars/ Self-study	
References/Readings	1. Krishnan, M. S. (1982) *Geology of India and Burma*, CBS Publishers, Delhi 2. Doyle, P. and Bennett, M. R. (1996) *Unlocking the Stratigraphic Record*. John Wiley 3. Ramakrishnan, M. and Vaidyanadhan, R. (2008) *Geology of India* Volumes 1 and 2, Geological Society of India, Bangalore.	
Learning outcomes	The main outcome of the course is to use the stratigraphic principles in practical problems related to stratigraphy. It also gives knowledge with respect of distribution and location of various stratigraphic units of India.	

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Title of the Course: Geological Field Training
Course Code: GLC-22-207 **Number of Credits:** 4
Total Contact Hours: 60 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	The main objective of this course is to give students the hands on experience in the field to understand the lithology structure and their plates in Stratigraphy besides getting a thorough knowledge of field mapping.	
Pedagogy:	Lectures and on-field observation/ Training.	
References/ Readings	1. *Geology of Gujarat*, Mehr S.S., Geological Society of India, 1991. 2. *Geology of Karnataka*, Radharishnan B.P. and Vaidhyanadhan R., Geological Society of India. 1977. 3. *Geology of Rajasthan*, S. Sinha Roy. Geological Society of India.1991. 4. Geology of Rajasthan (North-West India-Precambriam to Recent) A.B Roy and S.R. Jakhar. Scientific Publishers, 2012. 5. *Geology of Andhra Pradesh*. P.K. Raman and V. N. Murty, Geological Society of India. 2012. 6. *Field Guide Book of Geology of Kutch (Kachchh) Basin, Gujarat, India*. 7. *Geology and Mineral Resources of Goa*. A.G. Dessai 8. *Geology of Maharashtra* Second Edition. G.G. Deshpande and Pitale. U. L. Geological Society of India. 2012.	
Content:	Visit to important mines/mineral deposits; Visit to Industry/Professional Organizations/National Institutes which may include short term in-house training at respective labs. The	

	training program will be carried out under the supervision of teachers. Students are expected to learn the techniques and methodologies applied on site in the professional organizations and also to gain knowledge related to instrumentation. Students are expected to write a detailed report on their visit and followed by a viva-voce examination based on the field report.	
Learning outcomes	The students will be able to understand the working of the mines, drilling sites, and various organization and prepare geological map and write a detail technical report of the area.	

Title of the Course: Exploration Geophysics
Course Code: GLO-22-208 **Number of Credits:** 3
Total Contact Hours: 45 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	The main objective of this course is to get students acquainted with applications of geophysics in geology.	
Content:	**Module 1:** Introduction to exploration geophysics: Introduction to electro-magnetic spectrum, usefulness of various methods, Electrical methods: instrumentation, field procedure and interpretation using electrical methods. Electrical profiling and sounding using Wenner and Schlumberger configurations. Principles and fundamental procedures of data collection and interpretation. **Module 2:** Seismic Methods: Principles, instrumentation, survey procedures and interpretation using seismic methods. Correction applied to seismic data. Geophysical well logging: Introduction well logging methods, porosity logs, well log interpretation. Latest methods from air-borne sources including drones and helicopters. **Module 3:** Gravity and magnetic methods: Principles-field methods-gravimeters-corrections, interpretation of gravity data. Principles, instrumentation, field procedures, data analysis and interpretation of magnetic data. Principles and field application of Ground Penetrating Radar (GPR) for sub-surface studies. Data analysis and interpretation.	15 hours 15 hours 15 hours
Pedagogy:	It is a theory component and entire course is taught in the class and various case studies for the application of different geophysical methods are discussed.	

References/Readings	1. Kearey, P., Brooks, M., and Hill, I. (2002). *An introduction to geophysical exploration* (Vol. 4). John Wiley and Sons. 2. Telford, W. M., Geldart, L. P., and Sheriff, R. E. (1990). *Applied geophysics*. Cambridge university press. 3. William, L. (1997). Fundamentals of geophysics. 4. Sharma, P. V. (1985). Geophysical methods in geology. 5. Dobrin, M. B., and Savit, C. H. (1960). *Introduction to geophysical prospecting* (Vol. 4). New York: McGraw-Hill.	
Learning outcomes	Upon completion of this course the student will learn to appreciate the application of geophysics for understanding the physical conditions of the Earth.	

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Title of the Course: Practical of Exploration Geophysics (GLO-22-208)
Course Code: GLO-22-209 **Number of Credits:** 1
Total Contact Hours: 30 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	The main objective of this course is to get students acquainted with various method of Geophysical-exploration and interpretation of the results.	
Content:	Exploration Geophysics Field survey using resistivity methods. Interpretation of resistivity data using master curves matching and digital techniques; Interpretation of seismic refraction and reflection data; Field survey using magnetometers and data interpretation; Interpretation of well logs. GPR applications and interpretations.	30 hours
Pedagogy:	It is a practical component. Case studies are discussed.	
References /Readings	1. Kearey, P., Brooks, M., and Hill, I. (2002). *An introduction to geophysical exploration* (Vol. 4). John Wiley and Sons. 2. Telford, W. M., Geldart, L. P., and Sheriff, R. E. (1990). *Applied geophysics*. Cambridge university press. 3. William, L. (1997). Fundamentals of geophysics. 4. Sharma, P. V. (1985). Geophysical methods in geology. Dobrin, M. B., and Savit, C. H. (1960). *Introduction to geophysical prospecting* (Vol. 4). New York: McGraw-hill.	
Learning outcomes	Upon completion of this course the student will learn to interpret the geophysical data so as to understand the subsurface geology.	

Title of the Course: Economic Geology
Course Code: GLO -22-210 **Number of Credits:** 3
Total Contact Hours: 45 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	To provide a conceptual understanding of economic minerals, processes involving formation of economic mineral, economic importance of economic minerals	
Content:	**Module 1: Introduction** Introduction: scope of economic geology Mineral economics. Ore, tenor, gangue, resource, reserves Texture and structures of ore deposits. Classification of ore deposits. **Module 2:** Ore bearing fluids: type, nature, chemistry Physico-chemical controls of ore deposition Wall-rock alteration. Controls of ore localization. Distribution of ore deposits in relation to plate tectonic settings. Magmatic and hydrothermal deposits. **Module 3:** Ore Deposits of India (Banded Iron Formations; Iron ore deposits; Manganese ore deposits; Polymetallic ore deposits: copper, lead, zinc; Chromite deposits; Laterite and Bauxite deposits: distribution in India and genesis; Asbestos deposits of India; Barite deposits; Gold in India; Diamond deposits. Offshore and deep sea deposits. Mineral deposits of Goa.	15 hours 15 hours 15 hours
Pedagogy:	Lectures/ tutorials/assignments/field study/discussion	
References/Readings	1. Gilbert and Parks: Geology of Ore Deposits 2. Parks and McDiarmid: Ore Deposits 3. Bateman, A. M. : Economic Mineral Deposits 4. Hutchson: Economic Mineral Deposits 5. Atkinson: Economic Ore Deposits 6. Smirnov: Economic Ore Deposits 7. Jensen, M. L. and Bateman, A. M.,: Economic Mineral Deposits 8. Brown and Dey: The minerals and nuclear fuels of the Indian Subcontinent 9. Burma Roy, B.C., : Indian Mineral Resources: Industries and Economics 10. Deb: Industrial Minerals and Rocks of India 11. Gokhale and Rao: Ore Deposits of India 12. Wadia, D. N.,:Mineral wealth of India 13. Krishnaswami: Indiaand#39;s Mineral Resources 14. Arndt N. andamp; Ganino C.: Metals andamp; Society. Springer. 15. Taylor R.: Ore Textures. Springer. 16. Metals and Society: An Introduction to Economic Geology. Springer.	
Learning outcomes	The students will get comprehensive knowledge of economic deposits.	

Title of the Course: Practical of Economic Geology (GLO-22-210)
Course Code: GLO-22-211 **Number of Credits:** 01
Total Contact Hours: 30 **Effective from AY:** 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in geology of any UGC recognized University or an examination of any other University recognized as equivalent.	
Objective:	To provide a conceptual understanding of economic minerals, processes involving formation of economic mineral, economic importance of economic minerals	
Content:	Study of representative ores, and industrial minerals in hand specimens. Preparation of charts showing the distribution of ore minerals in India. Mineralogical and textural studies of common ore minerals in incident light.	30 hours
Pedagogy:	Lectures/field study/mine visits/discussion	
References/Readings	1. Gilbert and Parks. *Geology of Ore Deposits* 2. Parks and McDiarmid. *Ore Deposits* 3. Bateman, A. M.,*Economic Mineral Deposits* 4. Hutchson. *Economic Mineral Deposits* 5. Atkinson. *Economic Ore Deposits* 6. Smirnov. *Economic Ore Deposits* 7. Jensen, M. L. and Bateman, A. M., *Economic Mineral Deposits*	
Learning outcomes	The students will get comprehensive knowledge of economic deposits and distribution of ores minerals in India.	

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