## M.Sc. Degree Course in Geology: Structure and Mark Distribution
(Outcome-based education syllabus, 2020 admission onwards)

<table>
<thead>
<tr>
<th>Paper Code</th>
<th>Title of the paper</th>
<th>Distribution of hours</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>GL 211</td>
<td>Physical Geology and Geomorphology</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>GL 212</td>
<td>Structural Geology and Engineering Geology</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>GL 213</td>
<td>Crystallography and Mineralogy</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>GL 224</td>
<td><strong>Practical I :</strong> Geomorphology, Structural Geology, Crystallography and Mineralogy</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>GL221</td>
<td>Environmental Geology</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>GL 222</td>
<td>Sedimentology and Geochemistry</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>GL 223</td>
<td>Remote Sensing and Geographic Information System Applications</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Dissertation/Field work or Field Visit*</td>
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<tr>
<td></td>
<td>(Dissertation)</td>
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<tr>
<td>GL 225</td>
<td><strong>Practical II :</strong> Sedimentology, Remote Sensing and Survey</td>
<td>6 (Sed. &amp; RS) 2 (Survey)</td>
<td>25</td>
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<tr>
<td>GL 231</td>
<td>Stratigraphy and Palaeontology</td>
<td>7</td>
<td>25</td>
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<tr>
<td>GL 232</td>
<td>Igneous and Metamorphic Petrology</td>
<td>4</td>
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</tr>
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<td>GL 233</td>
<td>Hydrogeology</td>
<td>6</td>
<td>25</td>
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<tr>
<td>GL 244</td>
<td><strong>Practical III :</strong> Igneous and Metamorphic Petrology and Hydrogeology</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>GL 241</td>
<td>Economic Geology</td>
<td>4</td>
<td>25</td>
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<tr>
<td>GL 242</td>
<td>Exploration Geology</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>GL 243</td>
<td>Applied Geology and Geostatistics</td>
<td>6</td>
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<td></td>
<td>Dissertation/Field work/Group Mapping#</td>
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<td></td>
<td>(Dissertation)</td>
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<tr>
<td>GL 245</td>
<td><strong>Practical IV :</strong> Economic Geology, Exploration Geology and Applied Geology</td>
<td>8</td>
<td>25</td>
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<tr>
<td>GL 246</td>
<td>Dissertation</td>
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<td></td>
<td>Comprehensive Viva Voce</td>
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<td></td>
<td>(Includes 10 marks for Group Mapping)</td>
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<tr>
<td></td>
<td>Grand total marks</td>
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</tbody>
</table>

**Note:**
- Dissertation work commences in 2nd Semester with 2 hours per week. Field visit or field work in 2nd Semester refers to a period of maximum 10 days duration (10 x 5 = 50 Hours) and is a compulsory part of the curriculum.
- # Dissertation work continues in 4th Semester with 2 hours per week and an additional Field work component for a period of maximum 10 days duration (10 x 5 = 50 Hours). Group Mapping includes field training in geological mapping for a period of maximum 10 days duration (10 x 5 = 50 Hours) and is a compulsory part of the curriculum to be carried out in the 3rd semester.
- @ Practical Examinations of 1st and 2nd Semesters will be conducted at the end of second semester and that of 3rd and 4th Semesters will be conducted at the end of 4th Semester and each practical examination will be of four (4) hours duration.

OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
University of Kerala

M.Sc. Degree Course in Geology (Outcome-based education OBE syllabus)
(Effective from 2020 Admissions)

Acronyms used
PO – Program outcomes
PSO – Program Specific Outcomes
CO – Course Outcomes

Knowledge categories
F – Factual
C – Conceptual
P – Procedural

Cognitive levels
R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create

Program specific outcomes (PSO) of MSc Geology program in the colleges under University of Kerala

The MSc Geology program comprises 12 theory courses, 4 practical courses, and dissertation.

PSO 1: Understand the basic concepts of physical geology, geomorphology, structural geology, engineering geology and environmental geology and apply this knowledge to analyze geological formations and structures for effective human use.

PSO 2: Understand the various crystal systems, and properties and their mineralogical expressions, and the economic significance of mineral deposits, apply the concepts of exploration geology to analyze the formation and significance of ore deposits.

PSO 3: Understand how rocks are formed, the underlying geochemical and petrological principles and apply this knowledge to analyze sedimentary, igneous and metamorphic rocks for unravelling earth history and economic utilization.

PSO 4: Understand the principles of stratigraphy and palaeontology, and apply this knowledge to analyze the evolution of the Earth and life on it.

PSO 5: Understand how Earth can be sensed remotely, resources mapped geographically, and analysed statistically and how water behaves within the Earth, and apply this knowledge to analyze groundwater resources.

PSO 6: Analyze and apply the knowledge gained through studies into a thesis that incorporates scientific planning and execution of work, methodology, analyses, and presentation of results, all within the ambit of research ethics, possibly leading to the creation of new knowledge in geosciences.
GL 211: PHYSICAL GEOLOGY AND GEOMORPHOLOGY

AIM
To familiarize students with the basic concepts of physical geology and geomorphology, and to equip them to decipher the pattern of landforms representative of various geological processes.

OBJECTIVES
To make the student understand the various surficial and internal processes which shape the surface of the earth and be able to evaluate the role of each in sculpting the earth. Students can gain an understanding of the past and present processes operated by different geomorphologic agents.

Course outcomes

CO1: Understand the basics of geochronology and the different dating techniques and their limitations

CO2: Understand the geophysical characteristics of Earth and how palaeomagnetism and plate tectonics are related to these

CO3: Understand the philosophy and different schools of thoughts of environmental dynamism and passivism and compare and analyse different landscape evolution models.

CO4: Understand the origin of various landforms, the concept of morphogenetic regions and influence of climate and structure on it and evaluate the Land forms and structures as geomorphic indicators of neotectonic movements. Understand the geological work of rivers, oceans, wind, glaciers

CO5: Understand the drainage pattern and network characteristics of drainage basin and understand the Soil Formation and classification in Kerala and India

CO6: Understand the geomorphological features of Kerala and India and also understand the basics of tectonogeomorphology.

CO-PSO map

<table>
<thead>
<tr>
<th>CO No.</th>
<th>CO Statements</th>
<th>Cognitive Level</th>
<th>Knowledge Category</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the basics of geochronology and the different dating techniques and their limitations</td>
<td>U &amp; E</td>
<td>F &amp; C</td>
<td>PSO1</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the geophysical characteristics of Earth and how palaeomagnetism and plate tectonics are related to these</td>
<td>U &amp; E</td>
<td>F &amp; C</td>
<td>PSO1</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the philosophy and different schools of thoughts of environmental dynamism and passivism and compare and analyse different landscape evolution models.</td>
<td>U &amp; E</td>
<td>F &amp; C</td>
<td>PSO1</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the origin of various landforms, the concept of morphogenetic regions and influence of climate and structure on it and evaluate the Land forms and structures as geomorphic indicators of neotectonic movements. Understand the geological work of rivers, oceans, wind, glaciers</td>
<td>U &amp; E</td>
<td>F &amp; C</td>
<td>PSO1</td>
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OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
CO5 Understand the drainage pattern and network characteristics of drainage basin and understand the Soil Formation and classification in Kerala and India

U F, C & P PSO1

CO6 Understand the geomorphological features of Kerala and India and also understand the basics of tectonogeomorphology.

U F & C PSO1

Knowledge category: F – Factual C – Conceptual P – Procedural
Cognitive levels: R – Remember, U – Understand , A – Apply, An – Analyze, E – Evaluate, C – Create

GL 211: PHYSICAL GEOLOGY AND GEOMORPHOLOGY

UNIT I

UNIT II
Gravity, Geomagnetism and Thermal history of the earth – Geodesy – Density distribution, shape and mass of the earth, density vs depth profile – Brief idea of Gravity, gravity anomalies and their interpretation - The earth as Magnet, Earth’s magnetic field, changes in magnetic field, origin of geomagnetic field, palaeomagnetism – Basic ideas of Seismotectonics, Plate tectonics and Rheological stratification of the mantle.

UNIT III

UNIT IV

OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
UNIT V

UNIT VI

Reference books

GL 212: STRUCTURAL GEOLOGY AND ENGINEERING GEOLOGY

AIM
To understand the rock deformation and different structures produced by brittle and ductile deformation and analysis of structures. To understand geological properties of materials and earth structures as applied to construction of engineering structures.

OBJECTIVES
The objectives of this course are: (i) to develop an understanding of rock deformation and factors involves in it. (ii) how the classification of structures based on geometry and origin (iii) analysis of structures based on stereographic projection.

OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
Course outcomes

CO1: Understand the concepts of rock deformation, types of Stress and strain, its use in studying the stages of deformation and factors affecting deformation.

CO2: Understand the brittle and shear failure including fault, lineaments, deep fractures, Joints and Shear zone, tectonites, petrofabrics, foliation and lineation.

CO3: Understand the concept, classification and mechanism of fold. Understand Superposed fold and interference patterns.

CO4: Understand Structural and geometric analysis. Application of stereographic and equal area projections in the representation of structures and geometric analysis of folds and lineations.

CO5: Understand the interpretation of geologic maps. Analyse the Trigonometric, graphic and stereographic problems.

CO6: Understand the engineering properties of rocks and their use in locating engineering structures

CO – PSO map

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<tr>
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<tbody>
<tr>
<td>CO 1</td>
<td>Understand the concepts of rock deformation, types of Stress and strain, its use in studying the stages of deformation and factors affecting deformation.</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO 2</td>
<td>Understand the brittle and shear failure including fault, lineaments, deep fractures, Joints and Shear zone, tectonites, petrofabrics, foliation and lineation.</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO 3</td>
<td>Understand the concept, classification and mechanism of fold. Understand Superposed fold and interference patterns.</td>
<td>U, Analyze</td>
<td>F, C &amp;P</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO 4</td>
<td>Understand Structural and geometric analysis. Application of stereographic and equal area projections in the representation of structures and geometric analysis of folds and lineations.</td>
<td>U, Analyze</td>
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<td>CO 6</td>
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Cognitive levels: R – Remember, U – Understand , A – Apply, An – Analyze, E – Evaluate, C – Create

OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
GL 212 : STRUCTURAL GEOLOGY AND ENGINEERING GEOLOGY

UNIT I

UNIT II

UNIT III

UNIT IV

UNIT V

UNIT VI
geological conditions on foundations and design of buildings. Geological considerations in investigations for construction of highways, bridges and shoreline structures.

**Reference books**

Billings, M. P. Structural Geology Prentice Hall, 1974  

**GL 213 : CRYSTALLOGRAPHY AND MINERALOGY**

**AIM**
The aim of this course is to study the major mineral groups, their occurrences, physical, chemical and crystallographic properties and their possible uses in industry.

**OBJECTIVES**
In this course the students will learn about the structure and chemical makeup of minerals. Focus is given on the physical and chemical properties of minerals, from macroscopic to microscopic.

**Course outcomes**

**CO1:** Understand the Repetition and Translation periodicity of crystals and derivation of 32 crystal classes. Understand and analyse Stereographic Crystal projection.

**CO2:** Understand the diagnostic and advanced optical properties of common rock forming minerals.

**CO3:** Understand the mineral chemistry and the advanced instrumental analytical techniques used for minerals.

**CO4:** Understand the physical characters, optical properties, classification, uses and distribution of gem stones. Understand the basics of gem identification by using invisible spectrum radiation.

**CO5:** Understand the different mineralogical expression of radioactivity and understand structures and different characters of silicate family minerals.

**CO6:** Understand the mineralogy, classification, identification and genesis of different clay with conventional techniques. Understand the clay mineral separation.
## CO – PSO map

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>CO 1</td>
<td>Understand the Repetition and Translation periodicity of crystals and derivation of 32 crystal classes. Understand and analyse Stereographic Crystal projection.</td>
<td>U &amp; A</td>
<td>F &amp; C</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO 2</td>
<td>Understand the diagnostic and advanced optical properties of common rock forming minerals.</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO 3</td>
<td>Understand the mineral chemistry and the advanced instrumental analytical techniques used for minerals.</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO 4</td>
<td>Understand the physical characters, optical properties, classification, uses and distribution of gem stones. Understand the basics of gem identification by using invisible spectrum radiation.</td>
<td>U &amp; A</td>
<td>F, C, P</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO 5</td>
<td>Understand the different mineralogical expression of radioactivity and understand structures and different characters of silicate family minerals.</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO 6</td>
<td>Understand the mineralogy, classification, identification and genesis of different clay with conventional techniques. Understand the clay mineral separation.</td>
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<td>F &amp; C</td>
<td>PSO2</td>
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</tbody>
</table>

Knowledge category: F – Factual    C – Conceptual    P – Procedural  
Cognitive levels: R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create

## GL 213 : CRYSTALLOGRAPHY AND MINERALOGY

### UNIT I


### UNIT II


### UNIT III


OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
UNIT IV

Gemmology: Physical characters (including electrical, thermal and magnetic characters); optical properties. Classification of gemstones. Common precious and semi-precious stones; their properties, mode of occurrence and distribution in India.


UNIT V

Mineralogical expression of radioactivity – metamictisation, fracturing, discoloration, pleochroic haloes and fission tracks. Structure and classification of silicates. – Distinctive chemical and optical characters of the minerals of the following groups – Olivine, garnet, aluminosilicates, epidote, pyroxene, amphibole, mica, feldspar and feldspathoid; tourmaline, beryl, spinel.

UNIT VI

Clay mineralogy characterization, classification and structure of clay minerals, clay mineral identification by XRD and DTA. Genesis of clays. Different methods of clay mineral separation.

Reference books
Berry L. G. and Mason B. Mineralogy, Freeman, 1959.

GL 221: ENVIRONMENTAL GEOLOGY

AIM

To understand how environmental geology impinges on everyday life and also to have an insight on environmental pollution, climate change and mitigation.

OBJECTIVES

To make the student understand Fundamental concepts of environmental science, disaster management, and Environmental impact assessment (EIA).
Course outcomes

CO1: Understand the fundamental concepts of environmental geology and understand how climate change can be addressed.

CO2: Understand the concepts of land and ocean resources and sustainable development.

CO3: Understand natural hazards and apply disaster mitigation measures.

CO4: Understand waste and pollutants and their management, and geology of human health.

CO5: Understand how to develop an EIA, and use it for specific landuse projects.

CO6: Understand the environmental impacts of infrastructure development and application of EIA.

CO – PSO map

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<tbody>
<tr>
<td>CO 1</td>
<td>Understand the fundamental concepts of environmental geology and understand how climate change can be addressed.</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO1</td>
</tr>
<tr>
<td>CO 2</td>
<td>Understand the concepts of land and ocean resources and sustainable development.</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO1</td>
</tr>
<tr>
<td>CO 3</td>
<td>Understand natural hazards and apply disaster mitigation measures.</td>
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GL 221: ENVIRONMENTAL GEOLOGY

UNIT I


UNIT II

UNIT III


UNIT IV


UNIT V


UNIT VI


Reference books
GL 222: SEDIMENTOLOGY AND GEOCHEMISTRY

AIM
To understand the sediments provenance and sedimentary rock formation using texture, structure, geochemistry and isotopes systematic.

Objectives
To create an understanding on how fluid flow influence the sediment movement ii) how the sediment texture, heavy mineral assemblages and geochemistry useful for provenance determination iii) how the sedimentary environment influence the texture and structures of sedimentary rocks iv) how the facies models and environments helpful for sedimentary basin analysis and v) how the isotope geology useful in geochronology and geochemical processes.

Course outcomes

CO1: Understand the influence of fluid flow in sediment movements. Understand the sediment texture and heavy mineral assemblages, and determine the sediment provenances
CO2: Understand the sedimentary structures and determine its environmental significances
CO3: Understand the composition, texture, structure and classification of clastic and non-clastic rocks, and determine the sedimentation processes. Understand the facies models and environments in sedimentary basin determination.
CO4: Understand the composition and formation of carbonates, evaporites, and relation between sedimentation and plate tectonics
CO5: Understand the geochemistry of Earth, natural waters and of specific elements. Also understand the fundamental geochemical and isotope concepts and applications of stable isotopes in geochemical studies
CO6: Understand thermodynamic concepts, redox reactions, and Eh-pH conditions in nature

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</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the influence of fluid flow in sediment movements. Understand the sediment texture and heavy mineral assemblages, and determine the sediment provenances</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the sedimentary structures and determine its environmental significances</td>
<td>U, Apply</td>
<td>F, C&amp; P</td>
<td>PSO3</td>
</tr>
</tbody>
</table>
Understand the composition, texture, structure and classification of clastic and non-clastic rocks, and determine the sedimentation processes. Understand the facies models and environments in sedimentary basin determination.

CO4
Understand the composition and formation of carbonates, evaporites, and relation between sedimentation and plate tectonics

CO5
Understand the geochemistry of Earth, natural waters and of specific elements. Also understand the fundamental geochemical and isotope concepts and applications of stable isotopes in geochemical studies

CO 6
Understand thermodynamic concepts, redox reactions, and Eh-pH conditions in nature

Knowledge category: F – Factual  C – Conceptual  P – Procedural
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GL 222: SEDIMENTOLOGY AND GEOCHEMISTRY

UNIT I

UNIT II

UNIT III
UNIT IV

Limestone – Mineralogy, carbonate sand, carbonate mud, carbonate framework, organic matter.
Limestone forming environments – carbonate platform, tidal flat, fresh water carbonate deposits.

UNIT V

REE – and introduction with special reference to its distribution in meteorites and rocks. mantle. Geochemistry of Cu, Al, Fe and Mn.

UNIT VI


Reference books
Krauskopf E. B. Introduction to Geochemistry, 1967.
GL 223: REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM APPLICATIONS

AIM
Understand the basic concepts of GIS, Remote Sensing and Aerial Photography and develop skills to assess the use of the data in various areas of geological investigations.

OBJECTIVES
Gain understanding of acquisition, compilation, and processing of Remote sensing and GIS data, generation of data products which can be used in in spatial planning and natural resource management.

Course outcomes

CO1: Understand the basic concepts of remote sensing and aerial photo interpretation

CO2: Understand how remote sensing is done across the electromagnetic spectrum

CO3: Evaluate the use of remote sensing and aerial photography in natural resource and disaster management and apply it to different scenarios

CO4: Understand the basics of GIS, and the nature of spatial data

CO5: Understand how GIS data can be managed and then integrated with remote sensing data

CO6: Understand GIS analysis and its applications in planning and natural resource management

CO – PSO map

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<tr>
<td>CO 1</td>
<td>Understand the basic concepts of remote sensing and aerial photo interpretation</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO5</td>
</tr>
<tr>
<td>CO 2</td>
<td>Understand how remote sensing is done across the electromagnetic spectrum</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO5</td>
</tr>
<tr>
<td>CO 3</td>
<td>Evaluate the use of remote sensing and aerial photography in natural resource and disaster management and apply it to different scenarios</td>
<td>U, Analyze, Apply</td>
<td>F, C, P</td>
<td>PSO5</td>
</tr>
<tr>
<td>CO 4</td>
<td>Understand the basics of GIS, and the nature of spatial data</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO5</td>
</tr>
<tr>
<td>CO 5</td>
<td>Understand how GIS data can be managed and then integrated with remote sensing data</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO5</td>
</tr>
<tr>
<td>CO 6</td>
<td>Understand GIS analysis and its applications in planning and natural resource management</td>
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<td>PSO5</td>
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OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
GL 223: REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM APPLICATIONS

UNIT I
Concept of remote sensing – Electromagnetic radiation – characteristics, remote sensing regions and bands; radiation principles and energy resources, energy interaction with the atmosphere. Acquisition and interpretation of remote sensing data Aerial photography – types of aerial photographs, their geometry and photo characters, stereoscopy, stereoscopic parallax, relief displacement; principles of photogrammetry. Aerial photo and imagery pattern and interpretation – principles, elements and procedures. Digital image processing – characteristics of remote sensing data, pre-processing, enhancements, classification.

UNIT II

UNIT III
Application of aerial photographs in photogrammetry, land use, forestry, agriculture, geology and environmental studies. Remote sensing applications in interpreting structure and tectonics, lithological mapping, in geomorphologic, fluvial, coastal, structural, stratigraphic, mineral resources, groundwater studies, natural hazards and disaster mitigation and environmental monitoring. Status of remote sensing studies in India – Bhaskara and IRS systems.

UNIT IV

UNIT V

UNIT VI

OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
GL 231: STRATIGRAPHY AND PALAEOONTOLOGY

AIM

Understand how the different rock and sediment strata on was developed, how it can be interpreted to arrive at theories on the evolution of Earth and the vertebrate and invertebrate life on it.

OBJECTIVES

Study the major theories underpinning stratigraphy, and the techniques used to decipher information from strata. Understand the evolution of life and decipher its record in the strata.

Course outcomes

CO1: Understand stratigraphic principles and its history, and gain deeper understanding of select stratigraphic systems.

CO2: Understand the different types of stratigraphic analytical techniques and gain an understanding of boundary problems

CO3: Understand the models of crustal evolution with special reference to the Indian shield

CO4: Examine the patterns of evolution of invertebrates, to understand palaeoclimatic and palaeogeographic dispositions

OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
CO5: Understand the evolution of vertebrates and extinction events, and the record of plant fossils and its significance

CO6: Understand microfossils, their morphology, palaeoecology and applications in petroleum exploration

### CO – PSO map

<table>
<thead>
<tr>
<th>CO No.</th>
<th>CO Statements</th>
<th>Cognitive Level</th>
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</tr>
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<tbody>
<tr>
<td>CO 1</td>
<td>Understand stratigraphic principles and its history, and gain deeper understanding of select stratigraphic systems.</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO4</td>
</tr>
<tr>
<td>CO 2</td>
<td>Understand the different types of stratigraphic analytical techniques and gain an understanding of boundary problems</td>
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<td>PSO4</td>
</tr>
<tr>
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<td>U</td>
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<tr>
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<td>Understand microfossils, their morphology, palaeoecology and applications in petroleum exploration</td>
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Knowledge category: F – Factual    C – Conceptual    P – Procedural
Cognitive levels: R – Remember, U – Understand , A – Apply, An – Analyze, E – Evaluate, C – Create

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**GL 231: STRATIGRAPHY AND PALAEONTOLOGY**

**UNIT I**


**UNIT II**

Allostratigraphy, Pedostratigraphy and Chemostratigraphy. Basic ideas of Quaternary Stratigraphy.

UNIT III

UNIT IV

UNIT V

UNIT VI

Reference books
GL 232: IGNEOUS AND METAMORPHIC PETROLOGY

AIM

To understand igneous and metamorphic rocks, their structure, texture, chemistry and processes that generate and transform the rocks of the Earth as well as the tectonic settings of these rock types.

OBJECTIVE

Understand the thermal and tectonic history of the earth in association with igneous petrogenesis, evolution of magmas and their products. Understand how phase rule applies to metamorphic mineral paragenesis and how metamorphic rocks are formed, and analyse the textures and structures of metamorphic rocks.

COURSE OUTCOMES

CO1: Understand the application of thermodynamics and reaction principle in the petrogenesis of different igneous rocks, and evaluate the role of phase rule in the study of binary and ternary silicate systems

CO2: Understand the physical properties, chemical composition and evolutionary mechanisms of magmas

CO3: Evaluate the different schemes of classification and nomenclature of igneous rocks and their tectonic associations

CO4: Understand limits, factors and types of metamorphism and application of Phase rule in Chemographic diagrams

CO5: Understand classification of metamorphic rocks and textures and structures of metamorphic rocks

CO6: Understand baric types of metamorphism, thermobarometry, and metamorphism of carbonate, pelitic, mafic rocks

CO- PSO MAP

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<td>U, Analyse</td>
<td>F &amp; C</td>
<td>PSO3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the physical properties, chemical composition and evolutionary mechanisms of magmas. Evaluate the different schemes of classification and nomenclature of igneous rocks and their tectonic associations</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO3</td>
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<tr>
<td>CO3</td>
<td>Evaluate the different schemes of classification and nomenclature of igneous rocks and their tectonic associations</td>
<td>U, Evaluate</td>
<td>F &amp; C</td>
<td>PSO3</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand limits, factors and types of metamorphism and application of Phase rule in Chemographic diagrams</td>
<td>U, Apply</td>
<td>F, C, P</td>
<td>PSO3</td>
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<tr>
<td></td>
<td>Understand classification of metamorphic rocks</td>
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<td>PSO3</td>
</tr>
</tbody>
</table>
GL 232: IGNEOUS AND METAMORPHIC PETROLOGY

UNIT I


UNIT II


UNIT III


UNIT IV


UNIT V

Classification of metamorphic rocks. Concepts in metamorphism – Grubenmann’s depth zone concept, metamorphic zone concept – isograd and reaction isograd, metamorphic facies concept and facies series, Winkler’s grade concept, Miyashiro’s paired metamorphic belts and baric types.

Knowledge category: F – Factual    C – Conceptual    P – Procedural
Cognitive levels: R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create
of metamorphism, P-T-t paths – isobaric cooling (IBC) and isothermal decompression (ITD) paths. Prograde and retrograde metamorphism; Thermobarometry. Regional metamorphism of carbonate, pelitic and mafic rocks. Thermal metamorphism of carbonate rocks. Extraterrestrial Metamorphism (Impact and shock metamorphism).

UNIT VI


Reference books

GL 233: HYDROGEOLOGY

AIM
To understand the various aspects of origin, occurrence, distribution, movement, hydraulics, quality, pollution, recharge and over-exploitation, and the groundwater conditions in India and Kerala.

OBJECTIVES
The objectives of this course are:
i) to study the origin, occurrence, distribution of groundwater; aquifer types, properties and parameters in relation to groundwater hydraulics, groundwater movement and application of Darcy’s law, pumping test data analysis.

ii) to understand and describe groundwater exploration and prospecting methods, methods of drilling for groundwater and well design and maintenance criteria.

iii) to understand and infer groundwater quality for domestic and industrial uses using standard graphs and diagrams like Hill-Piper Trilinear diagram and U.S. Salinity diagram.

iv) to understand the concepts and methods of groundwater recharge, problems related to groundwater pollution and over-exploitation, groundwater legislation; and groundwater provinces of India and groundwater conditions in Kerala.

Course outcomes

CO1: Understand and describe the origin, occurrence, distribution and movement of groundwater in relation to hydrological cycle and aquifers.

CO2: Understand aquifer properties, and types of aquifers, vertical distribution of water in aquifers, and the application of radioisotopes in hydrogeology.

CO3: Understand groundwater hydraulics with reference to Darcy’s law, aquifer parameters and describe the procedures of pumping test and data analysis for determination and quantification of aquifer parameters.

CO4: Understand the various methods of groundwater exploration and prospecting with special emphasis on geo-electrical – electrical resistivity method; describe the methods of drilling for groundwater and explain water well construction and maintenance of production wells.

CO5: Understand groundwater quality studies related to well inventory, collection and analysis of water samples and interpretations of water quality for domestic and agricultural purposes based on standard graphs and diagrams like Hill-Piper Trilinear diagram and U.S. Salinity diagram; and to understand groundwater contamination and pollution.

CO6: Understand the concepts and methods of groundwater recharge, problems related to over-exploitation of groundwater, groundwater legislation; and groundwater provinces of India and groundwater conditions in Kerala.

CO – PSO map

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<tr>
<td>CO1</td>
<td>Understand and describe the origin, occurrence, distribution and movement of</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO5</td>
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<tr>
<td></td>
<td>groundwater in relation to hydrological cycle and aquifers.</td>
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<tr>
<td>CO2</td>
<td>Understand aquifer properties, and types of aquifers, vertical distribution</td>
<td>U</td>
<td>F &amp; C</td>
<td>PSO5</td>
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<td></td>
<td>of water in aquifers, and the application of radioisotopes in hydrogeology.</td>
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<td>CO3</td>
<td>Understand groundwater hydraulics with reference to Darcy’s law, aquifer</td>
<td>U, Analyze</td>
<td>F &amp; C</td>
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Understand groundwater quality studies related to well inventory, collection and analysis of water samples and interpretations of water quality for domestic and agricultural purposes based on standard graphs and diagrams like Hill-Piper Trilinear diagram and U.S. Salinity diagram; and to understand groundwater contamination and pollution.

Understand the concepts and methods of groundwater recharge, problems related to over-exploitation of groundwater, groundwater legislation; and groundwater provinces of India and groundwater conditions in Kerala.

Knowledge category: F – Factual    C – Conceptual    P – Procedural
Cognitive levels: R – Remember, U – Understand , A – Apply, An – Analyze, E – Evaluate, C – Create

GL 233: HYDROGEOLOGY

UNIT I

Introduction – definition and classification of subsurface water. Elements of surface hydrology: formation of precipitation, measurement and depth of precipitation over an area. Evaporation and transpiration – factors affecting evaporation and transpiration


UNIT II


Radioisotopes in hydrogeological studies.

UNIT III


UNIT IV


Water Well Construction – Water well design criteria and specifications. Well production tests – well loss, specific capacity. Maintenance of production wells.

UNIT V


UNIT VI


Reference Books

Todd D. K. Groundwater hydrology Wiley 1980
Bouwer H. Groundwater hydrology 1978
GL 241: ECONOMIC GEOLOGY

AIM
To understand the mode of occurrence, genesis and structure of mineral deposits and fossil fuels in India and the laws that govern their sustainable utilization.

OBJECTIVES
The objectives of this course are: (i) to develop an understanding of how the National Mineral Policy evolved (ii) how the mineral deposits of the oceans are managed and exploited (iii) how the various economic mineral deposits are distributed in India and (iv) the geological characteristics of the deposits and (v) to understand the importance of industrial minerals

Course outcomes

CO1: Understand the physicochemical properties of ore deposits, and theories, controls and age of ore formation.

CO2: Understand the classification of ore deposits, the origin of different rock – ore associations and the important characteristics of ore deposits formed in different geological environments

CO3: Understand metamorphic, metasomatic, volcanic, sedimentary, hydrothermal ore formation processes

CO4: Understand how global tectonics influences ore mineralization and understand ore microscopy to analyze ore textures and genesis.

CO5: Understand the National Mineral Policy and the origin and properties of U, Th, Cu, Al, Fe-bearing and other important mineral deposits of India

CO6: Understand the physico-chemical properties, origin and distribution of fossil fuels in India

CO – PSO Map

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<td>Understand the physicochemical properties of ore deposits, and theories, controls and age of ore formation.</td>
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<tr>
<td>CO2</td>
<td>Understand the classification of ore deposits, the origin of different rock – ore associations and the important characteristics of ore deposits formed in different geological environments</td>
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<tr>
<td>CO4</td>
<td>Understand how global tectonics influences ore mineralization and</td>
<td>U, Analyze</td>
<td>F, C, P</td>
<td>PSO2</td>
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OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
understand ore microscopy to analyze ore textures and genesis.

| CO5 | Understand the National Mineral Policy and the origin and properties of U, Th, Cu, Al, Fe-bearing and other important mineral deposits of India | U | F & C | PSO2 |
| CO6 | Understand the physico-chemical properties, origin and distribution of fossil fuels in India | U | F & C | PSO2 |

Knowledge category: F – Factual  C – Conceptual  P – Procedural
Cognitive levels: R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create

UNIT I


Dating of ore deposits. Controls of ore localization.

UNIT II

Classification of ore deposits. Environments of ore formation – genetic relationship between rocks and ore deposits. Diamond in kimberlite, ores in pegmatite. Cr, Pt, Ti, Cu and Ni deposits associated with basic and ultrabasic rocks.

UNIT III

Greisen deposits, skarn deposits, disseminated sulphide, oxide and sulphate deposits of sedimentary and volcanic environments. Salient characteristics of hydrothermal, stratiform, stratabound, sedimentary, residual and supergene ore deposits with examples. Metamorphism of ore deposits.

UNIT IV


UNIT V


UNIT VI

OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions

Petroleum – source rocks; process of transformation of organic matter to petroleum; migration and accumulation of petroleum. Some of the important petroliferous basins of India such as Assam shelf, Bombay offshore, Cambay basin, Cauvery basin, Krishna-Godavari basin, Andaman-Nicobar and Lakshwadeep basins.

Reference books
Brown J. C. and Dey A. K. India’s mineral wealth. Oxford, 1936
Krauskopf K. B. Introduction to Geochemistry.
Mukherjee A. Metamorphic and metamorphosed sulphide deposits. Econ. Geol., Vol. 65, No.70, 1970.
Van Krozalon D. Coal. Elsevier, 1964,

GL 242: EXPLORATION GEOLOGY

AIM
Introduce the basic principles and methodology of geophysics, geochemical and geobotanical exploration.

OBJECTIVES
Basic training in theory of geophysical instruments and related data interpretation. Impart an understanding of Trenching and Pitting, Drilling, Geophysical methods, Geochemical exploration. Sampling and sampling methods, Methods of geochemical prospecting, Biogeochemical prospecting, Geo-botanical prospecting, and analyse the data.
Course outcomes

CO1: Understand mineral exploration phases, methods, maps used, different methods by ground excavation, representation of data generated and importance of sampling in mineral prospecting.

CO2: Understand principles, survey methods, interpretation, corrections applied and applications of surface geophysical gravity and seismic methods.

CO3: Understand principles, survey methods, interpretation and applications of important surface electrical geophysical methods, radiometric prospecting and essentials of important subsurface geophysical techniques.

CO4: Understand principles, environment, methods and laboratory investigations done in geochemical, biogeochemical mineral prospecting and geobotanical indicators.

CO5: Understand objectives, types, economics in mineral exploration; commercial parameters of ores, ore classification and mineral reserve estimation methods.

CO6: Understand prospecting and reserves estimation of fuel minerals and polymetallic nodules.

CO – PSO map

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<td>U, Apply</td>
<td>F &amp; C</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO 2</td>
<td>Understand principles, survey methods, interpretation, corrections applied and applications of surface geophysical gravity and seismic methods.</td>
<td>U, Analyse, Apply, Evaluate</td>
<td>F &amp; C</td>
<td>PSO2</td>
</tr>
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<td>CO 3</td>
<td>Understand principles, survey methods, interpretation and applications of important surface electrical geophysical methods, radiometric prospecting and essentials of important subsurface geophysical techniques.</td>
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<td>CO 4</td>
<td>Understand principles, environment, methods and laboratory investigations done in geochemical, biogeochemical mineral prospecting and geobotanical indicators.</td>
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<td>Understand prospecting and reserves estimation of fuel minerals and polymetallic nodules.</td>
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OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
GL 242: EXPLORATION GEOLOGY

UNIT I

UNIT II

UNIT III

UNIT IV

UNIT V
Exploration programme – Objectives, economic factors and gestation period in Reconnaissance and Detailed exploration. Regional exploration programme. Reserve estimation Ore body modeling. Grade, tonnage, cut off grade and reserve classification. UNFC – Sampling and ore reserve calculation, plan methods and cross-section methods.

OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
UNIT VI


Reference Books
Peters W. C. Exploration and mining geology. Wiley.
Dobrin M. B. Introduction to geophysical prospecting. Pergamon Press.
Ginzburg D. H. Principles of geochemical prospecting. Pergamon
Umathy R. M. Textbook of Mining Geology.

GL 243: APPLIED GEOLOGY AND GEOSTATISTICS

AIM
To develop knowledge on mining, mining documentation, and application of statistics to geological problems

OBJECTIVES
To Understand different mining methods, Indian mining legislation, mining related documentation, and to also understand statistical techniques and its applications to geological problems.

Course outcomes
CO1: Understand Criteria for selecting mining method, different open cast methods, coal mining methods and basics of underground mining.
CO2: Understand petroleum mining, Indian mining legislation framework, different documents to be prepared and maintained for mining and underground coal gasification.
CO3: Understand statistical measures of average, dispersion and basics of probability
CO4: Understand random variables, probability distributions, sampling techniques and analyse sampling distributions
CO5: Understand statistical inference and testing of hypothesis, and independence, analysis of variance and application of non-parametric tests
CO6: Understand correlation and linear regression and apply to geological problems

**CO – PSO map**

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<td>CO 2</td>
<td>Understand petroleum mining, Indian mining legislation framework, different documents to be prepared and maintained for mining and underground coal gasification.</td>
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<td>PSO5</td>
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<tr>
<td>CO 6</td>
<td>Understand correlation and linear regression and apply to geological problems</td>
<td>U, A</td>
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</table>

Knowledge category: F – Factual  C – Conceptual  P – Procedural
Cognitive levels: R – Remember, U – Understand , A – Apply, An – Analyze, E – Evaluate, C – Create

**UNIT I**


Sea bed mining. Exploitation/Recovery/Mining/Extraction of petroleum. Mining legislation in India. Plans to be prepared and maintained in a mine – EMP, Mining Plan, Mine Closure Plan, Surface Plan, etc. Underground gasification of coal and lignite.

**UNIT II**


**UNIT III**

Scales of measurement: nominal, ordinal, interval and ratio; Averages: mean, median, mode, GM and HM; Measures of dispersion: Range, Mean deviation, Variance, Standard deviation, and quartile deviation, coefficient of variation (Only the Concepts & numerical problems in the field of geology).
Elements of probability: random experiments, sample space, event, disjoint events, definitions of probability, independence of events. Addition theorem, multiplication theorem, Bayes’ theorem (statements and simple problems).

UNIT IV
Concept of Random variables, probability distributions; standard probability distributions: Binomial, Poisson, and normal (examples and applications in Geology).
Importance of sampling in data collection; sampling techniques: simple random sampling, systematic sampling, stratified sampling, cluster sampling (methods, situations and examples);
Parameter and statistic; sampling distributions: normal, t, chi square and F (definitions, relation and applications).

UNIT V
Introduction to statistical inference: estimation, testing of hypothesis (basic principles, importance of statistical inference in decision making with suitable examples in Geology); t-test of mean, t-test for equality of means, Chi square test of independence, analysis of variance: one-way and two-way (numerical problems); Non-parametric tests (name of the tests and their applications only).

UNIT VI
Geological measurements of sequences of data: correlation and simple linear regression (concepts, least squares method, simple problems in geology);
Moving averages and Kriging, trend analysis, multiple regression, principle component analysis, discriminant analysis, cluster analysis, factor analysis (Only the Concepts and applications in Geology).

References
Davis J. C. Statistics and data analysis in Geology. Wiley.
Krumbein M. B. and Gray Hill H. A. Introduction to statistical methods.
Taggart A. P. Handbook of mineral dressing. Wiley.
Bhaskarathondaiman K. Blasting technology. India Cements Tirunelveli.
Surana I. S. Mining without drilling and blasting Mining Engineers Journal v 2(9), 2000.
GEOMORPHOLOGY

Interpretation of topographic maps and identification of salient geomorphic features. Morphometric studies.

AIM
To study and interpret topographic sheets and identify salient geomorphic features and to carry out morphometric analysis of drainage basins.

OBJECTIVES

1) To study the basic information from toposheets, viz., Scale, Index, Grid reference, Area location and Contour interval.
2) To make measurements from toposheets and determine distances between places, slopes, lengths of natural and man-made features and areas.
3) To identify and describe the salient geomorphic features such as hills, valleys and drainage networks and patterns.
4) To carry out morphometric analysis of drainage basins.

Course outcome GL 224: Practical I GEOMORPHOLOGY

CO 1: Identify and describe basic information of toposheets like Scale, Index, Grid reference, Area location and Contour interval; and make measurements, determine parameters like distances between places, slopes, lengths of natural and man-made features and areas.

CO 2: Identify and describe salient geomorphic features like hills, valleys and drainage networks and patterns in toposheets.

CO 3: Execute the various steps involved in morphometric analysis of drainage basins like stream ordering and determine the parameters like drainage area, basin length, length of streams, drainage density, stream frequency, bifurcation ratio and estimate relationships of parameters using regression analysis.

CO – PSO map

<table>
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<tr>
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<tbody>
<tr>
<td>CO 1</td>
<td>Identify and describe basic information of toposheets like Scale, Index, Grid reference, Area location and Contour interval; and make measurements, determine parameters like distances between places, slopes, lengths of natural and man-made features and areas.</td>
<td>Apply &amp; Analyze</td>
<td>F, C &amp; P</td>
<td>PSO1</td>
</tr>
</tbody>
</table>

OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
STRUCTURAL GEOLOGY

Interpretation of geologic maps. Trigonometric, graphic and stereographic solution to problems in structural geology. Geometric analysis of planar and linear structures.

AIM
To understand and analyse geological maps, structural problems and stereographic projections.

OBJECTIVES
The objectives of this course are: (i) to develop an understanding of geological maps and to develop how to draw the cross section of map. (ii) to know how to solve different structural problems. (iii) analysis of structures based on stereographic projection.

Course outcomes

CO1: Application of stereographic and equal area projections in the representation of structures and geometric analysis of folds and lineations.

CO2: Understand the interpretation of geologic maps. Analyse the Trigonometric, graphic and stereographic problems.

CO – PSO

<table>
<thead>
<tr>
<th>CO No.</th>
<th>CO Statements</th>
<th>Cognitive Level</th>
<th>Knowledge Category</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO 1</td>
<td>Application of stereographic and equal area projections in the representation of structures and geometric analysis of folds and lineations.</td>
<td>U, Analyze</td>
<td>F, C &amp; P</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO 2</td>
<td>Understand the interpretation of geologic maps. Analyse the Trigonometric, graphic and stereographic problems.</td>
<td>U, Analyze</td>
<td>F, C &amp; P</td>
<td>PSO2</td>
</tr>
</tbody>
</table>

Knowledge category: F – Factual  C – Conceptual  P – Procedural
Cognitive levels: R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create
CRYSTALLOGRAPHY AND MINERALOGY

CRYSTALLOGRAPHY – Stereographic projections – normal class isometric, tetragonal, hexagonal, trigonal, orthorhombic and monoclinic systems.
Calculation of the crystal elements, equation of normals, axial ratios, interfacial angles, indices of faces, Weiss zone law, rule of three faces in a zone, derivation of Millerian sign for a cozonal quartette.

AIM
To understand and analyse geological maps, structural problems and stereographic projections.

OBJECTIVES
The objectives of this course are: (i) to develop an understanding of geological maps and to develop how to draw the cross section of map. (ii) to know how to solve different structural problems. (iii) analysis of structures based on stereographic projection.

Course outcomes
CO1: Understand Stereographic projections of normal classes of crystals.
CO2: Understand different problems related to crystal elements and their applications.

CO – PSO map

<table>
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<tr>
<th>CO No.</th>
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<tbody>
<tr>
<td>CO1</td>
<td>Understand Stereographic projections of normal classes of crystals</td>
<td>U, Analyze</td>
<td>F, C &amp; P</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand different problems related to crystal elements and their applications</td>
<td>U, Analyze</td>
<td>F, C &amp; P</td>
<td>PSO2</td>
</tr>
</tbody>
</table>

Knowledge category: F – Factual  C – Conceptual  P – Procedural
Cognitive levels: R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create

MINERALOGY: OPTICAL MINERALOGY
Determination of the following optical characters of minerals by classical methods:
Relative refringence, order of interference colour, sign of elongation, birefringence, scheme of pleochroism and pleochroic formula, optic orientation, extinction angle, anorthite content.

MINERALOGY: MINERAL CHEMISTRY
Mineralogical calculations: garnet, olivine, pyroxene, feldspar and feldspathoid.
AIM

To develop skills in determining diagnostics optical properties of rock forming minerals in thin sections and to determine mineral formula using mineral chemical data.

OBJECTIVES

Understand how optical properties of minerals are diagnostic of each mineral and also to determine the mineral formula from chemistry of minerals

Course outcomes

**CO1: Understand and evaluate** important optical parameters of minerals using polarising microscope and optical accessories.

**CO2: Understand and evaluate mineral chemistry** by stoichiometric calculations, using chemical analysis data of members of important mineral families.

<table>
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<th>Cognitive Level</th>
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<tbody>
<tr>
<td>CO1</td>
<td><strong>Understand and determine important optical parameters of minerals using polarising microscope and optical accessories.</strong></td>
<td>U, Analyse, Apply, Evaluate</td>
<td>F &amp; C</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO2</td>
<td><strong>Understand mineral chemistry</strong> by stoichiometric calculations, using chemical analysis data of members of important mineral families.</td>
<td>U, Analyse, Apply, Evaluate</td>
<td>F &amp; C</td>
<td>PSO2</td>
</tr>
</tbody>
</table>

Knowledge category: F – Factual, C – Conceptual, P – Procedural

Cognitive levels: R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create

**GL 225: Practical II

SEDIMENTOLOGY, REMOTE SENSING AND SURVEY

SEDIMENTOLOGY: Textural analysis of sediments – Sieve analysis, settling analysis, thin section size analysis, measurement and calculation of shape parameters, plotting and interpretation of such data. Heavy mineral separation.

Study of thin sections and hand specimens of limestone, sandstone, shale, conglomerate, breccia and arkose. Study of grain mounts of magnetite, ilmenite, monazite, garnet, quartz and chromite.

AIM

To determine and analyze the sediment texture, heavy mineral assemblages and, properties of sedimentary rock and placer minerals

OBE syllabus MSc Geology Affiliated colleges effective from 2020 admissions
OBJECTIVES

To determine and analyze the i) how the sediment texture and heavy mineral assemblage changes in sediments ii) how the sedimentary rock characteristics changes in hand specimen and thin section iii) how the placer mineral characteristics changes in grain mounts.

Course outcomes

CO1: Determine the sediment texture using sieve, settling and microscopic methods, and shape parameters, and analyzes of such data
CO2: Determine the mineral assemblage using heavy mineral separation and analyze of such data
CO3: Determine the hand specimen and thin section properties of sedimentary rocks and analyzes of such data
CO4: Determine the grain mount properties of placer minerals and analyzes of such data

CO – PSO map

<table>
<thead>
<tr>
<th>CO No.</th>
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<th>Cognitive Level</th>
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<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO 1</td>
<td>Determine the sediment texture using sieve, settling and microscopic methods, and shape parameters, and analyzes of such data</td>
<td>Apply &amp; Analyze</td>
<td>F, C &amp; P</td>
<td>PSO3</td>
</tr>
<tr>
<td>CO 2</td>
<td>Determine the mineral assemblage using heavy mineral separation and analyze of such data</td>
<td>Apply &amp; Analyze</td>
<td>F, C &amp; P</td>
<td>PSO3</td>
</tr>
<tr>
<td>CO 3</td>
<td>Determine the hand specimen and thin section properties of sedimentary rocks and analyzes of such data</td>
<td>Apply &amp; Analyze</td>
<td>F, C &amp;P</td>
<td>PSO3</td>
</tr>
<tr>
<td>CO 4</td>
<td>Determine the grain mount properties of placer minerals and analyzes of such data</td>
<td>Apply &amp; Analyze</td>
<td>F, C &amp; P</td>
<td>PSO</td>
</tr>
</tbody>
</table>

Knowledge category: F – Factual C – Conceptual P – Procedural
Cognitive levels: R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create


AIM

To identify drainage features, land use patterns, geomorphological features, environmental features, lineaments, lithological features and geological structures in aerial photographs and to carry out a general study of satellite imageries. To acquire the knowledge and skill of the methods of survey.

OBJECTIVES
To identify, describe and interpret from aerial photographs: 1) drainage features, 2) land use patterns, 3) geomorphological features, 4) environmental features, 5) lineaments, 6) lithologies and litho-contacts, and 7) geological structures. To study the general information and characteristics of satellite imagery. To study the methods of survey viz., 1) Plane Table Method, 2) Intersection Method and 3) Radiation Method.

Course outcomes

CO 1: Identify, describe and interpret drainage features, land use patterns, geomorphological features, environmental features, lineaments, lithologies and litho-contacts, and geological structures from aerial photos.

CO 2: Describe the basic information from satellite imagery like source, year, reference grids, area imaged, etc.

CO 3: Understand the principles of Surveying in Civil Engineering and carry out the different methods of survey viz., Plane Table Method, Intersection Method and Radiation Method.

CO – PSO map

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<td>CO 1</td>
<td>Identify, describe and interpret drainage features, land use patterns, geomorphological features, environmental features, lineaments, lithologies and litho-contacts, and geological structures from aerial photos.</td>
<td>Apply &amp; Analyze</td>
<td>F, C &amp; P</td>
<td>PSO5</td>
</tr>
<tr>
<td>CO 2</td>
<td>Describe the basic information from satellite imagery like source, year, reference grids, area imaged, etc.</td>
<td>Apply &amp; Analyze</td>
<td>F, C &amp; P</td>
<td>PSO5</td>
</tr>
<tr>
<td>CO 3</td>
<td>Understand the principles of Surveying in Civil Engineering and carry out the different methods of survey viz., Plane Table Method, Intersection Method and Radiation Method.</td>
<td>Apply &amp; Analyze</td>
<td>F, C &amp; P</td>
<td>PSO5</td>
</tr>
</tbody>
</table>

Knowledge category: F – Factual  C – Conceptual  P – Procedural
Cognitive levels: R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create

GL 244: Practical III

IGNEOUS AND METAMORPHIC PETROLOGY AND HYDROGEOLOGY


Determination of modal composition, calculation of CIPW norms. Niggli values. Variation diagrams of Harker, Larsen, Niggli and Nockold and Allen. Spider diagrams. Calculation of differentiation index, Peacock’s alkali-lime index, Mg number, A/CNK values, use of triangular...
diagrams in the classification of igneous rocks. Construction of phase diagrams from experimental data in the following systems. Diopside-Anorthite, Anorthite-Albite, Forsterite-Silica. Computations of the course of crystallisation of magmas of various compositions in the above systems consequent on fractional crystallisation and assimilation.

**AIM**

To understand igneous and metamorphic processes, types and genesis of igneous and metamorphic rocks through study of mineralogy and geochemical plotting.

**OBJECTIVE**

The objective of this course are to develop an understanding of the mineralogy and textures of igneous and metamorphic rocks, and how phase rule applies to metamorphic mineral paragenesis, and the use of variation diagrams and triangle plots in deciphering the evolution of these rocks.

**COURSE OUTCOME**

**CO1**: To analyze the texture, microstructure, mineralogy and genetic significance of different igneous rocks in hand specimen and under the microscope

**CO2**: Calculation of CIPW Norm and their interpretation using the different indices and ratios of magmatic differentiation

**CO3**: The preparation of variation diagrams of Harker, Larsen, Niggli and Allen- Nockolds for the given geochemical data

**CO4**: The preparation of some common triangular diagrams in the classification of igneous rocks

**CO5**: Identify metamorphic rocks and analyse metamorphic mineral paragenesis using chemographic diagrams

**CO-PSO Map**

<table>
<thead>
<tr>
<th>CO</th>
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<th>Cognitive Level</th>
<th>Knowledge Category</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>To analyze the texture, microstructure, mineralogy and genetic significance of different igneous rocks in hand specimen and under the microscope</td>
<td>U</td>
<td>F, C</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO2</td>
<td>Calculation of CIPW Norm and their interpretation using the different indices and ratios of magmatic differentiation</td>
<td>U</td>
<td>F, C</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO3</td>
<td>The preparation of variation diagrams of Harker, Larsen, Niggli and Allen- Nockolds for the given geochemical data</td>
<td>U</td>
<td>F, C</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO4</td>
<td>The preparation of some common triangular diagrams in the classification of igneous rocks</td>
<td>U</td>
<td>F, C</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO5</td>
<td>Identify metamorphic rocks and analyse metamorphic mineral paragenesis using chemographic diagrams</td>
<td>A</td>
<td>F, P, A</td>
<td>PSO2</td>
</tr>
</tbody>
</table>

Knowledge category: F – Factual  C – Conceptual  P – Procedural

Cognitive levels: R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create
GL 244: PRACTICAL III


AIM

To solve problems and execute practical exercises related to the occurrence, distribution and movement of groundwater, determine the aquifer parameters from pumping test data to quantify aquifers and to determine the quality of groundwater for domestic and agricultural purposes using typical graphical representations.

OBJECTIVES

1) To study the occurrence, distribution and movement of groundwater using figures, water table contours and solve problems related to Darcy’s law.

2) To determine the aquifer parameters from pumping test data to quantify aquifers.

3) To determine the quality of groundwater for domestic and agricultural purposes using typical graphical representations like Hill-Piper Trilinear diagram and U.S. Salinity diagram.

Course outcome GL 244: Practical III HYDROGEOLOGY

CO 1: Describe and sketch the information related to the occurrence, distribution and movement of groundwater using figures like hydrological cycle, vertical distribution of groundwater, and water table contours; and solve problems based on Darcy’s law.

CO 2: Quantify aquifers by computing aquifer parameters like Hydraulic conductivity, Transmissivity and Storativity, using pumping test data.

CO 3: Determine groundwater quality for domestic and agricultural purposes using graphical representation like Hill-Piper Trilinear diagram and U.S. Salinity diagram.

CO – PSO map

<table>
<thead>
<tr>
<th>CO No.</th>
<th>CO Statements</th>
<th>Cognitive Level</th>
<th>Knowledge Category</th>
<th>PSO</th>
</tr>
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<tbody>
<tr>
<td>CO 1</td>
<td>Describe and sketch the information related to the occurrence, distribution and movement of groundwater using figures like hydrological cycle, vertical distribution of groundwater, and water table contours; and solve problems based on Darcy’s law.</td>
<td>Apply &amp; Analyze</td>
<td>F, C &amp; P</td>
<td>PSO5</td>
</tr>
<tr>
<td>CO 2</td>
<td>Quantify aquifers by computing aquifer parameters like Hydraulic conductivity, Transmissivity and Storativity, using pumping test data.</td>
<td>Apply &amp; Analyze</td>
<td>F, C &amp; P</td>
<td>PSO5</td>
</tr>
</tbody>
</table>
Determine groundwater quality for domestic and agricultural purposes using graphical representation like Hill-Piper Trilinear diagram and U.S. Salinity diagram.

<table>
<thead>
<tr>
<th>CO No.</th>
<th>CO Statements</th>
<th>Cognitive Level</th>
<th>Knowledge Category</th>
<th>PSO</th>
</tr>
</thead>
</table>
| CO 3   | Analyze data on mineral production, use and export                            | Apply & Analyze | F, C & P           | PSO5

Knowledge category: F – Factual  C – Conceptual  P – Procedural
Cognitive levels: R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create

GL 245: Practical IV

ECONOMIC GEOLOGY, EXPLORATION GEOLOGY AND APPLIED GEOLOGY

ECONOMIC GEOLOGY: Collection and display of data on production, consumption and export of important minerals, coal and petroleum in India. Megascopic identification of ore minerals.

AIM
Analyse data on mineral production, use and consumption, as well as identify ore minerals.

Objective
Develop the capability to analyze data on mineral production, use and export as well as the capability to identify ore minerals.

Course outcomes
CO1: Analyze data on mineral production, use and export
CO2: Identify ore minerals

<table>
<thead>
<tr>
<th>CO No.</th>
<th>CO Statements</th>
<th>Cognitive Level</th>
<th>Knowledge Category</th>
<th>PSO</th>
</tr>
</thead>
</table>
| CO 1   | Analyze data on mineral production, use and export | Apply & Analyze | F, C & P           | PSO2
| CO 2   | Identify ore minerals | U              | F & P              | PSO2

Knowledge category: F – Factual  C – Conceptual  P – Procedural
Cognitive levels: R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create

EXPLORATION GEOLOGY: Averaging assays, estimation of ore reserves, cut off grade, core logging and interpretations from litholog plotting.

EXPLORATION GEOLOGY AND APPLIED GEOLOGY

AIM
To estimate ore reserves, and design process flow charts and understand ore blending

OBJECTIVES
Undertand the baics of ore reserve estimation, and also design process flow charts in mineral processing, and mining related calculations.

Course outcomes

CO1: Estimate ore reserves by plan and cross section methods, make interpretations by plotting core drilling data.
CO2: Apply the various ore dressing and beneficiation methods for designing process flow charts in mineral processing, calculate ore and overburden ratios for open cast mining, determine ore blending proportions for grade enhancement.

CO – PSO map

<table>
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<tr>
<th>CO No.</th>
<th>CO Statements</th>
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<th>Knowledge Category</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Estimate ore reserves by plan and cross section methods, make interpretations by plotting core drilling data.</td>
<td>U, Analyse, Apply, Evaluate</td>
<td>F &amp; C</td>
<td>PSO2</td>
</tr>
<tr>
<td>CO2</td>
<td>Apply the various ore dressing and beneficiation methods for designing process flow charts in mineral processing, calculate ore and overburden ratios for open cast mining, determine ore blending proportions for grade enhancement.</td>
<td>U, Analyze, Apply</td>
<td>F, C, P</td>
<td>PSO2</td>
</tr>
</tbody>
</table>

Knowledge category: F – Factual C – Conceptual P – Procedural

Cognitive levels: R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create

DISSEMINATION

Aim
Dissertation is to empower the student to develop critical thinking, innovative research ideas, and deeper knowledge in the subject.

Objective
To develop skills which enable the synthesis of knowledge and improve scientific field work, data collection, analysis and writing skills. To develop and enhance independent research skills.
Course outcomes

**CO 1:** Understand a specific area of the subject in-depth including deeper insight into current research and development work, through primary, secondary and tertiary sources of information.

**CO2:** Plan the research, identify the problem, field area, collect data, classify and analyse the data.

**CO3:** Understand the methodology in the chosen research area and develop the critical thinking ability to choose the most appropriate methodology for the particular research problem.

**CO4:** Develop capability to use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.

**CO5:** Critically and systematically integrate the findings of the research into the current scenario in the area of research, with concern for and conscious of the ethical aspects of research.

**CO6:** Evaluate the results through writing the thesis and presenting the results to a learned audience.

### CO – PSO map

<table>
<thead>
<tr>
<th>CO No.</th>
<th>CO Statements</th>
<th>Cognitive Level</th>
<th>Knowledge Category</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand a specific area of the subject in-depth including deeper insight into current research and development work, through primary, secondary and tertiary sources of information.</td>
<td>U&amp;A</td>
<td>F &amp; C</td>
<td>F &amp; C</td>
<td>PSO6</td>
</tr>
<tr>
<td>CO2</td>
<td>Plan the research, identify the problem, field area, collect data, classify and analyse the data.</td>
<td>U,A&amp;E</td>
<td>F,P &amp; C</td>
<td>F,P &amp; C</td>
<td>PSO6</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the methodology in the chosen research area and develop the critical thinking ability to choose the most appropriate methodology for the particular research problem.</td>
<td>A&amp;E</td>
<td>F,P&amp; C</td>
<td>F,P&amp; C</td>
<td>PSO6</td>
</tr>
<tr>
<td>CO4</td>
<td>Develop capability to use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.</td>
<td>E&amp;C</td>
<td>F,C&amp;P</td>
<td>F,C&amp;P</td>
<td>PSO6</td>
</tr>
<tr>
<td>CO5</td>
<td>Critically and systematically integrate the findings of the research into the current scenario in the area of research, with concern for and conscious of the ethical aspects of research.</td>
<td>E&amp;C</td>
<td>F,P &amp; C</td>
<td>F,P &amp; C</td>
<td>PSO6</td>
</tr>
<tr>
<td>CO6</td>
<td>Evaluate the results through writing the thesis and presenting the results to a learned audience.</td>
<td>A&amp;C</td>
<td>F&amp;C</td>
<td>F&amp;C</td>
<td>PSO6</td>
</tr>
</tbody>
</table>

**Knowledge category:** F – Factual     C – Conceptual     P – Procedural

**Cognitive levels:** R – Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, C – Create

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Appendix I

Action Verbs associated with Bloom’s cognitive levels

**Remember**
- Recognize/Identify
- Recall/Retrieve: List, mention, state, draw, label, define, name, describe, prove a theorem tell, show, label, collect, examine, tabulate, quote, who, when, where, etc.

**Understand**
- Interpret: Translate, paraphrase, represent, describe, express, extend and clarify
- Exemplify: Illustrate and instantiate
- Classify: Categorize and subsume
- Summarize: Generalize and abstract
- Infer: Extrapolate, interpolate, predict, conclude
- Compare: Contrast, match, map, distinguish and differentiate
- Explain: Illustrate, construct a model, confirm, state, write down, associate and discuss

**Apply**
- Execute: Determine, calculate, compute, estimate solve, use, draw, and carry out (a procedure in known situation)
- Implementing: Determine, calculate, compute, estimate solve, use draw, and carry out (a procedure in unfamiliar situation)

**Analyze**
- Differentiate: discriminate, select, focus and distinguish (between accurate and inaccurate, cause and effect, consistent and inconsistent, dominant and subordinate, essential and inessential, facts and conclusions, facts and hypotheses, facts and inferences, facts and opinions, facts and value statements, plausible and implausible, possible and impossible, relevant and irrelevant, summaries and conclusions, supportive and contradictory, valid and invalid, verifiable and unverifiable, warranted and unwarranted)
- Organize: Identify (adequacy, assumptions, attributes, biases, causes, central issues, completeness, concepts, consequences, contradictions, criteria, defects, distortions, effects, elements, errors, exceptions, fallacies, inconsistencies, inferences, limitations, main ideas, nature of evidence, organization, plausibility, problems, procedures, reasoning, relationships, relevance, stereotypes, trends, validity, variables), structure, integrate, find coherence, outline and parse.
- Attribute: Deconstruct and ascertain (Assumptions, attitudes, biases, conditions, characteristics, motives, organization, points of view, purposes, qualities, relationships)

**Evaluate**
- Check/test (Accuracy, adequacy, appropriateness, clarity, cohesiveness, completeness, consistency, correctness, credibility, organization, reasonableness, reasoning, relationships, reliability, significance, usefulness, validity, values, worth), detect, monitor and coordinate.
- Critique/judge (Criteria, standards, and procedures)

**Create**
- Generate alternatives and hypotheses
- Plan/design
- Produce/construct

(Source: N.J.Rao, Nov 2010)
Appendix II

Educational Taxonomy

*has four* knowledge categories and *six* cognitive levels.

**Knowledge categories**

- Factual
- Conceptual
- Procedural
- Meta cognitive

**Cognitive levels**

- Remember
- Understand
- Apply
- Analyze
- Evaluate
- Create

**Program Outcomes (POs)** are those qualities that should be developed in any student by the end of their studies at any institution, and therefore, to be identified by the University/Institution.

**Examples**

- PO1 – Critical Thinking
- PO2 – Effective Communication
- PO3 – Effective Citizenship
- PO4 – Environment and Sustainability
- PO5 – Self-directed and Life-long learning
- PO6 – Social Interaction
- PO7 – Computational Thinking
- PO8 – Problem Solving
- PO9 – Global Perspective
- PO10 – Ethical conduct

**Program Specific Outcomes (PSO)**

PSOs are specific to a program (e.g., MSc Geology), and are to be identified by the users, e.g., for Geology, the users would be students, teachers, Board of Studies, Academic Council, etc of each University.

**Course outcomes (CO)**

Course Outcomes constitute the final attainment of POs and PSOs specifically through each course (or paper e.g, Hydrogeology)
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