

**Model Curriculum of
BScinEARTH SCIENCES**

5th& 6th Semester

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| Program Name | BSc in EARTH SCIENCES | Semester | V |
| Course Title | Environmental Science and Geotectonics (Theory) | | |
| Course Code: | ERS C-09 | No. of Credits | 04 |
| Contact hours | 60 Hours | Duration of | 2 |
| Formative Assessment | 40 | Summative Assessment Marks | 60 |

| | Contents | Hrs |
|--------|---|----------------------|
| Unit 1 | <p>Fundamentals of Environmental Science: Introduction, structure, composition and interactions among the land, atmosphere and ocean, Earth and Sun's relationships. Principles of weather and climate systems, and their impact on human activities. Meteorological hazards and extreme weather conditions (floods and droughts). Climate classifications and climatic zones of the earth with special reference to India. Proxies for understanding the long-term variations in the climate.</p> <p>Introduction to biogeochemical cycling of elements. Composition of air, water and sediments and its governing factors, including human activity. Principles of an ecosystem including biotic, abiotic components and food web. biodiversity and its conservation. Sampling equipment and analytical methods followed in the measurement of different environmental parameters.</p> | 15hrs 1 Credit |
| Unit 2 | <p>Environmental pollution, mitigation and legislation: Introduction, primary and secondary sources of pollutants in the environment. Principles of soil, air, water pollution. National and international standards for evaluating air, soil and water pollution. Solid and effluent wastes management and mitigation. Noise, thermal and marine pollution.</p> <p>Environmental Laws and legislation related to impact assessment conservation of water biodiversity, Forest and solid waste management.</p> | 15hrs 1 Credit |
| Unit 3 | <p>Introduction to geotectonics and global tectonics. Composition, mineralogy, and density and temperature variations in the interior layers of the earth. Continental and oceanic lithospheres, their interaction with the asthenosphere and upper mantle. Crustal heat-flow and its variations in different parts of the earth. Neotectonics and its importance in sea-level fluctuations.</p> <p>Volcanic hazard: Introduction, Types of volcanoes, Volcanic form and structure, Types of central eruption, Causes of volcanic eruptions, Volcanic products: volatiles, Volcanic products: pyroclasts, Volcanic products: lava flows, Specific threats, Community impacts, Volcanic hazard and prediction Mitigation strategies</p> <p>Mass movements: Soil creep and valley bulging, Causes of landslides, Classification of landslides, Landslides in soils Landslides in rock masses, A brief note on slope stability analysis. Monitoring slopes, Landslide hazard, investigation and mapping, Methods of slope control and stabilization Landslide Specific threats, Community impacts, Mitigation strategies.</p> | 15hrs 1 Credit |

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| Unit 4 | <p>Geodynamic processes: Morphology of the continental and oceanic floors. Continental Drift, different lines of evidence to support this hypothesis. The concept of the super continents and their fragmentation and migration in the history of the Earth. Sea-floor spreading, magnetic anomalies to support this hypothesis. Plate tectonics. Convergent and divergent plate boundaries, triple junction, hotspots and mantle plumes.</p> <p>Seismology: Earthquakes, and its prediction and measurement. Seismic zones of India. Seismic Tomography. Thermal springs and geothermal energy. Concept of vertical tectonics, isostasy and its adjustment with reference to glacial isostatic adjustment. Mountains, their types and building up of the Alpine-Himalayan mountain chain. Major mountains of India and their significance.</p> | 15hrs 1 Credit |
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Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

| References | |
|------------|--|
| 1 | Andrews, J.E., Brimblecombe, P., Jickells, T.D., Liss, P.S. and Reid, B. (2009). An introduction to environmental chemistry. John Wiley & Sons. |
| 2 | Belousov, V.V. (1980) Geotectonics. Mir Publishers, Moscow, Springer-Verlag, 330 pp., 1980. ISBN: 978-3-642-67176-0 |
| 3 | Bloom A.L., 2001: Geomorphology: A Systematic Analysis of Late Cenozoic Landforms, Prentice-Hall of India, New Delhi |
| 4 | Condie, K.C. (2013). Plate tectonics & crustal evolution. Elsevier. |
| 5 | Keller, E.A. (2007). Introduction to environmental geology. Prentice-Hall, Inc.. |
| 6 | Knödel, K., Lange, G. and Voigt, H.J., 2007. Environmental geology: handbook of field methods and case studies. Springer Science & Business Media. |
| 7 | Mackenzie, F.T. (2011) Our Changing Planet: An Introduction to Earth System Science and Global Environmental Change, 4th edition, Prentice Hall, New York, N.Y., 579 pp. |
| 8 | Scheidegger, A.E. (2012). Principles of geodynamics. Springer Science & Business Media. |
| 9 | Skinner, Brian J. and Stephen C. Porter (2000), The Dynamic Earth: An Introduction to physical Geology, 4th Edition, John Wiley and Sons |
| 10 | Turcotte, D.L. and Schubert, G. (2012) Geodynamics 2nd edition, Cambridge University Press, 2012, ISBN-13: 978-0521666244 (available in the internet). |
| 11 | Valdiya, K.S. (2004). Geology, Environment, and Society. Universities Press. |
| 12 | Valdiya, K.S. (2013). Environmental Geology: Ecology, Resource and Hazard Management. McGraw-Hill Education. |
| 13 | Valdiya, K.S., and Sanwal, J. (2017). Neotectonism in the Indian Subcontinent: landscape evolution. Elsevier. |

| Formative Assessment for Theory | |
|--|-----------------|
| Assessment Occasion/ type | Marks |
| Attendance | 10 |
| Seminar | 10 |
| Debate/Quiz/Assignment | 10 |
| Class test | 10 |
| Total | 40 Marks |
| Formative Assessment as per guidelines are compulsory | |

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|--|---|----------------------|-------------------------|
| Course Title | Structural Geology and Field Visit (Practical) | Practical Credits | 02 |
| Course Code | ERS C-10 | Contact Hours | 4 Hours per week |
| Formative Assessment | 25 Marks | Summative Assessment | 25 Marks |
| Practical Content | | | |
| <ol style="list-style-type: none"> 1. Thickness calculation problems. 2. Dip and strike Problems. 3. Interpretation of underground structure from borehole data. 4. Construction of geological cross-section. 5. Structural contour maps: Tracing of Outcrops. 6. Field Visits | | | |

Pedagogy: Experiential learning, Problem solving, Project

| Formative Assessment for Practical | |
|--|-----------------|
| Assessment Occasion/ type | Marks |
| Class Records | 05 |
| Test | 10 |
| Attendance | 05 |
| Performance | 05 |
| Total | 25 Marks |
| <i>Formative Assessment as per guidelines are compulsory</i> | |

References:

Billings, M.P. (1978) Structural Geology – Prentice – Hall of India Private Ltd. New Delhi.
Manual of geological maps N W GOKHALE
Suppe, J.(1985) – Principles of structural geology – Prentice – Hall
Badgley P.C. – Structural Geology for the exploration geologist.
Whitten, T- Structural Geology.

Field Visits:

Visit to important field areas showing good geological settings. Some selected areas like: Chitradurga Schist Belt, Kaladgi and Badami, Karighatta, Doddakanya mines, Pegmatite dykes in and around KRS Dam, Holenarasipura, Bageshapura, Chamundi Hills, Hutti Gold Mines, Arasikere areas, Byrapur, Ingaldhal, famous Igneous, Sedimentary and Metamorphic terrains of Karnataka.

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| Program Name | BSc in EARTH SCIENCES | Semester | V |
| Course Title | Geochemistry and Mining Geology (Theory) | | |
| Course Code: | ERS C-11 | No. of Credits | 04 |
| Contact hours | 60 Hours | Duration of SEA/Exam | 2 hours |
| Formative Assessment Marks | 40 | Summative Assessment Marks | 60 |

| Contents | | 45 Hrs |
|--------------------------|---|-----------------|
| Geochemistry | | |
| Unit 1 | Geochemistry: Basic concepts and Scope of Geochemistry. Geochemical classification of elements, Age, origin and composition of the universe with special reference to solar system. Biochemical classification of element and geochemical cycles. | 15hrs 1 Credit |
| Unit 2 | Geochemistry- Elements, Atoms, and Chemical Bonds, Principles of Geothermobarometry. Energy, Entropy and Fundamental Thermodynamic Concepts, Laws of Thermodynamics, Enthalpy, Entropy, Heat capacity and free energy, concept of equilibrium and equilibrium constant. Gibbs phase rule, application to mineralogical system - Forsterite-Fayalite; Albite-Anorthite; Albite-Orthoclase. Forsterite-Quartz and Diopside-Anorthite. Isotope geochemistry. | 15 hrs 1 credit |
| Mining Geology | | |
| Unit 3 | Introduction, mining terminologies, Classification of mining methods – Alluvial mining methods, open-cast mining methods, Quarrying, Underground mining methods – Open stopes, stoping with supports. Geological parameters for mine planning and designing. Drilling: methods and types of drilling methods and their uses. Mine safety, mine ventilation, Mining hazards, advantages and disadvantages of surface and subsurface mining. Impact of mining and mineral processing on environment and human health. | 15hrs 1 Credit |
| Mineral Economics | | |
| Unit 4 | Concept of economics and its importance in national development and economy. Resource scenario of India. Production, demand, supply and substitution of natural resources in global context. Structure and organisation of mineral industry, valuation of mineral property. Mineral deposits – meaning, specialities. Mineral legislation in India, Concept of mineral resources and its estimation, classification of mineral resources – Indian and International. Mineral legislation, national mineral policy, Mineral Conservation: Introduction, Growth and awareness. Methods of conservation. Limitations in the scope of conservation. | 15hrs 1 Credit |

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

| Formative Assessment for Theory | |
|--|-----------------|
| Assessment | Marks |
| Attendance | 10 |
| Seminar | 10 |
| Debate/Quiz/Assignm | 10 |
| Class test | 10 |
| Total | 40 Marks |
| <i>Formative Assessment as per guidelines are compulsory</i> | |

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|----------------------|--------------------------------|----------------------|-------------------------|
| Course Title | Ore Geology (Practical) | Practical Credits | 02 |
| Course Code | ERS C-14 | Contact Hours | 4 Hours per week |
| Formative Assessment | 25 Marks | Summative Assessment | 25 Marks |

Practical Content

Identification (with the help of physical properties), chemical composition, origin and Indian occurrences of the following Ore minerals and Industrial minerals

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|------------|------------|-----------|-------------|--------------|------------|
| Barite | Bauxite | Biotite | Calcite | Chalcopyrite | Chromite |
| Cuprite | Dolomite | Fluorite | Galena | Garnet | Graphite |
| Gypsum | Hematite | Ilmenite | Kyanite | Limonite | Magnesite |
| Magnetite | Malachite | Muscovite | Psilomelane | Pyrite | Pyrolusite |
| Serpentine | Sphalerite | Stibnite | Talc | Tourmaline | |

Distribution of mineral deposits

Formation, association and Indian distribution of following ore minerals: Mica, Copper, Manganese, Lead and Zinc, Bauxite, Chromite and Gold

Numerical on Ore reserve estimation

Pedagogy: Experiential learning, Problem solving, Project

| Formative Assessment for Practical | |
|--|-----------------|
| Assessment Occasion/type | Marks |
| Class Records | 05 |
| Test | 10 |
| Attendance | 05 |
| Performance | 05 |
| Total | 25 Marks |
| <i>Formative Assessment as per guidelines are compulsory</i> | |

| References | |
|-------------------|---|
| 1 | William M. White, Geochemistry, 2013, Wiley-Blackwell |
| 2 | Krauskopf, K. B. and D. K. Bird. 1995. Introduction to Geochemistry. New York: McGraw-hill. |
| 3 | Principles of Geochemistry – Brain Mason |
| 4 | Geochemistry by Rankama and sahama |
| 5 | Rare earth element Geochemistry by Henderson |
| 6 | Elements of Mining Geology - Young |
| 7 | Elements of Mining - Lewis |
| 8 | Mining of mineral deposits - Shevyekov |
| 9 | Introduction of mining - stoces |
| 10 | Principles of Mining Geology, Arogyaswamy |
| 11 | An Introduction to Mineral Economics by K K Chatterjee |
| 12 | Mineral Economics by Sinha R.K & Sharma N L, Oxford & IBH |

Model curriculum for VI semester



Government of Karnataka

Model Curriculum

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|----------------------|------------------------------------|----------------------------|----------------|
| Program | BSc in EARTH SCIENCES | Semester | VI |
| Course Title | Exploration Geology(Theory) | | |
| Course Code: | ERS C-13 | No. of Credits | 04 |
| Contact hours | 60 Hours | Duration of | 2 hours |
| Formative Assessment | 40 | Summative Assessment Marks | 60 |

| | Contents | Hrs |
|--------|---|--------------------------|
| Unit 1 | Principles of Prospecting and Exploration. Methods of Prospecting. Geological Criteria and Guides, Exploratory Works- Sampling, Coning and Quartering, Drilling Methods and their types. Economic Evaluation of Mineral Deposits-Ore reserve estimation. Geochemical methods of exploration, Primary and secondary dispersion haloes, Methods of Geochemical exploration – Lithochemical, hydrogeochemical, biogeochemical, Atmogeochemical Methods. | 15hrs 1 Credit |
| Unit 2 | Solid Earth Geophysics: Introduction to Geophysics and its branches. Gravity field of earth. Geomagnetism, elements of earth's magnetism: Internal and External fields and their causes, Paleomagnetism, Polar wandering paths.Principles of Gravity method, geophysical anomalies, regional and local gravity anomalies, instruments, interpretation of gravity anomalies. Principles of Magnetic method, magnetic properties of rocks and minerals, various instruments used in magnetic prospecting, and interpretation of magnetic anomalies. Interpretation of anomalies of simple geometric bodies using gravity and magnetic methods. Principles of Seismic prospecting, Elastic properties of rocks and minerals, various seismic methods. Principle of electromagnetic seismograph, displacement meters, velocity meters, accelerometers, Broadband | 15hrs 1 Credit |

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| Unit 3 | <p>SPMethod:OriginofSP,applicationofSPsurveys.InducedPolarization(IP) Method: Origin of IP, Membrane and Electrode polarization, time and frequency domains of measurement, chargeability, percent frequency effect and metalfactor.</p> <p>Principles of Electromagnetic prospecting, various EM methods: VLF (very low frequency); AFMAG (Audio frequency magnetic) methods; and central frequency sounding; transient electromagnetic methods; magneto-telluric method; geomagnetic depth sounding. (Only working principles, limitation and its application in geology, No derivations and problems)</p> <p>Principles of Well logging method, instrumentations, operational procedures and interpretations of various geophysical logs: SP, resistivity</p> | 15hrs 1 Credit |
| Unit 4 | <p>Electrical properties of rocks and minerals, concepts and assumptions of horizontally stratified earth, anisotropy and its effects on electrical fields, geoelectric and geological sections, D.C Resistivity method. Concept of natural electric field, various electrode configurations, Profiling and Sounding (VES). Types of Sounding curves (A,K,Q,H Curves), Concept of Electrical Resistivity Tomography (ERT).</p> <p>Radiometric and Airborne Geophysics: Principles of radioactivity, radioactivity decay processes, units, radioactivity of rocks and minerals, Instruments, Ionization chamber, G-M counter, Scintillation counter, Gamma rayspectrometer</p> | 15 hrs 1 credit |

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

| References | |
|------------|--|
| 1 | Introduction to geophysical prospecting - Milton B Dobrin |
| 2 | Exploration geophysics – Jakaosku JJ |
| 3 | Outlinesofgeophysicalprospecting-Amanualforgeologists–MBRamachandraRao |
| 4 | Geophysical Methods in Geology – P V Sharama |
| 5 | Exploration Geophysics for geologist and Engineers – BhimasanakaranandGaur |
| 6 | Principles of Applied Geophysics – D S Paransis |
| 7 | Introduction to Geophysics – C H Howel |
| 8 | Fundamentals of Geophysics - William Lowrie |
| 9 | Applied Geophysics – W. M. Telford |

| Formative Assessment for Theory | |
|--|-----------------|
| Assessment Occasion/ type | Marks |
| Attendance | 10 |
| Seminar | 10 |
| Debate/Quiz/Assignment | 10 |
| Class test | 10 |
| Total | 40 Marks |
| <i>Formative Assessment as per guidelines are compulsory</i> | |

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|--|---------------------------------------|----------------------|-------------------|-------------------------|
| Course Title | Applied Geophysics (Practical) | | Practical Credits | 02 |
| Course Code | ERS C-14 | | Contact Hours | 4 Hours per week |
| Formative Assessment | 25 Marks | Summative Assessment | 25 Marks | |
| Practical Content | | | | |
| <ol style="list-style-type: none"> 1. Geophysical Surveys and their Applications (Magnetic, Gravity, Seismic and Electrical methods) 2. Study and interpretation of Electrical Resistivity Data, methods of resistivity profiling and sounding. Vertical Electrical Sounding and Interpretation of Resistivity Curves. Calculation of apparent resistivity; Curve matching techniques. 3. Interpretation of Magnetic, Gravity and Seismic Data. | | | | |

Pedagogy: Experiential learning, Problem solving, Project

| Formative Assessment for Practical | |
|--|-----------------|
| Assessment | Marks |
| Class Records | 05 |
| Test | 10 |
| Attendance | 05 |
| Performance | 05 |
| Total | 25 Marks |
| <i>Formative Assessment as per guidelines are compulsory</i> | |

References

1. Interpretation of Resistivity Data, US geological survey professional paper 499
2. Geophysics for Mineral Exploration: A Manual for Prospectors

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|----------------------|---|----------------------------|----------------|
| Program Name | BSc in EARTH SCIENCES | Semester | VI |
| Course Title | Mineral Processing and Marine Mineral Resources (Theory) | | |
| Course Code: | ERS C-15 | No. of Credits | 04 |
| Contact hours | 60 Hours | Duration of | 2 hours |
| Formative Assessment | 40 | Summative Assessment Marks | 60 |

| | | Contents | 45 Hrs |
|---------------------------|---|-----------------|-------------------|
| Mineral Processing | | | |
| Unit 1 | <p>Mineral Processing: Definition, scope and necessity of Mineral Processing. Physical properties of Ores and their importance in Mineral Processing. Sampling: Definition, purpose, types of sampling and measurements of accuracy of sampling. Simple problems on estimation of recovery and concentration ratio.</p> <p>Laboratory Analyses: Definition and measurement of particle size, screening and sub-sieve sizing. Wet and dry sieving. Graphical representation of size analysis data and their applications. Industrial screens and their efficiency. Liberation: Definition, importance and application of ore microscopy in liberation studies and its analysis. Methods of liberation and behavior of locked particles.</p> | | 15hrs 1 Credit |
| Unit 2 | <p>Methods of Separation: Gravity separation, Magnetic separation and Electrical separation. Flotation: Introduction, classification of flotation machines and machine features. Physical aspects of flotation. Electrokineticphenemenon, Electrical Double Layer at the Solid-Liquid interface. Adsorption and its characteristics, pH, Solid/Liquid ratio. Micro flotation tests, Laboratory flotation tests, Flotation Kinetics and Factors affecting flotation.</p> <p>Dewatering and Drying. Flocculation and dispersion, principles of flocculation and dispersion phenomena. Different types of flocculants used in dewatering techniques, selective flocculation and their applications. Dewatering by gravity sedimentation and by using screens. Applications of dewatering processes in mineral industries. Filtration: Principles and factors affecting the filtration, different types industrial filters, cake filtration. Centrifuging and drying: Different types of thermal dryers and their application, centrifugal sedimentation.</p> <p>Tailing Disposal: Tailing ponds and Design & construction, Types,</p> | | 15hrs 1 Credit |
| Marine Resources | | | |

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| Unit 3 | <p>Polymetallic nodule deposits: Introduction – First discovery of nodules from different environments. Distribution; morphology; internal structure; mineralogy; geochemistry; accretion rate and genesis. Hydrothermal sulfides: Introduction; geological setting, genesis – hydrothermal activities, direct / indirect evidences, hydrothermal circulation, black and white smokers, mineralogy; geochemistry; ancient analogues; exploration methods.</p> <p>Metalliferous sediments: Introduction, definition, characteristics, geological setting genesis; occurrences; ancient analogues; Red Sea deposits-geology history of exploration / discovery details of deposits. Phosphorites: Introduction, geological setting and occurrences; associations; form; mineralogy; geochemistry; environments of modern phosphorite deposition; controls on phosphorite formation; genesis - inorganic precipitation and replacement theories, long-term conversion of disseminated deposits.</p> | 15hrs 1 Credit |
| Unit 4 | <p>Placers: Introduction - Characteristics, placer minerals, classification, environments of placer mineral deposition - rivers, beaches and offshore areas; sand as a resource.</p> <p>Ocean-energy resources: Introduction - importance, general characteristics; tidal energy-potential, harnessing, special features of tidal power plants in operation / under active consideration; the Indian scenario.</p> | 15hrs 1 Credit |

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

| Formative Assessment for Theory | |
|--|-----------------|
| Assessment Occasion/ type | Marks |
| Attendance | 10 |
| Seminar | 10 |
| Debate/Quiz/Assignment | 10 |
| Class test | 10 |
| Total | 40 Marks |
| <i>Formative Assessment as per guidelines are compulsory</i> | |

List of Reference Books:

1. Indian Mineral Resources –Kirshnaswamy.
2. Industrial Minerals & Rocks of India - Allied Publishers - Deb, S.(1987)
3. Mineral Economics - Call.No.553 - Sinha &Sharma
4. Ore Deposits - W.H. Freeman - Park C.F.(1975).
5. Principles of Mineral Dressing: A.M.Gaudin
6. Ore Processing: S.K.Jain
7. Mineral Processing Technology: B.A.Wills
8. Text Book of Ore Dressing: A.F.Taggart
9. Hand Book of Mineral Dressing: A.F.Taggart
10. Mineral Processing – Recent advances and future trends: S.P. Mehrotra & P.Sarkar
11. Laboratory Experiments in Mineral Processing: S. Venkatachalam &Degaleeson
12. Practicle Size Measurement: T.Allen

13. Mineral Deposits of the Deep Ocean Floor – by Emery, K.O. and Skinner, Brian J(1977)
14. The Indian Ocean: Exploitable Mineral and Petroleum Resources: by [G. S. Roonwal](#) Springer Berlin Heidelberg (1986) 198pages.
15. Sedimentology and Petroleum Geology: Bjorlykke K.(1989).
16. Production of Oil and Gas: by [F. Abdulin](#)(1985).
17. Drilling Oil and Gas Wells by Sidorov, N. A., MIR Publishers (1985) (p.35).
18. Petroliferous basins of India: Bhandari et al.(Ed.).

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|--|-------------------------------------|----------------------|-------------------|-------------------------|
| Course Title | Economic Geology (Practical) | | Practical Credits | 02 |
| Course Code | ERS C-16 | | Contact Hours | 4 Hours per week |
| Formative Assessment | 25 Marks | Summative Assessment | 25 Marks | |
| Practical Content | | | | |
| <ol style="list-style-type: none"> 1. Megascopic study of important economic minerals. 2. Megascopic study of industrial minerals – Abrasives, Refractory, Ceramic, Fertilizer, Chemical minerals, Mineral pigments. 3. Microscopic study of important economic minerals. 4. Mineral sampling and statistical calculations. 5. Calculation of mineral and ore reserves – average thickness of bed, assay value, assay width, specific gravity, tonnage, grade, volume and life of mine. | | | | |

Pedagogy: Experiential learning, Problem solving, Project

| Formative Assessment for Practical | |
|--|-----------------|
| Assessment Occasion/type | Marks |
| Class Records | 05 |
| Test | 10 |
| Attendance | 05 |
| Performance | 05 |
| Total | 25 Marks |
| <i>Formative Assessment as per guidelines are compulsory</i> | |

CBCS Question Paper Pattern for UG Semester
DSC, DSEC & OEC

| | | | |
|--------------|--------------------------------|-------|-----------|
| Paper Code: | | Paper | |
| Duration of | 2 Hours | Max | 60 |
| Instruction: | Answer all the sections | | |

Section-A

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| | Marks |
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Section-B

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|-------|--------------|
| | Marks |
| | |

Section-C

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| | Marks |
| | |