DAVANGERE UNIVERSITY

Department of Geology

Shivagangotri, Davanagere – 577 007

Bachelor of Science (BSc) Semester Scheme of SEP

Curriculum Structure for Undergraduate Programme for 2024-25 batch onwards

Sem	Title of the Paper	Teaching Hours/ week	Semester End Exam	Internal Assessment	Total Marks	Credits	Duration of the Exam
V	Chemistry-5A-T	3	80	20	100	3	3
	Chemistry-5B-T	3	80	20	100	3	3
	Chemistry-5AB-P	3	40	10	50	2	3
	Botany-5A-T	3	80	20	100	3	3
	Botany-5B-T	3	80	20	100	3	3
	Botany-5AB-P	3	40	10	50	2	3
	Structural Geology and Engineering Geology	3	80	20	100	3	3
	Hydrogeology and Environmental Geology	3	80	20	100	3	3
	Hydrogeology, Engineering Geology & Geological Mapping – Practical	3	40	10	50	2	3
	Elementary Research Methodology	2	40	10	50	2	2
Total		29	640	160	800	26	29
VI	Chemistry-6A-T	3	80	20	100	3	3
	Chemistry-6B-T	3	80	20	100	3	3
	Chemistry-6AB-P	3	40	10	50	2	3
	Botany-6A-T	3	80	20	100	3	3
	Botany-6B-T	3	80	20	100	3	3
	Botany-6AB-P	3	40	10	50	2	3
	Exploration Geology, Mining and Mineral Processing	3	80	20	100	3	3
	Ore Geology, Mineral Resources and Gemmology	3	80	20	100	3	3
	Exploration Geology and Applied Geoscience Practical's	3	40	10	50	2	3
	Project/ Internship/ Dissertation	2	40	10	50	2	2
Total		29	640	160	800	26	29

Prof. M. Govindappa
Dean-Science & Technology
Davangere University
Shivagangotri, Davangere-577007

Fifth Semester

Registrar
Davangere University
Shivagangotri, Davangere.

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Paper Title: Structural Geology and Engineering Geology

Course Outcomes (COs)

CO No.	Course Outcomes
CO 1	Identify and describe primary and secondary rock structures formed during and after lithification.
CO 2	Explain brittle and ductile deformation and interpret stress–strain behavior in rocks.
CO 3	Classify and analyze folds, faults, joints, and unconformities and recognize them in the field.
CO 4	Evaluate engineering properties of rocks and soils and their suitability for civil and geotechnical works.
CO 5	Assess geological factors influencing slope stability, landslides, and subsidence and suggest remedial measures.
CO 6	Apply geological and geoengineering principles to the design and stability of dams, bridges, and tunnels.
CO 7	Demonstrate field and laboratory competence for data collection, structural mapping, and report preparation.

PROGRAM OUTCOMES (POs)

PO No.	Program Outcome Description
PO 1	Acquire fundamental geological knowledge of earth materials, structures, and processes.
PO 2	Develop practical field and laboratory skills for geological investigation.
PO 3	Apply analytical and problem-solving abilities to interpret geological data.
PO 4	Understand the environmental and sustainability aspects of geological work.
PO 5	Apply professional ethics, project management, and teamwork in applied geology.
PO 6	Exhibit effective communication and lifelong learning for academic and professional growth.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO No.	Program Specific Outcome Description
PSO 1	Demonstrate understanding of geological structures and processes through field-based investigations.
PSO 2	Apply geological, geotechnical, and hydrogeological knowledge to resource evaluation and engineering projects.
PSO 3	Use modern techniques (GIS, Remote Sensing, and mapping) for geological interpretation and reporting.

Paper Title: Structural Geology and Engineering Geology

Total Teaching Hours: 56 **LTP/Credits: 400/4**
Teaching Hours: 4 Hrs./Week. **Exam. Duration: 3 Hrs.**
Exam. Marks Total: 100 (C_1 Test -10 mark: C_2 Test -10 mark: C_3 Main Exam-80 mark)

UNIT I – Structural Geology-I *(14 Hours)*

Introduction and Primary Structures

- Definition, scope, and importance of Structural Geology.
- Structural forms of rocks: **Primary** and **Secondary**.
- **Concept of deformation:** elastic, brittle, and ductile behavior.
- **Forces causing deformation:** compression, tension, torsion, and shear.

Primary Structural Forms

- **Sedimentary rocks:** bedding, lamination, graded bedding, ripple marks, cross-bedding, mud cracks.
- **Igneous rocks:** flow structures, vesicular and pillow structures, columnar and sheet joints.

Foliation, Lineation, and Unconformities

- **Foliation:** types, description, origin, **axial-plane cleavage** and tectonic significance.
- **Lineation:** types, origin, and relation with major folds and structures.

- **Unconformities:** para-, dis-, non-, angular, and regional types.

UNIT II – Structural Geology-II *(14 Hours)*

Secondary Structures and Cohesive Dislocations

- Distortion, bending, and folding.
- **Folds:** Definitions, parts (axis, limbs, axial plane, hinge, plunge, crest, trough).
    - **Mechanics:** buckling, bending, flexural slip, and flow folding.
    - **Types:** symmetrical, asymmetrical, anticline, syncline, anticlinorium, synclinorium, overturned, recumbent, isoclinal, chevron, fan, monocline, drag folds.
- **Denudational structures:** outlier and inlier.

Disruptive Dislocations – Joints and Faults

- **Joints:** definition, dip, strike, joint plane, joint set, joint system.
    - Classification – *Geometrical*: dip, strike, oblique, bedding joints; *Genetic*: columnar, mural, sheet, master joints.
    - Importance in groundwater movement, slope stability, quarrying.
- **Faults:** definition, elements (fault plane, hade, heave, throw, hanging and foot walls).
    - Classification – *Geometrical*: dip, strike, diagonal, bedding faults; *Movement*: normal and reverse; *Genetic*: thrust, over-thrust, under-thrust, gravity (step, ridge, trough).
    - Field criteria for recognition: displacement, drag, slickensides, fault breccia.

UNIT III – Engineering Geology *(14 Hours)*

Introduction and Engineering Properties of Rocks

- Role of geology in civil engineering projects.
- Engineering properties of rocks affecting construction.
- **Building stones and road materials:** granite, basalt, sandstone, shale, marble, charnockite, laterite.

Soil Studies

- Soil profile and formation.
- Structure and texture of soils.
- Physical and chemical properties – porosity, permeability, plasticity.
- Soil classification by particle size.

Mass Wasting and Slope Processes

- Types of movements – slides, falls, flows.
- Causes of landslides – geological, climatic, human activities.
- **Subsidence:** natural (carbonate dissolution) and man-made (mining, groundwater withdrawal).

Slope Stability and Site Considerations

- Classification of slopes: stable and unstable.
- Geological parameters and stabilization measures.
- Cuttings in rock slopes – design and control factors.
- **Building sites:** requirements, foundation problems, ground conditions (bedrock, soil, slope).

UNIT IV – Geoengineering Studies *(14 Hours)*

Bridge Sites

- Bridge structures and types.
- Geological parameters for bridge foundations – lithology, structure, hydrology.
- Common bridge problems – scour, settlement, erosion.

Dams and Reservoirs

- **Types of dams:**
    1. Masonry/Concrete – gravity, arch, buttress.
    2. Earth dams.
    3. Composite dams.

- Geological considerations for site selection – topography, structure, lithology, seismicity.
- **Foundation and seepage problems** and their treatment (grouting, rock bolting, drainage).
- **Reservoir problems:** seepage, silting, slope instability.

Tunnels

- Terminology and types – hard-rock and soft-rock tunnels.
- Geological factors – lithology, structure, groundwater, stress conditions.
- Ground failures and support mechanisms.

Additional Topics

- Concrete aggregate sources and alkali-aggregate reaction.
- Geological site investigations for engineering projects.
- **Aseismic design and earthquake-resistant structures.**

Reference Books

1. Billings, M.P. (1972) – *Structural Geology*, Prentice-Hall.
2. Ramsay, J.G. (1967) – *Folding and Fracturing of Rocks*, McGraw-Hill.
3. Parbin Singh (2001) – *Engineering and General Geology*, S.K. Kataria & Sons.
4. Krynine, D.P. & Judd, W.R. (1957) – *Principles of Engineering Geology and Geotechnics*, McGraw-Hill.
5. Bell, F.G. (2007) – *Engineering Geology*, Elsevier.
6. Gokhale, N.W. (1996) – *Theory of Structural Geology*, CBS Publishers.
7. Blyth, F.G.H. & De Freitas, M.H. (1984) – *A Geology for Engineers*, Edward Arnold.

Suggested Learning Activities

- Drawing of folds, faults, and joints using block diagrams.
- Field measurement of dip and strike.
- Observation of landslide-prone areas and slope stabilization methods.
- Case studies of dams, bridges, and tunnels in Karnataka.
- Laboratory demonstration of rock and soil testing methods.

SEP BSc-V Semester: Elementary Research Methodology
(for Biochemistry, Biotechnology, Botany, Chemistry, Electronics, Environmental Science, Food Technology, Microbiology, Zoology)

Subject	**Elementary Research Methodology**	Semester	V
Number hr/week	2 hours	Total hours	32
Duration of the exam	2 hours	Credits	2

Learning Outcomes:
After the completion of this course the learner will be able to:

- Describe the basic concepts of research and its methodologies.
- Identify the appropriate research topics and set up hypothesis.
- Perform literature survey using library (print) and internet (online) sources.
- Design experiments/surveys, collect data and and represent data in table and figure forms.
- Analyze data with appropriate software tools, internet results and draw conclusions.
- Write scientific report/ review and prepare seminar/ conference presentations oral or poster.
- Understand the methods of citations and referencing styles, check plagiarism.
- Identification of lacuna (finding gap-areas), hypothesis formulation, framing objectives, and preparation of questionnaire.

Unit-1	***Scientific Methods and Research:*** Concept, Definitions of research; Purpose, importance, steps levels and rigor of research; different paradigms of research. ***Types of Research:*** Fundamental/Applied research, Descriptive/Analytical research, Quantitative /Qualitative research, Conceptual/Empirical research, Diagnostic/Hypothesis testing research, Conclusion oriented/Decision oriented research, Theoretical / Action research, Longitudinal /Cross sectional research ***Research Question:*** Introduction, types and identification; ***Research Problem:*** Definition, identification of problem, ways of understanding problem, criteria of a good problem, guidelines for selecting meaningful problem; ***Research Objective:*** Definition, broad and specific objectives, goals; ***Research Hypothesis:*** Meaning of research hypothesis, sources of hypothesis, qualities of workable hypothesis, utilities of hypothesis;	8 h
Unit-2	***Introduction and review of sampling***: Definition, needs, steps; Definitions of population, sample, sampling unit, sampling frame, sampling error and non sampling error; Steps in sampling; Fundamentals, characteristics, advantages and disadvantages of sampling. ***Types of sampling***: Probability (simple, stratified, systematic , cluster and multistage –in brief), Process of selecting random sample; non probability sampling (convenience, purposive, quota, snowball, self selecting); Advantages and disadvantages (brief discuss only) ***Size of sample***: Factor affecting size of sample, Testing the reliability of sample, Methods of estimating sample size, Process of selecting random sample	8 h

Unit-3	***Designing of research work:*** Introduction, Purposes, Characteristics of a research design, Principles of designing a research, conceptual framework and its operationalization, Sectors of research design, Research methods as research designing, similarities and differences between Research design and research method. ***Conventional research method:*** Principle and Importance conventional methods, Scientific methods as conventional methods, Characteristic of a scientific method; Aspects of scientific Method, Evolution of scientific Studies Steps in scientific methods,	8 h
Unit-4	***Historical Research Method:*** Nature and Steps in Historical method, Importance and fundamentals of Historical method, Sources of Historical data, Limitations. ***Experimental Research Method:*** Introduction, Types of experiments, steps in experimental research, Problems in experimentation; Ex-post facto research: definition and technique. ***Survey Research Method:*** Introduction, and Importance of survey method, Comparison of survey method with other methods; Objectives of social and survey and technical survey, types of social and technical survey, Steps in social and technical surveys, Pilot survey ***Case study:*** Introduction, Types of case studies: Exploratory and Hypothesis testing; Steps in case studies, Sources of case data, limitations. **Analysis of data**- introduction, data analysis tools. Project time line, literature review and references, research report structure, plagiarism.	8 h

Prof. M. Govindappa
Dean-Science & Technology
Davangere University
Shivagangotri, Davangere-577007

Registrar
Davangere University
Shivagangotri, Davangere

Fifth Semester

Title: Hydrogeology and Environmental Geology

COURSE OUTCOMES (COs): After successful completion of this course, the students will be able to:

- **CO1:** Explain the fundamental concepts of hydrogeology, hydrologic cycle components, aquifer characteristics, and groundwater occurrence in different geological terrains of India and Karnataka.
- **CO2:** Apply principles of groundwater flow, Darcy's law, and well hydraulics to determine aquifer parameters, groundwater flow direction, recharge estimation, and resource assessment.
- **CO3:** Analyze groundwater chemistry using hydrochemical parameters, facies classification, and graphical techniques, and assess groundwater quality, contamination, and seawater intrusion issues.
- **CO4:** Evaluate groundwater management strategies including artificial recharge, rainwater harvesting, GIS-based hydrogeochemical mapping, and sustainable groundwater development under climate variability.
- **CO5:** Assess environmental hazards and natural disasters in India, apply disaster management concepts, and utilize GIS and Remote Sensing tools for hazard zonation, vulnerability mapping, and mitigation planning.

PROGRAM OUTCOMES (POs): Graduates of the B.Sc. Earth Sciences program will be able to:

- **PO1:** Demonstrate fundamental knowledge of Earth systems, geological processes, and environmental interactions.
- **PO2:** Apply geological, hydrogeological, geochemical, and geophysical principles to solve real-world Earth science problems.
- **PO3:** Analyze and interpret geological, hydrogeological, and environmental data using quantitative, graphical, and geospatial techniques.
- **PO4:** Use modern tools such as GIS, Remote Sensing, numerical models, and field instruments for Earth science investigations.
- **PO5:** Evaluate environmental and natural resource issues with emphasis on sustainability, hazard mitigation, and resource conservation.

PROGRAM SPECIFIC OUTCOMES (PSOs)

- **PSO1:** Apply hydrogeological principles to assess groundwater occurrence, movement, quality, and sustainability in diverse geological and climatic settings.
- **PSO2:** Integrate hydrogeology, environmental geology, GIS, and Remote Sensing techniques for groundwater management, hazard assessment, and environmental planning.
- **PSO3:** Evaluate natural and anthropogenic hazards and design mitigation and disaster management strategies relevant to Indian conditions.

Paper Title: ***Hydrogeology and Environmental Geology***

Total Teaching Hours: 56 **LTP/Credits: 400/4**
Teaching Hours: 4 Hrs./Week. **Exam. Duration: 3 Hrs.**
Exam. Marks Total: 100 (C_1 Test -10 mark: C_2 Test -10 mark: C_3 Main Exam-80 mark)

UNIT I – Fundamentals and Processes in Hydrogeology *(14 hours)*

- Definition, scope, and societal relevance of Hydrogeology.
- Hydrologic cycle – components and their quantitative importance.

- Precipitation, evapotranspiration, infiltration, runoff, and subsurface movement of water.
- Rock properties influencing groundwater occurrence: porosity, permeability, specific yield, specific retention, and transmissivity.
- Vertical distribution of subsurface water – zone of aeration, capillary fringe, and zone of saturation.
- Types of aquifers – confined, unconfined, perched, and leaky aquifers; anisotropy and heterogeneity of aquifers.
- Aquifer storage properties and potential mapping using geospatial data.
- Groundwater occurrence in igneous, sedimentary, and metamorphic terrains of India.
- Introduction to hydrostratigraphic classification and groundwater provinces of Karnataka.

UNIT II – Groundwater Flow, Well Hydraulics, and Exploration *(14 hours)*

- Darcy's Law – concept, validity, and limitations; laminar and turbulent groundwater flow.
- Intrinsic permeability and hydraulic conductivity – controlling factors and measurement techniques.
- Determination of groundwater flow direction and velocity – flow nets and potentiometric surface maps.
- Well hydraulics – drawdown, specific capacity; equilibrium and non-equilibrium flow in confined and unconfined aquifers (Thiem's and Theis' equations).
- Surface and subsurface groundwater exploration – geological, geophysical, and remote sensing methods.
- Introduction to borehole logging methods – resistivity, gamma, and SP logs.
- Introduction to Principles of groundwater modelling and numerical simulation.
- Recharge estimation techniques and water balance computation.
- Overview of groundwater resource assessment (GEC methodology).

UNIT III – Groundwater Chemistry and Management *(14 hours)*

- Physical and chemical properties of groundwater – pH, EC, TDS, hardness, alkalinity, and salinity.
- Major ions in groundwater and hydrochemical facies – interpretation using Piper, Stiff, and Gibbs diagrams.
- Groundwater contamination and pollution – natural and anthropogenic sources, preventive and control measures.
- Seawater intrusion in coastal aquifers – causes, mechanisms, and preventive strategies.
- Groundwater–surface water interaction and groundwater level fluctuations.
- Groundwater management – monitoring techniques, artificial recharge methods, and rainwater harvesting.
- Groundwater Quality Indices (GQI) and Water Quality Index (WQI) approaches.
- GIS-based hydrogeochemical mapping and spatio-temporal analysis.
- Concept of sustainable groundwater development and climate-change impacts on aquifer systems.

UNIT IV – Environmental Geology and Disaster Management *(14 hours)*

Environmental Geology:

- Scope and importance of environmental geology and its relation to sustainable development.
- Types and classification of environmental hazards – global and Indian context.
- Natural disasters in India –
  - Earthquakes: causes, characteristics, and hazard zones.
  - Floods: causes, types, and management in Indian river basins.
  - Landslides and avalanches: causes, mechanisms, and mitigations.
  - Drought: causes, classification, and drought-prone regions.

- Mining and industrial pollution – effects on air, water, and soil; waste management and environmental restoration.
- Soil and groundwater pollution: sources, pathways, and remediation strategies.

Disaster Management:

- Disaster terminology – hazard, vulnerability, risk, resilience, and mitigation.
- Disaster management cycle: preparedness, response, relief, rehabilitation, and reconstruction.
- Disaster management framework in India – national, state, and district levels.
- GIS and Remote Sensing applications in hazard zc nation, vulnerability mapping, and early warning systems.
- Case studies: earthquake, flood, drought, landslide, coastal erosion, and avalanche management.

Suggested Textbooks

1. Groundwater Hydrology — David K. Todd & Larry W. Mays
2. Applied Hydrogeology — C. W. Fetter Jr.
3. Hydrogeology — K. R. Karanth
4. Groundwater Geochemistry and Isotopes — Ian Clark
5. The Geochemistry of Natural Waters — *(Online resource/book)*
6. Hydrology in Practice — Elizabeth M. Shaw
7. Environmental Geology — Edward A. Keller
8. Environmental Geology: Ecology, Resource and Hazard Management — K. S. Valdiya
9. Natural Hazards — Edward Bryant
10. Groundwater Quality and Contamination — C. A. J. Appelo & Dieke Postma

Fifth Semester
Practical Paper-5
Paper Title: Hydrogeology, Engineering Geology & Geological Mapping (Practical)

Practical Course Outcomes (COs): After successful completion of this **practical course**, the students will be able to:

- **CO1:** Solve numerical problems related to hydrogeology, including estimation of porosity, permeability, transmissivity, groundwater flow, well hydraulics, and water budget calculations.
- **CO2:** Prepare, contour, and interpret water table maps and hydrographs to determine groundwater flow direction, fluctuation trends, and aquifer behavior under different hydrogeological conditions.
- **CO3:** Analyze and interpret groundwater quality data using standard graphical and analytical methods such as Piper trilinear diagrams, Gibbs diagrams, WQI zonation maps, and agricultural water suitability classifications.
- **CO4:** Prepare and interpret engineering geological maps for tunnels, roads, railways, and dams, and evaluate geological conditions relevant to civil engineering projects.
- **CO5:** Interpret topographical and geological maps by identifying relief features, drawing geological sections, recognizing folds, faults, intrusions, unconformities, and completing geological outcrops accurately.

PRACTICAL PAPER-5
V SEMESTER B.Sc. DEGREE PROGRAMME, GEOLOGY
Paper Title: Hydrogeology, Engineering Geology & Geological Mapping (Practical)

Total Teaching Hours: 54 **LTP/Credits: 004/2**
Teaching Hours: 4 Hrs./Week. **Exam. Duration: 3 Hrs.**
Total Marks: 50 **(C_1 Attendance -5 mark, C_2 Record -5 mark: C_3 Main Exam-40 mark)**

Hydrogeology – Quantitative and Interpretative Exercises *(Total: 6 Practicals)*

1. **Simple numerical problems** related to:
   - Determination of porosity, permeability, and transmissivity
   - Groundwater flow calculations
   - Well hydraulics (drawdown, discharge)
   - Water budget and recharge estimation
2. **Preparation and interpretation of Water Table Maps**
   - Contouring of water levels
   - Identification of groundwater flow direction
3. **Groundwater Quality Interpretation using Standard Graphical Methods**
   - Piper trilinear diagram
   - Gibbs diagram
   - Drinking water suitability (TDS, Fluoride, Nitrate, WQI zonation maps)
   - Agricultural water suitability (EC, Percent Sodium, USSL and Wilcox classifications)

Engineering Geology *(Total: 2 Practicals)*

4. **Preparation of Engineering Geological Maps**
   - Tunnel alignment map
   - Road alignment map
   - Railway alignment map
   - Dam site map

Geological Map Interpretation *(Total: 4 Practicals)*

5. **Geological Maps**
   - Drawing geological sections
   - Interpretation of geological structures and stratigraphy
6. **Structural Maps**
   - Folds – 2 maps
   - Igneous intrusions – 2 maps
   - Faults – 4 maps
   - Unconformities – 2 maps
7. **Completion of Outcrops**
   - Completion and interpretation of incomplete geological outcrops

MODEL QUESTION PAPER FOR C_3

Time: 3 Hour **Max. Marks: 40**

Q1. Numerical Problems (Hydrogeology) – (2 × 4 = 8 Marks)

Problems on **Porosity, Permeability, Transmissivity, and other hydrological properties.**

- Two problems to be solved
- Each problem carries **4 marks**

Q2. Generation of Maps and Interpretation – (2 × 4 = 8 Marks)

Preparation and interpretation of **any TWO** maps from the following:

- Water table map
- Hydrograph
- Engineering geological map (Tunnel / Road / Railway / Dam)

Q3. Water Quality and Suitability Maps – (2 × 4 = 8 Marks)

Interpretation of groundwater quality and suitability using:

- Piper / Gibbs diagram
- Drinking or irrigation water suitability map
- Two diagrams/maps

Q4. Geological Maps – Section & Interpretation – (3 × 4 = 12 Marks)

Geological maps showing folds, faults, intrusions, or unconformities.

- Three geological maps
- Drawing of section and interpretation

Q5. Completion of Outcrop – (1 × 4 = 4 Marks)

Completion and interpretation of **one incomplete geological outcrop map**.

Question	Component	Marks
Q1	Numerical problems	8
Q2	Map generation & interpretation	8
Q3	Water quality & suitability	8
Q4	Geological maps & sections	12
Q5	Outcrop completion	4
Total		**40**

Sixth Semester

Paper Title: Exploration Geology, Mining and Mineral Processing

COURSE OUTCOMES (COs): After successful completion of this course, students will be able to:

- **CO1:** Explain the principles, stages, and techniques of mineral prospecting and exploration, including geological guides, dispersion haloes, exploratory drilling, and UNFC-based economic evaluation of mineral deposits.
- **CO2:** Describe and interpret geochemical, biogeochemical, and geobotanical exploration methods, identify geochemical anomalies and pathfinder elements, and analyze dispersion patterns with reference to Indian case studies.
- **CO3:** Apply gravity, magnetic, seismic, and electrical geophysical methods to subsurface investigations, interpret geophysical data, and solve basic numerical problems related to geophysical exploration.
- **CO4:** Explain mining geology concepts including surface, underground, and offshore mining methods, mine planning and design criteria, and basic principles of mine infrastructure and cost estimation.
- **CO5:** Describe the principles and applications of mineral processing techniques such as comminution, gravity separation, flotation, magnetic and electrical separation, and interpret simplified beneficiation flow sheets for major ores.

PROGRAM OUTCOMES (POs): Graduates of the B.Sc. Earth Sciences program will be able to:

- **PO1:** Demonstrate comprehensive knowledge of Earth systems, geological processes, and mineral resources.
- **PO2:** Apply geological, geochemical, geophysical, and mining principles to explore, evaluate, and utilize mineral resources.
- **PO3:** Analyze and interpret geological, geochemical, and geophysical data using quantitative, graphical, and field-based techniques.
- **PO4:** Use modern tools and techniques including GIS, Remote Sensing, geophysical instruments, and laboratory methods in Earth science investigations.
- **PO5:** Evaluate mineral resource development in terms of sustainability, environmental impact, safety, and socio-economic considerations.

PROGRAM SPECIFIC OUTCOMES (PSOs)

- **PSO1:**Apply integrated geological, geochemical, and geophysical methods for systematic mineral exploration and resource assessment.
- **PSO2:**Interpret geophysical and geochemical datasets to delineate subsurface ore bodies and evaluate mineral potential using standard classification systems.
- **PSO3:**Understand mining geology and mineral processing principles to assess ore beneficiation routes and sustainable mineral resource utilization.

Paper Title: Exploration Geology, Mining and Mineral Processing

Total Teaching Hours: 56 **LTP/Credits: 400/4**
Teaching Hours: 4 Hrs./Week. **Exam. Duration: 3 Hrs.**
Exam. Marks Total: 100 (C_1 Test -10 mark: C_2 Test -10 mark: C_3 Main Exam-80 mark)

UNIT I – Exploration Geology (14 hrs)

- Introduction to Prospecting and Exploration; stages of mineral exploration.
- Classification of prospecting methods.
- Principles and techniques of Geological, Geophysical, and Geochemical exploration.

- **Geological Exploration:** River-float tracing, panning, guides and criteria for locating ore deposits.
- Geological and non-geological guides: structural, lithological, stratigraphic, geomorphological, palaeogeographic, and palaeoclimatic criteria.
- Dispersion haloes (primary and secondary), gossans, and old workings.
- Preliminary and detailed exploration; exploratory works – drilling, core logging, exploratory grids, and sampling methods.
- Economic evaluation of mineral deposits – **UNFC classification.**
- **Mining overview:** Introduction to surface, underground, and offshore mining methods.

UNIT II – Geochemical and Biogeochemical Exploration (14 hrs)

- Introduction and scope of geochemical exploration.
- **Geochemical cycle:** Deep-seated and surficial; mobility of elements.
- Pathfinder elements, threshold values, and geochemical anomalies.
- Dispersion patterns – primary and secondary.
- **Geochemical methods:** Lithogeochemistry, soil geochemistry, stream-sediment, hydrochemical, and atmochemical techniques.
- **Biogeochemical and Geobotanical methods:** Principles, indicators, and applications in mineral exploration.
- Case studies of geochemical exploration in India.

UNIT III – Geophysical Exploration (14 hrs)

- Introduction; scope and principles of geophysical exploration.
- **Gravity method:** Principle, gravity of the Earth, gravity reductions, density estimates of rocks and minerals, gravimeters, field operations, interpretation; simple numerical problems (vertical component, gravity gradient, gravity curvature).
- **Magnetic method:** Principle, Earth's magnetism, magnetic susceptibilities of rocks and minerals, field instruments, field operations, interpretation; numerical problems (vertical and horizontal components).
- **Seismic methods:** Principles of reflection and refraction, field equipment (geophones), data interpretation; numerical problems.
- **Electrical methods:** Electrical properties of rocks and minerals, resistivity method (theory, resistivity meters, electrode configurations – Wenner and Schlumberger), field procedures, and **applications in groundwater exploration.**

UNIT IV – Mining Geology and Mineral Processing (14 hrs)

A. Mining Geology:

- Overview of mining methods: Surface (open-pit, strip, hydraulic, dredging) and Underground (room and pillar, longwall, stoping, caving methods).
- Mine planning and design criteria: slope design, stripping ratio, pit ramps, waste-dump design, pit dewatering, and land reclamation.
- Introduction to mine infrastructure – shafts, hoists, haulage, pumping, and ventilation.
- Capital and operating cost estimation (basic principles).

B. Mineral Processing:

- Scope, objectives, and limitations of mineral processing.
- **Comminution:** Crushing and grinding; types of crushers and mills – principles and applications.
- **Liberation and size reduction:** Importance, determination, laboratory sizing and screening.
- **Gravity concentration:** Jigging, heavy media, spirals, and flowing-film concentrators.
- **Froth flotation:** Principles, reagents, flotation of sulphides, oxides, and coal.
- **Magnetic and electrical separation:** Principles, applications, and limitations.

- **Simplified flow sheets** for beneficiation of coal, copper, lead-zinc, iron, chromite, gold, and manganese ores.

Reference Books

1. C. J. Moon, A. M. Whateley and E. G. Evans, *Introduction to Mineral Exploration*, Wiley–Blackwell.
2. W. M. Telford, L. P. Geldart and R. E. Sheriff, *Applied Geophysics*, Cambridge University Press.
3. Barry A. Wills and Tim Napier-Munn, *Mineral Processing Technology*, Butterworth-Heinemann.
4. John Ridley, *Ore Deposit Geology*, Cambridge University Press.
5. U. K. Banerjee, *Economic Geology*, Allied Publishers, New Delhi.
6. H. E. Hawkes and J. S. Webb, *Geochemical Exploration*, Harper & Row.
7. M. G. Routhier, *Geochemical Methods of Prospecting*, Elsevier.
8. A. Kabata-Pendias, *Biogeochemistry of Trace Elements*, CRC Press.
9. William Lowrie, *Fundamentals of Geophysics*, Cambridge University Press.
10. D. S. Parasnis, *Principles of Applied Geophysics*, Chapman & Hall.
11. D. J. Deshmukh, *Elements of Mining Technology*, Denett & Co.
12. E. G. Kelly and D. J. Spottiswood, *Introduction to Mineral Processing*, Wiley.

Government / Institutional Publications (Supplementary Reading)

13. **Geological Survey of India**,
    Manual of Mineral Exploration, Special Publications.
14. **Indian Bureau of Mines**,
    UNFC Guidelines, Mineral Conservation and Mining Manuals, Government of India.

Paper Title: Ore Geology, Mineral Resources and Gemology

Total Teaching Hours: 56 **LTP/Credits: 400/4**
Teaching Hours: 4 Hrs./Week. **Exam. Duration: 3 Hrs.**
Exam. Marks Total: 100 (C_1 Test -10 mark: C_2 Test -10 mark: C_3 Main Exam-80 mark)

Course Outcomes (Cos)

CO No.	Course Outcome
CO 1	Explain the formation processes, textures, and classification of ore deposits.
CO 2	Describe the origin, occurrence, and distribution of major metallic, non-metallic, and energy resources of India.
CO 3	Identify and characterize gemstones and understand their genesis and industrial significance.
CO 4	Apply the basic principles of mineral economics and sustainable resource management in geological studies.

UNIT I – Ore Geology *(14 hrs)*

- Introduction to ore geology in relation to industry, commerce, and the national economy.
- Ore minerals and gangue minerals; tenor of ore.
- **Principles and processes of ore formation:**
  - *Magmatic processes* – Early magmatic (dissemination, segregation, injection) and Late magmatic (residual liquid segregation/injection, immiscible liquid segregation/injection).
  - *Contact metasomatism* – Skarn deposits.
  - *Hydrothermal processes* – Migration and deposition of hydrothermal fluids; cavity filling and replacement deposits; sources, transport mechanisms.
  - *Weathering processes* – Residual and mechanical (placer) concentrations: eluvial, stream, and marine deposits.
  - *Sedimentation* – Fe and Mn cycles.
  - *Oxidation and supergene enrichment* – Gossans.
  - *Metamorphism* – Metamorphic deposits.
- Classification of ore deposits – Jensen & Bateman.
- Metallogenic epochs and provinces.

UNIT II – Mineral Resources *(14 hrs)*

- **Metallic mineral resources:** Metallogenic epochs; study of Indian deposits (with special reference to Karnataka):
  - Gold (Kolar, Gadag, Hutti); Copper (Ingaldhal, Kalyadi, Thintini); Iron (Chikmagalur, Bellary, North Kanara); Manganese (Shivamogga, Chitradurga, Sandur, Tumkur); Aluminium (Boknur-Navge, Paduvare, Bababudan).
- **Coal:** Definition; stages and periods (Gondwana, Tertiary, Cretaceous); composition, properties, Seyler's classification, origin, accumulation, distribution (including peat and lignite); basic mining methods.
- **Petroleum:** Occurrence, accumulation, and origin; source-rock formation, migration; reservoir and cap rocks; petroleum traps; distribution of Indian on-shore and off-shore oilfields.
- **Industrial minerals:** Applications and major occurrences of:
  - *Mica* (Bihar, Nellore, Rajasthan)
  - *Abrasives* – Diamond, Corundum, Garnet, Quartz, Fuller's earth, Soapstone & Talc
  - *Refractories* – Fire clay, Silica, Sillimanite, Kyanite, Magnesia, Chromite

- *Building & ornamental stones* – Granite, Dolerite, Sandstone, Basalt, Limestone, Marble, Laterite, Slate, Soapstone
- *Glass & ceramics* – Clay, Feldspar, Quartz, Magnesite
- *Fertilizer minerals* – Gypsum, Phosphate (Apatite/Phosphorite), Potash, Pyrite, Sulphur

UNIT III – Gemology *(14 hrs)*

- **Introduction:** Gem minerals and gemstones, qualities, testing, units of measurement.
- **Physical properties:** Colour and chromophores, colour centres, luminescence, iridescence, dispersion, inclusions, alexandrite effect, pleochroism, colour zoning, chatoyancy, asterism, hardness, specific gravity.
- **Optical properties:** Refractive index and other optical effects.
- **Flaws:** External flaws, fractures, cleavage, parting, zoning, solid/gas/fluid inclusions.
- **Synthetic gemstones:** Need, growth techniques, diamond synthesis.
- **Gem cutting:** Cabochon and faceted cuts; diamond and coloured-stone cutting.
- **Study of important gem minerals and Indian occurrences:**
  - *Isotropic:* Diamond, Garnet
  - *Uniaxial:* Corundum, Beryl
  - *Biaxial:* Chrysoberyl, Jade
  - *Organic/Miscellaneous:* Pearl, Amber, Coral

UNIT IV – Mineral Economics and Resource Management *(14 hrs)*

- **Introduction to mineral economics:** Scope and significance; role of minerals in national economy and industry; renewable vs non-renewable resources; overview of National Mineral Policy (2019).
- **Valuation of mineral deposits:** Factors affecting value – grade, tonnage, accessibility, market; categories of reserves – proved, probable, possible; cut-off grade, stripping ratio, recovery factor; mine valuation principles and life of mine.
- **Resource classification and inventory:** UNFC system; Indian Bureau of Mines classification; strategic, critical, and essential minerals.
- **Mineral conservation and substitution:** Need and methods; recycling and reuse of industrial minerals and metals; substitution by synthetic materials.
- **Environmental and sustainable aspects:** Impacts of mining; mine-site reclamation; sustainable development and the geologist's role in circular economy.

Recommended Reading

1. Bateman, A.M. (1981). *Economic Mineral Deposits.* John Wiley & Sons.
2. Evans, A.M. (1993). *Ore Geology and Industrial Minerals.* Blackwell.
3. Jensen & Bateman (1979). *Economic Mineral Deposits.* Wiley.
4. Mason, B. & Berry, L.G. (1968). *Elements of Mineralogy.* Freeman.
5. Kraus, E.H., Hurlbut, C.S., & Pough, F.H. (1990). *Manual of Mineralogy and Gemology.* Wiley.
6. Indian Bureau of Mines (IBM). *National Mineral Inventory and Policy Documents.*

PRACTICAL PAPER-6
V SEMESTER B.Sc. DEGREE PROGRAMME, GEOLOGY
Paper Title: Exploration Geology and Applied Geoscience Practicals

Total Teaching Hours: 54 **LTP/Credits: 004/2**
Teaching Hours: 4 Hrs./Week. **Exam. Duration: 3 Hrs.**
Total Marks: 50 **(C_1 Attendance -5 mark, C_2 Record -5 mark: C_3 Main Exam-40 mark)**

1. **Calculation of Thickness of Strata:** Geometric methods and Mathematical methods
   - Three types of thickness problems
   - Three problems from each type
2. **Dip and Strike Problems**: Geometric methods and Trigonometric methods
   - Three types of dip–strike problems
   - Two problems from each type
3. **Generation and Interpretation of Geochemical Prospecting Maps**
   - Plotting geochemical data
   - Identification of anomalous zones
   - Interpretation of dispersion patterns
4. **Ore Reserve Estimation Problems:** Included Area Method and Extended Area Method
5. **Electrical Method of Geophysical Exploration**
   - Interpretation of Vertical Electrical Sounding (VES) data
   - S-line method
   - Curve matching method
6. **Disaster Management Case Studies**
   - Hypothetical flood-prone area: hazard analysis and management plan
   - Hypothetical earthquake-prone area: risk assessment and mitigation report
   - Preparation of short disaster management reports

MODEL PRACTICAL QUESTION PAPER

Time: 3 Hour **Max. Marks: 40**

Q1. Calculation of Thickness of Strata (2 × 4 = 8 Marks)
Q2. Dip and Strike Problems (1 × 8 = 8 Marks)
Q3. Geochemical Prospecting Map (1 × 4 = 4 Marks)
Q4. Ore Reserve Estimation (1 × 4 = 4 Marks)
Q5. Electrical Method of Geophysical Exploration (1 × 6 = 6 Marks)
Q6. Disaster Management Case Study (1 × 6 = 6 Marks)

Question	Topic	Marks
Q1	Thickness of strata	8
Q2	Dip & Strike	8
Q3	Geochemical maps	4
Q4	Ore reserve estimation	4
Q5	Geophysical (VES)	6
Q6	Disaster management	6
Total		**40**

Prof. M. Govindappa
Department of Science & Technology
Davangere University
Shivagangotri, Davangere-577007

Paper Code:

THEORY EXAMINATION QUESTION PAPER PATTERN

B.Sc. Examination, (Semesters V –VI)

(Semester Scheme) (SEP)

GEOLOGY

Paper Title:

Time: 3 Hours **Max. Marks: 80**

Instructions to candidates

1. **All sections are compulsory**
2. **Draw a neat and labelled diagrams wherever necessary.**

SECTION – A

1. Answer ALL the following questions **(2 × 10 = 20 Marks)**

a) .
b) .
c) .
d) .
e) .
f) .
g) .
h) .
i) .
j) .

SECTION – B

Answer any SIX questions **(5 × 6 = 30 Marks)**

2. .
3. .
4. .
5. .
6. .
7. .
8. .
9. .

SECTION – C

Answer any THREE questions **(10 × 3 = 30 Marks)**

10. Unit - 1
11. Unit - 2
12. Unit - 3
13. Unit – 4

Attendance Marks-breakup

<75% - 00 Marks
75-80% - 01 Mark
80-85% - 02 Marks
85-90% - 03 Marks
90-95% - 04 Marks
>95% - 05 Marks

Prof. M. Govindappa
Dean-Science & Technology
Davangere University
Shivagangotri, Davangere-577007

Registrar
Davangere University
Shivagangotri, Davangere.