

**Syllabus for  
Master of Science in Geology  
Under Choice Based Credit System**

**Academic Session:  
w.e.f. 2020-2022**



*for*  
***All Constituent/Affiliated Colleges Under***  
**Binod Bihari Mahto Koyalanchal University,**  
**Dhanbad**

॥ तमसो मा ज्योतिर्गमय ॥



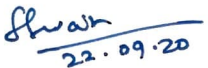

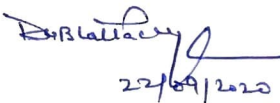
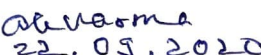
ESTD: 2017



# UNIVERSITY DEPARTMENT OF GEOLOGY

BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY,  
DHANBAD- 828130 (JHARKHAND)

**Members of Board of Studies of CBCS Under- Graduate Syllabus as per Guidelines of the Binod Bihari Mahto Koyalanchal University, Dhanbad.**

Name of Members	Signature
1. Prof. (Dr.) Uday Kumar, Retd. Head, Department of Geology, Ranchi University Ranchi	-Chairman  22.09.20
2. Dr. Atul Kumar Sinha, Head, University Dept. of Geology, BBMKU, Dhanbad	-Convenor  22.09.20
3. Dr. Sagar Kumar Swain, Head, Dept. of Geology, P.K.R.M. College, BBMKU, Dhanbad	-Member  22.09.20
4. Mr. Santosh Kumar Singh Retd. Scientist, CIMFR, Dhanbad, Guest Faculty, University Dept. of Geology, BBMKU, Dhanbad	-Member  22/09/20
5. Prof. (Dr.) Deepak Kumar Bhattacharya Retd. Dean, Faculty of Science, Ranchi University, Ranchi	-External Member  22/09/2020
6. Prof. (Dr.) Atul Kumar Varma, Department of Applied Geology, IIT(ISM), Dhanbad	-External Member  22.09.2020

## CONTENTS

S. No.	Topic/Title	Page No.
<b>SEMESTER I</b>		
1.	GEO-F-101 Mineralogy & Geochemistry	09
2.	GEO-C-102 Structural Geology & Geotectonics	11
3.	GEO-C-103 Igneous Petrology	13
4.	GEO-C/P-104 Core Practicals (C-102 & 103)	15
<b>SEMESTER II</b>		
5.	GEO-S-205 Instrumental Techniques for Geoscientists	16
6.	GEO-C-206 Sedimentary & Metamorphic Petrology	17
7.	GEO-C-207 Stratigraphy & Palaeontology	19
8.	GEO-C/P-208 Core Practicals (C-206 & 207)	21
<b>SEMESTER III</b>		
9.	GEO-A-309 Environmental Geology	22
10.	GEO-C-310 Economic Geology	24
11.	GEO-C-311 Hydro Geology, Engineering, Geology, Environmental Geology, Mining Geology	26
12.	GEO-C/P-312 Core Practicals (C-310 & 311)	28
<b>SEMESTER IV</b>		
13.	GEO-E-413A Ore Geology I	29
14.	GEO-E-413B Fuel Geology I	31
15.	GEO-E-413C Hydro Geology I	33
16.	GEO-E-414A Ore Geology II	35
17.	GEO-E-414B Fuel Geology II	37
18.	GEO-E-414C Hydro Geology II	39
19.	GEO-E/P-415A Practical (413A-414A)	41
20.	GEO-E/P-415B Practical (413B-414B)	42
21.	GEO-E/P-415C Practical (413C-414C)	43
22.	GEO-D-416 Dissertation/Project Work	44
23.	Annexure-1 Research Methodology	45
24.	Question Format	46
25.	Question Format	47



## COURSE STUCTURE

## SEMESTER –I

Course	Course Code (Credit, Lectures)	Name of Papers	Full Marks	End Semester	Mid Semester (Internal) Marks (Written 20 marks) + Day to Day assessment includes extracurricular activities (5 marks) + Attendance (5 marks)
Foundation Course	<b>GEO-F-101</b> (5 Credits, 60 Lectures + 15 Tutorials)	<b>Mineralogy &amp; Geochemistry</b>	<b>100</b>	<b>70</b>	<b>30</b>
Core Papers	<b>GEO-C-102</b> (5 Credits, 60 Lectures + 15 Tutorials)	<b>Structural Geology &amp; Geotectonics</b>	<b>100</b>	<b>70</b>	<b>30</b>
	<b>GEO-C-103</b> (5 Credits, 60 Lectures + 15 Tutorials)	<b>Igneous Petrology</b>	<b>100</b>	<b>70</b>	<b>30</b>
	<b>GEO-C/P-104</b> (5 Credits, 75 Lectures)	<b>Practical Based on 102 &amp; 103</b>	<b>100</b>	<b>70</b>	<b>30</b>

## SEMESTER –II

Course	Course Code (Credit, Lectures)	Name of Papers	Full Marks	End Semester	Mid Semester (Internal) Marks (Written 20 marks) + Day to Day assessment includes extracurricular activities (5 marks) + Attendance (5 marks)
Skill Enhancement Course (SEC)	<b>GEO-S-205</b> (5 Credits, 60 Lectures + 15 Tutorials)	<b>Instrumental Techniques for Geoscience</b>	<b>100</b>	<b>70</b>	<b>30</b>

<b>Core Papers</b>	<b>GEO-C-206</b> (5 Credits, 60 Lectures + 15 Tutorials)	<b>Sedimentary &amp; Metamorphic Petrology</b>	<b>100</b>	<b>70</b>	<b>30</b>
	<b>GEO-C-207</b> (5 Credits, 60 Lectures + 15 Tutorials)	<b>Stratigraphy &amp; Palaeontology</b>	<b>100</b>	<b>70</b>	<b>30</b>
	<b>GEO-C/P-208</b> (5 Credits, 75 Lectures)	<b>Practical Based on 206 &amp; 207</b>	<b>100</b>	<b>70</b>	<b>30</b>

### SEMESTER –III

<b>Course</b>	<b>Course Code (Credit, Lectures)</b>	<b>Name of Papers</b>	<b>Full Marks</b>	<b>End Semester</b>	<b>Mid Semester (Internal) Marks</b> (Written 20 marks) + Day to Day assessment includes extracurricular activities (5 marks) + Attendance (5 marks)
<b>Open Elective</b>	<b>GEO-A-309</b> (5 Credits, 60 Lectures + 15 Tutorials)	<b>Environmental Geology</b>	<b>100</b>	<b>70</b>	<b>30</b>
<b>Core Papers</b>	<b>GEO-C-310</b> (5 Credits, 60 Lectures + 15 Tutorials)	<b>Economic Geology</b>	<b>100</b>	<b>70</b>	<b>30</b>
	<b>GEO-C-311</b> (5 Credits, 60 Lectures + 15 Tutorials)	<b>Hydro Geology, Engineering Geology, Environmental Geology, Mining Geology</b>	<b>100</b>	<b>70</b>	<b>30</b>
	<b>GEO-C/P-312</b> (5 Credits, 75x2 Lectures)	<b>Practical Based on 310 &amp; 311</b>	<b>100</b>	<b>70</b>	<b>30</b>

## SEMESTER –IV

Course	Course Code (Credit, Lectures)	Name of Papers	Full Marks	End Semester	Mid Semester (Internal) Marks (Written 20 marks) + Day to Day assessment includes extracurricular activities (5 marks) + Attendance (5 marks)
<b>Discipline Centric Elective Theory</b>	<b>GEO-E-413A/ GEO-E-413B/ GEO-E-413C</b> (5 Credits, 60 Lectures + 15 Tutorials)	<b>A: Ore Geology I Or B: Fuel Geology I Or C: Hydro Geology I</b>	<b>100</b>	<b>70</b>	<b>30</b>
	<b>GEO-E-414A/ GEO-E-414B/ GEO-E-414C</b> (5 Credits, 60 Lectures + 15 Tutorials)	<b>A: Ore Geology II Or B: Fuel Geology II Or C: Hydro Geology II</b>	<b>100</b>	<b>70</b>	<b>30</b>
<b>Elective Practical</b>	<b>GEO-E/P-415A/ GEO-E/P-415B/ GEO-E/P-415C</b> (5 Credits, 75 Lectures)	<b>A: 413A &amp; 414A Or B: 413B &amp; 414B Or C: 413C &amp; 414C</b>	<b>100</b>	<b>70</b>	<b>30</b>
	<b>GEO-D-416*</b> (5 Credits, 150 Lectures)	<b>Dissertation/ Project</b>	<b>100</b>	<b>70</b>	<b>30</b>
<b>Total Marks</b>			<b>1600</b>	<b>1120</b>	<b>480</b>

**\*Dissertation/Project:** Evaluation of project dissertation work may be as per the following guidelines:

- **Mid-Semester/Internal Assessment Examination** = 30 marks (**Annexure-1**)
- **End Semester Examination:** Project model (if any) and the Project record notebook, Project presentation and viva-voce = 70 marks  
(Jointly conducted by One External & One Internal Examiners)

**Overall project dissertation may be evaluated under the following heads:**

- Motivation for the choice of topic
- Project dissertation design
- Methodology and Content depth
- Results and Discussion
- Future Scope & References
- Participation in Internship programme with reputed organization
- Application of Research technique in Data collection



- Report Presentation
- Presentation style
- Viva-voce

**Note:**

- (a) Each student must submit two copies of the dissertation work duly forwarded by the Head of the Department and duly signed by the supervisor concerned. The forwarded copies will be submitted to the concerned Department of University, for evaluation.

The paper will consist of

- Field work/Lab work related to the project.
  - Preparation of dissertation based on the work undertaken.
  - Presentation of project work in the seminar on the assigned topic & open viva there on.
- (b) Each student shall have to complete a project work on any topic of his choice, but relevant to the frontier area of Science and Technology, or on a topic allotted by his/her Project Guide/Supervisor/Department in Semester -IV. This is compulsory and the candidates shall ensure that his project is on a relevant topic completed by him independently with the help and inputs from his/her guide/supervisor. Other guidelines pertaining to this paper shall be provided by the Department.
- (c) Student alone or in a group of not more than five, shall undertake one Project approved by the Subject Teacher/H.O.D. of the Department/College concerned. The progress of the Project shall be monitored by the faculty members at regular intervals.
- (d) Students will select topics for the project work in consultation with a teacher of the Department. The Seminar will be held in the concerned Department of University.

**Format of the Dissertation/Project:**

The **Dissertation/Project** shall be presented with the following specifications:

- (a) **Size of Paper:** A4. Dissertation/Project must be printed on one side of the paper.
- (b) **Font Type:** Times New Roman/Arial for English and Kruti Dev 010 for Hindi.
- (c) **Font Size:** Font size for English text is 12pt. in standard form and for Hindi is 14pt.
- (d) **Font of Chapter Headings and Sub-Headings:**
- Chapter headings may be written in all Capitals, bold text in point size 15
  - Sub-headings are written with left margin alignment
  - First level sub-headings are written in normal sentence case using bold text in point size 14
  - Second level sub-headings are point size 13
- (e) **Spacing and Paragraphing:**
- Printing shall be in standardised form with 1.5 line spacing
  - Leave as triple spacing (2 empty lines) in base point size 12 before and after sub-headings and one empty line after all sub-headings
  - Use one empty line between left-justified paragraphs
- (f) **Margin:** Left margin should be 4cms and right and top margin should be 2cms. Bottom margins should be 2.5cms. No ornamental bordering of sides is permitted.

- (g) **Page Numbering:** Preliminary pages of the **Dissertation/Project**, i.e. those preceding in text are to be numbered in Roman numbered. Text should be numbered in Arabic beginning with Pg No 1 on the first page of chapter 1.
- (h) Preliminary sections of the **Dissertation/Project** should include, Declaration of Attendance, Certificate from Supervisor, Declaration by Candidate and Supervisor regarding Plagiarism, Acknowledgement, Table of Contents, List of Tables, List of Figures/Diagrams, List of Abbreviations (if any) and an Abstract of the Dissertation/Project.
- (i) **Referencing and Citation Style:** Citation i.e. a way of giving credit to individuals for their creative and intellectual works that you utilised to support your research, differs by faculty in the style of ordering, punctuating and formatting of name, date, page, work etc. The referencing of work and Citation style in the Dissertation/Project submitted in **Faculty of Science and Social Science** will be in **American Psychological Association (APA) style (6<sup>th</sup> edition)**, for **Faculty of Humanities** except for the Indian Languages, format shall be **Modern Language Association (MLA) (8<sup>th</sup> edition)** and for **Medical Science**, it shall be **Vancouver style**.



## SEMESTER-I

<b>GEO-F-101</b>	<b>MINERALOGY &amp; GEOCHEMISTRY</b>	<b>(5 Credits, 60 Lectures + 15 Tutorials)</b>
------------------	--------------------------------------	--

### ***Instruction to faculty members and Question Setter for:***

#### ***Mid Semester Examination (MSE):***

There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **multiple type questions** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.

The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best of Two**" shall be applicable for computation of marks for SIA.

(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).

**End Semester Examination (ESE):** There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

## **MINERALOGY & GEOCHEMISTRY**

### **Unit 1**

Periodicity and symmetry-concept of space lattice. Introduction to crystal chemistry, Crystal structure of minerals-Bonding in Crystal structures, Close-packed structures-

Hexagonal close-packing, cubic close-packing and body centred structure, Structure types based on close-packing, Minerals with structures based on close packing, structures built from polyhedral.

### **Unit 2**

Crystal structure of minerals-Bonding in Crystal structures, Close-packed structures-

Hexagonal close-packing, cubic close-packing and body centred structure, Structure types based on close-packing, Minerals with structures based on close packing, structures built from polyhedral.

Crystals structure of silicate minerals: Silicates with isolated tetrahedra, Single chain silicates, Double chain silicates, the layer silicates, the framework silicates. Description of chemistry, optical and physical properties, and paragenesis of the following mineral groups: Olivine group, Garnet Group, Epidote group, Pyroxene group, Amphibole group

### **Unit 3**

Optical classification of minerals, Isotropic materials, Anisotropic materials; Interference phenomena, Extinction, Function of accessory plates, Concept of Optical indicatrix, Mineral colour and pleochroism, Extinction angle and sign of elongation, Interference figures.

Introduction to diffraction and imaging, X-ray diffraction, Reciprocal lattice, Ewald's Sphere, Crystal field theory. Application of SEM, TEM and EPMA in mineral characterisation.

#### Unit 4

Origin of chemical elements and stellar evolution. Abundance of elements in cosmos, solar system and earth. Distribution of elements in core, mantle, hydrosphere and atmosphere. Geochemistry of igneous rocks. Distribution coefficients and its application with numerical examples. Behaviour of major and trace including rare earth elements during magmatic crystallization and its application in petrogenesis and as tectonic discriminants.

#### Unit 5

Near surface geochemical environment: Eh-pH diagram; Principle of chemical mass balance and rock cycle; Chemical weathering of minerals and rocks. Radiogenic isotopes in geochronology and petrogenesis: Rb-Sr, Sm-Nd, U-Pb isotopic system.

#### Suggested Books

- Putnis A. *Introduction to mineral Sciences*, Cambridge publication, 1992
- Cornelis Klein and Barbara Dutrow, *The manual of Mineral Science*, Wiley Publication 2007
- Kerr P. F. *Optical Mineralogy*, 1959. McGraw-Hill.
- Verma P. K., *Optical mineralogy*, CRC press 2009
- Nesse W. D., *Introduction to Optical mineralogy*. 2008, Oxford University Press.
- Deer W. A., Howie R. A. and Zussman, J., *An introduction to the rock forming minerals*, ELBS publication 1962-1963
- Mason, B (1986). *Principles of Geochemistry*. 3rd Edition, Wiley New York.
- Rollinson H. (2007) *Using geochemical data-evaluation. Presentation and interpretation*. 2nd Edition. Publisher Longman Scientific & Technical.
- Walther John, V., 2009 *Essentials of geochemistry, student edition*. Jones and Bartlett Publishers
- Albarede, F, 2003. *An introduction to geochemistry*. Cambridge University Press.
- Dickin' A. P., 1995, *Radiogenic Isotope Geology*, Cambridge University Press
- Faure, G., 1986. *Principle of Isotope Geology*, J. Wiley & Sons.
- Henderson, P., 1982. *Inorganic Geochemistry*, Pergamon Press, Oxford.
- Krauskopf, K. B., 1979 *Introduction to Geochemistry*. McGraw Hill.
- Mason, B. 1982 *Principles of Isotope Geology*, J. Wiley & Sons.

॥ तमसो मा ज्योतिर्गमय ॥

ESTD: 2017



GEO-C-102	STRUCTURAL GEOLOGY & GEOTECTONICS	(5 Credits, 60 Lectures + 15 Tutorials)
-----------	-----------------------------------	---

**Instruction to faculty members and Question Setter for:**

**Mid Semester Examination (MSE):**

There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **multiple type questions** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.

The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best of Two**" shall be applicable for computation of marks for SIA.

(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).

**End Semester Examination (ESE):** There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

## STRUCTURAL GEOLOGY & GEOTECTONICS

### Unit 1: Introduction to rock mechanics and rheology

Concept of Stress and Strain: 2-D stress and strain analysis; Strain ellipses of different types and their geological significance; Mohr diagrams and their use; concept of stress-strain compatibility. Behaviour of rocks under stress: elastic, plastic, viscous and visco-elastic responses and their geological significance. Concept of continuous and discontinuous media; deformation mechanism at grain scale: dislocation and diffusion creep, strain hardening and softening mechanisms, lattice preferred orientation, superplasticity. Mechanics of rock fracturing: fracture initiation and propagation; Coulomb's criterion and Griffith's theory; Crack linkage and their importance.

### Unit 2: Analysis of geological structures – I: Ductile regime

#### A) Fold:

Morphological classification of folds. Mechanical aspects of folding: buckling, bending, flexural slip and flow folding. Mechanics of single layer and multilayer buckling: Ptygmatic fold, cusped-lobate fold, disharmonic and polyharmonic folds, kink fold. Fold interference and superposed folds. Strain distribution in a folded layer and its significance. Axial plane cleavage and Transected cleavage.

#### B) Foliation and Lineation:

Different types of planar and linear structures in deformed rocks; Mechanism of cleavage formation; Kinematic significance of foliation and lineation. Importance of cleavage bedding intersection in a folded terrain. Use of stereographic projection for plotting linear and planar structures and their geologic applications.

### Unit 3: Analysis of geological structures – II: Brittle and brittle-ductile regime

#### A) Fault and Joint:

Mechanics of faulting: Anderson's theory and its limitations. Complex geometry of normal, strike-slip and thrust faults with natural examples. Concept of fault zone weakening; fault reactivation and its significance.



Geometric analyses of joints – Importance of Tectonic, Columnar and Release joints. Mechanical aspect of fracturing and joint formation. Joints with relation to folds and faults.

### **B) Shear Zone:**

Shear zones-geometry and kinematics: Analysis of strain in shear zones; Kinematic significance of different shear zone structures; Shear sense indicators; Flow behaviour of sheared rocks – ductile and brittle-ductile shear zones. Large scale shear zones and their importance in continental crustal evolution. Fault/shear zone rocks: Cataclasite/Gouge/ Breccia, Mylonite, Pseudotachylyte.

### **Unit 4: Large-scale deformation of the lithosphere**

Brittle-plastic transition and seismic behaviour of the continental and oceanic lithosphere. Plate convergence and continental deformation: transpressional and transtensional tectonics; Concept of subduction and orogeny - Indian and overseas examples.

### **Unit 5:**

Basic concept of palaeomagnetism Major tectonic features of the earth-shield areas, mobile belts, rift valleys, mid oceanic ridges, continental shelves and slopes, submarine canyons. Plate Tectonics: concept, geological and tectonic environment of Plate boundaries, Sea Floor Spreading, Island arcs, Hydrothermal vents; Orogeny and orogenic cycles – Epeirogeny and evolution of plateaus. Structural and tectonic features of India. Tectonic framework of India; Structure and Origin of the Himalaya. Quaternary tectonics.

### **Suggested Books:**

- *Condie, Kent. C. (1982): Plate Tectonics and Crustal Evolution, Pergamon Press Inc.*
- *Gass I.G. (1982): Understanding the Earth. Artemis Press (Pvt) Ltd. U.K.*
- *Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Development. Pergamon Press.*
- *Hobbs, B.E., Means, W.D. and Williams, P.F. (1976): An outline of Structural Geology, John Wiley and Sons, New York*
- *Naqvi, S.M. (2005) Geology and Evolution of the Indian Plate (From Hadean to Holocene - 4Ga to 4 Ka) GSI, Bangalore*
- *Ramsay, J.G. (1967): Folding and fracturing of rocks, McGraw Hill.*
- *Windley B. (1973): The Evolving continents, John Wiley and Sons, New York.*
- *N.J. Price and J.W. Cosgrove (1990) Analysis of Geological Structures, Cambridge University Press*
- *Ragan, Donal M.: Structural Geology, Cambridge University Press*
- *Whitten, E. H. Timothy (1966) Structural Geology of folded rocks. Chicago: Rand McNally,*
- *George H. Davis (2011) Structural Geology of Rocks and Regions, John Wiley and Sons*
- *Fossen H (2010) Structural Geology, Cambridge University Press*

ESTD: 2017

GEO-C-103	IGNEOUS PETROLOGY	(5 Credits, 60 Lectures + 15 Tutorials)
-----------	-------------------	---

**Instruction to faculty members and Question Setter for:**

**Mid Semester Examination (MSE):**

There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **multiple type questions** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered. The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. **“Best of Two”** shall be applicable for computation of marks for SIA.

(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).

**End Semester Examination (ESE):** There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

## **IGNEOUS PETROLOGY**

### **Unit 1**

#### **(A) Fundamentals:**

Igneous petrology and its scope, differentiation of the Earth, major structural units of the Earth, energy and mantle heat engine, gravity, pressure and geobaric gradient, viscosity of melts chemical diffusion, heat diffusion, nucleation and crystal growth, vesiculation and fragmentation of magma, igneous rock series.

**(B) Thermodynamics and kinetics:** First law of thermodynamics, enthalpy, entropy, second and third law of thermodynamics, stability (phase) diagrams, thermodynamics of solutions, fugacity and activity, equilibrium constant, silica activity, silica buffers and silica saturation and, alumina saturation. Fe-Ti oxide buffers.

### **Unit 2**

**(A) Crystal-melt equilibria in magmatic systems:** Phase relations in binary systems, feldspar-melt equilibria, anhydrous olivine and pyroxene crystal-melt equilibria, crystal-melt equilibria in basalt magma systems, haplo-granite system. geobarometers and geothermometers.

**(B) Classification of magmatic rocks:** Classification of magmatic rocks - based on fabric, field relations, mineralogical and modal, and whole rock compositions, IUGS classification of plutonic, hypabyssal and volcanic rocks, Irvine-Baragar classification of volcanic rocks, classification of basalt, igneous rock names, chemical discriminants of rock types. MELT programme.

**(C) Igneous structures and fabric related to magmatic rocks:** Mega, minor and microstructures associated with igneous rocks, Kinetic paths and fabric of magmatic rocks.

### **Unit 3**

**Mantle Melting and the Generation of Basaltic Magma:** Melt composition, mantle material, partial melting of the peridotite mantle and magma generation, alkaline magma generation, magma generation in continental crust, differentiation (open and closed systems) and assimilation, hybrid magmas, magma storage, ascent and emplacement, field relations of intrusions



## Unit 4

**Trace elements and isotopes:** Trace elements behavior, geochemical characteristics of primary magma, palaeotectonic setting indicators, chemical fractionation, partition coefficient and trace element compatibility, rare earth elements and batch melting models, , magma evolution models (batch melting, incremental batch melting, fractional crystallization, Rayleigh fractionation), Stable and radiogenic isotopes, mass fractionation, radiogenic decay, isotopes as petrogenetic indicators, K-Ar system, isochron technique, Rb-Sr, U-Pb-Th and Sm-Nd systems, model ages, interpretation of chronological data, isotope reservoirs.

## Unit 5

**Petrotectonic associations:** Idea of consanguinity, rock suites and their distribution in time and space

**Igneous rocks of oceanic regions:** Oceanic spreading ridges and related basaltic rocks, mantle plumes and oceanic island volcanic rocks, plume heads and flood basalt plateau lavas, arc magmatism, oceanic island arcs.

**Other associations:** Igneous rocks associated with convergent plate boundaries, continental flood basalt and large igneous provinces, large layered igneous complexes, continental alkaline rocks, ultra-alkaline and silica poor alkaline rocks, alkaline cratonic associations, ophiolite, granites and granites, continental rift associations.

## Suggested Books:

- Shrivastava, J. P. 2009 Igneous Rocks National Science Digital Library, CSIR, New Delhi <http://hdl.handle.net/123456789/1034>
- Cox, K. G., Bell, J. D. and Pankhurst, R. J. 1979 Interpretations of igneous rocks. George Allen and Unwin, London.
- Wilson, M. 1989 Igneous Petrogenesis. London Unwin Hyman.
- Blatt, H. Tracy, R. J. and Owens, B. E. 2006 Petrology. W. H. Freeman and Company.
- Ragland, P. C. 1989 Basic analytical Petrology. Oxford University Press.
- Anthony R. Philpotts and Ague, J. J. 2009 Principles of Igneous and Metamorphic Petrology. Cambridge
- Winter, J. D. 2001 Igneous and Metamorphic Petrology. Prentice Hall
- Best, M. G. 2013 Igneous and Metamorphic Petrology. Wiley Blackwell
- White, W. M. Isotope Geochemistry. Wiley Blackwell
- Faure, G. and Mensing, T. M. 2009 Isotope principles and Applications.
- Riddle Chris (Ed) Analysis of Materials. Marcel Dekker, Inc.
- Rollinson, H. R. 1993 Using Geochemical Data: Evaluation, Presentation, Interpretation

॥ तमसो मा ज्योतिर्गमय ॥

ESTD: 2017



GEO-C/P-104	PRACTICALS (C-102 & 103)	(5 Credits, 75 Lectures)
-------------	--------------------------	-----------------------------

**Instruction to Question Setter:**

*End Semester Practical Examination (ESE Pr):*

*The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.*

**Note:**

*(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).*

**PRACTICAL**

- i. Analysis and interpretation of geological maps, Tracing of outcrops, Structure contour maps
- ii. Stereographic analysis of structural data; Use of specialized softwares, if necessary.
- iii. Stereographic techniques: Significance of contour diagrams: orientation analyses of foliation and lineation data for regional structural geometry.
- iv. Structural problems related to borehole data.
- v. Study of igneous rocks in hand specimens and under the petrological microscope
- vi. Whole rock analysis of igneous rocks using XRF
- vii. Calculation of C.I.P.W. Norm and Niggli Values
- viii. Norm calculations and application of GEOSOFTWARE.
- ix. Mineral formulae calculations
- x. Ar<sup>40</sup>-Ar<sup>39</sup> age calculations using the ArArCALC software.
- xi. Model age calculations

**SEMESTER-II**

<b>GEO-S-205</b>	<b>INSTRUMENTAL TECHNIQUES FOR GEOSCIENCE</b>	<b>(5 Credits, 60 Lectures + 15 Tutorials)</b>
------------------	---	--

***Instruction to faculty members and Question Setter for:******Mid Semester Practical Examination (MSE):***

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.*

*(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).*

***End Semester Practical Examination (ESE):***

*The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.*

**INSTRUMENTAL TECHNIQUES FOR GEOSCIENCE****Unit 1**

The destructive and non-destructive analytical techniques in Geology The working principle of Scanning Electron Microscope (SEM), X-ray Fluorescence (XRF), X-ray Diffraction (XRD), ICP-OES, Flame Photometry, EPMA and SEM-EDS, Optical spectrometry - Atomic Absorption Spectroscopy (AAS), Atomic emission spectroscopy (AES), Mass spectrometry - Inductively coupled plasma mass spectrometry (ICP-MS), Raman spectrometry Chromatography Accuracy and Precision of Data International reference materials/ Standards Sample preparation and analysis using the above instruments.

**Unit 2**

Sampling, Slide Preparation, analyses, geo-standards, accuracy and precision, major, minor and trace elements and relative abundances, oxidation states and volatile, FeO, Fe<sub>2</sub>O<sub>3</sub> and Total Fe, Mg #, mole conversions, mineral formulae calculations, chemical compositions and variation diagrams.

**Suggested Books:**

1. S.J.B. Reed, *Electron Probe Analysis and Scanning Electron Microscopy in Geology*, Cambridge
2. B. Welz, and M. Sperling, *Atomic Absorption Spectrometry*, John Wiley
3. P.J. Potts, *A handbook of silicate rock analysis*, Springer
4. B. He. Bob, *Two-Dimensional X-Ray Diffraction*, John Wiley

ESTD: 2017



GEO-C-206	SEDIMENTARY & METAMORPHIC PETROLOGY	(5 Credits, 60 Lectures + 15 Tutorials)
-----------	--	--

**Instruction to faculty members and Question Setter for:**

**Mid Semester Practical Examination (MSE):**

The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. “**Best of Two**” shall be applicable for computation of marks for SIA.

(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).

**End Semester Practical Examination (ESE):**

The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.

**SEDIMENTARY & METAMORPHIC PETROLOGY**

**Unit 1: Sedimentary Processes and Products:**

Developments in sedimentology, Earth's sedimentary shell

Weathering and sedimentary flux: Physical and chemical weathering, submarine weathering, soils and paleosols, Fluid flow and sediment transport. Types of fluids; Laminar vs. turbulent flow. Reynolds number, Froude Number, Boundary layer effect, Particle entrainment, transport and deposition, sediment gravity flows, Concept of flow regimes and bedforms.

**Unit II: Sediment texture, Sedimentary structure and Paleocurrent:**

Sedimentary texture: Grain size scale, particle size distribution, statistical treatment of particle size data, particle shape and fabric

Sedimentary structures: Primary (Depositional, Erosional, Penecontemporaneous deformational) and secondary Paleocurrent analysis (Scalar and Vector attributes)

Siliciclastic rocks: Conglomerates, sandstones, mudrocks (texture, composition, classification and origin and occurrence),

**Paleo environment analysis:** Concept of facies and facies association. Sedimentary Environment: Continental (Glacial, Fluvial, Eolian, Lacustrine), marginal marine (Delta, Estuary, tidal, Chenier) and marine (shelf, slope, deep marine)

Lithification and diagenesis of siliciclastic rocks

Application of radioactive and stable isotopes in reconstruction of paleoenvironment

**Unit III: Non-siliciclastic rocks and environments:**

Carbonate rocks: controls on carbonate deposition, Carbonate Mineralogy, Allochemical and Orthochemical components. Classification of limestone Diagenesis of carbonate: Meteoric (Vadose, Phreatic) and Deep burial; Lithification, Carbonate sedimentary environments: Ramp, Rimmed Platform and Isolated platform, Chert and siliceous sediments, Phosphorites, Evaporites, Dolomite and dolomitisation; Dolomite problem, Sedimentary basins and their classification, basin analysis (maps, cross sections, Isopach, petrofacies, geological history, applications); Concept of Geohistory analysis, Geosynclines, Sedimentation in Intra- and Inter-plate basins. Basins in Orogenic belts.

Plate tectonics and sedimentation (sedimentation-divergent margins, convergent margins, transform margins)



## Unit IV

Introduction- Significance of metamorphic studies, Definition and limits of metamorphism, Overview of different types of metamorphism; Factors controlling transformations, Heat flow, Minerals as pure and impure phases, Textures of contact and regional metamorphism, Plate tectonics and metamorphic processes; Paired metamorphic belts, Archaean and Proterozoic terrains; polymetamorphosis. Rocks as chemical system, intensive and extensive variables, closed and open systems, Gibbs phase rule and Goldschmidt's mineralogical phase rule, composition-space, Cartesian and Barycentric projections, Phase diagrams including pseudocomponent diagrams (ACF, AKF, AFM etc.), Tie-line flip and rotations, continuous and discontinuous reactions, exchange vectors, Clausius-Clayperon equation

## Unit V

Zones and isograds, Progressive metamorphism of atleast any two types of bulk compositions (from pelites, quartzfeldspathic rocks, mafic rocks, ultramafics or calcareous rocks) illustrating localized variation of bulk composition as well as that of the metamorphic path in evolution of mineral assemblages, Metamorphic facies, Schreinemakers rules, Mineral formula calculation, geothermobarometry, Petrogenetic grid and pseudosections, Time scales of metamorphism, metasomatism, migmatites, Metamorphic field gradient and P-T-t paths,

## Suggested Books

- Allen, P.A., 1997. *Earth Surface Processes*, Blackwell publishing.
- Collinson, J.D. and Thompson, D.B., 1988. *Sedimentary Structures*, Unwin-Hyman, London.
- Hsu, K.J., 2004. *Physics of Sedimentology*, Springer Verlag, Berlin.
- Leeder, M.R., 1982. *Sedimentology: Process and Product*. George Allen & Unwin, London, 344p.
- Lindholm, R.C., 1987. *A Practical Approach to Sedimentology*, Allen & Unwin, London.
- Pettijohn, F.J., 1975. *Sedimentary Rocks*, Harper and Row Publ. New Delhi.
- Prothero and Schwab, 2004. *Sedimentary Geology*, Freeman and Co. New York, 557p
- Miall, A.D., 1999. *Principles of Sedimentary Basin Analysis 3rd Ed* Springer Verlag, New York.
- Nichols, G., 1999. *Sedimentology and Stratigraphy*, Blackwell publishing.
- Sam Boggs, 1995. *Principles of Sedimentology and Stratigraphy*, Prentice Hall, New Jersey.
- Tucker, M.E., 2006. *Sedimentary Petrology*. Blackwell Publishing.
- James, N.P and Jones, B., 2016 *Origin of carbonate sedimentary rocks*. Wiley
- Bucher, K. and Grapes, R., 2010. *Petrogenesis of Metamorphic Rocks*, Springer.
- Fry, N., 1985. *Field Description of Metamorphic Rocks*, New York, Geological Society of London Handbook Series.
- Best, M.G., 2003. *Igneous and Metamorphic Petrology*, Blackwell Science.
- Vernon, R. H., and Clarke G.L. 2008. *Principles of Metamorphic Petrology*, Cambridge University Press.
- Winter, I.D., 2001. *An Introduction to Igneous and Metamorphic Petrology*, Prentice Hall.
- Yardley, B.W.D., 1997. *An Introduction to Metamorphic Petrology*, Longman Earth Science Series.
- Spear, F.S., 1995, *Metamorphic Phase Equilibria and Pressure-Temperature-Time paths*, Mineralogical Society of America Monograph.

<b>GEO-C-207</b>	<b>STRATIGRAPHY &amp; PALAEONTOLOGY</b>	<b>(5 Credits, 60 Lectures + 15 Tutorials)</b>
------------------	---	--

**Instruction to faculty members and Question Setter for:**

**Mid Semester Practical Examination (MSE):**

The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. “**Best of Two**” shall be applicable for computation of marks for SIA.

(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).

**End Semester Practical Examination (ESE):**

The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.

**STRATIGRAPHY & PALAEONTOLOGY**

**Unit I**

International Stratigraphic Code and development of a standardised stratigraphic nomenclature. Concepts of Stratotypes, Global Stratotype Section and Point (GSSP). Principles of stratigraphy and correlation, Facies Concept in Stratigraphy, Walther's Law. Basic concepts of sequence stratigraphy, magneto-, seismic and chemo-stratigraphy. Methods of measurements of geological time. Recent advances in refinement of Geological Time Scale. Precambrian and its subdivisions. Plate tectonics during the Precambrian. Tectonostratigraphic framework of Dharwar craton, an overview of Bastar, Singhbhum, Bundelkhand and Aravalli cratons, Eastern Ghat mobile belt, Central Indian Tectonic Zone; Proterozoic sedimentary basins of India; Precambrian biota and its stratigraphic significance.

**Unit II**

Major plate movements during Phanerozoic. Subdivisions of Phanerozoic up to Stage level. Stratigraphic framework of Marine Palaeozoic rocks of Himalaya with special reference to Kashmir, Spiti, Kumaon and their correlatives in Salt Range and peninsular India. Criteria for recognising major stratigraphic boundaries of Phanerozoic and their GSSPs. Marine Mesozoic Rocks of the Himalaya; Gondwana Supergroup of rocks, its fauna and flora, depositional history, economic importance and climate; Jurassic sedimentary basins of Kachchh and Jaisalmer; Cretaceous stratigraphy of the Cauvery Basin and Narmada Valley; Deccan Volcanic Province;

**Unit III**

Cretaceous-Palaeogene boundary sections of India. Stratigraphic boundary problems –Pre Cambrian-Cambrian (P/C), Permian-Triassic (P/Tr) and Cretaceous –Tertiary (K/T) boundaries.

Palaeogene stratigraphy of Kachchh. Stratigraphy of the Himalayan foreland basin (Subathu, Murree/Dagshai-Kasauli, Siwalik) and recent advances. Indus Basin sediments of the Indus Tsangpo Suture Zone. Quaternary deposits of Andaman Islands, continental Quaternary deposits and their significance.

ESTD: 2017



#### Unit IV

Study of Ichno fossils; Taphonomy and preservation. MorpholGeology, classification, biostratigraphy and evolutionary trends of Trilobites, Brachiopods, Bivalves, Cephalopoda, Gastropods and Echinoids.

#### Unit V

Vertebrate and its classification. Evolutionary trends in Equidae, Proboscidae and Man; Siwalik mammals and their causes of extinction; Micro-palaeontology; Foraminifera, diamorphism, morpholGeology and biostratigraphy; Gondwana flora and their significance, Palynogeology, types of Gondwana palynomorphs and its importance; Microfossils and their significance in oil exploration.

#### Suggested Books

- Doyle, P. and Bennett, M.R., 1996. *Unlocking the Stratigraphic Record*, John Willey.
- Dunbar, C.O. and Rodgers, J., 1957. *Principles of Stratigraphy*. John Wiley & Sons.
- Krishnan, M.S., 1982. *Geology of India and Burma*, C.B.S.Publishers, Delhi
- Naqvi, S.M. 2005. *Geology and Evolution of the Indian Plate: From Hadean to Holocene-4 Ga to 4 Ka*.
- Capital Pub., New Delhi.
- Pascoe, E.H., 1968. *A Manual of the Geology of India & Burma (Vols.IN)*, Govt. of India Press, Delhi.
- Pomerol, C., 1982. *The Cenozoic Era - Tertiary and Quaternary*. Ellis Harwood Ltd., Halsted Press.
- Schoch, R.M., 1989. *Stratigraphy: Principles and Methods*, Van Nostrand Reinhold, New York.
- R.Vaidyanathan & M.Ramakrishnan, 2008. *Geology of India*, Geological Society of India.
- Boardman, R.S., Cheethan, A.M. and Rowell, A.J. (1988): *Fossil Invertebrates*, Blackwell.
- Clarksons, E.N.K. (1998): *Invertebrate PaleontolGeology and Evolution*, Allen and Unwin, London.
- Horowitz, A.S. and Potter, E.D. (1971): *Introductory Petrography of Fossils*, Springer Verlag.
- Mayr, E. (1971): *Population, Species and Evolution*, Harvard.
- Prothero, D.R. (2004): *Bringing Fossil to Life – An Introduction to PaleontolGeology* (2nd Ed.), McGraw Hill.
- Raup, D.M. and Stanley, S.M. (1985): *Principles of PaleontolGeology*, CBS Publ.
- Romer A.S.(1959)*The Vertebrate Story*, Univ. of Chicago Press
- Smith, A.B.(1994): *Systematics and Fossil Record – Documenting Evolutionary Patterns*, Blackwell.
- Strean, C.W. and Carroll, R.L. (1989): *PaleontolGeology – the record of life*, John Wiley
- Shrock R.R.(1953)*Principles of Invertebrate PaleontolGeology*, Mc Graw Hill Book Co.
- Alfred Traverse (1988): *PaleopalynolGeology*, Unwin Hyman, USA.
- Arnold (2002): *Quaternary Environmental MicropaleontolGeology* (Ed. Simon K. Haslett), Oxford University Press, New York.
- Bignot, G., Grahm and Trottman (1985): *Elements of MicropaleontGeology*, London.



GEO-C/P-208	PRACTICAL- C-206 & 207	(5 Credits, 75 Lectures)
-------------	------------------------	--------------------------

*End Semester Practical Examination (ESE Pr):*

*The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.*

**Note:**

*(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd, 5 marks ).*

**PRACTICAL:**

- i. Megascopic and Microscopic studies of Sedimentary and Metamorphic rocks.
- ii. Megascopic studies of Sedimentary structures.
- iii. Graphic representation of Modal analyses in QAP and APF diagrams
- iv. Graphic representation of chemical analyses in ACF, AKF and AFM diagrams.
- v. Particle size distribution and statistical treatment, Paleocurrent analysis,
- vi. Petrography of clastic and non-clastic rocks through hand specimens and thin sections
- vii. Study of geological map of India and identification of major stratigraphic units;
- viii. Study of rocks in hand specimens from known Indian stratigraphic horizons;
- ix. Drawing various paleogeographic maps of Precambrian time; Study of different Proterozoic supercontinent reconstructions.
- x. Study of fossils showing various modes of preservation; Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils
- xi. Geological Mapping of two weeks duration in a geologically complex area and Field Work Report based on it

**SEMESTER III**

<b>GEO-A-309</b>	<b>ENVIRONMENTAL GEOLOGY</b>	<b>(5 Credits, 60 Lectures + 15 Tutorials)</b>
------------------	------------------------------	--

***Instruction to faculty members and Question Setter for:******Mid Semester Practical Examination (MSE):***

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.*

*(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).*

***End Semester Practical Examination (ESE):***

*The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.*

**ENVIRONMENTAL GEOLOGY****Unit 1**

Basics of Environment; Type of Environment; Man and Environment; Components of environmental Geology, Concepts and principles of Environmental Geology; Time scales of global changes in the ecosystem and climate; Atmosphere, structure and composition of atmosphere; Global warming. Greenhouse effect.; CO<sub>2</sub> increase and global warming in the present and past atmospheres;

**Unit 2**

Environmental Pollution: Sources of Air Pollution, emission of major industrial air pollutants, effects of air pollution on atmospheric processes, oxides of carbon as pollutants, greenhouse effect, global warming, chlorofluoro carbons (CFC's), depletion of ozone layer, effects of ozone depletion, smog, acid rain; Natural Hazards: Its causes, prediction and forecasting, control measures and its proper management. Problems of urbanization, human population and their impact on environment.

**Unit 3**

Distribution, magnitude and intensity of earthquakes; Seismic hazard zones; Neotectonics in seismic hazard assessment; volcanic hazards, their causes and control. Landslide, soil creeping, mass movements; Coastal erosion, coastal inundations, cyclones, Tsunamis its causes and mitigation measures. Application of Remote Sensing techniques for Natural Hazards management; Water Pollution: Types of water pollution, groundwater pollution and its effects, sources of water pollution; organic and inorganic contamination of groundwater and its remedial measures.

**Unit 4**

Natural resources and its conservation. Concept of ecosystem and its biotic and abiotic factors. Types of resources – conservation of soil, forest, minerals. Mineral resources in India and environmental issues. Alternative energy resources. Desert and Desertification; Impacts of global warming on surface water, groundwater resources and Glaciers; Mass movement-types, Factors influencing slope stability. Solid waste management. Human impact on soil, water, climate and atmosphere. Impact assessment of degradation and contamination of surface water and groundwater quality due to industrialization and urbanization; organic and inorganic contamination of groundwater and its remedial measures; Water logging problems due to the indiscriminate construction of canals, reservoirs and dams; Geogenic and anthropogenic causes of water contamination;



## Unit 5

Issues of Arsenic and Fluoride contamination in groundwater ,Methods for amelioration of Arsenic and Fluoride contamination in groundwater, Problems of Arsenic and Fluoride contamination in Jharkhand; Application of Remote Sensing for Water resources, Snow and Glacier and Wetland management; Global initiatives for mitigation of environmental issues; Indian Constitution and Environment; Environmental protection and conservation laws in India viz. The Prevention and Control of pollution Act,1974, Water (Prevention & Control ) Act 1974,The Forest (Conservation) Act, 1980,Air (Prevention and Control of Pollution) Act 1981,Environmental (Protection) Act, 1986.

### Suggested Books:

- *Abhijit Dutta.Environmental Issues and Challenges*
- *B. K. Sharma Environmental Pollution*
- *Bell, F.G. (1999): ogical Hazards, Routledge, London.*
- *Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press.*
- *Keller, E.A. (1978) Environmental Geology*
- *Rekha Ghosh and D. S. Chatterjee :Environmental Geology*
- *Valdiya, K.S. (1987) Environmental Geology- Indian Context*
- *Patwardhan, A.M. (1999) The Dynamic Earth System*
- *Smith, K.(1992) Environmental Hazards*
- *Subramaniam,V.(2001) Textbook of Environmental Hazards*
- *Strahler and Strahler: Environmental Geology*

<b>GEO-C-310</b>	<b>ECONOMIC GEOLOGY</b>	<b>(5 Credits, 60 Lectures + 15 Tutorials)</b>
------------------	-------------------------	--

**Instruction to faculty members and Question Setter for:**

**Mid Semester Practical Examination (MSE):**

The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. “**Best of Two**” shall be applicable for computation of marks for SIA.

(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd, 5 marks ).

**End Semester Practical Examination (ESE):**

The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.

**ECONOMIC GEOLOGY**

**Unit 1**

Concepts of Ore Genesis; Distribution of Ore deposits-Global Perspective; Mode of occurrences and morphology of ore bodies, Controls of Ore localization; Classification of Ore deposits; Processes of Ore formation – Magmatic, Sedimentary, Metamorphic associations and Weathering processes; Ore deposits and Plate Tectonics.

**Unit 2**

Occurrence and distribution in India of metalliferous deposits - base metals, iron, manganese, aluminium, chromium, nickel, gold, silver, molybdenum. Indian deposits of non-metals – Diamond, mica, asbestos, barytes, gypsum, graphite, apatite and beryl. Gemstones, refractory minerals, abrasives and minerals used in glass, fertilizer, paint, ceramic and cement industries. Building stones. Phosphorite deposits. Placer deposits, rare earth minerals.

**Unit 3**

Coal: Origin, mode of occurrence and types of coal; Proximate and Ultimate analysis; Concept of Macerals and Microlithotypes; Classification, rank, and grade of coal; Important coal basins of India with special reference to Jharkhand. Fundamentals of Coal Bed Methane.

**Unit 4**

Petroleum: Origin and migration of Petroleum, Properties of source and reservoir rocks, Petroleum Traps; geological and geophysical methods of petroleum exploration; Petroliferous basins of India; Atomic Minerals: Atomic fuel resources of India – distribution and prospects.

**Unit 5**

Geological Mapping techniques; Geological criteria for mineral prospecting; Basic principles of Geochemical Exploration ;Principles and application of surface geophysical exploration techniques; Brief outline of various well logging techniques; Strategic, critical and essential minerals. India's status in mineral production vis a vis world scenario; National Mineral Policy.

**Suggested Books:**

- ArGeologyaswami, R.P.N. (1996): *Courses in Mining Geology*, Oxford and IBH Publ.



- Bagchi, T.C., Sengupta, D.K., Rao, S.V.L.N. (1979): *Elements of Prospecting and Exploration*, Kalyani Publ.
- Banerjee, P.K. and Ghosh, S. (1997): *Elements of Prospecting for Non-fuel Mineral deposits*, Allied Publ.
- Chaussier, Jean – Bernard and Morer, J. (1987): *Mineral Prospecting Manual.*, North Oxford Academic.
- Clark, G.B. (1967): *Elements of Mining*, (3rd Ed.), John Wiley.
- Dobrin, M. B.; Savit, C. H. (1988): *Introduction to Geophysical Prospecting*, McGraw-Hill.
- Keary, P., Brooks, M. and Hill, I. (2002): *An introduction to geophysical exploration*, (3rd Ed.), Blackwell
- Rider, M. H. (1986): Whittles Publishing, Caithness. *The logical Interpretation of Well Logs*, (Rev. Ed.).
- Robert, D. (1985): *Encyclopedia of Well Logging*
- T.S. Ramakrishna (2006), *Geophysical Practice in Mineral Exploration and Mapping* GSI, Bangalore
- Mookherjee, A. (2000): *Ore Genesis-A Holistic Approach*, Allied Publisher
- Dhanraju, R. (2005): *Radioactive Minerals*, . Soc. India, Bangalore.
- Craig J M and Vaughan D J (1981) *Ore Petrography and Mineral Geology*, John Willey
- Evans (1973 ) *Ore Geology and Industrial Minerals*
- Cogen B and Dey A K (1975) *Mineral and Nuclear Fuels of India*, Oxford Pub.
- Bagchi, T.C., Sengupta, D.K., Rao, S.V.L.N. (1979): *Elements of Prospecting and Exploration*, Kalyani Publ.
- Banerjee, P.K. and Ghosh, S. (1997): *Elements of Prospecting for Non-fuel Mineral deposits*, Allied Publ.
- Chaussier, Jean – Bernard and Morer, J. (1987): *Mineral Prospecting Manual.*, North Oxford Academic.

<b>GEO-C-311</b>	<b>HYDRO GEOLOGY, ENGINEERING GEOLOGY, ENVIRONMENTAL GEOLOGY, MINING GEOLOGY</b>	<b>(5 Credits, 60 Lectures + 15 Tutorials)</b>
------------------	--	--

***Instruction to faculty members and Question Setter for:***

***Mid Semester Practical Examination (MSE):***

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.*

*(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).*

***End Semester Practical Examination (ESE):***

*The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.*

## **HYDRO GEOLOGY, ENGINEERING GEOLOGY, ENVIRONMENTAL GEOLOGY, MINING GEOLOGY**

### **Unit-1**

Role of groundwater in the hydrological cycle; Controls of Geology on groundwater occurrence and distribution; Classification of aquifers and aquifer systems; Darcy's law; Hydraulic conductivity, transmissivity, storage coefficient and specific capacity; Water table contour maps and flow net analysis. Causative factors of groundwater level fluctuations and environmental influences

### **Unit-2**

Chemical characteristics of groundwater in relation to various uses – domestic, industrial and irrigation; Groundwater contamination and problems of arsenic, fluoride and nitrates; Management of groundwater resources: Artificial recharge to groundwater and rainwater harvesting;; Groundwater exploration; Hydrogeomorphic mapping using various Remote Sensing techniques ;Groundwater provinces of India.

### **Unit-3**

Engineering Properties of rocks, and Soils; Properties and selection of Construction Materials; Landslides and stability of Hill slopes; geological investigation for Engineering Projects.: geological investigations and criteria for sites selection of Dam sites, Reservoirs Tunnels and Bridges; Engineering Projects- Case Histories from India.

### **Unit-4**

Components of environment. Carbon dioxide in atmosphere, global warming caused by CO<sub>2</sub> increase in the atmosphere. Impact assessment of degradation and contamination of surface water and ground water quality due to industrialization and mining. Soil Quality degradation due to irrigation, use of fertilizers and pesticides. Introduction to climatic changes, causes of climatic changes, world climate during geological periods. Impact of climate on society. Impact of man on climate. Distribution, magnitude and intensity of earthquakes; Seismic hazard zones; Neotectonics in seismic hazard assessment; volcanic hazards, their causes and control. Landslide, soil creeping, mass movements; Coastal erosion, coastal inundations, cyclones, Tsunamis its causes and mitigation measures. Application of Remote Sensing techniques for Natural Hazards management;



## Unit-5

Mining terminology, methods of mining, open cast, underground and alluvial mining. Mining of metalliferous ore deposits. Factors affecting mine layout development, surface mining, Mining Machinery, Basic operations of Large open-pit mine. Methods of stopping, shaft sinking. Mine support and ventilation. Blasting and explosives. Coal mining methods. Types of drilling methods. Mining Hazards: mine inundation, mine fire and rock burst

### Suggested Books:

- ArGeologyaswami, R.P.N. (1996): *Courses in Mining Geology*, Oxford and IBH Publ.
- Clark, G.B. (1967): *Elements of Mining*, (3rd Ed.), John Wiley.
- Dobrin, M. B.; Savit, C. H. (1988): *Introduction to Geophysical Prospecting*, McGraw-Hill.
- Keary, P., Brooks, M. and Hill, I. (2002): *An introduction to geophysical exploration*, (3rd Ed.), Blackwell
- Rider, M. H. (1986): Whittles Publishing, Caithness. *The logical Interpretation of Well Logs*, (Rev.Ed.).
- Robert, D. (1985): *Encyclopedia of Well Logging*
- T.S. Ramakrishna (2006), *Geophysical Practice in Mineral Exploration and Mapping GSI*, Bangalore
- D.K. Todd (1995): *Groundwater HydrolGeology*, John Wiley and Sons.
- H.M. Raghunath (1990): *Groundwater*, Wiley Eastern Ltd.,
- K. R. Karanth (1989): *HydroGeology*, Tata McGraw Hill Publ..
- S.N. Davies and R.J.N. De Wiest (1966): *HydroGeology*, John Wiley and Sons, New York.
- Krynine, D.H. and Judd, W.R. (1998): *Principles of Engineering Geology*, CBS Publ..
- Schultz, J.R. and Cleaves, A.B. (1951): *Geology in Engineering*, John Willey and Sons, New York.
- Singh, P. (1994): *Engineering and General Geology*, S.K. Kataria and Sons, Delhi.

<b>GEO-C/P-312</b>	<b>PRACTICAL- C-310 &amp; 311</b>	<b>(5 Credits, 75 Lectures)</b>
--------------------	-----------------------------------	---------------------------------

*End Semester Practical Examination (ESE Pr):*

*The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.*

**Note:** (Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd, 5 marks ).

**PRACTICAL:**

- i. Megascopic study of important ores and their textures.
- ii. Megascopic study of important industrial, metallic and non-metallic, precious and semi-precious stones.
- iii. Exercises on ore reserve calculations.
- iv. Location of different ore deposits, non-metallic deposits, atomic fuel, gemstones and REE on the outline map of Jharkhand, India and World;
- v. Reserve estimation for metals, industrial rocks and coal;
- vi. Estimation of coal quality on the basis of proximate analysis data supplied;
- vii. Location of petroliferous basins and coalfields on the outline map of India;
- viii. Hydrologic properties of rocks;
- ix. Location of Hydrostratigraphic units of India;
- x. Computation of index properties of rocks.
- xi. Computation of RQD, RSR, RMR and 'Q'
- xii. Plotting of Major Dams/ Tunnels on the outline map of India.
- xiii. Study of Seismic / landslide zones of India.
- xiv. Preparation of seismic and volcanic zonation maps of India and world.
- xv. Demarcation of flood prone areas in the outline map of India.
- xvi. Chain survey, Compass survey, Plane table survey, Dumpy level survey, GPS survey.

॥ तमसो मा ज्योतिर्गमय ॥

ESTD: 2017



**SEMESTER-IV**

<b>GEO-E-413A</b>	<b>ORE GEOLOGY- I</b>	<b>(5 Credits, 60 Lectures + 15 Tutorials)</b>
-------------------	-----------------------	--

***Instruction to faculty members and Question Setter for:******Mid Semester Practical Examination (MSE):***

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.*

*(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).*

***End Semester Practical Examination (ESE):***

*The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.*

**ORE GEOLOGY- 1****Unit-1**

**Ore Geology in a broader framework:** Ore deposits and ore minerals. Classification of ore deposits, Relationship between crustal evolution, plate tectonics and metallogeny; concepts of metallogenic epochs and provinces, Magma related mineralization through geological time.

**Unit-2**

**Magmatic Ore Deposits:** Petrological and geochemical background to ore formation; role of element partitioning in magmatic systems; ore formation in relation to partial melting, differentiation, melt immiscibility, extreme melt fractionation and melt assimilation; general characteristics and genesis of magmatic ore deposits - LREE ores in Carbonatites, chromite deposits, base-metal Ni-Cu sulfide deposits, PGE sulfide deposits, rare-metal Pegmatites and diamond deposits associated with Kimberlites and Lamproites

**Unit-3**

**Hydrothermal Ore Deposits:** Basic concepts related to hydrothermal ore formation - Role of physical and chemical environment on metal complexing, transport and deposition; chemical nature of hydrothermal ore fluid in magmatic, metamorphic and sedimentary basinal environments; fluid flow in sedimentary basins. General characteristics and genesis of hydrothermal ore deposits - Porphyry deposits; greisens and related ore deposits; skarn and carbonate-replacement deposits; epithermal deposits; volcanic-hosted massive sulfide deposits;

**Unit-4**

Orogenic gold deposits; carlin-type deposits; iron oxide-copper-gold (IOCG) deposits; Mississippi Valley-type (MVT) Pb-Zn deposits; SEDEX Pb-Zn-Ag deposits; Kupferschiefer or red-bed copper deposits and various type of uranium deposits (unconformity-related, tabular-shaped, roll-front type and shear zone-hosted). Fluid inclusion studies of ores, Geothermometry, Isotopic studies

## Unit-5

**Ore deposits Formed by Chemical and Clastic Sedimentary Processes:** Ore deposits formed by chemical precipitation from surface waters (hydrogene deposits) and clastic sedimentation - Iron ores in ironstones; sedimentary-rock-hosted Mn and P deposits; coastal heavy mineral sand deposits; and fluvial placer (and paleoplacer) deposits. Ore deposits formed by supergene processes - In-situ supergene ores and formation of lateritic bauxite and Ni-Co deposits; overprinting of hypogene ores and formation of supergene gold (in lateritic weathering) and copper (in arid and semi-arid climates) ores. Stratiform and stratabound ores.

### Suggested Books

- Edwards, R. and Atkinson, K. (1986) *Ore Deposit Geology*. Chapman and Hall, London.
- Craig, J.M. and Vaughan, D.J. (1981) *Ore Petrography and Mineral Geology*. John Wiley.
- Evans, A.M. (2012) *Ore Geology and Industrial Minerals*. Third Edition (Reprint), Blackwell
- Sawkins, F.J. (1984) *Metal Deposits in relation to Plate Tectonics*. Springer Verlag.
- Stanton, R.L. (1972) *Ore Petrology*. McGraw Hill.
- Torling, D.H. (1981) *Economic Geology and Geotectonics*. Blackwell Sci. Publ.
- Barnes, H.L (1979) *Geochemistry of Hydrothermal Ore Deposits*. John Wiley.
- Klemm, D.D. and Schneider, H.J. (1977) *Time and Strata Bound Ore Deposits*. Springer Verlag.
- Guilbert, J.M. and Park, Jr. C.F. (1986) *The Geology of Ore Deposits*. Freeman.
- Mookherjee, A. (2000) *Ore genesis -a Holistic Approach*. Allied Publishers.
- Wolf, K.H. (1981) *Hand book of Strata Bound and Stratiform Ore Deposits*. Elsevier.



<b>GEO-E-413B</b>	<b>FUEL GEOLOGY-I</b>	<b>(5 Credits, 60 Lectures + 15 Tutorials)</b>
-------------------	-----------------------	--

**Instruction to faculty members and Question Setter for:**

**Mid Semester Practical Examination (MSE):**

The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. “**Best of Two**” shall be applicable for computation of marks for SIA.

(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).

**End Semester Practical Examination (ESE):**

The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.

**FUEL GEOLOGY-I**

**Unit 1**

Definition and origin of coal, sedimentology of coal bearing strata; Mode of occurrence and structures of coal; Coal forming epochs in the geological past; Rank, grade and types of coal; Types of coking and non-coking coals; Classification of Coal

**Unit 2**

Proximate and ultimate analysis and its implication in terms of coal classification and utilization. Application of coal petrography. Concept of maceral and its classification: their physical chemical and optical properties. Concept of carbominerates and its classification. Technique and methods of coal microscopy. Sample preparation methods for coal microscopy, application of reflectance and fluorescence microscopy in coal. Application of macerals in coal seam correlation, climate and paleogeography.

**Unit 3**

Macroscopic and microscopic examination of coal, Concepts of Macerals and Microlithotypes, Origin and classification of macerals, Concept of coal rank; Application of Coal Petrology, Geological and geographical distribution of coal and lignite in India.

**Unit 4**

Concept of Coal Bed Methane (CBM) an unconventional source of energy, concept of generation of methane in coal seam, methods of reserve estimations of CBM and its production technique, Concept of carbon capture and sequestration (CCS) and environmental benefit, comparison between conventional oil/gas exploration and CBM, potential of CBM in India. Concept of underground coal gasification (UGC), clean coal technology-coal liquefaction, coal carbonization, coal gasification, prospecting;

**Unit 5**

Microscopic techniques for evaluation of rank, Palaeo environmental study and characterization of coal for carbonization, gasification and hydrogenation processes, Gas Hydrates, Shale gas, Coal forming epochs in geological past, Concept of Gondwanaland and plate tectonics and its effect on distribution of coal on earth.

### Suggested Books

- Chandra, D., Singh, R.M. Singh, M.P. (2000): *Textbook of Coal (Indian context)*, Tara Book Agency, Varanasi.
- Scott, A.C. (1987): *Coal and Coal-bearing strata: Recent Advances*, Blackwell Scientific Publications.
- Singh, M.P. (1998): *Coal and organic PetrolGeology*, Hindustan Publishing Corporation, New Delhi.
- ,G.H., Teichmuller, M., Davis, A., Diessel, C.F.K., Littke, R. and Robert P. (1998): *Organic PetrolGeology*, Gebruder Borntraeger, Stuttgart.
- Thomas, Larry (2002): *Coal Geology*, John Wiley and Sons Ltd., England.
- Van Krevelen Stach;, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichumullelr, M. and Teichmuller R. (1982): *Stach Textbook of Coal PetrolGeology*, Gebruder Borntraeger, Stuttgart.
- Taylor, D. W. (1993): *Coal :TypolGeology-Physics-Chemistry-Constitution*), Elsevier Science, Netherlands



<b>GEO-E-413C</b>	<b>HYDRO GEOLOGY-I</b>	<b>(5 Credits, 60 Lectures + 15 Tutorials)</b>
-------------------	------------------------	--

**Instruction to faculty members and Question Setter for:**

**Mid Semester Practical Examination (MSE):**

The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. “**Best of Two**” shall be applicable for computation of marks for SIA.

(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).

**End Semester Practical Examination (ESE):**

The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.

**HYDRO GEOLOGY-I**

**Unit 1**

Hydrologic Cycle, Distribution of water in Earth crust, Groundwater in hydrologic cycle; Ground water, origin, types, importance; Aquifer, their types and characteristics; Hydrologic properties of aquifer materials: porosity; permeability; specific yield; specific retention, hydraulic conductivity, transmissivity, storage coefficient;

**Unit 2**

Forces and laws of groundwater movement; Darcy law and its application in hydroGeology; Confined, unconfined, steady, unsteady and radial flows of groundwater; Methods of pumping test and evaluation of aquifer parameters. Springs: types, origin and movement of water; Water Table map and its significance;

**Unit 3**

Hydrographic analyses, Water budget studies; Water resource inventory of the basin; Consumptive and conjunctive use of surface and groundwater; Causative factors for Water Table fluctuation. Wells: types, drilling methods, construction, design and development of wells;

**Unit 4**

Physical and Chemical characteristics of groundwater. Interpretation of chemical analysis. Relationship of quality to use. Ground water pollution; Sources of surface and subsurface pollution; Control of ground water pollution

**Unit 5**

Chemical characteristics of groundwater in relation to various uses – domestic, industrial and irrigation; Water contaminants and pollutants, natural (geogenic) and anthropogenic contaminants; Saline water intrusion in coastal and other aquifers and its prevention; Groundwater contamination and problems of arsenic and fluoride in Indian subcontinent with special reference to Jharkhand.

**Suggested Books**

- C.F. Tolman (1937): *Groundwater*, McGraw Hill, New York and London.
- D.K. Todd (1995): *Groundwater Hydrology*, John Wiley and Sons.

- *F.G. Driscoll (1988): Groundwater and Wells, UOP, Johnson Div.St.Paul. Min. USA.*
- *H.M. Raghunath (1990): Groundwater, Wiley Eastern Ltd.,*
- *H.S. Nagabhushaniah (2001): Groundwater in Hydrosphere (Groundwater hydrology), CBS Publ..*
- *K. R. Karanth (1989): HydroGeology, Tata McGraw Hill Publ..*
- *S.N. Davies and R.J.N. De Wiest (1966): HydroGeology, John Wiley and Sons, New York.*
- *Patra, H. P., Adhikari, Shyamal Kumar, Kunar, Subrata(2016)Groundwater Prospecting and Management, Springer*
- *Jakeman, A.J., Barreteau, O., Hunt, R.J., Rinaudo, J.-D., Ross, A. (2016) Integrated Groundwater Management: Concepts, Approaches and Challenges, Springer*
- *Ramanathan, A., Johnston, S., Mukherjee, A., Nath, B. (Eds.)2015, Safe and Sustainable Use of Arsenic- Contaminated Aquifers in the Gangetic Plain*
- *A Multidisciplinary Approach; Springer*
- *C.W. Fetter Jr.(2016)Applied HydroGeology (4th Edition) 4th Edition Pearson Education Ltd.*
- *Kevin M. Hiscock(2009)HydroGeology: Principles and Practice, Wiley-Blackwell*
- *Singhal, B.B.S. Gupta R.P.(2010)Applied HydroGeology of Fractured Rocks, Springer*



<b>GEO-E-414A</b>	<b>ORE GEOLOGY-II</b>	<b>(5 Credits, 60 Lectures + 15 Tutorials)</b>
-------------------	-----------------------	--

**Instruction to faculty members and Question Setter for:**

**Mid Semester Practical Examination (MSE):**

The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. “**Best of Two**” shall be applicable for computation of marks for SIA.

(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).

**End Semester Practical Examination (ESE):**

The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.

**ORE GEOLOGY-II**

**Unit 1**

Non-magmatic processes of mineralization, Occurrence and distribution in India of iron and base metal deposits.

**Unit 2**

Occurrence and distribution in India of manganese, aluminium, chromium, nickel and gold deposits. Energy and fuel minerals, PGE and associated ores.

**Unit 3**

Indian deposits of non-metals: mica, asbestos, gypsum, graphite and apatite. Gemstones, refractory minerals, abrasives and minerals used in glass, fertilizer, paint, ceramic and cement industries.

**Unit 4**

Strategic, critical and essential mineral. India's status in mineral production. National Mineral Policy. Marine mineral resources and Laws of Sea. Mineral concession rules.

**Mineral Resources**

Resource reserve definitions, Mineral resources in industries – historical perspective and present, A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies.

**Unit 5**

Principles of mineral exploration, Prospecting and exploration, Various methods of sampling. subsurface sampling including pitting, trenching and drilling, Geochemical exploration. Surface and sub-surface explorations. Definition and outline of UNFC classification of mineral reserves and resources. Grade and recovery of ores. Methods of ore reserves estimation, density and bulk density, Factors affecting reliability of reserve estimation

**Suggested Books:**

- Mookherjee, A. (2000) *Ore genesis -a Holistic Approach*. Allied Publishers.
- Wolf, K.H. (1981) *Hand book of Strata Bound and Stratiform Ore Deposits*. Elsevier.

- Jensen, M.L. and Bateman, A.M. (1981) *Economic Mineral Deposits*. John Wiley and Sons, New York.
- McKinsty, H.E. (1972) *Mining Geology*. Prentice-Hall Inc.
- ArGeologyaswamy, R.N.P. (1995) *Courses in Mining Geology*. Oxford and IBH Publishing Co., New Delhi.
- Thomas, L.J. (1978) *An Introduction to Mining*. Methuen, Brisbane.
- Clark, G.B. (1967) *Elements of Mining*. Asia Publishing House.
- Sinha, R.K. & Sharma, N.L. (1993) *An Introduction to Mineral Economics*, Wiley Eastern
- Chaterjee, K.K. (1993) *An Introduction to Mineral Economics*, Wiley Eastern.





<b>GEO-E-414B</b>	<b>FUEL GEOLOGY-II</b>	<b>(5 Credits, 60 Lectures + 15 Tutorials)</b>
-------------------	------------------------	--

***Instruction to faculty members and Question Setter for:***

***Mid Semester Practical Examination (MSE):***

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. “Best of Two” shall be applicable for computation of marks for SIA.*

*(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).*

***End Semester Practical Examination (ESE):***

*The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.*

## **FUEL GEOLOGY-II**

### **Unit 1**

Elementary idea about coal preparation, Washing and beneficiation of coal, Blending of coal; coal carbonisation, coal gasification, coal liquefaction and coal combustion; Briquetting of coal

### **Unit 2**

Assessment of coal reserves; geological, Geobotanical and Geophysical survey for coal; Gondwana palynology and its application for coal exploration;

### **Unit 3**

Mining of coal- underground mining and open cast mining; Coal Mining hazards and its mitigation; Trace elements in coal; Coal as environment pollutant; Conservation of coal

### **Unit 4**

Unit geological and geographical distribution of coal deposits of Jharkhand

### **Unit 5**

Geological and geographical distribution of coal and Lignite deposits in India except Jharkhand;

### **Unit 6**

Origin and nature of oil and gas; Amount, type and maturation of organic matter; Migration of Petroleum; Reservoir rocks - Geology of reservoir rocks, porosity and permeability; Reservoir traps – structural, stratigraphic and combination traps. Identification and characterization of petroleum source rocks, Oil and source rock correlation.

### **Unit 7**

Petroleum basins of India, important oil fields of India; Brief idea about global occurrence of Petroleum; Position of oil and natural gas in India, Future prospects and economic scenario. ; Palaeo depositional and palaeo environmental models with the help of microfossils and Palynology; Quantitative evaluation of oil and gas, Geological, Geochemical and Geophysical exploration of Petroleum.

### Suggested Books:

- Chandra, D., Singh, R.M. Singh, M.P. (2000): *Textbook of Coal (Indian context)*, Tara Book Agency, Varanasi.
- Scott, A.C. (1987): *Coal and Coal-bearing strata: Recent Advances*, Blackwell Scientific Publications.
- Singh, M.P. (1998): *Coal and organic PetrolGeology*, Hindustan Publishing Corporation, New Delhi.
- ,G.H., Teichmuller, M., Davis, A., Diessel, C.F.K., Littke, R. and Robert P. (1998): *Organic PetrolGeology*, Gebruder Borntraeger, Stuttgart.
- Thomas, Larry (2002): *Coal Geology*, John Wiley and Sons Ltd., England.
- Van Krevelen Stach;, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichumullelr, M. and Teichmuller R. (1982): *Stach Textbook of Coal PetrolGeology*, Gebruder Borntraeger, Stuttgart.
- Taylor, D. W. (1993): *Coal :TypolGeology-Physics-Chemistry-Constitution*), Elsevier Science,



<b>GEO-E-414C</b>	<b>HYDRO GEOLOGY-II</b>	<b>(5 Credits, 60 Lectures + 15 Tutorials)</b>
-------------------	-------------------------	--

**Instruction to faculty members and Question Setter for:**

**Mid Semester Practical Examination (MSE):**

The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. “**Best of Two**” shall be applicable for computation of marks for SIA.

(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).

**End Semester Practical Examination (ESE):**

The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.

## **HYDRO GEOLOGY-II**

### **Unit 1**

Occurrence of groundwater in different rock types; geologic structures favouring groundwater occurrence; Occurrence of groundwater in various hydrostratigraphic units of India; Groundwater provinces of India.

### **Unit 2**

Components of Groundwater basin characterization: slope characteristics, lithology and associated geological structures, soil type and thickness, etc.; Geomorphic controls for groundwater accumulation; Drainage pattern, their relationship with lithology and geologic structure; tools.

### **Unit 3**

Groundwater basin characterization and prioritization by Remote Sensing and GIS.

Surface and subsurface geological and geophysical methods of groundwater exploration; Identification of groundwater potential zones by various Remote sensing techniques, Application of GPR in groundwater exploration, Use of radio isotopes in hydrological studies.

### **Unit 5**

Groundwater problems and management related to foundation work, mining, reservoirs, tunnels and effects of water in landslides; Environmental effects of over-exploitation of groundwater; Water logging problems;

### **Unit 6**

Watershed- concept, classification; Components of watershed; rainfall, temperature, topography, nature of soil and depth, lithology and geological structures, drainage pattern, land use pattern Valley to basin concept in water management. Natural and artificial recharge of groundwater, Rain water harvesting techniques for rural and urban areas; Physical structures for water resource management in Rural areas; Use of Remote sensing and GIS in Watershed Management;

### **Unit 7**

Water management physical structures and their characteristics such as Ridge area treatment, gully plug, contour bunding, check dams, gabion structure, percolation tanks etc. Traditional methods for water resource management in India; Basic components of Watershed Guidelines of India,

Participatory approach for programme implementation of watershed. Water management and Panchayati Raj Acts; Legislations related to water resources: Basic Constitutional provisions, Water Pollution Acts, National Water Policy

### Suggested Books

- C.F. Tolman (1937): *Groundwater*, McGraw Hill, New York and London.
- D.K. Todd (1995): *Groundwater HydrolGeology*, John Wiley and Sons.
- F.G. Driscoll (1988): *Groundwater and Wells*, UOP, Johnson Div. St. Paul. Min. USA.
- H.M. Raghunath (1990): *Groundwater*, Wiley Eastern Ltd.,
- H.S. Nagabhushaniah (2001): *Groundwater in Hydrosphere (Groundwater hydrolGeology)*, CBS Publ..
- K. R. Karanth (1989): *HydroGeology*, Tata McGraw Hill Publ..



GEO-E/P-415A	PRACTICAL (413A-414A)	(5 Credits, 75 Lectures)
--------------	-----------------------	--------------------------

**Instruction to Question Setter:**

*End Semester Practical Examination (ESE Pr):*

*The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.*

**Note:**

*(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd, 5 marks ).*

**PRACTICAL**

- i. Megascopic & microscopic study of important ores and their textures.
- ii. Megascopic study of important industrial, metallic and non-metallic, precious and semi-precious stones.
- iii. Ore petrographic study of ore minerals and establishment of paragenetic sequence
- iv. Study of Geological cross-section of important mineral deposits.
- v. Study of distribution of important ore deposits in India
- vi. Exercises on ore reserve calculations.
- vii. Reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks)
- viii. Estimation of grade of ores.
- ix. Regular and irregular grid patterns, statistics and error estimation

<b>GEO-E/P-415B</b>	<b>PRACTICAL (413B-414B)</b>	<b>(5 Credits, 75 Lectures)</b>
---------------------	------------------------------	---------------------------------

**Instruction to Question Setter:**

*End Semester Practical Examination (ESE Pr):*

*The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.*

**Note:**

*(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd, 5 marks ).*

**PRACTICAL**

- i. Megascopic study of Coal and Coal bearing strata
- ii. Proximate analysis of coal
- iii. Drawing and labelling of parts of Gondwana Plant Fossils from different coalfields.
- iv. Identification of different palynomorphs
- v. Microscopic examination of coal macerals
- vi. Microscopic study of Heavy minerals
- vii. Borehole problems and calculation of reserves from borehole
- viii. Study of Geological Maps and Sections of important oil fields of India



GEO-E/P-415C	PRACTICAL (413C-414C)	(5 Credits, 75 Lectures)
--------------	-----------------------	--------------------------

**Instruction to Question Setter:**

**End Semester Practical Examination (ESE Pr):**

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

**Note:**

(Attendance Upto 75%, 1 mark; 75 < Attd. < 80, 2 marks; 80 < Attd. < 85, 3 marks; 85 < Attd. < 90, 4 marks; 90 < Attd., 5 marks).

**PRACTICAL**

- i. Determination of porosity of aquifer materials.
- ii. Determination of temperature, pH, T.D.S., conductivity TSS, alkalinity, dissolved oxygen, hardness etc.
- iii. Construction of Water Table and piezometric surface maps and their interpretations.
- iv. Interpretations of geological cross sections for locating water bearing horizons.
- v. Pumping test for evaluation of aquifer parameters.
- vi. Construction of litholog and their interpretations.
- vii. Graphical representation of hydrochemical data on Piper Trilinear diagram.
- viii. Plotting and interpretation of resistivity data.
- ix. Delineation of watershed on topographical and satellite imageries.

GEO-D-416	Dissertation/Project Work	(5 Credits, 150 Lectures)
-----------	---------------------------	---------------------------

#### Guidelines to Examiners for:

- *Mid-Semester/Internal Assessment Examination* = 30 marks
- *End Semester Examination: Project model (if any) and the Project record notebook, Project presentation and viva-voce* = 70 marks  
(Jointly conducted by One External & One Internal Examiners)

#### Overall project dissertation may be evaluated under the following heads:

- Motivation for the choice of topic
- Project dissertation design
- Methodol Geology and Content depth
- Results and Discussion
- Future Scope & References
- Participation in Internship programme with reputed organization
- Application of Research technique in Data collection
- Report Presentation
- Presentation style
- Viva-voce

The paper will consist of

- (a) Field work/Lab work related to the Elective Paper.
- (b) Preparation of dissertation based on the work undertaken.
- (c) Presentation of project work in the seminar on the assigned topic in the P.G. Department of Geology, B.B.M.K. University, Dhanbad & open viva there on.

**NB:-** The students will select topics for the project work in consultation with a teacher of the department.

#### PROJECT WORK

Each student has to submit **two** copies of the dissertation work duly forwarded by the Supervisor and Head of Department concerned. The forwarded copies will be submitted in the University Department of Geology, B.B.M.K. University, Dhanbad for evaluation.



**Annexure-1****Research Methodology (Common for All Faculties)****M.A./M.Sc./M.Com. Courses****Semester-IV****Paper Code: GEO-D-416**

**Mid Semester Examination (MSE):** There will be **two** groups of questions in written examinations of **30 marks**. **Group A is compulsory** and will contain ten questions of **multiple type questions** consisting of **1 mark** each. **Group B** will contain **descriptive type eight questions** of **five marks** each, out of which any **four** are to be answered.

**Broad topics of the syllabus are as under:**

**Introduction of Research Methodology:** Meaning of Research, Objectives of Research, Research Methods

**Types of Research:** Descriptive vs. Analytical Research, Applied vs. Fundamental Research, Quantitative vs. Qualitative Research, Conceptual vs. Empirical Research

**Research Process:** Basic Overview; Literature Review; Formulating the Research Problem, Hypothesis, Research Questions, Research Methodology

**Data Collection:** Primary and Secondary Data, Sampling Method, Observation Method, Interview Method, Questionnaires, Case Study Method, Historical Method, Processing and Analysis of Data, Interpretation of Data/Results, Conclusions/Findings.

**Research Writing:** Synopsis, Article/Research Paper, Research Project, Thesis, Dissertation, Book, Book-Review, Case Review, Criteria of Good Research, Plagiarism

**Citation Style & Methods:** MLA, APA, Foot Note, Text Note, End Note, Footnotes, Bibliography, References

**Reference Books:**

- a) Best and Kahn, Research Methodology, PHI Limited.
- b) Kothari, C.R. Research Methodology (Methods and Techniques), New Age Publisher.

Annexure-2**Format of question Paper of Mid-Semester Theory Examination****Binod Bihari Mahto Koyalanchal University, Dhanbad****Mid-Semester Examination xxxx(Session: xxxx-xx)****Subject/Code:**

Full Marks: 20

Pass Marks: 08

Time: 1.5 Hours

**General Instructions:**

Candidates are required to give their answers in their own words as far as practicable.

The Questions are of equal value.

**Answer any five questions of the following in which Q.1 is compulsory.****Group A****1. Multiple Choice Questions****(1x5=05)**

- (i) .....
- (ii) .....
- (iii) .....
- (iv) .....
- (v) .....

**Group B****(Descriptive answer type questions)****Answer any three of the following.****(5x3=15)**

2. ....
3. ....
4. ....
5. ....
6. ....

.....X.....

॥ तमसो मा ज्योतिर्गमय ॥

ESTD: 2017



## Format of question Paper of End-Semester Theory Examination



**Binod Bihari Mahto Koyalanchal University, Dhanbad**

**End-Semester Examination xxxx(Session: xxxx-xx)**

**Subject/Code:**

Full Marks: 70

Pass Marks: 28

Time: 3Hours

### **General Instructions:**

Candidates are required to give their answers in their own words as far as practicable.

The Questions are of equal value.

**Answer any five questions of the following in which Q.1 is compulsory.**

### **Group A**

#### **1. (A) Multiple Choice Questions**

**(1x6=06)**

- (i) .....
- (ii) .....
- (iii) .....
- (iv) .....
- (v) .....

#### **(B) Short answer type questions**

**(4x2=08)**

- (a) .....
- (b) .....

### **Group B**

**(Long answer type questions)**

**Answer any four of the following.**

**(14x4=56)**

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

#### **9. Short notes type questions (7x2=14)**

- (a) .....
- (b) .....
- (c) .....
- (d) .....

**X**

**ESTD: 2017**