Department of Applied Geology

School of Engineering & Technology

Curriculum Framework Master of Technology
in
Applied Geology

Based on

National Education Policy-2020

Date of BoS: 12/09/2022

Department of Applied Geology
Doctor Harisingh Gour Vishwavidyalaya
(A Central University)
Sagar-Madhya Pradesh 470003

About the Department

The Department of Geology was started in 1946 to offer B.Sc. and M.Sc. degrees classes under the headship of Professor G.W. Chiplonkar. The Department of Applied Geology started independently in the year 1956 offering three year's post graduate courses leading to M.Tech. degree in Applied, under the headship of Professor W. D. West. After six years both the departments (Pure and Applied Geology) were merged into the Department of Applied Geology. The Department was expanded when it enjoyed the status of a Centre of 'Advanced Study in Geology' from 1964.

The Department has laboratories in the major thrust areas of Metamorphic & Igneous Petrology, Micropaleontology, Ore Microscopy and Economic Geology, Mineralogy, Sedimentology, Photo Geology, and Geochemistry with basic laboratory equipment's required for teaching and research on various aspects in the major thrust area identified under R & D Programme. The students are given field training in geological mapping, mineral exploration, and oil exploration, from three to four weeks in even semesters.

Curriculum Framework based on National Education Policy-2020

NEP-2020 has conceptualized the idea to develop well rounded competent individuals for making the nation a self-reliant and global leader. In the same spirit, we have developed a curriculum frame work to encompass the goals of NEP-2020. To this end, we have incorporated choice of subject/disciplines of study, creating academic pathways having constructive combinations of disciplines for study with multiple entry and exit points as well as focus on **experiential learning** for students by introducing **multidisciplinary and skill enhancement courses** and actual Hand's on training in the recent and trending aspects of the area concerned.

Post Graduate Curriculum Framework for Master of Technology (M.Tech.) in Applied Geology

1. **Name of the Programme: Master of Technology (M.Tech.) in Applied Geology**
2. **About the Programme:** The Department of Applied Geology offers a three year's post graduate course (Six Semesters) leading to Master of Technology Degree in Applied Geology.
3. **Objectives of the Programme:**

- The students are imparted field training in geological mapping, mineral exploration, and oil-exploration, from three to four weeks in even Semesters.
- Topographical Surveying worth **02** credits (Skill Enhancement Course) is a unique feature of the M. Tech. Course.
- The Scheme of Syllabi of M. Tech has a Seminar of **02** credits (Skill Enhancement Course) in all the Semesters offered to inculcate confidence among the PG students in developing PowerPoint presentation before the board of Coordinators involved in each Semester.
- The Syllabus of II Semester in M. Tech includes a Programme of 3 weeks duration (12 credits; Multi - Disciplinary: Major-3) to impart training for techniques of geological mapping by establishing a field camp within 100 km vicinity of Sagar where the students and faculties Camp during this programme.
- Petrology & Economic Geology Tour of M.Tech. IV Semester is a part of the syllabus worth **10** credits under Multi - Disciplinary: Major-3.

- The Syllabus of VI Semester in M.Tech. Includes a Programme of 3 weeks duration (**12** credits under Discipline Specific: Major-2) attachment with Atomic Mineral Division (AMD), Geological Survey of India (GSI), Coal India and Oil and Natural Gas Commission (ONGC).
- Modern tools of teaching: Class room teachings are supported by Modern Tools of teaching such as PowerPoint, Video Lectures etc. Department has one smart classroom with 15 terminals for students..
- Popular lectures**:** Students are encouraged to participate and attend various subjects related regular popular lectures training virtual organized by Atomic Mineral Division (AMD), Geological Survey of India (GSI).
- Faculty of Applied Geology Offered 08 UG-MOOCs and 01 PG- MOOC for SWAYAM plateform which are running regularly since November, 2016 onwords. Among them few courses are very popular within and outside India, especially Petrology and Metamorphic Petrology & Thermodynamics.
  PG-MOOC – Metamorphic Petrology & Thermodynamics
  Course Coordinator **-** Prof. Harel Thomas
- To emphasize on need-based syllabus to enable the students for economic independence.
- To cater to the educational needs of the society with an inclusive approach.

After completion of the Programme the learner will be able to:

i. Serve the Nation as Geologist / Government officers in (GSI, ONGC, AMD, DGM and NMDC).
ii. They should be able to join national/multinational to work as geologist in India / abroad
iii. They should be able to work as consultant Geologist. .

4. Programme Learning Outcomes:

The programme learning outcomes are attained by learners through the essential learning's acquired on completion of selected courses of study within a programme. The outcomes and attributes described in qualification descriptors are attained by students through learning acquired on completion of a programme of study.

5. Structure of the Programme

Postgraduate Curriculum Framework
Syllabus - M. Tech. (Applied Geology) 2022-23
L-8
I & II Semester

I- Semester

Year/Semester	Nature of Course	Courses	Credits
L-8	Discipline Specific: Major	GEO-DSM-131 Structure Geology	04
	Discipline Specific: Major	GEO-DSM-132 Structure Geology Practical	02
	Discipline Specific: Major	GEO-DSM-133 Mineralogy & Mineral Optics	04
	Discipline Specific: Major	GEO-DSM-134 Mineral, Mineral Optics & Crystallography Practical	02
I - Semester	Multi - Disciplinary: Major	GEO-MDM-131 Geomorphology	04
	Multi - Disciplinary: Major	GEO-MDM-132 Crystallography	02
	Skill Enhancement Course	GEO-SEC-131 Topographical Surveying	04
	Skill Enhancement Course	GE0-SEC-132 Seminar	02
Total Credits			**24**

MOOC: Crystallography & Mineralogy offered by the University. Course Coordinator: Prof. Harel Thomas, available on SWAYAM Platform.

II Semester

Year/Semester	Nature of Course	Courses	Credits
L-8 II Semester	Discipline Specific: Major	GEO-DSM-231 Applied Micropaleontology	04
	Discipline Specific: Major	GEO-DSM-232 Applied Micropaleontology Practical	02
	Discipline Specific: Major	GEO-DSM-233 Stratigraphy- (Phanerozoic)	04
	Discipline Specific: Major	GEO-MDM-234 Stratigraphy-(Precambrian)	04
	Multi - Disciplinary: Major	GEO-MDM-231 Geological Field Work, Geological Report & Viva - Voce	12
	Skill Enhancement Course	GEO-SEC- 231 Seminar	02
	Skill Enhancement Course	GE0-SEC - 232 Mineral Resources	02
Total Credits			**28**
Exit with M.Tech Applied Geology Certificate			

Note: Student can choose either GEO-231 or 232 in one Semester

L-9
III & IV Semester

III- Semester

Year/ Semester	Nature of Course	Courses	Credits
L - 9 III Semester	Discipline Specific: Major	GEO-DSM-331 Igneous Petrology	04
	Discipline Specific: Major	GEO-DSM-332 Igneous Petrology Practical	02
	Discipline Specific: Major	GEO-DSM-333 Ore Geology	04
	Discipline Specific: Major	GEO-MDM-334 Economic & Ore Geology Practical	02
	Multi - Disciplinary: Major	GEO-MDM-331 Sedimentology	04
	Multi - Disciplinary: Major	GEO-MDM-332 Sedimentology Practical	02
	Skill Enhancement Course	GEO-SEC-331 Industrial Minerals	03
	Skill Enhancement Course	GEO-SEC-332 Seminar	02
Total Credits			**23**

IV – Semester

Year/Semester	Nature of Course	Courses	Credits
L - 10 IV Semester	Discipline Specific: Major	GEO-DSM-431 Metamorphic Petrology & Thermodynamics	04
	Discipline Specific: Major	GEO-DSM-432 Metamorphic Petrology & Thermodynamics Practical	02
	Discipline Specific: Major	GEO-DSM-433 Geochemistry	04
	Discipline Specific: Major	GEO-MDM-434 Geochemistry Practical	02
	Multi-Disciplinary: Major	GEO-MDM-431 Geodynamics & Tectonics	04
	Multi-Disciplinary: Major	GEO-MDM-432 Economic Geology, Petrology Tour & Viva-Voce	10
	Skill Enhancement Course	GEO-SEC-431 Fuel Geology (Coal, Petroleum & Atomic)	02
	Skill Enhancement Course	GEO-SEC-432 Seminar	02
Total Credits			**30**
Exit with M.Tech Applied Geology Diploma			

PG-MOOC: Metamorphic Petrology & Thermodynamics offered by the University. Course Coordinator: Prof. Harel Thomas, available on SWAYAM Platform.
MOOC: Petrology offered by the University. Course Coordinator: Prof. Harel Thomas, available on SWAYAM Platform.

MOOC: Geochemistry offered by the University. Course Coordinator: Prof. Harel Thomas, available on SWAYAM Platform.

L-11 V and VI Semester

V – Semester

Year/Semester	Nature of Course	Courses	Credits
L-11 V Semester	Discipline Specific: Major	GEO-DSM-531 Mining & Exploration Geology	04
	Discipline Specific: Major	GEO-DSM-532 Mining & Exploration Geology Practical	02
	Discipline Specific: Major	GEO-DSM-533 Ground Water Hydrology	04
	Discipline Specific: Major	GEO-MDM-534 Ground Water Hydrology Practical	02
	Multi - Disciplinary: Major	GEO-MDM-531 Geoinformatics	04
	Multi - Disciplinary: Major	GEO-MDM-532 Geoinformatics Practical	02
	Skill Enhancement Course	GEO-SEC-531 Seminar	02
	Skill Enhancement Course	GEO-SEC-532 Instruments used in Geosciences	02
Total Credits			**22**

MOOC: Photogeology & Remote Sensing course offered by the University. Course Coordinator: Prof. R. K.Rawat, available on SWAYAM Platform.

VI - Semester

Year/Semester	Nature of Course	Courses	Credits
L - 11 VI Semester	Discipline Specific: Major	GEO-DSM -631 Engineering Geology & Geotechniques	04
	Discipline Specific: Major	GEO-DSM -632 Engineering, Geotechniques & Environmental Geology Practical	02
	Discipline Specific: Major	GEO-DSM -633 Dissertation on Mineral Exploration (Industrial/Organization Attachment) & Viva-Voce	14
	Multi - Disciplinary: Major	GEO-MDM - 631 Environmental Geology	04
	Multi - Disciplinary: Major	GEO-MDM - 632 Mineral Economics	02
	Skill Enhancement Course	GEO-SEC- 631 Seminar	02
	Skill Enhancement Course	GEO-SEC-632 Research Methodology	02
Total Credits			**28**
Exit with M.Tech. Applied Geology Degree			

Note: Student can choose either GEO-631 or 632 in one Semester

Allied branches: Geology, Geochemistry and Hydrogeology.

Relevant branches: Geophysics, Marine Geology/Oceanography.

Discipline Specific: Major (DSM) Course = 12 = 82
Multi - Disciplinary: Major (MDM) Course = 09 = 51
Skill Enhancement Course (SEC) Course = 12 = 22

Total Credits of Core Courses = 153

I-Semester

Year/Semester	Nature of Course	Courses	Credits
L-9	Discipline Specific: Major	GEO-DSM-131 Structure Geology	04
	Discipline Specific: Major	GEO-DSM-132 Structure Geology Practical	02
	Discipline Specific: Major	GEO-DSM-133 Mineralogy & Mineral Optics	04
	Discipline Specific: Major	GEO-DSM-134 Practical Mineral, Mineral Optics & Crystallography	02
I-Semester	Multi - Disciplinary: Major	GEO-MDM-131 Geomorphology	04
	Multi - Disciplinary: Major	GEO-MDM-132 Crystallography	02
	Skill Enhancement Course	GEO-SEC-131 Topographical Surveying	04
	Skill Enhancement Course	GE0-SEC-132 Seminar	02
Total Credits			**24**

MOOC: Crystallography & Mineralogy offered by the University. Course Coordinator: Prof. Harel Thomas, available on SWAYAM Platform.

M. Tech. I Semester

Discipline Specific: Major
GEO-DSM-131- Structure Geology

(Credits 4; 60 Hrs; M.M. 100 = 60 End Sem. + 40 sessional)
Course Coordinator: Dr. G. K. Singh

Learning Objective of the Course

This course proposes an objective to give an outline of the basic structural analysis by discussion, drawing and measurements along with some field work.

Unit 1

Primary Structures: Introduction, types and their applications; Field techniques of lithological and structural mapping; Unconformities; plutons, study of toposheet, V-rule and outcrop patterns; stereographic projections of structural elements. **(Lectures 12)**

Unit 2

Folds and folding: buckling and banding folds; Geometry of folded surfaces- Single and multilayer. Geometric classification; Mechanism of folding; folding of obliquely inclined surfaces and of early lineation. Superimposed folding Outcrop patterns of superimposed structures, comprising two fold systems. **(Lectures 12)**

Unit 3

Strain analysis: Strain and its types; Strain ellipse and strain ellipsoid; Geological application of strain theory. Progressive deformation: Graphic methods of representation treated in simple manner. Stress analysis, Compressive and shear stress; biaxial triaxial stress; Mohr's Circle; Mean and deviatoric stress; Dynamics of faulting; principal stress orientation for three main fault types; relationship between stress and strain. **(Lectures 12)**

Unit 4

Fault: Nomenclature, classification, element, types of fault; Mechanics of faulting.Rock deformation: Stress-strain relationship controlled by confining pressure; Strain rate; temperature; fluid medium; Properties of elastic, plastic and various materials; Petrofabrics: Field laboratory techniques and procedures: preparation of petrofabric diagrams & their interpretation; Cleavage, schistosity: Slaty cleavage, Schistosity: Crenulation cleavage; Strain slip cleavage; Fracture cleavage; Mode of generation of above cleavages & their relation to deformation & major structures. **(Lectures 12)**

Unit 5

Lineation and Foliation: Introduction and types: deformation pebbles and oolites; elongated minerals; intersection of two planes; crinkles; slickenside; boudinage; mineral streaks; rodding & mullion structure-their mode of development & relation to major structure; Joints & their classification; analysis & relation to major

structure. Major tectonic fields of India & world. Introduction and types of lineation and its significance in structural analysis. **(Lectures 12)**

Expected Learning Outcome

The manifestation of the course, if completed successfully, can be reflected in the form of an insight to develop a skill in order to study and interpret the structural features of naturally deformed rocks on Earth and some specific craters of Mercury.

Essential Reading

1. Ghosh, S.K. (1985): Structural Geology- Fundamental & Modern Development,.
2. Ramsay, J.G.(1967): Folding & Fracturing of Rocks, Pergamon Press, Mc Graw Hill, New Delhi.
3. Ramsay, J.G. (1983): Strain Analysis & Deformation, Academic Press.
4. Saklani, P.S. (1983):Structural & Tectonics of Himalaya, Today & Tomorrow Pub. New Delhi
5. Billing, M.P. (1974): Principle of Structural Geology, III Edi. Prentice Hall Int. Inc.

Suggested Reading:

6. Ramsay, J. G. and Huber, M. I. (1993): The Techniques of Modern Structural Geology, V. I & II,Academic Press.
7. Seyfert, C. K. (1987): Encyclopedia of Structural Geology, Vay Norstand Reinhold, New York.
8. Valdiya, K. S. (1980):Geology Kumaun Himalaya, WIHG, H.T. Press, Dehradon
9. Jain, A. K. (2014): Structural Geology, Geol. Soc. of India, Bangalore.

Discipline Specific: Major
GEO-DSM-132 – Structure Geology Practical

(Credits 2; 30 Hrs; M.M. 100 = 60 End Sem. + 40 sessional)

Course Coordinator: Dr. G. K. Singh

- Stereographic projection: Problems in angular relationships-true dip, apparent dip, plunge and rake of the intersection of the planes.
- Beta and Pi diagrams. Pi Pole Girdle. Contouring of stereographically plotted data. Study of major structure in hand specimens.
- Presentation and interpretation of advanced geological maps and structural contour maps of inclined strata, folds, faults and unconformities.
- Three point problems: geometric solutions for three point problems. Analysis of geometry and style of folds.
- Use of computer programme in plotting of structural data and petrofabric analysis. Strain analysis and derivation of principal stress axes field data.

Discipline Specific: Major
GEO-DSM-133 – Mineralogy & Mineral Optics

(Credits 4; 60 Hrs; M.M. 100 = 60 End Sem. + 40 sessional)

Course Coordinator: Prof. H. Thomas

Learning Objective of the Course

The course aims to make to the students well-versed with the strength of mineralogy applications in the field of Geology.

Unit 1

Minerals as solid solutions; Principles governing solid solution mineral chemistry phenomena. Ex-solution; Ionic radius; Co-ordination number; Radius ratio: Bonding: Paulings principles. Structure of silicate minerals. Bearing of structure on certain properties of minerals. **(Lectures 10)**

Unit 2

A study of the following mineral groups/minerals comprising structure, chemistry, physical and optical properties, and paragenesis of Nesosilicate, Cycleosilicate and Sorosilicate: Olivine, Garnet, Aluminosilicate, Zircon, Epidote, Tourmaline, Amphibole and Pyroxenes. **(Lectures 10)**

Unit 4

A study of the following mineral groups/minerals comprising structure, chemistry, physical & optical properties, and paragenesis of Phyllosilicate and Tectosilicate group of minerals: Clay, Chlorite, Muscovite, Biotite. Quartz, Feldspar, Feldspathoid and staurolite, cordierite, chloritoid, carbonates and sulphate minerals. **(Lectures 10)**

Unit 5

General principles of optics, optical properties of light and optical classification of crystals.Pola-risation of light, Nicol prism, polaroid plates. Polarising microscope. Refringence, Determination of refractive Indices of isoaxial, uniaxial & biaxial minerals. Interference phenomenon, determination of the order of Interference colour in anisotropic minerals.Birefringence, Michael Levy's Chart, Berek's compensator. Applications of X- ray crystallography. **(Lectures 10)**

Unit 6

Optical Indicatrix: uniaxial and biaxial.Study of Interference figures, uniaxial and biaxial. Determination of optic sign in minerals. Selective absorption. Determination of dichroism and pleochronic, scheme in minerals.Extinction phenomenon. Dispersion in minerals. Optical anomalies in minerals and their study. **(Lectures 10)**

Expected Learning Outcome

The students will develop capability to transform the knowledge into higher aspects like identification of mineralized zone and find out economic minerals in the field.

Essential Reading

1. Alexander, P.O. (2009): Handbook of Rocks, Minerals, Crystals & Ores. New India Pub.
2. Babu, S.K. (1987): Practical Manual of Crystal Optics, CBS Pub. & Dist.
3. Phillips, W. R. and Griffen, D. T. (1986): Optical Mineralogy, Etd. CBS Pub & Dist.
4. Ray, S. (1958): Optical Mineralogy. CBS Pub. & Dist
5. Kerr, P. (1977): Optical Mineralogy,McGraw- Hill Book Co.

Suggested Reading:

6. Flint, F. (1964): **Essentials of Crystallography**, Peace Pub., Russia.
7. Deer,W. A., Howie, R. A. &Zussman, J.(1966): **An Introduction to Rock Forming Minerals.**
8. Deer,W. A., Howie, R. A. & Zussman, J.(1996): **The Rock Forming Minerals**, Longman
9. Winchell, A. N. (1939): **Elements of Optical Mineralogy**, Lincoln Pub. Co., New York.
10. Naidu, P. R. J. (1918):**Optical Mineralogy**, Allied Pub., Kolkata.
11. MOOC: Crystallography & Mineralogy offered by the University. Course Coordinator: Prof. Harel Thomas, available on SWAYAM Platform.

Discipline Specific: Major
GEO-DSM-134 - Mineral, Mineral Optics & Crystallography Practical

(Credits 2; 30 Hrs; M.M. 100 = 60 End Sem. + 40 sessional)

Course Coordinator: Dr. K. K. Prajapati

- Study of different forms of normal class in different systems; Study of a few important twin crystals. Stereographic projection of crystals such as garnet, zircon, anatase, topaz, sulphur and gypsum.
- Determination of refenegence by immersion method using the Becke effect; determination of order of interference colours of minerals. Determination of pleochoric scheme of biaxial minerals.
- Study of the conoscopic figures of uniaxial and biaxial crystals using optic axial and acute bisectrix figures; determination of extinction angle using sensitive tint and by the Biet-Fresnel law.
- Determination of optic axial angle on the universal stage.
- Determination of the composition of feldspar by Reinhard method.
- Megascopic identification of common rock forming minerals. Microscopic study of important rock forming minerals.Determination of Birefringence using Berek's compensator. Michael Levy's chart.
- Extinction angle and its determination.

Multi - Disciplinary: Major
GEO-MDM-131-Geomorphology

(Credits 4; 60 Hrs; M.M. 100 = 60 End Sem. + 40 sessional)

Course Coordinator: Prof. P. K. Kathal

Learning Objective of the Course

The course for the geomorphology is running with a view to providing a glance to different exogenic processes that shape landforms on earth.

Unit 1

Introduction: Weathering, soil processes and mass wasting; fundamental concepts of geomorphology. **(Lectures 12)**

Unit 2

The fluvial geomorphic cycle: Fundamental concepts; streams and valleys; stages of cycle; drainage patterns and their significances; stream meandering and lateral erosion; interruptions and rejuvenation; shifting stream divides; misfit rivers; river terraces; causes of stream deposition- resulting landforms. **(Lectures 12)**

Unit 3

The cycle of erosion; The basic principles and graphical presentation. topography on domal and folded structures; geomorphic cycle. Karst topography: Various features associated with Karst region and Karst cycle.

Arid cycle: differences between arid and humid regions; origin of deserts; major landforms of arid regions; the arid erosion cycle; aeolian land forms; topographic effects of wind erosion; aeolian deposits. **(Lectures 152**

Unit 4

Glacial Cycle: Ice ages and past climates; geologic and palaeontological evidences; the Quaternary ice ages; Permo-carboniferous ice ages; Pre-Cambrian ice-ages. Types and characteristics of glaciers; motion-regimen-effectiveness of erosion; mountain glaciations; major features of erosion; depositional landforms; multiple mountain glaciation.

Geomorphology of coasts: Marine erosion, the shore profile, resulting topographic features; classification of coasts and shorelines; shoreline development **(Lectures 12)**

Unit 5

Topography of ocean floors: Introduction; continental shelves and slopes and their geomorphic features.

Techniques of Geomorphology: Morphometric analysis; drainage basin analysis; long river profile and geomorphological mapping.

Applied Geomorphology: Application to hydrology, economic geology and engineering projects; problems of land use and development; geomorphological methods. **(Lectures 12)**

Expected Learning Outcome

The students get an insight to study the cause, effects and consequences that any geomorphic area shows besides varieties of soil and their utility in agriculture; land use and urban planning.

Essential Reading

1. Jain, Shreepat. (2014): Fundamentals of Physical Geology, Springer
2. Summerfield, M. A. (1999): Global geomorphology- an introduction to the study of landforms, Longman
3. Barkbank, D. W. and Anderson, R. S, (2008): Tectonic Geomorphology. Blackwell Science.
4. Ford, D. and Williams, P. (2007): Karst Hydrology and Geomorphology. John Wiley & Sons.
5. Hugget, R. J. (2007): Fundamentals of Geomorphology (2nd Ed.), Routledge, London
6. Charlton, R. O. (2007): Fundamentals of Fluvial geomorphology, Routledge
7. Harvey, A. M., Mathar, A. E. and Stokes, M. (2005): Alluvial fans- Geomophology, Sedimentology, Dynamics, Geol. Soc. London, Sp Pub. 251.
8. Thornbury, W. D. (2004): Principles of Geomorphology – Reprint CBS Pub., New Delhi

Suggested Reading:

9. Allison, R. J. (2002): Applied geomorphology, John Wiely & Sons. Inc.
10. Turk, G. R. and Thompson, J. (1997) Introduction to Physical Geology (2nd Ed.), Brooks Cole.
11. Holmes, A. (1978): Principles of Physical Geology (3rd Ed.), Wiley,730p (3rd Ed)
12. Cotton, C. A. (1952) Geomorphology, John Wiley & Sons Inc.

Multi - Disciplinary: Major
GEO-MDM-132-Crystallography
(Credits 2; 30 Hrs; M.M. 100 = 60 End Sem. + 40 sessional)

Course Coordinator: Dr. K.K. Prajapati

Learning Objective of the Course

The course aims to make the students well-versed with the basic aspects of a crystal including the axes and system in which it usually crystallizes.

Unit -1

Introduction to crystal elements, symmetry; the principles of crystallography the common holohedral, hemihedral and hemimorphic forms in crystallography. **(Lectures 06)**

Unit - 2

Zones; space groups; stereographic projection; Twinning in crystals, the principles of twinning. The symmetry characters of the 32 symmetry classes. **(Lectures 06)**

Unit -3

Cubic: Normal, pyritohedral, tetrahedral and plagiohedral; Tetragonal: Normal tripyramidal, pyramidal hemunorphic, sphenoidal and trapezohedral. **(Lectures 06)**

Unit - 4

Hexagonal: Normal tripyramidal, pyramidal hemimorphic, trapezohedral, rhombohedral hemimorphic, trirhombohedral. **(Lectures 06)**

Unit - 5

Orthorhombic: Normal hemimorphic sphenoidal. Monoclinic: normal asymmetrical class. Triclinic: Normal. **(Lectures 06)**

Expected Learning Outcome

The students will develop capability to study the parts of a crystal, axes and their measurements in hand specimen and find out economic minerals in the field.

Essential Reading

12. Alexander, P.O. (2009): Handbook of Rocks, Minerals, Crystals & Ores. New India Pub.
13. Babu, S.K. (1987): Practical Manual of Crystal Optics, CBS Pub. & Dist.
14. Phillips, W. R. and Griffen, D. T. (1986): Optical Mineralogy, Etd. CBS Pub & Dist.
15. Ray, S. (1958): Optical Mineralogy. CBS Pub. & Dist.
16. Kerr, P. (1977): Optical Mineralogy,McGraw- Hill Book Co.

Suggested Reading:

17. Flint, F. (1964): Essentials of Crystallography, Peace Pub., Russia.
18. Deer,W. A., Howie, R. A. &Zussman, J.(1966): An Introduction to Rock Forming Minerals.
19. Deer,W. A., Howie, R. A. & Zussman, J.(1996): The Rock Forming Minerals, Longman
20. Winchell, A. N. (1939): Elements of Optical Mineralogy, Lincoln Pub. Co., New York.
21. Naidu, P. R. J. (1918): Optical Mineralogy, Allied Pub., Kolkata

Skill Enhancement Course
GEO-SEC-131 Topographical Surveying Practical
Credits: 04; Hours: 60; (M.M. 100= 60 End Sem + 40 sessional)

Course Coordinator: Dr. K. K. Prajapati

- Elementary idea of surveying and levelling. Study of toposheet, especially of area covering Sagar town.
- Close-traverse surveying with prismatic compass. Levelling with dumpy level. Plane Table surveying; three point problem. Measurement of horizontal and vertical angles with theodolite; Triangulation; and contouring with telescopic alidade. Application of Global Positioning System (GPS) in self-location and traverse mapping.
- An introduction to Total Station.

Skill Enhancement Course
GEO-SEC-132-Seminar
Credits: 02; Hours: 30; (M.M. 100)

Course Coordinator: Prof. P. K. Kathal

Seminar will be based on DSM Subjects

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II-Semester

Year/Semester	Nature of Course	Courses	Credits
L-9 II-Semester	Discipline Specific: Major	GEO-DSM-231 Applied Micropaleontology	04
	Discipline Specific: Major	GEO-DSM-232 Applied Micropaleontology Practical	02
	Discipline Specific: Major	GEO-DSM-233 Stratigraphy- (Phanerozoic)	04
	Discipline Specific: Major	GEO-MDM-234 Stratigraphy-(Precambrian)	04
	Multi - Disciplinary: Major	GEO-MDM-231 Geological Field Work, Geological Report & Viva - Voce	12
	Skill Enhancement Course	GEO-SEC- 231 Seminar	02
	Skill Enhancement Course	GE0-SEC - 232 Mineral Resources	02
Total Credits			28
Exit with M.Tech Applied Geology Certificate			

Note: Student can choose either GEO-231 or 232 in one Semester

II-Semester

Discipline Specific: Major

GEO-DSM-231-Applied Micropaleontology

Credits: 04; Hours: 60; (M.M. 100= 60 End Sem + 40 sessional)

Course Coordinator: Prof. P.K. Kathal

Learning Objective of the Course

The Course aims to make to the students well-versed with the strength of micro-paleontological applications in the field of Geology.

Unit 1

Introduction to Micropalaeontology: Palaeontology, its relation with other branches of science and scope; history and significance of Micropalaeontology; Methods of sampling, treatment and separation of microfossils from fossiliferous rocks; Types of environments and biotic distribution. Use of microfossils in dating, biozonation, biostratigraphic correlation; biozones and their types. **(Lectures 12)**

Unit 2

Foraminifera: Living animal, habit, life cycle; dimorphism; test shape, wall composition, wall structure, lamellar character of wall in Foraminifera; Formation and arrangement of chambers and ornamentation in Foraminifera; Test openings, apertures, perforations, pore plates and taxonomic importance in Foraminifera. Classification of Foraminifera. **(Lectures 12)**

Unit 3

Ostracoda: Living animal, life habit, morphology and classification. Classification, ecology and stratigraphic distribution of Ostracoda. Use of Ostracoda in petroleum exploration. **(Lectures 12)**

Unit 4

Conodonts: Elementary idea of Conodonts and their classification. **Diatoms:** Elementary idea of Diatoms and their classification. **Palynology:** An elementary idea of Palynology and its applications. **(Lectures 12)**

Unit 5

Nannofossils: Introduction, historical background and significance of various groups of nannofossils. Sampling and methods of separation of nannofossils; Calcareous Nannoplanktons: Living organism, habitat, life history; Formation, utility and mineralogy of Nannoliths in Nannoplanktons; Types of Nanoliths: Nannoplanktons, Discoasters, Nannoconids; Classification of Nannoplanktons. Classification, ecology and paleoecology; Utility of nannofossils in high resolution biostratigraphy. **(Lectures 12)**

Expected Learning Outcome

The students will develop capability to transform the 'taxonomic aspects' of microfossils into higher 'resolution biostratigraphy, and aspects like 'oil-exploration', 'paleo-monsoonal studies' etc. through 'reconstructing the environment of sedimentation' based on 'their paleo-ecological aspects. They will also develop insight of interpretation of climate of the past.

Essential Reading

1. Kathal, P.K., Nigam, R. & Talib, A., (2017) Micropaelontology, and its Applications. Scientific publishers, New Delhi, Jodhpur 342 p.
2. Saraswati, P. K. & Srinivasan, M. S. (2016): Micropaelontology, Principles & Applications, Springer, 224p.
3. Kathal, P. K. (2012): Applied Geological Micropaleontology, Scientific Publishers, 230 p. New Delhi-Jodhpur.
4. Murray, John, (2006): Ecology & Application of Benthic Foraminifera, Cambridge University Press, 426 p.
5. Clarkson, E. N. K. (1979 & 2002), Invertebrate Paleontology & Evolution, London Gorge Allen & Unwin, 323 p.
6. Sen Gupta, B. K. (1998): Modern Foraminifera, Kluwer Academic Publishers, 371 p.
7. Loelich, A. R. (Jr.) & Tappan, J. (1988): Foraminifera Genera & Their Classification (v. 1 & 2), Van Nostrand Renhold. 970 p., pls. 847.
8. Bignot, G. (1985): Elements of Micropaleontology, Graham & Trotman, London, 212 p.
9. Aldrige, R. J. (1985): Paleobiology of Conodonts, (Ed.),British Micropaleontological Society,
10. Kennet, J. P. and Srinivasan, M. S. (1983): Neogene-Planktonic Foraminifera. Hutchison Ross Publ. Co., U. S. A., 263 p.
11. Braiser, M. D., (1982): Microfossils, Gorge Allen & Unwin, London, 193p.
12. Haynes, J. R. (1981): Foraminifera, MacMillan Pub. Ltd., 432p.

Suggested Reading:

13. Haq, B. U. & Boersma, A. (Eds.), (1978): Introduction to Marine Micropaleontology, Elsevier, New York, 250 p.
14. Cushman, J. A. (1947): Foraminifera Their Classification & Economic Uses, Harvard Univ.
15. Glassener, M. F. (1945): Principles of Micropaleontology, Haftner Press, New York, 645 p.

Discipline Specific: Major

GEO-DSM - 232 Applied Micropaleontology Practical

Credits: 02; Hours: 30; (M.M. 100= 60 End Sem. + 40 sessional)

Course Coordinator: Prof. P.K. Kathal

- Preparation of micro-faunal slides of microfossils. Foraminifera: Morphology, wall composition, geological range, ecology and paleoecology.
- Study of larger foraminifera in thin sections. Ostracoda: Morphology, geological range, ecology and paleoecology of important groups of Ostracoda.Nannoplanktons:
- Study of SEM images; Identification of representatives of different groups of nannofossils in SEM photomicrographs. Preparation of range charts of Foraminifera, Ostracoda and Nannofossils. Computer techniques.
- Digital image formation, Illustration using Camera Lucida, annotations, comparison of different species.
- Ecological interpretation based on foraminiferal assemblages with especial emphasis on conditions for oil formation. Identification of fossiliferous rocks of India.

Discipline Specific: Major

GEO-DSM-233-Stratigraphy (Phanerozoic)

Credits: 04; Hours: 60; (M.M. 100= 60 End Sem. + 40 sessional)

Course Coordinator: Prof. S. H. Adil

Learning Objective of the Course

The course is being propagated with a view to establish a firm and a profound understanding of the genesis and tectonic evolution of the Phanerozoic rocks exposed in different parts of India and its correlation with the isochronous rocks exposed elsewhere.

Unit 1

Tectonic History and life of Palaeozoics. Paleozoic of Salt Range and the age of the Saline Series. Precambrian-Cambrian boundary.Marine Palaeozoic rocks of Tethys and Lesser Himalayas. Marine Paleozoic rocks of Peninsular India. **(Lectures 15)**

Unit 2

Tectonic History and life of Mesozoics. Permian Triassic boundary.Marine Mesozoic Formations of Tethyan and Lesser Himalayas.Marine Mesozoic rocks of Peninsula, India. **(Lectures 10)**

Unit 3

Concept of Gondwanaland. Classification, lithology, age correlation, and fossils of Gondwana Supergroup. **(Lectures 10)**

Unit 4

Cretaceous-Tertiary boundary problem.Tectonic History and life of Cenozoic'sDeccan Traps and Intertrappeans. **(Lectures 10)**

Unit 5

Sabathu, Dagshai and Kasauli Formations. Tertiary of Assam. Siwaliks Group, Karaikal Beds, Warkala Beds and Coastal formations.Tectonic evolution of Indo-Gangetic Plain. Quaternary Stratigraphy and dating methods. **(Lectures 15)**

Expected Learning Outcome

The manifestation of the course, if completed successfully can be reflected in the form of an insight as to how earth has behaved during Phanerozoic eon that in turn covers significant part of the geological time. It also enables the students to link events and to correlate them at several scales.

Essential Reading

1. Ramakrishnan, N. & Vaidyanandan, R. (2010): Geology of India, v. II, Geol. Soc. Ind.
2. Pomerol, C. (1982): The Cenozoic Era? Tertiary and Quaternary, Ellis Harwood Ltd.
3. Krishnan, M.S. (1982): Geology of India and Burma; 6th edition, CBS Pub. & Dist.

Suggested Reading:

4. Pascoe, E.S. (1960): A manual of the Geology of India and Burma. Vols. I & II Govt. of India Pub.
5. Review of papers (1972): Stratigraphy of India, Rec. Geol. Surv. Ind., v. 101, pt. 2.

Discipline Specific: Major

GEO-DSM-234-Stratigraphy (Precambrian)

Credits: 04; Hours: 60; (M.M. 100= 60 End Sem. + 40 sessional)

Course Coordinator: Dr. G.K. Singh

Learning Objective of the Course

The course is being propagated with a view to establish a firm and a profound understanding of the genesis and tectonic evolution of the Precambrian rocks exposed in different parts of India and its correlation with the isochronous rocks exposed elsewhere.

Unit 1

Stratigraphy, its relation with other branches of geology. Principles of stratigraphy: Nature of geological record. Stratigraphic classification & nomenclature: litho-, chemo-, bio-, seismo-magneto and chrono-stratigraphy. Correlation of strata based on litho-, bio-,geochronological, structural & metamorphic criteria. Standard stratigraphic scale.

(Lectures 07)

Unit 2

Surface and subsurface procedures of correlation, physical and palaeontological methods. Major geological events during the different periods of the earth's history. Physiographic divisions of India and tectono-stratigraphy.Precambrian stratigraphic framework of India. **(Lectures 13)**

Unit 3

Classification, structure and tectonics of the Dharwar craton. Ancient supracrustal sequence (Sargur Type). Schist belts of eastern Karnataka (Kolar Type). Younger schist belts (Dharwar Type). Gneiss complex, granulites, Charnockites (Eastern Ghat).Ancient granites, *viz*. Singbhum, Chitradurga, etc.Bundelkhand Granite Gniesses (BGC) Supracrustal and Bundelkhand Granites.Structure, tectonics and stratigraphy of the BGC, Bhilwara Groups of Rajasthan. **(Lectures 20)**

Unit 4

Stratigraphy of Sukma, Bengpal, Bailadila Sonakhan, Sausar, Sakoli, Chilpi, Nandgaon, Dongargarh and Khairagarh Groups from central India.Structure, tectonics and stratigraphy of Older Metamorphic Gneisses (OMG), Older Metamorphic Tonalitic Gneisses (OMTG), Iron Ore Gr. (Singbhum Craton). Archaeans of Extra Peninsular region. **(Lectures 10)**

Unit 5

Archaean-Proterozoic boundary**.**Stratigraphy sedimentation, tectonics and evolution of the following Proterozoic basins/Purana formations in India: Delhi-Aravalli Supergroup, Singbhum-Kolhan Group, Cuddapah-Kurnool, Kaladgi-Bhima-Badami, Pranhita-Godavari (Pakhal & Sullavai), Mahakoshal -Bijawar -Gwalior, Dongarhgarh Supergroup. Marwar, Abujhmar- Indravati, Vindhyans- Chattisgarh- Singhora Supergroups. **(Lectures 10)**

Expected Learning Outcome

The manifestation of the course, if completed successfully, would give a deep insight in to the general stratigraphy and Precambrian Geology with special reference to a detailed field work in Bundelkhand craton. It also enables the students to link events and to correlate themsuccessfully at several scales.

Essential Reading

1. Ramakrishnan, N. & Vaidyanandan, R. (2010): Geology of India, v. I, Geol. Soc. Ind.
2. *Weller*, J. M. (1960): *Stratigraphic Principles and Practice*, Harper and Brothers.
3. Wadia, D. N. (1967): Geology of India, McMillan & Co., London
4. Danbar, C.O. and Rodgers, J. (1957): Principles of Stratigraphy, ohn Wiley & Sons.
5. Naqvi, S.M. and Rogers, J.J.W. (1987): Precambrian Geology of India, Oxford Univ. Press.

Suggested Reading:

6. Krishnan, M.S. (1982): Geology of India and Burma, 6th Ed., CBS Pub. & Dis.
7. Pascoe, E. S. (1960): A Manual of Geology of India & Burma, I & II Govt. of India Pub.
8. Sarkar, S.N.(1968): Precambrian Stratigraphy & Geochrnonology of Peninsular India, Dhanbaad

Multi - Disciplinary: Major
GEO-MDM - 231
Geological Field Work, Geological Report & Viva - Voce
Credits: 12; Hours: 180; (M.M. 100 = 60 End Sem. + 40 sessional)
Course Coordinator: Dr. G. K. Singh

A field report and *viva-voce* based on the three to four weeks compulsory course in geological mapping in the Geological camp organized by the Department.

Skill Enhancement Course
GEO-SEC-231-Seminar
Credits: 02; Hours: 30; (M.M. 100)

Course Coordinator: Prof. P. K. Kathal

Seminar will be based on DSM Subjects

Skill Enhancement Course
GEO-SEC-232-Mineral Resources
Credits: 02; Hours: 30; (M.M. 100 = 60 End Sem. + 40 sessional)

Course Coordinator: Mr. Rajiv Khalkho

Learning Objective of the Course

The course is being propagated with a view to establish a firm and a profound understanding of the genesis and evolution of the various mineral resources found in different parts of India and its correlation with the similar deposits exposed elsewhere.

Unit 1

Definition of mineral. Classification of minerals, Ore Mineral forming processes. Chemical composition, physical and optical properties of minerals, Composition of Mamga. **(Lecture 6)**

Unit 2

Metallic Mineral Deposits of India with reference to thin mode of excursusesDiagnostic physical properties, chemical composition, uses, modes of occurrence & distribution in India of following: 1) Economic Minerals: Gold, Silver, Copper, Lead, Zinc, Iron, Manganese, Chromium, Tin, Aluminium; 2) Industrial Minerals: Asbestos, Barite, Graphite, Gypsum and Mica; 3) Abrasives: Diamond, Corundum, Emery garnet, Abrasive sand, Tripoli, Pumice, Sand feldspar, Limestone, Clay, Talc; 4) Refractories: fireclay, graphite, Dolomite & sillimanite group of minerals, diaspore, pyrophillite, zircon; 5) Ceramic minerals: Clay, Feldspar, Wollastonite. **(Lectures 6)**

Unit 3

Abrasives: Diamond, Corundum, Emery garnet, Abrasive sand, Tripoli, Pumice, Sand feldspar, Limestone, Clay, Talc; Refractories: fireclay, graphite, Dolomite & sillimanite group of minerals, diaspore, pyrophillite, zircon; Ceramic minerals: Clay and gem minerals. **(Lectures 6)**

Unit 4

Fossil fuels: coal and lignite, uses, classification, constitution, origin and distribution in India. Petroleum- composition, uses, theories of origin, oil traps, & important oil fields of India. A brief account of mineral deposits in Beacs Sand of Kerala. Significance of minerals in National Economy. Strategic, critical & essential minerals. Mineral wealth of Madhya Pradesh Environmental impact of mineral exploration. **(Lectures 6)**

Unit 5

Radioactive Mineral, Composition, type, Radioactive metals: Thorium, Uranium, Titanium; Distribution of Radioactive minerals. **(Lectures 6)**

Expected Learning Outcome

The manifestation of the course, if completed successfully can be reflected in the form of an insight as to what kinds of minerals are formed on earth. It also enables the students to link events and to correlate them at several scales.

Essential Reading

1. Craig, J. R. and Vaughan, D. J. (1994): Ore microscopy and ore petrography, John Wiley & Sons.
2. Evans, A. M. (1992): Ore geology and industrial minerals, Blackwell Science.
3. Jensen, M. L. & Bateman, A. M. (1981): Economic mineral deposits, John Wiley & Sons.
4. Misra, K. C. (1999): Understanding Mineral Deposits, Kluwer Academic Publishers.

Suggested Reading:

5. Mookherjee, A. (1998): Ore genesis - a holistic approach. Allied Publishers.
6. Stanton, R. L. (1981): Ore Petrology, McGraw Hill.1. Gokhale and Rao Ore deposits of India.
7. Chatterjee, K. K. (1993): An introduction to mineral economics, Wiley Eastern Ltd.

Note: Student can choose either GEO-231 or 232 in one Semester

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Board of Studies Meeting held on 12th September, 2022

(Prof. P.K. Kathal) **Member**	**(Prof. R. K. Rawat)** **Member**	**(Prof. S.H. Adil)** **Member**	**(Dr. G. K. Singh)** **Member**
(Prof. Ashish Verma) **Member**	**(Prof. Ratnesh Das)** **External Member**	**(Prof. A.D. Singh)** **External Member**	**(Prof. Santosh Kumar)** **External Member**
(Prof. H. Thomas) **Chairman**			

School Board of Studies Meeting held on 15th September, 2022

(Prof. P.K.Kathal) **Member**	**(Prof. Sanjay K. Jain)** **Member**	**(Prof. S. H. Adil)** **Member**	**(Prof. Asmita Gajbhiye)** **Member**
(Prof. H. Thomas) **Member**	**(Prof. Vandana Soni)** **Member**	**(Prof. Umesh K. Patil)** **Member**	**(Dr. Sushil K. Kashav)** **Member**
(Dr. Dharmendra Jain) **Member**	**(Mr. Rajiv Khalkho)** **Member**	**(Prof. A.P. Mishra)** **Member**	**(Prof. Ranveer Kumar)** **Member**
(Prof. Devesh Walia) **External Member**	**(Prof. Pankaj K. Shrivastava)** **External Member**	**(Prof. Sailendra Saraf)** **External Member**	**(Prof. Sushant Shrivastava)** **External Member**
(Dr. Anil Kharia) **External Member**	**(Prof. R.K. Rawat)** **Chairperson**		