Department of Applied Geology

School of Engineering and Technology

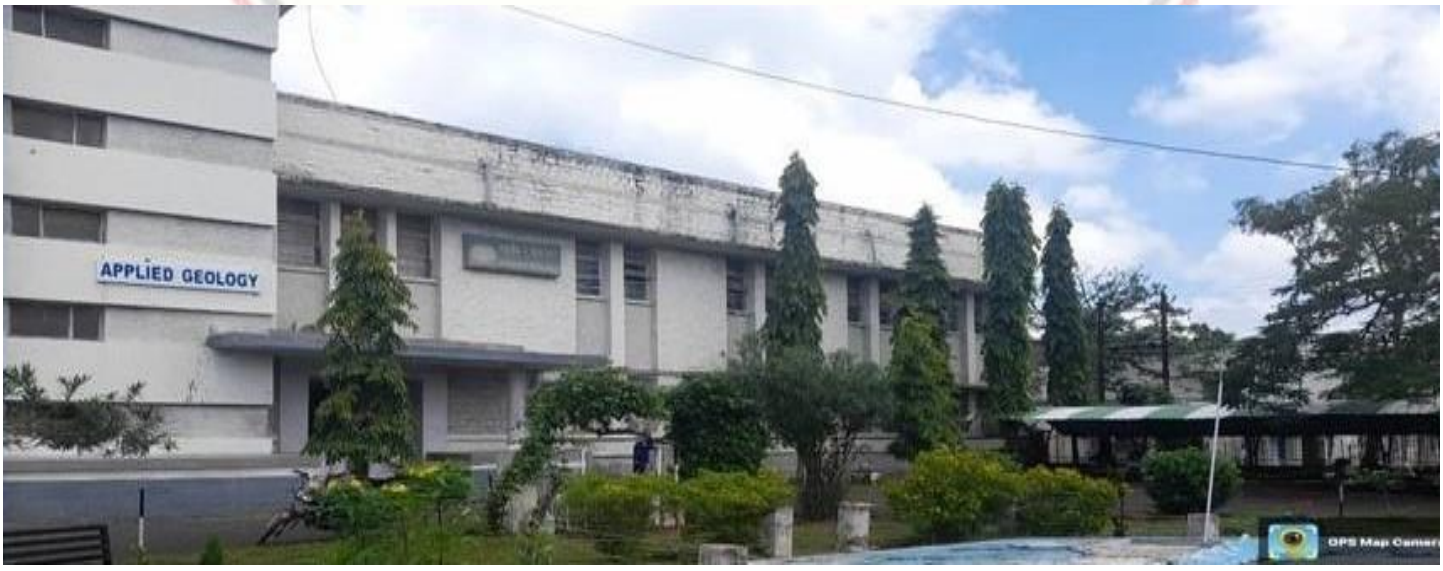
Dr. Harisingh Gour Vishwavidyalaya Sagar (M.P.)

A Central University

Syllabus

Master of Technology In Applied Geology

(Session 2020-21)



Syllabus - M. Tech. (Applied Geology) 2020-21

I Semester

Course no.	Course Name	L	T	P	C
GEO CC 131	Geomorphology	4	0	0	4
GEO CC 132	Crystallography & Mineral Optics	4	0	0	4
GEO CC 133	Mineralogy	4	0	0	4
GEO CC 134	Practical- Crystallography Mineral Optics & Mineralogy	0	0	2	2
GEO CC 135	Structural Geology	4	0	0	4
GEO CC 136	Practical- Structural Geology	0	0	2	2
GEO CC 137	Practical- Topographical Surveying	0	0	4	4
GEO SE 131	Seminar	0	2	0	2
L= Lecture, T= Tutorial, P= Practical, C= Credits		**Total Credits**			**26**

II Semester

Course no.	Course Name	L	T/F	P	C
GEO CC 231	Applied Micropaleontology	4	0	0	4
GEO CC 232	Practical Applied Micropaleontology	0	0	2	2
GEO CC 233	Stratigraphy -I (Precambrian)	4	0	0	4
GEO CC 234	Stratigraphy- II (Phanerozoic)	4	0	0	4
GEO CC 235	Geological Field Work & Mapping	0	12	0	12
GEO SE 231	Seminar	0	2	0	2
OE		2	0	0	2
L= Lecture, T= Tutorial, P= Practical, C= Credits, F= Field Work		**Total Credits**			**30**

GEO OE 231	Mineral Resources	2	0	0	2

III Semester

Course no.	Course Name	L	T	P	C
GEO CC 331	Igneous Petrology	4	0	0	4
GEO CC 332	Practical- Igneous Petrology	0	0	2	2
GEO CC 333	Sedimentology	4	0	0	4
GEO CC 334	Practical- Sedimentology	0	0	2	2
GEO CC 335	Ore Geology	4	0	0	4
GEO CC 336	Practical- Ore-Microscopy & Economic Geology	0	0	2	2
GEO EC 331	Industrial Minerals & Fuels	4	0	0	4
GEO SE 331	Seminar	0	2	0	2
OE		2	0	0	2
L= Lecture, T= Tutorial, P= Practical, C= Credits		**Total Credits**			**26**

GEO OE 331	Paleontology	2	0	0	2

IV Semester

Course no.	Course Name	L	T/F	P	C
GEO CC 431	Metamorphic Petrology & Thermodynamics	4	0	0	4
GEO CC 432	Practical-Metamorphic Petrology	0	0	2	2
GEO CC 433	Geochemistry	4	0	0	4
GEO CC 434	Practical- Geochemistry	0	0	2	2
GEO CC 435	Geodynamics & Tectonics	4	0	0	4
GEO SE 431	Seminar	0	2	0	2
GEO CC 436	Geological Tour Report (Eco. Geol. & Petro.) & Field *Viva Voce*	0	8	0	8
L= Lecture, T= Tutorial, P= Practical, C= Credits, F= Field Work		**Total Credits**			**26**

V Semester

Course no.	Course Name	L	T	P	C
GEO CC 531	Ground Water Hydrology	4	0	0	4
GEO CC 532	Practical Groundwater & Hydrology	0	0	2	2
GEO CC 533	Exploration Geology	4	0	0	4
GEO CC 534	Mining Geology	4	0	0	4
GEO CC 535	Practical Mining and Exploration Geology	0	0	2	2
GEO CC 536	Geoinformatics	4	0	0	4
GEO CC 537	Practical Geoinformatics	0	0	2	2
GEO SE 531	Seminar	0	2	0	2
GEO SE 532	Seminar: Advanced Instrumentation and techniques in geosciences	0	2	0	2
L= Lecture, T= Tutorial, P= Practical, C= Credits		**Total Credits**			**26**

VI Semester

Course no.	Course Name	L	T/F	P	C
GEO CC 631	Environmental Geology	4	0	0	4
GEO CC 632	Engineering Geology & Geotechniques	4	0	0	4
GEO CC 633	Practical Engineering & Environmental Geology	0	0	2	2
GEO EC 631	Mineral Economics	4	0	0	4
GEO SE 631	Seminar	0	2	0	2
GEO CC 634	Dissertation on Mineral Exploration & *Viva-Voce*	0	16	0	16
L= Lecture, T= Tutorial, P= Practical, C= Credits, F= Field Work		**Total Credits**			**32**

Allied branches: Geology, Geochemistry, and Hydrogeology.
Relevant branches: Geophysics, Marine Geology/Oceanography.

Total Credits of Core Courses + EC = 162
Credit of 02 open elective course= 04
Total Credits =166

Dr. Harisingh Gour Vishwavidyalaya, Sagar
Syllabus - M. Tech. (Applied Geology) I Semester 2020-21

Course no.	Course Name	L	T	P	C
GEO CC 131	Geomorphology	4	0	0	4
GEO CC 132	Crystallography & Mineral Optics	4	0	0	4
GEO CC 133	Mineralogy	4	0	0	4
GEO CC 134	Practical- Crystallography & Mineralogy	0	0	2	2
GEO CC 135	Structural Geology	4	0	0	4
GEO CC 136	Practical- Structural Geology	0	0	2	2
GEO CC 137	Practical- Topographical Surveying	0	0	4	4
GEO SE 131	Seminar	0	2	0	2
L= Lecture, T= Tutorial, P= Practical, C= Credits		**Total Credits**			**26**

M. Tech. I Semester GEO CC 131 Geomorphology

Credits: 04 **Hours: 60** **(M.M. 100= 60 end sem. + 40 sessional)**

Learning Objective of the Course

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

Unit 1

Introduction: Relation with other branches of geology; Weathering, soil processes and mass wasting; Fundamental concepts of geomorphology.

(Lectures 5)

Unit 2

The fluvial geomorphic cycle: Fundamental concepts; streams and valleys; stages of cycle; drainage patterns and their significance; stream meandering and lateral erosion; interruptions and rejuvenation; shifting stream divides; misfit rivers; river terraces; causes of stream deposition- resulting landforms.
(Lectures 15)

Unit 3

The cycle of erosion; The Fundamental 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 10)

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 10)

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.

Climatology & Meteorology: Basic concepts of Climatology & Meteorology. **(Lectures 20)**

Expected Learning Outcome

The students get an insight to study the cause, effects and consequences that any geomorphic area shows.

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.

GEO CC 132 Crystallography & Mineral Optics

Credits: 04 Hours: 60 (M.M. 100= 60end sem. + 40 sessional)

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. It also includes the relationship of behaviour of light and the crystals.

Unit 1

Introduction to crystal elements, symmetry; the laws of crystallography the common holohedral, hemihedral and hemimorphic forms in crystallography; zones; space groups; stereographic projection; Twinning in crystals, the laws of twinning. **(Lectures 9)**

Unit 2

The symmetry characters of the 32 symmetry classes; Cubic:Normal, pyritohedral, tetrahedral and plagiohedral; Tetragonal: Normal tripyramidal, pyramidal hemunorphic, sphenoidal and trapezohedral; Hexagonal: Normal tripyramidal, pyramidal hemimorphic, trapezohedral, rhombohedral hemimorphic, trirhombohedral; Orthorhombic: Normal hemi-morphic sphenoidal.Monoclinic: normal asymmetrical class. Triclinic: Normal. **(Lectures 18)**

Unit 3

General principles of optics, theory 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.**(Lectures 12)**

Unit 4

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 13)**

Unit 5

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 08)**

Expected Learning Outcome

The students will develop capability to study the parts of a crystal, axes and their measurements in hand specimen and optical properties under microscope.

GEO CC 133 Mineralogy

Credits: 04 Hours: 60(M.M. 100= 60end sem. + 40 sessional)

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 22)**

Unit 2

A study of the following mineral groups covering structure, chemistry, physical properties and paragenesis of feldsparsn and pyroxenes. **(Lectures 08)**

Unit 3

A study of the following mineral groups/minerals comprising structure, chemistry, physical and optical properties, and paragenesis of: amphiboles, mica, garnet and olivine. **(Lectures 07)**

Unit 4

A study of the following mineral groups/minerals comprising structure, chemistry, physical & optical properties, and paragenesis of epidote, felspathoid, chlorite, silica group and aluminosilicates. **(Lectures 10)**

Unit 5

A study of the following mineral groups/minerals comprising structure, chemistry, physical & optical properties and paragenesis: staurolite, cordierite, chloritoid, clay minerals, carbonates, sulphate.**(Lectures 13)**

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**.
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

GEO CC 134 Practical Crystallography, Mineral Optics & Mineralogy

Credits: 02 **Hours: 30 (M.M. 100= 60end sem. + 40 sessional)**

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.

GEO CC 135 Structural Geology

Credits: 04 Hours: 60 (M.M. 100= 60end sem. + 40 sessional)

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 toposheets, V-rule and outcrop patterns; stereographic projections of structural elements. **(Lectures 10)**

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 15)**

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 15)**

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 10)**

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 10)**

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. Hills, S. E. (1950): **Structural Geology**.
6. Billing, M.P. (1974): **Principle of Structural Geology**, III Edi. Prentice Hall Int. Inc.

Suggested Reading:

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

GEO CC 136 Practical- Structural Geology

Credits: 02 Hours: 30 (M.M. 100= 60end sem. + 40 sessional)

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.

GEO CC 137 Practical-Topographical Surveying

Credits: 04 Hours: 60 (M.M. 100= 60end sem. + 40 sessional)

Elementary idea of surveying and levelling. Study of toposheets, 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.

GEO SE 131 Seminar

Credits:02 Hours: 30 (M.M. 100)

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Syllabus- M. Tech. (Applied Geology) II Semester 2020-21

Course no.	Course Name	L	T/F	P	C
GEO CC 231	Applied Micropaleontology	4	0	0	4
GEO CC 232	Practical Applied Micropaleontology	0	0	2	2
GEO CC 233	Stratigraphy -I (Precambrian)	4	0	0	4
GEO CC 234	Stratigraphy- II (Phanerozoic)	4	0	0	4
GEO CC 235	Geological Field Work & Mapping	0	12	0	12
GEO SE 231	Seminar	0	2	0	2
OE		2	0	0	2
L= Lecture, T= Tutorial, P= Practical, C= Credits, F= Field Work		**Total Credits**			**30**

GEO OE 231	MINERAL RESOURCES	2	0	0	2

M. Tech II Semester GEO CC 231 Applied Micropalaeontology

Credits: 04 **Hours: 60** **(M.M. 100= 60 end sem. + 40 sessional)**

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, history of study 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.

Essential Reading

1. Kathal, P.K., Nigam, R. & Talib, A., (2017) **Micropaelontology, and its Applications**. Scientific publishers, New Delhi, Jodhpur 342 p.

3. Saraswati, P. K. & Srinivasan, M. S. (2016): **Micropaelontology, Principles & Applications**, Springer, 224p.
4. Kathal, P. K. (2012): **Applied Geological Micropaleontology**, Scientific Publishers, 230 p. New Delhi-Jodhpur.
5. Murray, John, (2006): **Ecology & Application of Benthic Foraminifera**, Cambridge University Press, 426 p.
6. Clarkson, E. N. K. (1979 & 2002), **Invertebrate Paleontology & Evolution**, London Gorge Allen & Unwin, 323 p.
7. Sen Gupta, B. K. (1998): **Modern Foraminifera**, Kluwer Academic Publishers, 371 p.
8. Loelich, A. R. (Jr.) & Tappan, J. (1988): **Foraminifera Genera & Their Classification** (v. 1 & 2), Van Nostrand Renhold. 970 p., pls. 847.

9. Bignot, G. (1985): **Elements of Micropaleontology,** Graham & Trotman, London, 212 p.
10. Aldrige, R. J. (1985): **Paleobiology of Conodonts,** (Ed.),British Micropaleontological Society,
11. Kennet, J. P. and Srinivasan, M. S. (1983): **Neogene-Planktonic Foraminifera**. Hutchison Ross Publ. Co., U. S. A., 263 p.
12. Braiser, M. D., (1982): **Microfossils**, Gorge Allen & Unwin, London, 193p.
13. Haynes, J. R. (1981): **Foraminifera**, MacMillan Pub. Ltd., 432p.

Suggested Reading:

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

GEO CC 232 Practical-Applied Micropaleontology

Credits: 02 Hours: 30 (M.M. 100= 60end sem. + 40 sessional)

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.

GEO CC 233 Stratigraphy -I (Precambrian)

Credits: 04 Hours: 60 (M.M. 100= 60end sem. + 40 sessional)

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

GEO CC 234 Stratigraphy- II (Phanerozoic)

Credits: 04 Hours: 60 (M.M. 100= 60end sem. + 40 sessional)

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.**(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

Types of biozones and their interpretations. 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.

GEO CC 235 Geological Field Work, Mapping & Viva Voce

Credits: 12 **Hours: 120** **(M.M. 100= 60end sem. + 40 sessional)**

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.

GEO SE 231 Seminar

Credits: 02 **Hours: 30** **M. M. 100**

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Dr. Harisingh Gour Vishwavidyalaya, Sagar
M. Tech. (Applied Geology) II Semester 2020-21

OPEN ELECTIVE COURSE

GEO OE 231 Mineral Resources

Credits: 02 **Hours: 30 Max. (M.M. 100= 60 end sem. + 40 sessional)**

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.

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. Jensen and Bateman A.M. – **Economic Mineral Deposits**, Year
8. Krishnaswamy, S. Indian Mineral Resources
9. Park and Macdiarmid -**Ore Deposits**
10. Umeshwer Prasad- **Economic geology**

Dr. Harisingh Gour Vishwavidyalaya, Sagar
M. Tech. (Applied Geology) III Semester 2020-21

Course no.	Course Name	L	T	P	C
GEO CC 331	Igneous Petrology	4	0	0	4
GEO CC 332	Practical- Igneous Petrology	0	0	2	2
GEO CC 333	Sedimentology	4	0	0	4
GEO CC 334	Practical- Sedimentology	0	0	2	2
GEO CC 335	Ore Geology	4	0	0	4
GEO CC 336	Practical- Ore-Microscopy & Economic Geology	0	0	2	2
GEO EC 331	Industrial Minerals & Fuels	4	0	0	4
GEO SE 331	Seminar	0	2	0	2
OE	Palaeontology	2	0	0	2
	L= Lecture, T= Tutorial, P= Practical, C= Credits	Total Credits			26

GEO OE 331	Palaeontology	2	0	0	2

GEO CC 331 Igneous Petrology

Credits: 04 Hours: 60 (M.M. 100= 60 end sem. + 40 sessional)

Learning Objective of the Course

The Course aims to make to the students well-versed with the strength of Igneous Petrology Theory applications in the field of Geology.

Unit 1

Scope of igneous Petrology; Composition of the crust and upper mantle, their emplacement and their relation with the plate tectonics;

Origin of Magma: Magma: Its physics, nature, factors affecting magma and its evolution. Thermal structure of the earth and melting of mantle.Plate tectonics and generation of different magmas in various tectonic settings.Concept of primary and secondary magma.

Structure and textures: Definition, description, rock examples and genetic implications of common structures and textures of igneous rocks. **(Lectures 12)**

Unit 2

Classification of igneous rocks: Mode, CIPW norms, IUGS, Chemical, mineralogical and other standard classification. Bowen's reaction principle: Reactions series and their applications to petrogenesis.

Magmatic evolution and differentiation: Fractional crystallization, gravitational differentiation, gas streaming, liquid immiscibility, and assimilation. Mantle, onset and process of partial melting in mantle, mantel-magmas in relation to degree and depth level of partial melting. **(Lectures 12)**

Unit 3

Phase equilibrium in igneous system: Binary and ternary system. Crystallization of the basaltic magma in relation to the following systems: Albite-Anorthite (b) Diopside-Anorthite (c) Forsterite-Fayalite (d) Forsterite-Silica (e) Diopside-Albite-Anorthite (f) Diopside-Forsterite-silica. Crystallization of granitic magma in relation to Quartz Orthoclase-Aalbite-Anorthite-H2O system.Their relation to magma genesis and crystallization in the light of modern experimental works. **(Lectures 12)**

Unit 4

Magmatism and tectonics: Inter-relationship between tectonic settings and igneous rock suites.Igneous rock suites: Form, structures, texture, model mineralogy, petrogenesis and distribution of ultramafic rocks: Dunite-peridotite-pyroxenite suite; Kimberlites, lamprophyres, lamproites, komatiites. Basic rocks: Gabbro-norite-anorthosite-troctolite suite, Mafic dyke swarms, boninites, Dolerites; Basalt and related rocks. Intermediate rocks: Diorite-monzonite-syenite suite, Andesites and related rocks; Acidic rocks: Granites-syenite-granodiorite-tonalite suite; Rhyolites and related rocks**.(Lectures 12)**

Unit 5

Alkaline rocks: Shonkinite, ijolite, urtite, melignite, alkali gabbros, alkali basalt, alkali granite, alkali syenite, nepheline syenite and phonolite; Carbonatites, Ophiolite suite.**Petrogenetic proviances**: Continental areas: Volcanic flood basalts-tholeiites (Deccan Traps, Columbia River basalts). Layered gabbroic intrusions: The Bushveld complex, Shaergaard

intrusion, Still water complex. Plutonic: Carbonatites and alkaline rock complex of India.Oceanic Rift valleys, MORB-Tholeiites-Ophiolites.**(Lectures 12)**

Expected Learning Outcome

The course definitely provides better capability to transform the processes and principles involved during the origin and evolution of the igneous rocks.

GEO CC 332 Practical Igneous Petrology

Credits: 02 Hours: 30 (M.M. 100= 60 end sem. + 40 sessional)

Megascopic study of different igneous lithotypes. Petrological calculations: calculation of mineral formulae, CIPW Norms calculation and interpretation. Microscopic study of igneous lithotypes. Identification of texture in igneous rocks: intergrowth, porphyritic, eequigranular, reaction rims, panidiomorphic, perthitic and their petrogenetic significance.Application of different computer software's for understanding of different setup of igneous rocks.

Essential Reading

1. Best, Myron G. (2002):**Igneous and Metamorphic Petrology**. Wiley-Blackwell Science
2. Bose, Mihir K., (1997):**Igneous Petrology**, The World Press Pvt. Ltd., Calcutta, p.568.
3. Carmichael, I. S. E., Turner, F. J. & Verhoogen, J. (1971) **Igneous Petrology**, Mc Graw Hill
4. Ehlers, E.G. & Blatt, H. (1982):**Igneous, Sedimentary, and Metamorphic Petrology**, CBS Pub. Dist., New Delhi
5. Winter, J. D. (2012):**Principles of Igneous and Metamorphic Petrology** 2nd Edition, PHI Learning Pvt. Ltd., New Delhi
6. Philpotts Anthony R. (1992): **Principles of Igneous & Metamorphic Petrology**, Prentice Hall
7. E-content available at CEC-UGC-MHRD New Delhi website
8. Thomas, H. (2016) Massive open Online Course on Petrology: Swayam Plateform Govt of India.
9. S.C. Chatterjee (1974):**Igneous and Metamorphic Petrology**
10. Tyrell, G. W. (1963): **Principles of Petrology**, Metheun

Suggested Reading:

11. A.K. Gupta (1998):**Igneous Petrology**
12. Alexander, P. O. (2008): **Handbook of Minerals, Crystals, Rocks & Ores**, New India Pub.
13. Blatt, H. and Tracy, R. J. (1996): **Petrology (Igneous, Sedimentary &, Metamorphic)**, W.H. Freeman and Co., New York
14. Tyrell, G. W. (1963): **Principles of Petrology**, Metheun
15. Thomas, H. (2016) MOOC on Petrology by Prof. H.Thomas, SWAYAM.GOV.In

GEO CC 333 Sedimentology

Credits: 04 Hours: 60 (M.M. 100= 60 end sem. + 40 sessional)

Learning Objective of the Course

The Course aims to make to the students well-versed with the strength of Sedimentology and its applications in the field of Geology.

Unit 1

Geologic cycle; Sedimentary textures (Granulometric analysis, shape and roundness studies, surface textures); Sedimentary structures (physical structures, biogenic sedimentary structures, diagenetic structures. **(Lectures 9)**

Unit 2

Heavy mineral and insoluble residue analysis; petrography of rocks of clastic, chemical and biochemical origin (Conglomerates, Sandstone, Mudstone, Limestone & Dolomite). **(Lectures 9)**

Unit 3

Evaporite, phosphorite, chert, iron and manganese rich sediments; volcanogenic sedimentary rocks. **(Lectures 12)**

Unit 4

Clastic transport and fluid flow (fluid flow in theory and in nature, Reynold's Numbers, Froude; Number, sediment lift, transport, deposition, sedimentary gravity flow). **(Lectures 15)**

Unit 5

Digenesis of clastic and non-clastic rocks. Wlather's law of facies succession. Concepts of sequence stratigraphy. Concept of Sedimentary facies association models (Marine, Nonmarine, and Mixed DepositionalEnvironment); Sedimentation and Tectonics. **(Lectures 15)**

Expected Learning Outcome

The course aims to provide better capability to visualize the processes and principles involved during the origin and evolution of the sedimentary rocks.

GEO CC 334 Practical- Sedimentology

Credits: 02 **Hours: 30 (M.M. 100= 60 end sem. + 40 sessional)**

Size Analysis (Procedures, Cumulative curve, Histogram, Visher's curve and Statistical calculation); Shape analysis (Calculation and Classification). Heavy mineral analysis (Procedure and identification); Insoluble residue analysis (Procedure and identification).

Megascopic and studies of conglomerate and breccias; megascopic and microscopic study of sandstone; megascopic and microscopic study of limestone; sedimentary structure (identification and classification); paleocurrent and basin analysis calculation. Fence diagram, preparation and interpretation.

Essential Reading

1. Babu, S. K. &Sinha, D. K.(1987): **Sedimentary Petrology Practical**, CBS Pub., N. Delhi.
2. Blatt, M. and Murray (1980):**Origin of sedimentary rocks**, Printice Hall Inc.
3. Blatt, H.E., (1972):**Sedimentary Petrology**, 2nd Ed. W. H. Freeman & Co. New York.
4. Collins, J.D. and. Thompson, D.B (1982):**Sedimentary Structures**, George Allen & Unwin,.
5. Pettijohn, F.J. (1975):**Sedimentary rocks**, Harper and Row Publ., New Delhi.
6. Reading, H. G. (1986):**Facies**. Blackwell Scientific Publication.
7. Reinbeck, H. E. & Singh, I. B. (1980):**Depositional Sedimentary Environments**. Springer.
8.

Suggested Reading:

9. Boggs, Sam (Jr.) (1996):**Princiles of Stratigraphy and Sedimentology**. 2nd Ed. Prentice Hall.
10. Selly, R. C. (1976):**An Introduction of Sedimentology**. Academic Press London.
11. Sengupta, S. M. (2007):**Introduction of Sedimentology**. 2nd Ed. CBS Pub., New Delhi.
12. Sukhtankar, R. K. (2004):**Applied Sedimentology**. 1st Ed. CBS Pub. & Dist.,New Delhi.
13. Tucker, M.E. (1981):**Sedimentary Petrology: an introduction**. John Willey&Sons, New York.

GEO CC 335 Ore Geology

Credits: 04 Hours: 60 (M.M. 100= 60 end sem. + 40 sessional)

Learning Objective of the Course

The Course aims to make to the students well-versed with the processes that lead to the formation of an ore in nature along with their distribution on earth.

Unit 1

Sources and nature of ore-bearing fluids and recent concept of ore forming processes. Magma and its relation to mineral deposits, greenstone belts, komatite; ophiolite and carbonatite etc. Pegmatite deposits. **(Lectures 7)**

Unit 2

Hydrothermal deposit (Hypothermal, Mesothermal, Epithermal, Telethermal and Xenothermal. Pyrometasomatic deposit (Skarn deposit). Active ore forming systems. **(Lectures 8)**

Unit 3

Weathering and its significance (Residual concentration deposit). Sedimentation (Chemical Precipitation). Sedimentation (Mechanical concentration). Oxidation and chemistry in the zone of oxidation.Gossans, interpretation and significance. Supergene enrichment and Metamorphism of ores. **(Lectures 15)**

Unit 4

Nature, morphology, texture, structures, Para genesis and zoning in ore deposits. Geothermometry. Metallogenic Province and Epochs. Mineralization related to Plate tectonics. Classification of ore deposits.**(Lectures 15)**

Unit 5

The stratigraphic position, occurrence, ore and gangue mineralogy, genetic aspects and distribution of the following ore deposits in India and important examples from other countries and world resources and reserves: (1) Chromium, nickel, gold, silver, Molybdenum; (2). Tin Tungsten, Uranium (3) Iron and Manganese (4) Copper, Lead and Zinc and (5) Aluminum. **(Lectures 15)**

Expected Learning Outcome

The course definitely provides better capability to understand the processes and principles involved during the origin and evolution of the ore minerals.

GEC CC 336 Practical Ore-Microscopy & Economic Geology

Credits: 02 Hours: 30 (M.M. 100= 60 end sem. + 40 sessional)

An introduction to Ore Microscopy and its applications. Polishing of ores, identification of polished ore minerals in reflected light; colour, reflectivity, internal reflection colour, cleavage, polishing hardness, reflection pleochroism, anisotropism, number of extinction positions, false bireflections recognition of common textures in ores. Interpretation of ore textures in terms of paragenesis giving examples.Study of common ore minerals in hand specimen with respect to structure, texture, association, genesis and occurrences. Industrial products of geological material and their specifications. Important world Deposits.

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.

GEO EC 331 Industrial Minerals & Fuels

Credits: 04 Hours: 60 (M.M. 100= 60 end sem. + 40 sessional)

Learning Objective of the Course

The Course aims to make to the students well-versed with the strength of Industrial Mineral & Fuels and its applications in the field of Geology.

Unit 1

The study of the following minerals with reference to origin, mode of occurrence, quality specification, distribution in India and uses. World resources and reserves: mica, vermiculite, asbestos, barytes and gypsum, garnet, corundum, kyanite and sillimanite, graphite, talc, fluorspar, beryl and ochre. **(Lectures 12)**

Unit 2

A study of the raw-materials with respect to their occurrences, industrial specifications and distribution in India for following industries: Refractories, abrasives, ceramics and glass industries, fertilizers and chemicals, paint & pigments and cement. **(Lectures 12)**

Unit 3

Coal, origin and classification, chemical and mineralogical constituents of the coal, Occurrence and distribution in India. Indian coal reserves. Conservation of coal in India. **(Lectures 12)**

Unit 4

Petroleum, natural gas & oil shale. Origin & accumulation of gas & oil traps. Classification of oil and gas reserves. Petroleum bearing regions of India. New gas & oil fields. **(Lectures 12)**

Unit 5

Atomic minerals and fuels. Gem minerals (Diamond, ruby, topaz, almandine. Properties, origin, distribution and processing. **(Lectures 12)**

Expected Learning Outcome

The course definitely provides better capability to understand the processes and principles involved during formation of Industrial Mineral & Fuels.

Essential Reading

1. Sinha, R. K. & Sharma, N. L. (1981): **Mineral Economics**, Oxford & IBH Pub. Co. Pvt. Ltd.
2. Hussain, A. M. (1985): **The Economics and Economic Geology of the Mineral Industries**, Allied Pub. (Pvt.) Ltd., New Delhi.

Suggested Reading:

3. Chatterjee, K. K. (1993): **An introduction to mineral economics**, Wiley Eastern Ltd.

GEO SE 331 Seminar

Credits: 02 Hours: 30 M. M. 100

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Dr. Harisingh Gour Vishwavidyalaya, Sagar
M. Tech. (Applied Geology) III Semester 2020-21

OPEN ELECTIVE COURSE

Code GEO OE 331 Paleontology

Credits: 02 **Hours: 30** **(M.M. 100= 60 end sem. + 40 sessional)**

Learning Objective of the Course

The course aims introduce the students with the utility of fossils.

Unit 1

Introduction, an elementary idea about origin of life; fossil record; Modes of fossilization; and types and uses of fossils. Study of fossils in Museum. **(Lectures 06)**

Unit 2

Morphology and classification of Graptolites and Trilobites. **(Lectures 06)**

Unit 3

Morphology and classification of Lamellibranchia, Gastropoda & Cephalopoda. **(Lectures 06)**

Unit 4

Morphology and classification of Brachiopodes and Rugose Corals. **(Lectures 06)**

Unit 5

Elementary idea of Micropalaeontology and Palaeobotany.Basic ideas about Micropalaeontology. Uses of Microfossils. Foraminifera, their wall composition, morphology. Gondwana flora. **(Lectures 06)**

Expected Learning Outcome

The students will develop capability to visualize the 'evolution of life' and its applications in interpreting of sedimentation.

Essential reading

1. H. Woods (1963) **Palaeontology Invertebrate**CBS Pub. & Dist., (Low Price Ed.) New Delhi. 477p.
2. M. Rhona Black (1989) **Elements of paleontology**Cambridge University Press; 2nd Ed.
3. P. K. Kathal (2012) **Applied Geological Micropaleontology** Scientific Publ., New Delhi, Jodhpur 230p.

Suggestive reading

1. P. K. Kathal (1989) **Applications of Microfossils** CBS Publishers & Distributors, New Delhi, 198p.
2. P.C. Jain and M.S. Anant Raman (2000) **an introduction to Invertebrate Palaeontology**, Vishal Pub. Jalandhar, 346P.

Dr. Harisingh Gour Vishwavidyalaya, Sagar
M. Tech. (Applied Geology) IV Semester 2020-21

Course no.	Course Name	L	T	P	C
GEO CC 431	Metamorphic Petrology & Thermodynamics	4	0	0	4
GEO CC 432	Practical- Metamorphic Petrology	0	0	2	2
GEO CC 433	Geochemistry	4	0	0	4
GEO CC 434	Practical- Geochemistry	0	0	2	2
GEO CC 435	Geodynamics & Tectonics	4	0	0	4
GEO SE 431	Seminar	0	2	0	2
GEO CC 436	Geological Tour Report (Eco. Geol. & Petro.) & Field *Viva Voce*	0	8	0	8
	L= Lecture, T= Tutorial, P= Practical, C= Credits	**Total Credits**			**26**

GEO CC 431 Metamorphic Petrology & Thermodynamics

Credits: 04 Hours: 60 (M.M. 100= 60 end sem. + 40 sessional)

Learning Objective of the Course

The Course aims to make to the students well-versed with the strength of Metamorphic Petrology & Thermodynamics Theory applications in the field of Geology.

Unit 1

Metamorphic Petrology: Scope, definition, Concepts and theory: Types/kinds of metamorphism and their controlling factors/variables; Metamorphic zones and metamorphic grade.

The concept of classification of metamorphic facies and facies series. Extraterrestrial metamorphism (impact and shock metamorphism), poly-metamorphism. Role of fluids in metamorphic reaction, metamorphism types and products.

Types of metamorphic and classification based on metamorphic agent. Classification based on geological setting. Subduction zone polarity and paired metamorphic belts; Isograde and reaction isograde. Field observations, petrographic classification of common metamorphic rocks. Plate tectonics and metamorphic facies series.

(Lectures 12)

Unit 2

The Common minerals of metamorphic rocks; Graphical representation of metamorphic mineral assemblages, ACF, AKF, AFM, CaO-Mg-Sio2, MgO-Al203-SiO2.Schreinemakers rules and construction of petrogenetic grids.

Structure and classification of metamorphic rocks. Deformation textures and textures related to recrystallization; Mineral assemblages, equilibrium/reaction textures. Mineralogical phase rules of closed and open system

Nature of Metamorphic reactions; Effect of metamorphism: Phase diagram and graphic representation of mineral assemblages: Prograde and retrograde metamorphism, metasomatism. **(Lectures 12)**

Unit 3

Description of facies, facies of low pressure (albite-epidote hornfels facies, hornblende hornfels facies, pyroxene hornfels facie and sanidinite facies).

Medium to high pressure (zeolite facies, green schist facies, amphibolites facies and granulite facies) with special reference to characteristic minerals; subdivision into zones/subfacies, mineral assemblages, metamorphic reaction and pressure – temperature conditions of metamorphism. **(Lectures 12)**

Unit 4

Very high pressure (blue schist facies and eclogite facies) with special reference to characteristic minerals; subdivision into zones/subfacies, mineral assemblages, metamorphic reaction and pressure-temperature conditions of metamorphism.

Regional and thermal metamorphism of pelitic rocks. UHP & UHT metamorphism. Regional and thermal metamorphism of basic and ultrabasic rocks. **(Lectures 12)**

Unit 5

Regional and thermal metamorphisms of impure, siliceous carbonate rocks.

Metamorphism and thermodynamics appraisals of metamorphic reactions. Geothermobarometers and P-T paths.

(Lectures 12)

Expected Learning Outcome

The course definitely provides better capability to transform the processes and principles involved during the origin and evolution of the Metamorphic Petrology & Thermodynamics rocks.

GEO CC 432 Practical- Metamorphic Petrology & Thermodynamics

Credits: 02 Hours: 30 (M.M. 100= 60 end sem. + 40 sessional)

Calculation of ACF, AKF, AFM, CaO-MgO-SiO_2, MgO-Al_2O_3-SiO_2values of different minerals and their graphic representation.Microscopic study of different metamorphic rocks belonging to different facies with reference to texture and structure, mineral paragenesis, parents rocks, metamorphic facies/zones to which the rock can be assigned and graphic representation of assemblages in ACF, AKF and AFM diagrams. Megascopic study of meatmorphic rocks with special reference to different facies, texture and structure, mineral paragenesis, parents rocks, metamorphic facies/zones to which the rock can be assigned and graphic representation of assemblages in ACF, AKF and AFM diagrams.Estimation of P-T and activity of common metamorphic minerals therough different important exchange and net transfer reactions. Application of different computer software for calculation of p-T and activities etc.

Essential Reading

1. Best, M. G. (2002):**Igneous and Metamorphic Petrology**, Wiley-Blackwell Science
2. Blatt, H. and Tracy, R.J. (1996):**Petrology(Igneous, Sedimentary &, Metamorphic)**, W.H. Freeman and Co., New York.
3. Winter, J. D. (2012):**Principles of Igneous & Metamorphic Petrology**(2nd Ed.)'PHI Learn.
4. Winkler, H. G. F. (1967): **Petrogenesis of Metamorphic Rocks**, Springer–Verlag./Narosa.
5. Thomas, H. (2005): **Metamorphism and Crustal Evolution**(Edited)
6. Thomas, H. (2019): MOOC on Metamorphic Petrology & Thermodynamics, SWAYAM.GOV.IN

Suggested Reading:

7. Kretz, R. (1994): **Metamorphic Petrology**
8. E-content available at CEC-UGC-MHRD New Delhi website
9. Mason, R. (1978): **Petrology of Metamorphic Rocks,** CBS Pub. & Dist., New Delhi

GEO CC 433 Geochemistry

Credits: 04 Hours: 60 (M.M. 100= 60 end sem. + 40 sessional)

Learning Objective of the Course

To provide a comprehensive introduction to geochemistry and familiarize you with the basic geochemical principles that are relevant to the study of Earth and ocean science. To gain an understanding of geochemistry by using basic geochemical principles to explain, interpret and predict common processes in Earth and ocean science. To recognize how an understanding of basic geochemical concepts can increase our understanding of the Earth and ocean system.

Unit 1

Introduction, history, scope and present status. Earth in relation to the solar system and universe; composition of planets.Cosmochemistry, solar and stellar composition; The planet's composition and structure; Detailed study of meteorites; Lunar rocks; Cosmic abundance pattern. Primary geochemical differentiation of the earth; Geochemical classification of elements; Composition and structure of the earth and principles of distribution of elements in the cosmos; Distribution of elements in the earth. **(Lectures 12)**

Unit 2

Thermodynamics and crystal chemistry; Periodic Table of elements and ionic substitution in minerals; principles of crystal structure. Isomorphism and polymorphism.Minor and trace elements during magmatic crystallization. Significance of REEs in igneous petrology and their importance in fractional crystallization during magmatic/partial melting; Salient geochemical features of pegmatites, kimberlite and carbonatites. **(Lectures12)**

Unit 3

Geochemistry of sedimentary process; Goldich stability series; Physico-chemical factors during sedimentary cycle; Products of sedimentation with special reference to clay minerals.Hydrosphere: Composition, principles of evolution and gains and losses through geological history.Atmosphere: Composition, principles of evolution and gains and losses through geological history.Biosphere: Composition and significance. Biogenic deposits; Minor and trace elements in coal and petroleum. **(Lectures 12)**

Unit 4

Metamorphism as a geochemical process; Mineralogy; Mineral stability, Metamorphic differentiation. Fate of minor and trace elements during Metamorphism.The geochemical cycle. A brief survey geochemical cycle of the following elements, Si, Al, Fe, U-Th& Au. Instrumentation Technique used in geosciences. **(Lectures 12)**

Unit 5

Law of radioactivity; Principles of isostopic dating; Decay schemes &derivation of equation of age. Isotope Geochemistry; Significance of strontium isotopes in igneous petrology. The stable isotopes, Si, C, O and H.Geological aspects &comparative study of different methods of radiometric dating of rocks.Basic concepts ofGeochemical exploration; Geochemical environment, mobility, dispersion & dispersion patterns. Geochemical background, threshold and anomaly. Geochemical association and pathfinder elements. Interpretation of geochemical anomaly; false anomalies. **(Lectures 12)**

Expected Learning Outcome

Demonstrate proficiency in common practical data handling skills in geochemistry. Plan and carry out appropriate mathematical strategies for solving geochemical problems. Synthesize the results of their problem-solving with other work in the form of short, well-organized articles. Critique possible over simplifications in geochemical models.

GEO CC 434 Practical- Geochemistry

Credits: 02 Hours: 30 (M.M. 100= 60 end sem. + 40 sessional)

Methods of geochemical sampling. Chemical elements in the earth's crust; pathfinders and common geochemical associations of elements.Methods of geochemical analysis: preparations of samples; decomposition and separation of elements; A relative study of commonly used methods of estimation. Methods of quick analysis as used in geochemistry; spot test paper, colorimetry, chromatography.

Essential Reading

1. Albarede, F.(2009):**Geochemistry an Introduction,** Cambridge Univ. press, (II Ed)330p
2. Beus, A. A. andGrigorian,S. V. (1977): **GeochemicalExploration Methods for Mineral Deposits**, Applied Publication, University of California,287p.
3. Brownlow, A. H.(1979): **Geochemistry,** Englewood Cliffs and LondonPrentice Hall, 498p.
4. Deckin, A. P.(2005): **RadiogenicIsotope Geology,**Cambridge University press, 492p (II Ed)
5. Hawkes, H. E. & Webb, J. S.(1962): **Geochemistry in Mineral Exploration,** Harper &Row.
6. Krauskopf, K. B. and Bird, D. K.(1995): **Geochemistry,** McGraw Hill, New York,640p

Suggested Reading:

7. Levinson, A.A.(1980): **Introduction to Exploration Geochemistry**, (2nd Ed) App. Pub., 924p.
8. Mason, B. and Moore, C. B.(1982): **Principles of Geochemistry,** Wiley Eastern Ltd.,344p.
9. Fairbridge,R. W. (1972): **Encyclopedia ofGeochemistry and Environmental Sciences,**Von NostrondReinhold Co,1321p.
10. Thomas, H. (2019) MOOC on Geochemistry, SWAYAM.GOV.IN

GEO CC 435 Geodynamics and Tectonics

Credits: 04 **Hours: 60** **(M.M. 100= 60 end sem. + 40 sessional)**

Learning Objective of the Course

Geodynamics is an important tool for understanding the structure and deformation of lithosphere plates. Close to active plate boundaries, volcanoes and earthquakes are an integral part of this deformation. Seismology, tectonics, paleomagnetism and magmatic petrology are important disciplines within the field, and computer science and mathematics are important supporting subjects for parts of the study program.

Unit 1

Planet Earth: Introduction- Scope and relation of geodynamics with other branches of geology; Interior of the earth: crust, mantle and core; Earthquakes: Distribution of epicentres; Intensities and isoseismic lines; Earthquake zones; internal zones of the earth on the basis of seismic data; seismic zones and major earthquakes of India. **(Lectures 12)**

Unit 2

Mantle & Core: Heat flow mechanism, core-mantle convection and mantle plumes. Crustal types; Distribution and characters; Age province or structural province; Plate reconstructions; chronological studies; Composition of Archaean crust. **(Lectures 12)**

Unit 3

Continental Displacement: Concepts of continental drift, geological and geophysical evidences of continental drift.; plate tectonics, plates, lithosphere, asthenosphere, types of plate margins and boundaries and associated geological features like Oceanic ridges and rises; Migrating oceanic volcanoes; ocean trenches; topography of mid-oceanic ridges; magnetic anomaly strips; transform faults; subduction zones; island/volcanic arcs; triple junctions; Plates and their reconstruction: Plate tectonics, mineralization and orogeny. MechanismCauses of global tectonic and expansion hypothesis. Thermal convection hypothesis. **(Lectures 12)**

Unit 4

Palaeo-magnetism: Theory and mechanism of sea floor spreading. Palaeomagnetic evidences; rock as fossil-compasses; normal and reversed magnetism; Palaeomagnetic time scale; Palaeo-position of India and geodynamics of the Indian plate. **(Lectures 12)**

Unit 5

Ocean Floor & Geosynclines: Topography, continental shelves and slopes and their geomorphic features; Ocean floor and it's relation to plate motion.Geosynclines, Orogenic belts. Evolution of folded mountains. Structural Tectonics & Mountain building. Tectonics of India & Himalayas. Mobile belts of India. Major tectonic features of the world. **(Lectures 12)**

Expected Learning Outcome

Students will gain an in-depth understanding of the mechanics of the lithosphere, deformation, stress, fluid mechanics as it applies to the Earth's interior, including thermal convection. Students will derive analytical solution to simplified problems that reveal the fundamental characteristics of more complex geodynamical models and provide a toolkit to interpret geological observations (Knowledge of advanced mathematics, typically including differential equations, linear algebra, complex variables, and discrete mathematics) Students will understand the relation between physics concept, especially continuum mechanics and (laminar) fluid dynamics, and geological observations (Interdisciplinary understanding)

Essential Reading

1. Holmes, A. (1978): **Principles of Physical Geology**, Wiley,(3rd Ed), 730p.
2. Datta, A. K. (2014): **Introduction to Physical Geology**, Kalyani Publishers, New Delhi.

3. Singh, S. (1999): **Physical Geology**, Prayag Pustak Bhawan, Allahabad, 555p.
4. Siddharth, K. (2015): **The Earth's Dynamic Surface**, Kisalaya Pub.(2nd Ed.), 600p.

Suggested Reading:

5. Condi, K. C. (1989): **Plate tectonics and crustal evolution**, Pergamon,(3rd Ed.), 504p.
6. Skinner, B. J., Porter, S. C. and Park, J. (2003): **The Dynamic Earth**: **An Introduction to Physical Geology**, (5th Ed.), Wiley.

GEO SE 431 Seminar

Credits:02 **Hours: 30** **M. M. 100**

GEO CC 436 Geological Tour Report (Eco. Geology & Petrology) & Field Viva Voce

Credits: 08 **Hours: 90** **M. M. 100**

A field report and *viva-voce* based on two to three weeks compulsory geological excursion to mines and places of petrological importance organized by the Department.

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Dr. Harisingh Gour Vishwavidyalaya, Sagar
M. Tech. (Applied Geology) V Semester 2020-21

Course no.	Course Name	L	T	P	C
GEO CC 531	Ground Water Hydrology	4	0	0	4
GEO CC 532	Practical Groundwater & Hydrology	0	0	2	2
GEO CC 533	Exploration Geology	4	0	0	4
GEO CC 534	Mining Geology	4	0	0	4
GEO CC 535	Practical Mining and Exploration Geology	0	0	2	2
GEO CC 536	Geoinformatics	4	0	0	4
GEO CC 537	Practical Geoinformatics	0	0	2	2
GEO SE 531	Seminar	0	2	0	2
GEO SE 532	Seminar: Advanced Instrumentation and techniques in geosciences	0	2	0	2
	L= Lecture, T= Tutorial, P= Practical, C= Credits	**Total Credits**			**26**

GEO CC 531 Groundwater Hydrology

Credits: 04 Hours: 60 (M.M. 100= 60 end sem. + 40 sessional)

Learning Objective of the Course

The Course aims to make to the students well-versed with the strength of Groundwater Hydrologyapplications in the field of Geology.

Unit 1

Sources of Groundwater. The hydrologic cycle. Occurrence, movements and origin of groundwater. Vertical distribution of groundwater, zones of aeration- perched water table, zone of saturation - free and confined groundwater, comparison of surface and sub-surface storage. Darcy's Law and its range of validity.Importance of meteorology in hydrologic investigations, rainfall- runoff estimation of seasonal and annual rainfall. Temperature, humidity and wind velocity. Measurement of stream flow measurement of evaporation and transpiration losses.Hydrological properties of water bearing material. – permeability, hydraulic conductivity, transmissivity, storativity, specific yield, specific retention, hydrostatic pressure, water table slope or hydraulic gradient.

(Lectures 12)

Unit 2

The water table- definition, water table in granular formations, in fractures and solution opening, water table maps and pressure surface maps, fluctuation of water table, groundwater basin, mounds, trenches and cascades. Groundwater and well hydraulics- groundwater flow- Permeability methods.Laboratory methods - direct and indirect, variable head and constant head methods Field Methods – Groundwater velocity methods- dye method, salt method, electrolyte method, discharging well method, drawdown method: Equilibrium method, Thiem method, Non-equilibrium methods - Theis Method, Cooper and Jacob Method, Chow Method; Recovery Method and Theis Recovery Method. **(Lectures 12)**

Unit 3

The construction of water wells- shallow well and deep wells. Types of wells - inverted wells, recharge wells, radial wells, drill wells, dug wells dug cum bore wells and open wells, infiltration galleries, collector wells. Development of wells - Different methods of development of wells, fundamental principles governing performance of wells, relation of drawdown to yield, relation of diameter to yields, specific capacity of wells and efficiency of wells step drawdown test.The completion of wells or design of wells - relation of slot openings to mesh sizes and gauge number. Corrosion of wells & encrustation of well screen. Gravel treatment of wells- basic principles of gravel treatment, hydraulics of gravel treated wells, development & pumping of gravel treated wells. Testing wells for yield, protection of wells.

(Lectures 12)

Unit 4

Impurities and treatment of natural water- origin of impurities in natural water, quality of water– physical, chemical, biological and radiological characteristics. Importance of quality in ground water. Monitoring of ground water quality. Ground water suitability for drinking, irrigation and industrial purposes. Groundwater pollution their sources and causes, treatment of ground water- increasing and decreasing hardness removal of impurities chlorination, removal of dissolved material. Saline water intrusion in aquifers. **(Lectures 12)**

Unit 5

Radio isotopes and hydro-geological studies. Basin wide groundwater development, conjunctive use of surface and ground water. Groundwater development assessment and management. Groundwater modelling.Artificial recharge of groundwaters, problems of over exploitation, groundwater legislation. **(Lectures 12)**

Expected Learning Outcome

The course definitely provides better capability to transform the processes and principles involved under Groundwater Hydrology.

Essential Reading

1. Tolman, C.F. (1937): **Groundwater,** Mcgraw Hills Book co inc. New York and London
2. Todd, D.K. (1980): **Groundwater hydrology**, Toppan Co. ltd., Tokiyo, Japan
3. Ramakrishnan, S. (1998): **Groundwater**
4. Freeze, R. A. and Cherry, J. A.(1979): **Groundwater**. Prentice Hall.

Suggested Reading:

5. Patrick, A.(1972):**Concepts and models in groundwater hydrology**. McGraw Hills
6. Sharma, R.K.(1979): **A text book of hydrology & water resources**, Dhanpatrai & Sons.
7. Walton,W.C.(1970):**Ground water resource evaluation**McGraw Hills Book Co.

GEO CC 532 Practical- Groundwater Hydrology

Credits: 02 Hours: 30 (M.M. 100= 60 end sem. + 40 sessional)

Delineation of hydrological boundaries on water table contour maps, pressure surface maps and estimation of permeability. Analysis of hydrograph and estimation of infiltration capacities, relation of relative drawdown to relative yield. Determination of T, S by different pumping test methods, computation of specific capacity of wells, chemical analysis of water, representation of chemical analysis data, suitability of water for irrigation drinking and industrial purposes. Resistivity survey and interpretation of resistivity data, study of well logs. Exercises on groundwater exploration using remote sensing techniques. Exercises on hydrometeorology.

GEO CC 533 Exploration Geology

Credits: 04 Hours: 60 (M.M. 100= 60 end sem. + 40 sessional)

Learning Objective of the Course

The main aim of the course is to understand the mineral basedexploration strategies and reduce the import dependency.

Unit 1

Techniques of Geochemical exploration: Introduction; historical development & present status.Geochemical exploration in relation to other methods of exploration; stages in geochemical survey.Different types of geochemical surveys; Lithogeochemical and atmogeochemical; pedogeochemical &drainage surveys; Botanical & other surveys. **(Lectures 12)**

Unit 2

Techniques employed in petroleum and natural gas exploration.Radiometric surveys.

Techniques of geological prospecting:drilling, exploration; methods and limitation of prospecting methods. Ore search: Guides to ore-location. **(Lectures 12)**

Unit 3

Geophysical and Geochemical methods of prospecting: Types & application of exploration; Electrical, Magnetic, Gravity, Seismic and Radioactive methods and well logging. **(Lectures 12)**

Unit 4

Drilling: Principles, types, application, borehole planning. Borehole deviation- causes & remedies. Drilling bits: types;problems in drilling and their ratification. Core recovery; core logging; arrangement of cores and sludge. **(Lectures 12)**

Unit 5

Principles and types ofSampling: Theory of sampling and precautions in sampling; preparation of samples and sample reduction.

Groundwater Exploration: Surface and subsurface geophysical and geological methods of groundwater exploration. hydro geomorphic mapping using remote sensing techniques. **(Lectures 12)**

Expected Learning Outcome

The manifestation of the course, if completed successfully can be reflected in the form of an insight in to the technology based mineral resource management. Additionally, the course provides a professional skill to interpret seismic, gravity and magnetic anomaly maps along with an insight in to the sample planning strategy for geochemical mapping.

GEO CC 534 Mining Geology

Credits: 04 Hours: 60 (M.M. 100= 60 end sem. + 40 sessional)

Learning Objective of the Course

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

Unit 1

History and significance of mineral mining, Mining terminology: Surface and sub surface. Planning of field work, Mine planning; mine examination and evaluation; Surface and underground mapping. **(Lectures 10)**

Unit 2

Developing & Mining: introduction to development a prospects; prospecting different features (shaft drift and tunnels, ventilation, illumination, transports, drainage etc). Advancements in mining/ extracting remote mineral resources, coal gasification, and coal bed methane process and its future scope. Mineral resources andmining of the sea bed materials. International law of sea / mining / navigation etc. biochemical and chemical leaching of important ore bodies, gas hydrates and its future potential in India. **(Lectures 15)**

Unit 3

Sampling: sampling methods, subsurface mine sampling techniques, channel sampling, bore hole sampling, Explosives; grades, uses and precaution. Elementary principles and methods of mining, open-pit Surface and underground. Duties of geologist in mining organization, mine development and mine machineries. **(Lectures10)**

Unit 4

Mining Methods: Surface, subsurface and underground methods for various minerals, building stones, ores and fuels. **(Lectures10)**

Unit 5

Mine hazards: Roof supports in underground mining, Mine ventilation, rock burst, mine fire, flooding etc.

(Lectures15)

Expected Learning Outcome

The course definitely provides better capability to understand the processes and principles of Mining Geology.

GEO CC 535 Practical- Mining & Exploration Geology

Credits: 02 Hours: 30 (M.M. 100= 60 end sem. + 40 sessional)

Correlation of subsurface data from different logs.Calculation of ore reserves from the given map data. Completion of surface maps from subsurface and surface data and to calculate reserves of deposits.Calculation of reserves for surface maps. Calculation of averages of assay values: sampling data on placer deposits; Sampling data on vein deposits; Sampling data on Bedded deposits; Demarcation of ore-bodies and calculation of averages on drill data; Study and interpretation of geochemical anomalies maps; Problems in methods of mining of different types of ore deposits & mining hazards.

Essential Reading

1. Arogyaswami, R. N. P. (1988): **A course in Mining Geology**, 2nd Ed., Moham Primlani (Oxford & IBH Pub. Co.), New Delhi
2. Peters, W. C. (1987): **Exploration and Mining Geology**. 2nd Ed., John Wiely & Sons, New York.

Suggested Reading:

3. H. E. (1960): **Mining Geology**, 1st Ind. Ed., Asia Pub. House, Kolkata.

GEO CC 536 Geoinformatics

Credits: 04 Hours: 60 (M.M. 100= 60 end sem. + 40 sessional)

Learning Objective of the Course

The Course aims to make to the students well-versed with the strength of geoinformatics and its applications in the field of Geology.

Unit 1

Introduction & scope of photo geology: types and acquisition of aerial photographs, their geometric characteristics, scale, factors affecting scale & aerial photography, mosaics, film and filter combination, aerial cameras & flying agencies.Stereoscopy**:**lens and mirror stereoscope,stereovision, pseudo stereovision, vertical exaggeration, image displacement. **(Lectures 05)**

Unit 2

Parallax and various distortions, measurement & their removal, instrumentation for interpretation, plotting and measurement. Basic elements of photo interpretation: recognition and interpretation of aeolian, glacial, fluvial and marine landforms in igneous, sedimentary and metamorphic terrain. **(Lectures10)**

Unit 3

Introduction & scope of remote sensing: Earth Resources Technology Satellites (ERTS), LANDSAT, SPOT & IRS mission, Meteorological and Ocean Monitoring Satellites. Indian and global missions.Remote Sensing- principles, electromagnetic spectrum and atmospheric windows, EMRquantities, radiationlaws, interactions with atmosphere and terrain objects, Platforms and sensors- multispectral scanners (MSS) & scanningmodes.

Types of remote sensing- thermal & microwave remote sensing, scale &resolutions,interpretation ofpanchromatic, black & white, false colour composites (FCC), coloured infrared, thermal infrared, radar, MSS and hyper spectral imageries, spectral signature. **(Lectures15)**

Unit 4

Concept of digital images and data formats: Pre-processing, enhancement,classificationalgorithms andaccuracy assessment, satellite data reception, product generation and orderingprocedure.Geographic Information System- hardware and software requirements,GIS packages, recent trends and developments.Spatial data models-data qualities and sources of errors, inputting, editing and topology creation, coordinate system- datum and projections. Spatial analysis. **(Lectures15)**

Unit 5

Digital Elevation Model (DEM), Triangular Irregular Network model and other models & their applications; network analysis. Applications of GIS- in geological, geomorphological, hydrogeological, engineering geological surveying and mapping.

Survey & mapping- of Soil, agriculture, forest, land use & land cover. Ecosystem analysis & biodiversity management, coastal zone management and oceanography, high resolution satellite images and human settlement analysis. GPS- components, positioning and corrections, navigation principles, differential GPS, other navigation systems, surveying methods & integration with GIS themes. **(Lectures15)**

Expected Learning Outcome

The course definitely provides better capability to transform the processes and principles involved in remote sensing, GIS and GPS as well as their integrated applications in different of fields of Geology

GEO CC 537 Practical- Geoinformatics

Credits: 02 Hours: 30 (M.M. 100= 60 end sem. + 40 sessional)

Photogeology: Photogrammetry- determination of scale, quantitative measurement of height of objects, dip of beds and slopes.

Photo-interpretation: Thematic mapping from aerial photos– structure, lithology, minerals, soils, groundwater, landforms and urban settlements etc.

Remote Sensing: Interpretation and analysis of panchromatic, black & white, FCC, IR, thermal IR, radar, MSS and hyper spectral band images. Digital image processing using available software.

GIS and GPS Applications: Thematic mapping from satellite imagery/data– structure, lithology, minerals, soils, groundwater, landforms using GIS software. Collection of GPS data and integration with GIS software.

Essential Reading

1. Avery, T.U. and Berlin, G.L. (1992):**Fundamentals of Remote Sensing and Air Photo Interpretation**, McMillion Publishing Co., New York.
2. Burrough, P.A. (1986):**Principles of Geographic Information Systems for Land Resources Assessment**.
3. Campbell, J. B. (1996):**Introduction to Remote Sensing**, 622pp.
4. Drury, S.A. (1987):**Image Interpretation in Geology**, Chapman and Hall.
5. Gupta, R.P. (2003):**Remote Sensing Geology.** 2nd Ed., Springer-Verlag, Heidelberg.
6. Jensen, J.R. (1986):**Introductory Digital Image Processing-A Remote Sensing Perspective,** Prentice Hall, New Jersey.
7. Lillesand, T. M. and Kiefer, R. (1987):**Remote sensing and image interpretation**, John Wiley.
8. Miller, V. C. (1961):**Photogeology,** McGraw Hill Book Co., New York.

Suggested Reading:

9. Pandey, S. N. (1987):**Principles and Applications of Photogeology**. Wiley Eastern Ltd., Delhi.
10. Ray, R.G. (1969):**Aerial photographs in Geologic Interpretation**. USGS Professional Paper 373.
11. Siegal, B.S. and Gillespie, A.R. (1980):**Remote Sensing in Geology**. John Wiley & Sons.

GEO SE 531- Seminar

Credits: 02 Hours: 30M.M. 100

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GEO SE 532- Seminar:
Advanced Instrumentation and techniques in geosciences

Credits: 02 Hours: 30 M.M. 100

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Dr. Harisingh Gour Vishwavidyalaya, Sagar
M. Tech. (Applied Geology) VI Semester Syllabus 2020-21

Course no.	Course Name	L	T/F	P	C
GEO CC 631	Environmental Geology	4	0	0	4
GEO CC 632	Engineering Geology & Geotechniques	4	0	0	4
GEO CC 633	Practical Engineering & Environmental Geology	0	0	2	2
GEO EC 631	Mineral Economics	4	0	0	4
GEO SE 631	Seminar	0	2	0	2
GEO CC 634	Dissertation on Mineral Exploration & Viva-Voce	0	16	0	16
	L= Lecture, T= Tutorial, P= Practical, C= Credits	**Total Credits**			**32**

GEO CC 631 Environmental Geology

Credits: 04 Hours: 60 (M.M. 100= 60 end sem. + 40 sessional)

Learning Objective of the Course

The Course aims to make to the students well-versed with the strength of Environmental Geology and its applications in the field of Geology.

Unit 1

Definition, scope, concepts, forms of environment: Interaction between man and natural systems. Application of geomorphology in environment. An idea of environmental impact of landslides, earthquakes, volcanoes, large civil engineering structures. Physico-chemical properties of rocks and their engineering geological significance. Primary and Secondary dispersion patterns; biogeochemical anomalies. Distribution and significance of heavy elements in rocks, their weathering products. **(Lectures 12)**

Unit 2

Environmental pollution: sampling of soil, water, biological materials. An idea of dating of soils and waters. Radioactive minerals and their impact of the environment. Principles of sedimentation, sedimentary environments. Clay mineralogy and related health hazards. Reservoir petrography of sandstones and limestone; sedimentary petrology in relation to military geology. **(Lectures 12)**

Unit 3

River flooding, erosion and sedimentation, coastal subsidence. Cement petrography and its application to pollution. Man as geological agent. Geological consequences of industrialization; Waster; their disposal and management of environment. Physical system, biological system and the oceans. Surface and subsurface water Contamination.

(Lectures 12)

Unit 4

Pollution of atmosphere: Types of energy resources, utilization and effects**.** Mining hazards, pollution. Geological factors affecting environmental purity. Classification of pathogenic bacteria and their utility in mineral beneficiation.

(Lectures 12)

Unit 5

Silicosis, and other industrial maladies; mine dust. Phthisis and fluorosis; their causes remedies and prevention. Geological factors of environmental health. Environmental elements of medical geology. Anthropogenic activities and environment. Planning and management of land, soil erosion, conservation, urban. Geology and environmental laws.

(Lectures 12)

Expected Learning Outcome

The course definitely provides better capability to understand the processes and principles of Environmental Geology.

Essential Reading

1. Valdia, K.S.(1987): **Environmental Geology**, Tata McGraw hills, New Delhi
2. Keller, A. E. (1978):**Environmental Geology**(5th Edt.) Charis and Merril Pub. Co.
3. Montgometry, C. W. (2016): **Environmental Geology**,Mc Graw Hall Global education Holding publishers

Suggested Reading:

4. Tonk, W. R. (1986): **Environmental Geology**, Oxford University Press, New York 1983

GEO CC 632 Engineering Geology & Geotechniques

Credits: 04 Hours: 60 (M.M. 100= 60 end sem. + 40 sessional)

Learning Objective of the Course

The Course aims to make to the students well-versed with the strength of Engineering Geology & Geotechniques and its applications in the field of Geology.

Unit 1

Geotechnical engineering and environmental geo-technology: Introduction and scope, recent trends & developments. Engineering properties of rocks, behavior under loads, stress & strain, elasticity (elastic constants), residual stresses, rock discontinuity (RQD, Q & RMR), geotechnical logging charts, engineering classifications (NGI, ISRM & CSIR), physical characters of building stones, concrete and other aggregates.Engineering properties of soils- soil profile, grading, index properties, consistency limits, influence of clay minerals, liquefaction, behavior under loads, effective, neutral and total stresses, lateral earth pressure and arching in soil, theories of failure, engineering classification, expansive pressure, consolidation and compressibility, geo-grids. **(Lectures 12)**

Unit 2

Dams and reservoirs: types and classification, forces acting on the dam body, reservoir induced seismicity, investigations for the construction of dams and reservoir, spillways etc., case studies. Foundation rock and abutment problems-abatement technology, reservoir area problems (such as assessment of mineral resources, agriculture, forest, silt survey, reservoir life and rehabilitation sites), bearing strength of foundation rocks/soils and their improvement, piles, case studies. Tunnels- types, problems due to underground water and fault-shear zones, tunneling in hard and soft grounds, investigations for tunnel alignment, tunnel support design, tunnel linings, TBM, case studies. **(Lectures 12)**

Unit 3

Bridges: Types, abutment and foundation problems across river and valley crossing, geological investigations for construction of bridges, Case studies. Canals-types, investigations for canals, drains and linings, problems and their control, river interlinking projects in India. Buildings– foundations and their selection, types of piles, foundation problems and their improvement, power plants and pumping station on fills. Aseismic designing - earthquake mechanism, intensity, magnitude, seismicity and zoning, calculation of safety factor (seismic coefficient), earthquake resistance design, geo-radars, major earthquakes and their impact. **(Lectures 12)**

Unit 4

Landslides and types of mass movements: Types and classification, causes and mechanism, subsidence and settlements, investigations for soil and rock slope instability, prevention and mitigations, earthquake induced landslides, hazard zoning, case studies of Himalayas. Highways and embankments– types, investigations for the construction of highways and embankments in plain and sloping land, cut and fill excavation, classification of excavation materials, foundation problems and their control, case studies. **(Lectures 12)**

Unit 5

Shoreline engineering and coastal geotectonics: destruction of shorelines, planning and construction of littoral barriers; sedimentation and its control in harbours. River training and flood control- river improvement for navigation, principles of flood control, control of abutment erosion, case studies. Military geology– Applying engineering geology to military problems, organizing geological services for the army, Military Engineering-BRO. Environmental considerations related to civil engineering projects. **(Lectures 12)**

Expected Learning Outcome

The course definitely provides better capability to understand the processes and principles of Engineering Geology & Geotechniques.

Essential Reading

1. Beavis, F.C. (1985):**Engineering Geology**.
2. Bell, F.G. (1999):**Geological Hazards**, Routledge, London.
3. Bieniawski, Z.T. (1989):**Engineering Rock Mass Classification**, John Wiley.
4. Bryant, E. (1985):**Natural Hazards**, Cambridge University Press.
5. Goodman, R.E. (1980):**Introduction to rock mechanics**.
6. Jagger, J.C.and Cook,N.G.W. (1979):**Fundamental of rock Mechanics**, Champman & Hall.
7. Johnson, R.B. and DeGraff, J.V. (1988):**Principles of Engineering Geology**, John Wiley.

Suggested Reading:

8. Legget, R. F.(1983): **Handbook of geology in civil engineering**, McGraw Hill, New York.
9. Schultz, J.R. & Cleaves, A.B. (1951):**Geology in Engineering,** John Willey & Sons, New York.
10. Schuster, R. I. & Krizek, R. J. (1978): **Landslides analysis and control,** Trans. Res. Board Spec. pub. 176 Nat. Acad. Sci. Washington D.C.
11. Vutukuri, V.S., Lama, R.D. and Saluja, S.S. (1974):**Handbook on mechanical properties of rocks,** Transtech Publications, Clausthal, Germany

GEO CC 633 Practical- Engineering & Environmental Geology

Credits: 02 Hours: 30 (M.M. 100= 60 end sem. + 40 sessional)

Selection of sites for dams, tunnels, bridges, highways and similar civil structures using topographic maps, interpretation of geological maps for landslide problems. Computation of reservoir area, catchment area, reservoir capacity and reservoir life. Computation of engineering properties of rocks/soils and evaluation of foundation strength. Evaluation of mechanical properties of concrete aggregates.

Determination of TCR, RQD, Q and RMR, preparation of geotechnical logs and plotting of data using national (ISI & CSIR) and International system (NGI & ISRM) of classification. Evaluation of Atterberg's (consistency) limits and computation of PI, LI, air-void ratio, flow index etc. for various types of soils. Computation of factor of safety for slopes, bearing strength of foundation material. Use of softwares for solving various geotechnical problems. Environmental Impact Assessment (EIA) and problems caused due to engineering geological constructions.

GEO EC 631 Mineral Economics

Credits: 04 Hours: 60 (M.M. 100= 60 end sem. + 40 sessional)

Learning Objective of the Course

The Course aims to make to the students well-versed with the strength of Mineral Economics and its applications in the field of Geology.

Unit 1

Importance of minerals in national economy. Geographic and political factors in minerals usage.Features peculiar to mineral industries; Economic factors common to mineral and manufacturing industries. **(Lectures 10)**

Unit 2

Foreign Development: Demand, Supply, Cartels and monopolies. Substitutes, market speculations, production cost, collaborations, Barter deals and prize fixation. **(Lectures 10**)

Unit 3

Changing norm in mineral consumption, patterns, quota system, embargoes, protective tariff and incentive measures. **(Lectures 10**)

Unit 4

Classification of Minerals: Strategic, Critical and Essential minerals. National mineral policy and comparison with USA. Industrial policy resolution and historical review of policy resolution. **(Lectures 15)**

Unit 5

Mineral concession rules in India. Importance of steel and fuels in modern economy. Impact of atomic energy on conventional fuels. Atomic energy minerals. Future energy status- Atomic energy, Non conventional energy resources, Coal bed methane. **(Lectures 15)**

Expected Learning Outcome

The course definitely provides better capability to understand the processes and principles of Mineral Economics.

Essential Reading

Sinha, R. K. (1993): **Mineral Economics**, 4th Ed., Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi

GEO SE 631 Seminar

Credits: 02 **Hours: 30** **M. M. 100**

GEO CC 634 Dissertation on Mineral Exploration & Viva-voce

Credits: 16 **Hours: 150** **M. M.100**

Viva voce examination on the dissertation submitted by students on 'mineral exploration and underground mapping techniques' based on 3 to 4 week's training, imparted by officials of geological organizations, organized by the Department.

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