EDP.

Ordinance, Regulations and Syllabus

for

M.Sc. Geology

(Semester System)

Self-Financing Mode

According to

New Education Policy (NEP)

Department of Geology

Institute of Earth and Environmental Sciences

Dr. Rammanohar Lohia Avadh University

Ayodhya-224001 (U.P.)

India

DR. RAM MANOHAR LOHIA AVADH UNIVERSITY, AYODHYA

Structure of Syllabus for the

Program: M.Sc., Subject: GEOLOGY

Structure of Syllabus Developed by			
Name of BoS Convener/ BoS Member	**Designation**	**Department**	**College/ University**
Prof. C.K. Mishra	Dean	Faculty of Science	Dr. R.M.L. Avadh University, Ayodhya
Prof. Jaswant Singh	Director & Convener	Institute of Earth and Environmental sciences	Dr. R.M.L. Avadh University, Ayodhya
Prof. A. D. Singh	External Expert	Department of Geology	Banaras Hindu University, Varanasi
Prof. D Prakash	External Expert	Department of Geology	Banaras Hindu University, Varanasi
Dr. Praveen Chandra Singh	Internal Expert	Department of Geology	Dr. R.M.L. Avadh University, Ayodhya
Dr. Saurabh Singh	Internal Expert	Department of Geology	Dr. R.M.L. Avadh University, Ayodhya

Course Code		**Course Title**	**Credits**	**T/P**	**Evaluation**	
					CIE	**ETE**
A	B	C	D	E	F	G
SEMESTER I (YEAR I)						
B090701T	CORE	Mineralogy and Crystallography	5	T	25	75
B090702T	CORE	Structural Geology	5	T	25	75
B090703T	CORE	Igneous Petrology	5	T	25	75
B090704T	FIRST ELECTIVE (Subject Elective) (Select any one)	Introduction to Earth and Planetary Sciences	5	T	25	75
B090705T		Environmental Hazards and Disaster Management	5	T	25	75
B090706P	SECOND ELECTIVE (Subject Elective) (Select any one)	Practical	5	P	50	50
B090707P		Field Visit	5	P	50	50
SEMESTER II (YEAR I)						
B090801T	CORE	Geomorphology and Geotectonics	5	T	25	75
B090802T	CORE	Metamorphic Petrology and Geochronology	5	T	25	75
B090803T	CORE	Sedimentology	5	T	25	75
B090804T	THIRD ELECTIVE	Life Through Ages	5	T	25	75

B090805T	(Generic Elective) (Select any one)	Remote Sensing and GIS	5	T	25	75
B090806P	FOURTH ELECTIVE (Subject Elective) (Select any one)	Practical	5	P	50	50
B090807P		Industrial Training	5	P	50	50
SEMESTER III (YEAR II)						
B090901T	CORE	Stratigraphy	5	T	25	75
B090902T	CORE	Economic and Mining Geology	5	T	25	75
B090903T	CORE	Geochemistry	5	T	25	75
B090904T	FIFTH ELECTIVE (Subject Elective) (Select any one)	Instrumentation Techniques in Geosciences	5	T	25	75
B090905T		Palaeontology	5	T	25	75
B090906P	SIXTH ELECTIVE (Subject Elective) (Select any one)	Practical and Field work	5	P	50	50
B090907P		Project Presentation	5	P	50	50
SEMESTER IV (YEAR II)						
B091001T	CORE	Petroleum and Coal Geology	5	T	25	75
B091002T	CORE	Engineering Geology and Geohydrology	5	T	25	75
B091003T	SEVENTH ELECTIVE (Subject Elective) (Select any one)	Environmental Geology	5	T	25	75
B091004T		Exploration Geophysics	5	T	25	75
B091005P	RESEARCH PROJECT/ DISSERTATION	Research Project/ Dissertation	10	P	50	50

Ordinance relating to the newly adopted semester system in M.Sc. courses in Geology

Ordinance:

1. A candidate who has passed B.Sc./B.Tech. from a recognized university is eligible for admission.
2. Admission will be made on the merit of the entrance test/merit of the qualifying exam.
3. The course of M.Sc. Geology degree shall consist of two academic sessions and each session shall consist of two semesters.
4. A candidate was successful at all four M.Sc. Geology course shall be admitted to semester examination after completing a regular course of study for at least 14 weeks each semester.
5. A candidate was successful at all four M.Sc. Geology semester examination, as specified in the regulation, will be awarded an M.Sc. degree in Geology.

Regulation:

1. The examination for the semester system in the M.Sc. course in Geology shall be by means of theory papers and practical as specified in the examination scheme, which consists of:
   (a) Three core theory papers, two elective papers each of the first, second, and third semesters.
   (b) In the fourth semester, there is two core theory papers, one elective paper and a dissertation work.
   (c) The student will get a maximum of 5 months to complete their Dissertation work in the fourth semester.
2. The name of the candidates successful in the semester system in the M.Sc. course in Geology examinations shall be arranged in the following classes:
   (a) First-class to those who secure 60% or more marks in aggregate.
   (b) The second class to those who secure 45% or more in aggregate.
3. The pass marks in each semester shall be:
   (a) 40% marks in each theory paper examinations.
   (b) 40% marks in practical examinations.
4. Couse Intake and Fee Structure:
   (a) Intake in this course will be 40 students.
   (b) The fee for the course will be Rs. 30,000/- (Rs. Thirty Thousand Only) for one year.

Ordinance relating to the newly adopted semester system in M.Sc. courses in Geology

1. A candidate taking the main examination of the newly adopted semester system in M.Sc. course in Geology Ist, IInd, IIIrd, and IVth semester will be eligible to appear in the second examination to be clubbed within the respective main examination of the next consecutive year.
2. An examinee shall be allowed in the second examination only under the following circumstances:
   (a) If the examinee has scored not less than 40% marks in each theory paper and not less than 40% marks in total of theory but has failed in practical and has unable to appear in the practical examination, the examinee may appear in the second examination in practical, no improvement is allowed in practical examination.
   (b) If in an academic session, an examinee has scored not less than 40% marks in total of all theory and in practical in each semester and has scored not less than 40% marks in aggregate in each semester but has failed to score 40% or more in only one or two theory papers, the examinee may appear in the second examination in any two of these theory papers only one academic session.
   (c) If an examinee has secured the pass marks are more in any main semester examination but desire to improve his marks, the examinee may appear in the second examination in only one theory paper of each of their choice.
   (d) Provided further that a candidate shall not be allowed to appear in more than two theory papers in second examinations in an academic session.
3. A candidate for any of the second examinations listed above shall apply not less than 15 days before the latest for the commencement of the respective examination to be held in the next year/ batch.
4. The candidate has to surrender their original marks sheet relating to the corresponding semester examination to the controller of the examination. They shall be eligible to take a second examination only when the original mark sheet has been surrendered.
5. A candidate opting for the second examination shall be entitled to appear in the respective main examination of the next consecutive year only.
6. The students who have failed or not eligible to appear in the second examination of the semester may appear as Ex-student in the main examination in the next session.
7. The number of attempts in the examination will be subject to university ordinances and regulations.

Program/Class: Master in Geology	Year: First	Semester: I
Subject: Geology		
Course Code: B090701T	Course Title: Mineralogy and Crystallography	

Course Objectives:

To understand the minerals and crystal system

Course outcomes:

After completion of this course, a student will:

Learn the mineral and it types

Know the physical and optical properties of mineral

Learn formation of mineral groups and resource

Understand the crystal formation, forms, and occurrences

Credits: 5	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Mineral: definition, physical properties of minerals- Olivine, Garnet, Aluminosilicates, Pyroxene, Amphibole, Mica, Feldspar, Clay, Silica and Spinel group; Structural classification of silicates; A detailed study of important silicate mineral groups- Nesosilicates (Olivine Group, Garnet Group, Aluminosilicate Group), Cyclosilicates (Beryl), Inosilicates (Pyroxene and Amphibole Group), Phyllosilicates (Kaolinite Group, Serpentine Group, Pyrophyllite, Talc, Mica Group, Chlorite), Tectosilicates (Feldspar Group, Cordierite).	18
II	Study of P olarizing Microscope and accessory plates, Optical properties of minerals- Uniaxial and Biaxial crystals, Indicatrix, Double refraction, Pleochroism, Sign of elongation, Interference figures and optic sign. Thin section preparation methods.	8
III	Basic idea about crystal, crystal growth and crystallization; Laws of crystallography; Crystal morphology; Crystallographic axes; Elements of symmetry; Crystallographic notations; Crystal forms; Habit and classification; Various types of projection.	10
IV	Twinning and Twin Laws: common types of Twins and their examples in minerals, Polymorphism, Pseudomorphism, Isomorphism, Solid solution and exsolution. Symmetry, Miller indices; Zoning, Concept of unit cell and Bravais lattices; 32 Crystal classes, Types of bonding, Pauling's rules and Co-ordination number.	12
V	Symmetry and forms of Cubic (Galena Type), Tetragonal (Zircon type), Hexagonal (beryl type and calcite type), Orthorhombic (Barytes type), Monoclinic (Gypsum type), and Triclinic (Axinite type) Crystal Systems	12

Suggested Readings:

1. Berry, L.G., Mason, B. and Dietrich, R.V. (1985): Mineralogy: Concepts, Descriptions and determinations. C.B.S. publishers.
2. Borchardt-Ott, Walter (2011): Crystallography an Introduction (3rd Edition). Springer-Verlag Berlin Heidelberg.
3. Cornelis, Klein and Barbara, Dutrow (2007): The manual of Mineral Science. Wiley Publication
4. Dana, E. S. and Ford, W. E. (2002): A Textbook of Mineralogy. Wiley Eastern Limited, New Delhi.
5. Deer, W. A., Howie, R. A. and Zussman, J. (2013): An Introduction to the Rock-Forming Minerals (3rd Edition). The Mineralogical Society, London.
6. Kerr, P. F. (1997): Optical Mineralogy. McGraw Hill Book Company.
7. Klein, C. and Hurlbut, C. S., Jr. (1977): Manual of Mineralogy. (21st Revised Edition), John Wiley Sons, Inc., New York.
8. Nesse, William D. (2012): Introduction to mineralogy (2nd Edition). Oxford University Press.
9. Nesse, William D. (2012): Introduction to optical mineralogy (3rd Edition). Oxford University Press.
10. Phillips, F.C (1971): Introduction to Crystallography. Longman Group Publication.
11. Putnis, A. (1992): Introduction to Mineral Sciences. Cambridge publication.
12. Sands, Donald E. (1975): Introduction to crystallography. Dover Publications, Inc. New York.
13. Whittaker, E.J.W. (1981): Crystallography: An Introduction for Earth Science (and Other Solid State) Students. Pergamon Press.
14. Winchell, E. N. (1951): Elements of Optical Mineralogy. John Willey and Sons Inc.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: First	Semester: I
Subject: Geology		
Course Code: B090702T	Course Title: Structural Geology	

Course Objectives:

The objectives of the course are to learn and understand the fundamentals structural geology, Interpretation of deformed structure.

Course outcomes:

After completing the course, student will understand:

Interpretation stress-strain imprinted in earth

Primary and secondary structures

Plate tectonics and motion of the plates

Credits: 5	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Introduction to structural geology; Basic concepts of stress and strain; Study of outcrop; Identification of bedding; Measurement of dip, strike and thickness of beds; Forms of igneous bodies (concordant and discordant)	12
II	Definition, Primary and Secondary structures, Methods and application of structural geology. Fold elements and terminology, Classification: Geometrical, Morphological and Genetic, Origin and Development of folds, Superposed Folds. Determination of top and bottom of beds. Recognition and Representation of folds.	12
III	Classification, and origin of joints, relation to other structures. Faults, terminology and Classification, Structures associated with faults. Gravity, Thrust and Strike-slip faults classification and description. Mechanics of fracturing. Block, Rifted and Wrench-faulted regions, Thrusts and Nappe structures, Tectonic mélanges, Dome and Basin structures, Metamorphic terrains, Mylonite zone and Pseudotachylytes.	12
IV	Unconformities: their classification, recognition and geological significance, onlap and offlap; Joint and its classification, Lineation and Foliation: basic introduction, Meteoritic Impact structures and Impactites, Collapse compaction, Diapers, Salt domes.	12
V	Causes of Plate motion; Mantle Plumes and Plume mechanics; Salient structural features of the Himalayan Arc. Indo-Gangetic Plains, Peninsular India and Indian Ocean.	12

Suggested readings:

1. Condie K.C. (1982): Plate Tectonics and Crystal Evolution. Pergamon Press Inc., New York.
2. Davis G.H., Reynolds S.J. and Kluth C.F. (2011): Structural Geology of Rocks and Regions (3rd edition). John Wiley and Sons, Inc.
3. Fossen H. (2010): Structural Geology. Cambridge University Press.
4. Ghosh S.K and Sengupta S. (1997): Evolution of geological structures in Micro- to Macroscales.

Springer, Berlin.

5. Ghosh S.K. (1993): Structural Geology, Fundamentals and Modern Developments. Pergamon Press.
6. Hatcher R.D. (1995): Structural Geology, principles, Concepts and Problems. Prentice Hall.
7. Marshak S. and Mitra G. (1988): Basic Methods of Structural Geology. Prentice Hall.
8. Park R. G. (2004): Foundation of Structural Geology. Routledge.
9. Pollard D. D. and Fletcher R. C. (2005): Fundamentals of Structural Geology. Cambridge University Press, New York.
10. Ragan D. M. (2009): Structural Geology: An Introduction to Geometrical Techniques. Cambridge University Press.
11. Ramsay J.G. and Huber M.I. (2003): The Techniques of Modern Structural Geology (Volume 1) Strain Analyses. Academic Press.
12. Ramsay J.G. and Huber M.I. (2003): The Techniques of Modern Structural Geology (Volume 2) Folds and Fracture. Academic Press.
13. Richard J. Lisle (2003): Geological Structures and Maps: A Practical Guide. Butterworth-heinemann.
14. Windley B. (1973): The Evolving continents. John Wiley and Sons, New York.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: First	Semester: I
Subject: Geology		
Course Code: B090703T	Course Title: Igneous Petrology	

Course Objectives:

The objective of the course is learning and understanding the fundamentals of igneous petrology, their classification, generation of magma, and the formation of different kind of Igneous rock groups under different tectonic settings etc.

Course outcomes:

After completion of this course, a student will be able to:

Learn the fundamentals of thermodynamics and its application to igneous petrology

Understand the chemistry and physics of the magma

Understand the classification schemes of the igneous rocks

Learn Primary and secondary textures

Understand formation, form and occurrence of igneous rocks or suits of rocks

Credits: 5	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0	

Unit	Topics	No. of Lectures
I	Igneous Petrology: Definition of important rock types, Phase Rule; Elements of Thermodynamics, Enthalpy, Entropy, Gibb's free energy, Phase equilibria studies on different rock types at variable temperature and pressure, different systems of binary, ternary diagram, Solid solution series; Phase equilibria studies in SiO_2, Diopside-Anorthite, Albite-Anorthite, Leucite-Silica and Diopside-Albite-Anorthite systems, Brief introduction to rocks.	12
II	Magma: definition, composition and origin; Bowen's reaction series; Magmatic differentiation and assimilation; Thermal structure of the earth and melting of mantle. Plate tectonics and generation of different magmas in various tectonic settings.	12
III	Concept of primary and secondary magma. Magma series, Dynamics, differentiation, emplacement and crystallization of the magma. Magma mixing, mingling and immiscibility.	12
IV	Textures of igneous rocks; IUGS classification of igneous rocks, Brief petrographic description of common igneous rocks; C.I.P.W. Norm.	12
V	Studies on rocks of basalt family, granites family, kimberlites, peridotites, komatiites, carbonatites, ophiolites, alkaline igneous rocks, lamprophyres and anorthosites. Structural and tectonic control and mode of emplacement of different igneous rocks.	12

Suggested Readings:

1. Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science, C.B.S. publishers, Delhi.
2. Bose, M.K. (1997): Igneous Petrology. World Press, Kolkata.
3. Bucher, K. and Martin, F. (2002): Petrogenesis of Metamorphic Rocks (7th Rev. Ed.), Springer–Verlag.
4. Cox, K.G., Bell, J.D. and Pankhurst, R.J. (1993): The Interpretation of Igneous Rocks. Champman and Hall,

London.
5. Evans, R. C. (1964): Introduction to Crystal Chemistry. Cambridge University Press, Cambridge.
6. Faure, G. (2001): Origin of Igneous Rocks. Springer.
7. Hall, A. (1997): Igneous Petrology. Longman,
8. LeMaitre R.W. (2002): Igneous Rocks: A Classification and Glossary of Terms, Cambridge University Press.
9. McBirney (1994): Igneous Petrology. C.B.S. publishers Delhi.
10. Phillpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology. Prentice Hall of India.
11. Wilson, M. (1993): Igneous Petrogenesis. Chapman and Hall, London.
12. Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology. Prentice Hall, New Jersey.

This course can be opted as an elective by the students of following subjects: M.Sc, Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: First	Semester: I
Subject: Geology		
Course Code: B090704T	Course Title: Introduction to Earth and Planetary Sciences	

Course Objectives:

Will learn origin of solar system, atmosphere and Earth

Course outcomes:

After completion of this course, a student will be able to understand:

Solar system and evolution of Earth

Internal structure of EarthFundamental forces in the atmosphere

Features of ocean floor: Continental shelf, slope and rise.

Physical and Chemical properties of seawater-temperature

Credits: 5	First Elective
Max. Marks: 25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Origin of Solar system; Characteristic of planets in detail; Kepler's Laws of Planetary Motion; Bode's Law, Evolution of the Earth; Earth's internal structure.	12
II	Principles of geodesy, Isostasy, Plate tectonics, Continental drift, Geomagnetism, Sea-floor spreading, Earthquakes and Volcanoes; Rock cycle.	12
III	Composition of the atmosphere and its structure; Study of atmosphere on the basis of lapse rate: Prevailing and adiabatic lapse rates, Isothermal constant lapse rate, dry adiabatic lapse rate, Homogeneous lapse rate; Humidity: definition derivation of relative and absolute humidity; Potential temperature dew point temperature, Instability of dry and moist air; Geopotential; Condensation nuclei; Precipitation.	12
IV	Fundamental forces in the atmosphere; Coriolis force and the Geostrophic wind, Gradient wind, Pressure Gradient wind, Basic structure and mechanism of atmospheric general circulation; Cyclones, Anticyclones and jet stream. Atmospheric Pollution and its various sources. Atmospheric aerosols and its affects with special emphasis on the processes occurring in the Indo-Gangetic basin.	12
V	Features of ocean floor: Continental shelf, slope and rise. Physical and Chemical Properties of seawater-Temperature, Salinity, Chlorinity, Density and their spatial variations, T-S diagrams. Residence times of elements in sea water. Ocean currents, waves and tides, important current systems, thermohaline circulation and the oceanic conveyor belt. La Nina, El-Nino Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD). Major water masses of the world's oceans. Biological productivity in the oceans.	12

Suggested Readings:

1. Brown, G. C. and Mussett, A. E. (1993): The Inaccessible Earth: An integrated view to its structure and composition. Springer Dordrecht.

2. Byers, H.R. (1974): General Meteorology. McGraw Hill.
3. Condie, K.C. (2015): Earth as an Evolving Planetary System. Elsevier.
4. Gass I.G., Smith, J. Peter, and Wilson R. C. L. (1982): Understanding the Earth. Artemis Press (Pvt.) Ltd. U.K.
5. Holmes, A. (1992): Holmes Principles of Physical Geology Edited by P. McL. D. Duff. Chapman and Hall, London.
6. Holton, J. R. and Hakim, G. J. (2013): An introduction to Dynamic Meteorology. Academic Press.
7. Sharma, H.S. (1990): Indian Geomorphology. Concept Publishing Co. New Delhi.
8. Thornbury, W.D. (1980): Principles of Geomorphology. Wiley Eastern Ltd., New York.
9. Trujilo, Alan and Thurman, Harold V. (2019): Essentials of Oceanography (13th Edition). Pearson.
10. Wallace, J.M. and Hobbs, P.V. (2006): Atmospheric Science: An Introductory Survey (2nd Edition). Academic Press.
11. Lowrie, William (2007): Fundamentals of Geophysics (2nd Edition). Cambridge University Press.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: First	Semester: I
Subject: Geology		
Course Code: B090705T	Course Title: Environmental Hazards and Disaster Management	
Course Objectives: The objective of this course is to learn and understand about environmental hazards and disaster management		
Course outcomes: After completion of this course, a student will be able to understand the: Natural hazards and disaster management Climate variabilities and disaster risk Anthropogenic hazards and its risk management Application of geoinformatics to natural hazard mapping and monitoring		
Credits: 5	First Elective	
Max. Marks: 25+75	Min. Passing Marks:40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	Natural hazards and disaster management concepts and overview. Risk determination, acceptable risk, and human response to hazards, anticipatory response to hazards.	15
II	Climate variabilities and disaster risk, Ecology and biodiversity, human domination of ecosystem, ecological restoration. Desertification and waste land reclamation. Linkage between hazardous events and the probability.	15
III	Anthropogenic hazards and its risk management. Disaster preparedness: artificial control of natural processes. Role of individual in conservation and protection of environment, Government interventions and institutional mechanism for disaster management: disaster management policies, local action and capacity building. Forecasting and warning system for hazards.	15
IV	Application of geoinformatics to natural hazard mapping and monitoring for environmental, hydrometeorological and geological.	15

Suggested Readings:

1. Bell, F.G. (1999): Geological Hazards. Routledge, London.
2. Bryant, E. (1985): Natural Hazards. Cambridge University Press.
3. Canter, L.W. (1977): Environmental impact assessment. MC Graw Hill, New York.
4. Keller, E.A. (1978): Environmental Geology. Bell and Howell, U.S.A.
5. Kulkarni, V.S. Kaul, S.N. and Trivedi, R.K. (2001): Handbook of E.I.A. Scientific Publishers, India.
6. Leelkrishnan, P. (2016): Environmental Law in India (4th Edition). LexisNexis Publisher.
7. Subramaniam, V. (2001): Textbook in Environmental Science. Narosa International.
8. Valdiya, K.S. (1987): Environmental Geology–Indian Context. Tata McGraw Hill.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: First	Semester: I
Subject: Geology		
Course Code: B090706P	Course Title: Practical	

Course Objectives:

The lab is designed to train the students in basic as well as advanced techniques of Geology related measurement of the geological data, preparing and reading the geological maps, recognizing the structures in the field as well as identification and characterization of minerals and igneous rocks.

Course outcomes:

After completion of this course, a student will able to:

Interpret the geological maps and related structures

Measure the geological data from field

Identify and characterize the minerals and igneous rocks

Credits: 5	Second Elective
Max. Marks: 50+50	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-6

Unit	Topics	No. of Lectures
I	Problems on dip, strike; Contour maps and completion of outcrops; study and Interpretation of topographical maps; Use of Clinometer compass, Calculation of apparent dip; Simple Lithology boundary tracing; Determination of Thickness of bed. Identification of fault and calculation of Throw; Identification of Unconformities; Identification of fold; Some Complex geological maps; Structural problems using stereographic methods.	60
II	Study of physical properties of rock forming minerals in hand specimens, with special reference to their origin and distribution. Stereographic projections and calculation of axial elements of zircon, apophyllite, beryl, calcite, barytes, orthoclase and hornblende. Study of the optical properties of rock forming minerals in thin section. Megascopic and microscopic Study of important igneous rocks. Calculation of C.I.P.W. norms and Niggli values.	60

Suggested Readings:

1. Bennison, G. M. (1992): An introduction to geological structures and maps. Springer US.
2. Lisle, Richard J. (2020): Geological structures, and maps: A practical guide (4th Edition). Butterworth-Heinemann.
3. McClay K. R. (1991): The mapping of geological structures. Geological Society of London Handbook.
4. Dana, E. S. and Ford, W. E. (2002): A Textbook of Mineralogy. Wiley Eastern Limited, New Delhi.
5. Deer, W. A., Howie, R. A. and Zussman, J. (2013): An Introduction to the Rock-Forming Minerals (3rd Edition). The Mineralogical Society, London.
6. Kerr, P. F. (1997): Optical Mineralogy. McGraw Hill Book Company.
7. Klein, C. and Hurlbut, C. S., Jr. (1977): Manual of Mineralogy. (21st Revised Edition), John Wiley Sons, Inc., New York.

8. Nesse, William D. (2012): Introduction to mineralogy (2nd Edition). Oxford University Press.
9. Nesse, William D. (2012): Introduction to optical mineralogy (3rd Edition). Oxford University Press.
10. Cox, K.G., Bell, J.D. and Pankhurst, R.J. (1993): The Interpretation of Igneous Rocks. Champman and Hall, London.
11. LeMaitre R.W. (2002): Igneous Rocks: A Classification and Glossary of Terms, Cambridge University Press.
12. Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology. Prentice Hall, New Jersey.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 50

Practical Record: 20 Marks, Class participation and activity: 5, Viva-voce: 25 marks

Program/Class: Master in Geology	Year: First	Semester: I
Subject: Geology		
Course Code: B090707P	Course Title: Field Work	
Course Objectives: The students will be able to understand rocks in their natural environment, structures, rock types, occurrences, and their tectonic relationship to one another.		
Course outcomes: After completion of the course, a student will be able to: observe and interpret the outcrops, exposures, landscapes, structures, dip, strike, and related rock types		
Credits: 5	Second Elective	
Max. Marks: 50+50	Min. Passing Marks: 40	
Every student shall be required to attend the field training and submit a detailed field work report, properly labeled and arranged collected specimens, and field diary with the signature of field tour guide faculty members to the Head of the Department. The marks awarded for the field work shall be based on these records, collection, and performance in the field.		

Program/Class: Master in Geology	Year: First	Semester: II
Subject: Geology		
Course Code: B090801T	Course Title: Geomorphology and Geotectonics	

Course Objectives: The objective of this course is to learn and understand about the geomorphological and geotectonic processes that shaping the Earth.

Course outcomes:

After completion of this course, a student will be able to understand the:

Basic concepts and significance of Geomorphology

Erosion and evolution of landforms

Geomorphology of India

Concept of geotectonic

Concept of Plate tectonics

Credits: 5	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0	

Unit	Topics	No. of Lectures
I	Basic concepts and significance of Geomorphology; Cycle of erosion, Fluvial landforms and drainage patterns; Evolution of landforms in Aeolian, marine, glacial and karst landscapes. An elementary idea about morphogenesis and morphography; Morphometric analysis; Morphochronology, Neotectonics: Geomorphological indicators, active faults, drainage changes, recurrent seismicity.	15
II	Geomorphology of India - Peninsular, extra-peninsular and Indo-Gangetic Plains. Application of Geomorphology in Mineral Prospecting, Civil Engineering, Military purposes, Hydrogeology and Environmental studies.	15
III	Introduction to geotectonics; Continental drift, seafloor spreading and convection current hypotheses; Paleomagnetism, polar wandering and reversal of earth's magnetic field; Geomagnetic time scale; Principal Geotectonic features: Features of the Ocean, Continent and Continental margins	15
IV	Plates and plate boundaries; Principles of Plate Tectonics; Force Balance and Mantle Plume models of plate movements; Orogeny and Epeirogeny; Anatomy of orogenic Belts; Geodynamic Evolution of Himalaya	15

Suggested Readings:

1. Small, R.J. (1978): Study of Landforms: A Textbook of geomorphology (2nd Edition). Cambridge University Press.
2. Halis, J.R. (1983): Applied Geomorphology.
3. Sharma, H.S. (1990): Indian Geomorphology. Concept Publishing Co. New Delhi.
4. Holmes, A. (1992): Holmes Principles of Physical Geology Edited by P. McL. D. Duff. Chapman and Hall, London.
5. Thornbury, W.D. (2004): Principles of Geomorphology (2nd edition). C.B.S. Publication.
6. Kale, V.S. and Gupta, Avijit (2010): Introduction to geomorphology. University Press.
7. Bloom, A.L. (2011): Geomorphology: A systematic analysis of Late Cenozoic Landforms (3rd Edition). Rawat Publications.

8. Summerfield, M.A (2011): Geomorphology and Global Tectonics. Wiley India Pvt Ltd.
9. Gautam, A. (2015): Geomorphology (5th Edition). Sharda Pustak Bhavan Allahabad.
10. Siddhardha, K. (2016): The Earth's Dynamic Surface- A book of Geomorphology. Kitab Mahal.
11. Singh, Savindra (2016): Geomorphology. Pravalika Publication Allahabad.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: First	Semester: II
Subject: Geology		
Course Code: B090802T	Course Title: Metamorphic Petrology and Geochronology	

Course Objectives:

The objective of the course is learning and understanding the fundamentals of Metamorphic Petrology and Geochronology.

Course outcomes:

After completion of the course, a student will be able to:

Learn the different kind of metamorphic processes shaping the earth

Formation of the metamorphic rocks and related ore minerals

Application of thermodynamics and its application in geothermobarometry

Learn the geothermobarometry and its applications

Know the radiogenic isotopes and its application in Earth sciences

Credits: 5	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Concept of metamorphic Petrology; different types of metamorphism, agents and protolith; Structure and textures of Metamorphic rocks, Concepts of metamorphic facies and facies series, the concept of Ultrahigh Temperature and Ultrahigh Pressure Metamorphism, Nature of metamorphic reactions, Graphical representation of mineral assemblages in A.C.F., A.K.F. and A.F.M. diagram.	12
II	Isograds and Reaction Isograds, Schrienemakers Rule and Construction of Petrogenetic Grids; Regional metamorphism in relation to Plate tectonics; Paired metamorphic belts; Metasomatism and metamorphic differentiation; Anatexis, Origin and structure of migmatites.	14
III	Description of each Facies related to the Contact, and Regional metamorphism	16
IV	Laws of thermodynamics; Thermobarometer and metamorphic P-T-t paths and their tectonic significance.	6
V	Radiometric dating methods: K-Ar, Ar-Ar dating; Rb-Sr isochron method; Sm-Nd dating; U-Th-Pb system; Concordia and Discordia diagrams; Radiocarbon, Fission Track (F.T.) and O.S.L. dating techniques; Dendrochronology and Lichenometry.	12

Suggested Readings:

1. Bard (1986): Microtextures of Igneous and Metamorphic Rocks. Reidel Dordrecht.
2. Best, M.G. (2013): Igneous and Metamorphic Petrology. Wiley Blackwell.
3. Bucher K. and Martin F. (2002): Petrogenesis of Metamorphic Rocks (7th Rev. Ed.). Springer–Verlag.
4. Frost, B.R. and Frost, C.D. (2014): Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.
5. Fry, N. (1985): Field Description of Metamorphic Rocks, New York, Geological Society of London

Handbook Series.

6. Phillpotts A.R. (1994): Principles of Igneous and Metamorphic Petrology. Prentice Hall of India.
7. Philpotts, A.R. and Ague, J.J. (2009): Principles of Igneous and Metamorphic Petrology. Cambridge University Press.
8. Shelley (1993): Igneous and Metamorphic Rocks under the microscope. Chapman and Hall.
9. Spear, F. S. (1993): Metamorphic phase equilibria and pressure–temperature–time Paths, Mineralogical Society of America.
10. Vernon, R.H. and Clarke, G.L. (2008): Principles of Metamorphic Petrology, Cambridge University.
11. Winter J.D. (2001): An Introduction to Igneous and Metamorphic Petrology. Prentice Hall, New Jersey.
12. Wood, B.J. and Fraser, D.G. (1976): Elementary Thermodynamics for Geologists, Oxford University Press, London.
13. Yardley B.W.D., Mackenzie W.S. and Guilford C. (1995): Atlas of Metamorphic Rocks and their textures. Longman Scientific and Technical, England.
14. Yardlley B.W.D. (1989): An Introduction to Metamorphic Petrology. Longman Scientific and Technical, New York.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: First	Semester: II
Subject: Geology		
Course Code: B090803T	Course Title: Sedimentology	

Course Objectives:

The objective of this course is to understand the fundamentals and importance sedimentology.

Course outcomes:

After completion of this course, a student will be able to:

Understand the processes of the formation of sedimentary rocks

Identify different types of sedimentary rocks and their economic uses

Credits: 5	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Sedimentary rock: definition and its scope; Classification of sedimentary rocks: Conglomerates, Sandstones, Shales, and Carbonate rocks, Provenance of Clastic sediments, Biogenic and Volcanogenic sediments, Diagenesis of Siliciclastic and Carbonate rocks.	12
II	Sedimentary textures- Grain size, Roundness, Sphericity, Shape and Fabric; Quantitative grain size analysis, Elements of hydraulics, Flow regimes and processes of sediment transport, Different type of sedimentary structures- their genesis and Stratigraphic significance, Penecontemporaneous deformation structure; Biogenic structures, Principles and application of Paleocurrent analysis.	12
III	Composition and significance of different types of Sandstone, Limestone, Banded iron formation, Mudstone, Conglomerate; Carbonate Diagenesis and Dolomitization.	12
IV	Sedimentary facies and environments, Facies models and depositional sequences of glacial, fluvial, lacustrine, delta, tidal flats and deep-sea regions; Carbonate platforms- types and facies models; Reconstruction of Paleoenvironments,	12
V	Tectonics and sedimentation, Formation and evolution of sedimentary basins: Geo-synclinal and plate tectonic models, Basin analysis. Principles of sequence Stratigraphy- concepts and factors controlling Base level changes, Parasequence, Clinoform, Systems tract, Unconformity and Sequence boundary.	12

Suggested Readings:

1. Blatt, H., Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks. Prentice Hall Inc, New Jersey.
2. Collinson, J.D., and Thompson, D.B., (1982): Sedimentary Structures. George Allen and Unwin, London.
3. Lindholmn, R.C., (1987): A Practical Approach to Sedimentology. Allen and Unwin, London.
4. Mc Lane, M. (1995): Sedimentology. Oxford University press, U.S.A.
5. Miall, A.D. (2000): Principles of Sedimentary Basin Analysis. Springer-Verlag.
6. Petti john, F. J. (1975): Sedimentary Rocks (3rd Edition). Harper and Row Publisher.

7. Prothero D.R. and Schwab, F. (2004): Sedimentary Geology. Freeman.
8. Reading, H.G. (1997): Sedimentary Environments and facies. Blackwell Scientific Publication.
9. Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments. Springer-Verlag.
10. Selley, R.C. (2000): Applied Sedimentology. Academic Press.
11. Sengupta, S.M. (2007): Introduction to sedimentology. C.B.S. Publication, New Delhi.
12. Tucker, M.E. (1981): Sedimentary Petrology: An Introduction. Wiley and Sons, New York.
13. Tucker, M.E. (1990): Carbonate Sedimentology. Blackwell Scientific Publication.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: First	Semester: II
Subject: Geology		
Course Code: B090804T	Course Title: Life Through Ages	

Course Objectives:

To understand the evolution of life on the Earth.

Course outcomes:

After completion of this course, a student will:

Learn the origin of life

Learn the evolution of human

Understand the formation of mineral group and resource

Understand the techniques of dating ancient life

Credits: 5	Third Elective
Max. Marks: 25+75	Min. Passing Marks:40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0	

Unit	Topics	No. of Lectures
I	Biosphere; Modern thoughts on origin of life; Chief characteristic of major phyla of organic world; Nature of primitive life (invertebrate, vertebrate and plants).	18
II	Rise and fall of dinosaurs; First flying birds; Mammalian explosion; Chance, coincidence and chaos in human evolution.	18
III	Mass extinctions, processes, causes and evidences; Ice age.	12
IV	Techniques of dating ancient life; Relative dating - cultural affiliation, pollen analysis, varve analysis, rate of accumulation; Absolute dating - dendrochronology, oxidized carbon ratio, archaeomagnetism; Potassium-Argon dating.	12

Suggested Readings:

1. Egan, C. and Odier, G. (2006): The Jurassic Mammal Explosion, Victoria, BC, Trafford.
2. Garylane, N. (1986): Life of Past S.K. Donovan -Mass Extinction: Process and Evidences.
3. Knight, C.R. (2001): Life through Ages, Indiana Univ. Press.
4. Norman, D. (1992): Dinosaurs, New York.
5. Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Palaeontology (2nd Ed.), McGraw Hill.
6. Tarling,D.H (1984): Palaeomagnetism: Principles and Applications in Geology, Geophysics and Archaeology, Chapman and Hall.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: First	Semester: II
Subject: Geology		
Course Code: B090805T	Course Title: Remote Sensing and G.I.S.	

Course Objectives:

The objective of this course is to understand the fundamentals of remote sensing and G.I.S.

Course Outcomes:

After completing the course, student will:

Learn the state of art technology, being effectively used to monitor and assess the earth's resources

Able to develop skills of interpretation of the visual and digital satellite data

Understand the interaction of humans with the geological environment.

Credits: 5	Third Elective
Max. Marks: 25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Remote Sensing: Electromagnetic Radiation – Characteristics and Remote Sensing Regions and bands, Scattering, Reflection, Atmospheric Window; Spectra of common natural objects – soil, rock, water and vegetation; Toposheet, Aerial photos– types, scale, resolution; properties of aerial photos.	12
II	Stereoscopy, Parallax, Relief displacement, Elements of photo and imagery pattern and interpretation, General Orbital characteristics of remote sensing satellites, G.P.S.	12
III	Data Processing and Interpretation (Digital Image Processing – D.I.P.), Characteristics of remote sensing data, Pixel, Digital number; Preprocessing; Enhancements, Classification.	12
IV	Types of Indian and Foreign Remote Sensing Satellites, Application in Geology: Remote sensing applications in Structure, Mineral Exploration, Groundwater potentials, Environmental monitoring.	12
V	Introduction to Geographic Information System (G.I.S.); components of G.I.S.; product generation in G.I.S.; tools for map analysis; integration of G.I.S. with remote sensing. Applications of G.I.S. in Landslides, Route location and pipeline alignments; Neo tectonism, seismic hazard and damage assessment.	12

Suggested Readings:

1. Drury, S.A. (1987): Image Interpretation in Geology. Allen and Unwin.
2. Gupta, R.P. (1991): Remote Sensing Geology. Springer, Berlin.
3. Halis, J.R. (1983): Applied Geomorphology.
4. Holmes, A. (1992): Holmes Principles of Physical Geology Edited by P. McL. D. Duff. Chapman and Hall, London.
5. Lillesand, T.M. and Kiefer, R.W. (1987): Remote Sensing and Image Interpretation. John Wiley, New

York.
6. Sabins, F.F. (2007): Remote Sensing: Principles and Interpretation. Waveland Pr. Inc., New York.
7. Sharma, H.S. (1990): Indian Geomorphology. Concept Publishing Co. New Delhi.
8. Siegal, B.S. and Gillespie, A.R. (1980): Remote Sensing in Geology. John Wiley
9. Thornbury, W.D. (1980): Principles of Geomorphology. Jhon Wiley and Sons, I.N.C. London.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: First	Semester: II
Subject: Geology		
Course Code: B090806P	Course Title: Practical	

Course Objectives:

The lab is designed to train the students in basic as well as advanced techniques of G.I.S. and visual interpretation of lithology, megascopic and microscopic identification as well as characterization of the sedimentary and metamorphic rocks.

Course outcomes:

After completion of the course, a student will be able to:

Visual interpretation of lithology and application of G.I.S.

Identify the sedimentary rocks and their characterization

Identify the metamorphic rocks and their characterization

Calculate the structural formula calculation of minerals from EPMA data

Plot mineral EPMA data in chemographic diagrams and its interpretation

Deduce the metamorphic reactions and its interpretation

Estimate pressure and temperature conditions of formation of metamorphic rocks

Credits: 5	Forth Elective
Max. Marks: 50+50	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-6	

Unit	Topics	No. of Lectures
I	A detailed study of textures in Rock Sections with reference to time relations between the phases of deformation and recrystallization of minerals, Calculation of A.C.F., A.K.F. and A.F.M. values from chemical and structural formulation of minerals and their graphical representation.	45
II	Study of sedimentary rocks in hand specimen and under microscope. Grain-size analysis, Identification of clay minerals, Roundness and shape analyses of clastic grains, Heavy mineral analysis, Study of sedimentary structures and Paleocurrent analysis, Megascopic and microscopic Study of sedimentary rocks, Staining techniques for identification of carbonate minerals, Study of profile sections of some selected sedimentary environment.	30
III	Study of Metamorphic Rocks in thin sections belonging to different facies with emphasis on texture/structure, mineral composition, parent rock, metamorphic facies / subfacies / zone to which the rock can be assigned and graphical representation of the assemblage in A.C.F., A.K.F. and A.F.M. diagrams. Study of metamorphic rocks of different metamorphic facies in Hand Specimens. Mineral formula calculations from EPMA data. Estimation of Pressure and Temperature from important models of Geothermobarometry.	45

Suggested Readings:

1. Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic). W.H. Freeman and Co., New York.
2. Blatt, H., Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks. Prentice-Hall Inc.
3. Bucher, K. and Martin, F. (2002): Petrogenesis of Metamorphic Rocks. Springer – Verlag, 7th Revised

Edition

4. Frost, B.R. and Frost, C.D. (2014): Essentials of Igneous and Metamorphic Petrology, Cambridge University Press
5. Kerr, P.F. (1959): Optical Mineralogy. McGraw Hill Book Company Inc., New York.
6. Lindholm, R.C. (1987): A Practical Approach to Sedimentology. Allen and Unwin, London.
7. Pettijohn, F.J. (1975): Sedimentary Rocks (3rd Edition). Harper and Row Publshers.
8. Philpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology. Prentice Hall.
9. Powell, R. (1978): Equilibrium thermodynamics in Petrology: An Introduction. Harper and Row Publishers, London.
10. Reading, H.G. (1997): Sedimentary Environments and facies. Blackwell Scientific Publication.
11. Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments. Springer-Verlag.
12. Selley, R. C. (2000): Applied Sedimentology. Academic Press.
13. Spry, A. (1976): Metamorphic Textures. Pergamon Press.
14. Tucker, M.E. (1981): Sedimentary Petrology: An Introduction. Wiley and Sons, New York.
15. Tucker, M.E. (1990): Carbonate Sedimentology. Blackwell Scientific Publication.
16. Vernon, R.H. and Clarke, G.L. (2008): Principles of Metamorphic Petrology. Cambridge University Press.
17. Winter, J.D. (2001): An introduction to Igneous and Metamorphic Petrology. Prentice Hall.
18. Wood, B.J. and Fraser, D.G. (1976): Elementary Thermodynamics for Geologists. Oxford University Press, London.
19. Yardley, B.W.D., Mackenzie, W.S. and Guilford, C. (1995): Atlas of Metamorphic Rocks and their textures. Longman Scientific and Technical, England.
20. Yardlley, B.W.D. (1989): An introduction to Metamorphic Petrology. Longman Scientific and Technical, New York.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Practical Record: 20 Marks, Class participation and activity: 5, Viva-voce: 25 marks

Program/Class: Master in Geology	Year: First	Semester: II
Subject: Geology		
Course Code: B090807P	Course Title: Industrial Training	
Course Objectives: The students will be able to familiar the industrial culture, their working philosophy, and instrumentation facilities.		
Course outcomes: After completion of the course, a student will be able to: Develop the industrial working culture Get exposure to different working methods of industries Get exposure to vital instrumentation training Get exposure to different software used in the industries		
Credits: 5	Forth Elective	
Max. Marks: 50+50	Min. Passing Marks: 40	
Every student shall be required to attend the industrial training and submit a detailed industrial training report, with the signature of industrial training guide to the Head of the Department. The marks awarded for the industrial training shall be based on these records, and performance in the training.		

Program/Class: Master in Geology	Year: Second	Semester: III
Subject: Geology		
Course Code: B090901T	Course Title: Stratigraphy	

Course Objectives:

The course is designed to make the students understand the concept and basic steps of stratigraphy and correlation of the parts of the globe with each other.

Course outcomes:

After completion of the course, a student will be able to understand the:

Basic principles and concept of stratigraphic

Concept of sequence stratigraphy

Physiographic divisions, Structure and tectonic history of Indian subcontinent

Stratigraphic sequences of different parts of the Indian subcontinents.

Origin of different cratons, mobile belts, and basins of Indian subcontinents and their correlation with other parts of the globe.

Evolution of the Himalaya

Credits: 5	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0	

Unit	Topics	No. of Lectures
I	Basic principles and definitions; Stratigraphic classification and Nomenclature; Brief account on Magneto stratigraphy, Stable Isotope Stratigraphy, Tephrochronology and Event Stratigraphy; Stratigraphic correlation, Paleontological and non-Paleontological criteria of correlation; Graphic correlation; Facies concept in stratigraphy; Lateral migration of facies.	12
II	Introduction to Sequence stratigraphy depositional sequence, Sequence architecture types and Boundaries, Conformity and types of Sequence Unconformities; Flooding surface, maximum flooding surface, marine flooding surface; Bed, Bedset, Para sequence, Para sequence boundary, Para sequence set; System tracts - Low stand system tract, Transgressive system tract, High stand system tract, Overlap, off lap, Top lap and On lap, Aggradation, Progradation, Retrogradation, Transgression and Regression; Eustatic sea level changes, sediment supply, Basin subsidence rate and Accommodation.	12
III	Physiographic divisions, Structure and tectonic history of Indian subcontinent; Precambrian basement of Indian Peninsula. Archaean rocks: distribution, Classification and Economic importance; Precambrian basement of Extra-peninsula- Tethyan basement, Lesser Himalaya; Basement-cover transition; Proterozoic formations of Indian Peninsula- Cuddapah, Delhi, Bijawar and Gwalior Group and their equivalents. Vindhyan Supergroup and its equivalents; Correlation of equivalent Proterozoic formations in Extra-peninsular India. Chronology of Orogenies.	12
IV	Paleozoic Era- Paleogeographic, Paleoclimatic and tectonic set up, A detailed study of succession, lithology, Age, Depositional environments, Economic	12

	importance and fossil contents of various formations of Salt Range, Tethys Himalaya and Lesser Himalaya Ranges; Gondwana sequences. Mesozoic Era- Paleogeographic, Paleoclimatic and tectonic set up formations of Extra-peninsular and Peninsular India. Deccan Traps: distribution, Petrology and age. Lameta beds, Bagh beds, Intertrappeans and Infra-trappeans.	
V	Cenozoic Era- Paleogeographic, Paleoclimatic and tectonic set up along with Himalayan Orogeny. A detailed study of succession, Lithology, Age, Depositional environments, Economic importance and fossil contents of various Paleogene and Neogene formations of Extra-peninsular and Peninsular India; Siwalik Supergroup.	**12**

Suggested Readings:

1. Krishnan, M.S. (1982): Geology of India and Burma, C.B.S. Publ, Delhi, John Wiley and Sons, New York.
2. Nichols, G. (1999): Sedimentology and stratigraphy, Blackwell Science, Oxford, 355 pages, ISBN 0-632-03578-1.
3. Ramakrishnan, M. and Vaidyanadhan, R. (2008): Geology of India (In 2 Volumes), Geological Society of India, Bangalore.
4. Kumar, R. (1996): Fundamentals of Historical geology and stratigraphy of India. New Age International Publishers.
5. Schoch, R.M. (1989): Stratigraphy: principles and methods. Van Nostrand Reinhold.
6. Coe, Angela L., Bosence, D.W.J., Church Kevin D., Flint, Steve, Howell, John and Wilson, R. Chris L. (2002): The Sedimentary Record of Sea Level Change, Cambridge University Press.
7. Emery, D. and Myers, K.J. (1996): Sequence Stratigraphy. Blackwell Scientific.
8. Miall, A.D. (1997): The Geology of Stratigraphic Sequence. Springer-Verlag.
9. Reineck, H.E. and Singh, I.B. (1980): Depositional Sedimentary Environments. Springer-Verlag.
10. Valdiya, K.S. (2016): The Making of India: Geodynamic Evolution. Springer Cham.
11. Jain, A.K., Banerjee,D.M., and Kale S., Vivek (2020): Tectonics of the Indian Subcontinent. Springer Cham.
12. Sharma, Ram (2010): Cratons and Fold Belts of India. Springer Berlin, Heidelberg.

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: Second	Semester: III
Subject: Geology		
Course Code: B090902T	Course Title: Economic and Mining Geology	

Course Objectives:

The objectives of the course are to learn and understand the fundamentals of Economic and Mining Geology etc.

Course outcomes:

After completion of this course, a student will be able to:

Understand the formation of the different types of economic minerals and deposits

Classifying the economic minerals

Understand the mining processes

Understand Different types of economic minerals of India and their reserve

Understand Mineral policy of India

Credits: 5	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0	

Unit	Topics	No. of Lectures
I	Classification of mineral deposits; Processes of formation of ores: magmatic, hydrothermal, oxidation and supergene enrichment; Concept of critical, Porphyry and skarn mineralization. Fluid inclusion studies	12
II	Mineralization associated with (i) ultramafic, mafic and acidic rocks, (ii) greenstone belts, (iii) komatiites, anorthosites and kimberlites and (iv) submarine volcanism, Stratiform and strata bound ores. Ores and metamorphism cause and effect relations, Forms of ore deposits,	12
III	Methods of ore microscopy, Metallogenic epochs and provinces of India, Strategic, essential and Critical minerals with examples. Occurrence, origin and distribution of the important mineral deposits of India: iron, manganese, aluminum, chromium, nickel, gold, silver, molybdenum asbestos, barytes, gypsum, graphite, apatite and beryl), Phosphorite deposits, rare earth mineral Deposits. Raw material for ceramic, refractory, cement, paint, fertilizer, and glass industries and building stones, Gemstones. Distribution of mineral deposits in India.	12
IV	Tenor, grade and specification; strategic, critical and Essential minerals, Classification of mining methods. Mining Methods: Placer mining methods, open pit methods, Underground mining methods, Coal Mining methods and Ocean bottom mining methods; their advantages and disadvantages. Ventilation in underground mining: Purpose, types and arrangements of ventilation in underground mining. Mining hazards and safety measures.	12
V	India's status in mineral production; co-products and by-products, consumption, substitution and conservation of minerals; National Mineral Policy, Mineral Concession Rules, Marine mineral resources and Laws of the sea.	12

Suggested Readings:

1. Arogyaswami, R.P.N. (1996): Courses in Mining Geology (4th Edition). Oxford & I.B.H. Publishing.
2. Bateman, A.M. (1959): Economic mineral deposits. Asia Publishing House.
3. Clark, G.B. (1967): Elements of Mining (3rd edition). John Wiley.
4. Evans, A.M. (1993): Ore geology and Industrial minerals, Blackwell.
5. Gaudin, A.M. Principles of Mineral Dressing. McGraw Hill Publishing Company Limited, Bombay.
6. McKinstry, H. E. (1976): Mining Geology. Prentice Hall, Englewood Clifts, N.J.
7. McKinstry, H.E. (1948): Mining Geology. Prentice Hall, Englewood Clifts, N.J.
8. Mookherjee, A. (2000): Ore genesis-A holistic approach. Allied Publishers, New Delhi.
9. Prasad, U. (2003): Economic geology. C.B.S. Publishers, Delhi.
10. Stanton, R.L. (1972): Ore Petrology. McGraw Hill, New York.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: Second	Semester: III
Subject: Geology		
Course Code: B090903T	Course Title: Geochemistry	

Course Objectives: The objective of the course is learning and understanding the processes that control the abundance, composition, and distribution of chemical elements, compounds and isotopes in natural environments.

Course outcomes:

After completion of this course, a student will be able to:

Learn various geological phenomena at the atomic and subatomic levels on the earth and in the universe

Understand geochemical classification of elements and Element partitioning

Learn about the stable isotopes and their application in Geology

Understand Implication of geochemistry in petrogenesis of sedimentary and igneous rock

Credits: 5	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0	

Unit	Topics	No. of Lectures
I	Earth System Science and various reservoirs. Introduction to the chemical composition and properties of atmosphere, lithosphere, hydrosphere and biosphere. Geochemical cycles. Concept of biogeochemical cycle.	15
II	Concept of equilibrium. Entropy, enthalpy, Gibbs free energy and laws of thermodynamics. Chemical kinetics in geoscience and its applications: disequilibrium textures, kinetics of radioactive decay, and diffusion. Meteorites, their classification, mineralogy and origin.	15
III	Geochemical classification of elements. Element partitioning in mineral/rocks formation and concept of distribution coefficient. Utility of trace elements in petrogenesis of rocks. Interpretation of REE patterns. Sampling procedures and introduction to important analytical techniques used in geochemistry.	10
IV	Stable isotope geochemistry of carbon and oxygen and its applications to Geology. Radiogenic isotopes. Decay scheme of K-Ar, U-Pb, Rb-Sr and Sm – Nd. Radiometric dating of single minerals and whole rocks. Petrogenetic implications of Sm-Nd, Rb-Sr systems.	10
V	A brief introduction to geochemistry of natural waters. Introduction to sedimentary geochemistry. Geochemical processes involved in rock weathering and soil formation. Mineral stability in Eh-Ph diagrams.	10

Suggested Readings:

1. Bloss, F.D. (1971): Crystallography and Crystal Chemistry. Holt, Rinehart, and Winston, New York.
2. Robin Gill (2015) Chemical Fundamentals of Geology and Environmental Geoscience. John Wiley & Sons Ltd.
3. Alan P. Dickins (2005) Radiogenic Isotope Geology. Cambridge University Press.
4. Hoefs, J. (1980): Stable Isotope Geochemistry. Springer and Verlag.
5. Hugh R. Rollinson (2007) Early Earth Systems: A Geochemical Approach.Blackwell Publishing Ltd.

6. Gunter Faure (1977) Principles of Isotope Geology. John Wiley & Sons Ltd.
7. Hugh R. Rollinson (1993) Using Geochemical Data: Evaluation, Presentation and Interpretation. Pearson Prentice Hall.
8. Albarde Francis (2003): Geochemistry- Introduction. Cambridge University Press.
9. Kula C Misra (2012): Introduction to Geochemistry: Principles and Applications. Wiley-Blackwell.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: Second	Semester: III
Subject: Geology		
Course Code: B090904T	Course Title: Instrumentation Techniques in Geosciences	
Course Objectives: The objective of this course is to learn and understand the basic principles and applications of Instrumentation Techniques in Geosciences		
Course outcomes: After completion of this course, a student will be able to understand the: Role and importance of instrumentation techniques in Geosciences Principle and application of various instrumentation techniques for evaluation and assessment of geoscientific fields		
Credits: 5	Fifth Elective	
Max. Marks: 25+75	Min. Passing Marks:40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	Role and importance of instrumentation techniques in Geosciences. Sample preparation techniques. Quality, Precision, Accuracy, calibration and standards. Destructive and non-destructive techniques.	20
II	Principle and application of following instrumental techniques in Mineralogy: Microcopes, UV lamp, X-ray diffractometer, Image Analyzer, Electron Probe Micro Analyzer, Scanning Electron Microscope, Infra-red spectrometer, Raman Spectroscope, and isodynamic separator.	15
III	Principle and application of following instrumental techniques in Geochemistry: Atomic absorption spectrometer, x-ray fluorescence spectrometer, inductively coupled plasma analyzer, Mass spectrometer and MC- LA-ICP-MS.	15
IV	An introduction to various mineral dressing and geophysical instruments	10

Suggested Readings:

1. Dhanaraju, R. (2009) Handbook of geochemistry: techniques and applications in mineral exploration. Geological Society of India.
2. Kerr, P.F (1977): Optical Mineralogy. McGrew Hill.
3. Perkins, D. (2013): Mineralogy. Prentice Hall.
4. Ramachandra Rao, M.B. (1975): Outlines of geophysical prospecting: a manual for geologists. Ms. Wesley Press, Mysore.
5. Ramana Murty, V.V. (2012): Operational Hand book of mineral Processing. Denett & Co.
6. Reed, S.J. B. (1996): Electron Microprobe Analysis and Scanning electron Microscopy in Geology. Cambridge University press.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: Second	Semester: III
Subject: Geology		
Course Code: B090905T	Course Title: Palaeontology	

Course Objectives:

The objective of this course is to learn and understand the basic as well as advanced concepts of paleontology

Course outcomes:

After completion of this course, a student will be able to:

Know the evolutionary processes of life on the earth through time

Understand the characteristics of different species on earth during the geological past

Know the causes of extinction of species during geological past

Understand the geological time scale in the view of species and correlation

Credits: 5	Fifth Elective
Max. Marks: 25+75	Min. Passing Marks:40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0	

Unit	Topics	No. of Lectures
I	Definition, objectives and scope. Conditions and modes of fossilization. Organic evolution and classification. Concept of species. Habit and habitats. Dispersal, migration and extinction. Paleoecology, concepts and approaches. Taphonomy.	12
II	Detailed shell morphology, classification, composition and structure of the shell and geological description of the following invertebrate fossil groups; Brachiopoda, Bivalvia, Gastropoda and Cephalopoda.	12
III	Morphology, classification and geological description of Echinoidea, Trilobita, Graptoloidea and Corals. Evolutionary trends in Graptoloidea and Ammonoidea. Functional morphology of bivalvia. Buoyancy of cephalopod shells. Heteromorphs and extinction in ammonites.	12
IV	Elements of micropaleontology and its applications. Collection and preparation of microfossils. Types of microfossils. Brief morphological Study of the following types of microfossils and their paleoceanographic and paleoenvironmental significance; Calcareous (Foraminifera, Ostracoda, Pteropods), Siliceous (Radiolaria, Diatoms).	12
V	Brief morphological Study of Phosphatic (Conodonts) and Organic- walled (Acritarchs, Tasmanitids and Dinoflagellates) microfossils. Introduction to paleobotany with special reference to Gondwana plant fossils. Introduction to vertebrate paleontology. Vertebrate life through geological time. Study of Siwalik vertebrate fauna. Brief Study about evolution of dinosaur, horse, elephant and primate.	12

Suggested Readings:

1. Arnold (2002): Quaternary Environmental Micropaleontology (Editor Simon K. Haslett), Oxford University Press.
2. Benton, M.J. (1990): Vertebrate Paleontology. Unwin Hyman, Lindon.

3. Bignot, G. (1985): Elements of Micropaleontology. Springer Science & Business Media.
4. Clarkson, E.N.K. (1998): Invertebrate Palaeontology and Evolution. ELBS/Allen and Unwin, London.
5. Colbert, E.H. (1984): Evolution of Vertebrates. Wiley Eastern Ltd.
6. Gross, M. Grant (1977): Oceanography: A view of the Earth. Prentice Hall.
7. Haq, B.U. and Boersma, A. (1998): Introduction to Marine Micropaleontology. Elsevier.
8. Houghton, John (1997): Global Warming. Cambridge University Press.
9. Jones, T.P. and Rowe, T.P. (1999): Fossil plants and spores, Modern Techniques. Geological Society of London.
10. Pinet, P.R. (1992): Oceanography: An introduction to the Planet Oceanus. West Publishing Company.
11. Prothero, D.R. (1998): Bringing Fossil to Life–An Introduction to Palaeontology. McGraw Hill.
12. Raup, D.M. and Stanley, S.M. (1985) Principles of Palaeontology. W.H. Freeman and Company, New York.
13. Saraswati, P.K. and Srinivasan, M.S. (2016): Micropaleontology: Principles and Applications. Springer.
14. Tolmazin, David (1985): Elements of Dyanamic Oceanography. Allen and Unwin.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: Second	Semester: III
Subject: Geology		
Course Code: B090906P	Course Title: Practical and Field work	
Course Objectives: The lab is designed to train the students in basic and advanced techniques of Geology related with the paleontology, geochemistry, stratigraphy and economic geology.		
Course outcomes: After completion of this course, a student will able to: Identify and characterize the fossils Age correlation of horizons across the globe Analyze the rocks sample and interpretation of obtained data Identify the ore minerals and associated processes		
Credits: 5	**Sixth Elective**	
Max. Marks: 50+50	**Min. Passing Marks:40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-6		

Unit	Topics	No. of Lectures
I	Visual interpretation of lithology, structure and land use from aerial photographs and satellite data; Mapping from aerial photographs in different lithologies. Digital image processing. Application of G.I.S. in geomorphology studies. Morphometric analysis of River and channel	30
II	Study of rocks in hand specimens from known Indian stratigraphic horizons and type localities; Exercises on stratigraphic classification and correlation, sequence, and magneto stratigraphic interpretations.	30
III	Megascopic study of Indian metallic ores and industrial minerals in hand specimens; Study of ore structures in hand specimens; Study of optical properties and identification of important ore minerals under ore-microscope. Preparation of maps showing distribution of metallic and industrial minerals in India and also classical world mineral deposits.	30
IV	Every student shall be required to attend the field training and submit a detailed field work report, properly labeled and arranged collected specimens, and field diary with the signature of field tour guide faculty members to the Head of the Department. The marks awarded for the field work shall be based on these records, collection, and performance in the field.	7 days

Suggested Readings:

1. Craig, James, R. and Vaughan, David J. (1994): Ore Microscopy and Petrography. John Wiley & Sons, Inc.
2. Cuilbert, J.M. and Park, Jr. C.F. (1986): The Geology of Ore Deposits. Oxford and New York (W. H. Freeman and Co.).
3. Evans, A.M. (1993): Ore Geology and Industrial Minerals. Blackwell.
4. Klemm, D.D. and Schnieder, H.J. (1977): Time and Strata Bound Ore Deposits. Springer-Verlag.
5. Mookherjee, A. (2000): Ore Genesis-A Holistic Approach Allied Publisher.
6. Ramdhor, P. (1969): The Ore Minerals and their Intergrowths. Pergamon Press.
7. Stanton, R.L. (1972): Ore Petrology. McGraw Hill.
8. Wolf, K.H. (1976-1981): Hand Book of Stratabound and Stratiform Ore Deposits. Elsevier Publ.

9. Drury, S.A. (1987): Image Interpretation in Geology. Allen and Unwin.
10. Gupta, R.P. (1991): Remote Sensing Geology. Springer, Berlin.
11. Holmes, A. (1992): Holmes Principles of Physical Geology Edited by P. McL. D. Duff. Chapman and Hall, London.
12. Lillesand, T.M. and Kiefer, R.W. (1987): Remote Sensing and Image Interpretation. John Wiley, New York.
13. Sabins, F.F. (2007): Remote Sensing: Principles and Interpretation. Waveland Pr. Inc., New York.
14. Siegal, B.S. and Gillespie, A.R. (1980): Remote Sensing in Geology. John Wiley

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: Second	Semester: III
Subject: Geology		
Course Code: B090907P	Course Title: Project Presentation	
Course Objectives: The students will be able to undertake a project and its successful defense.		
Course outcomes: After completion of the course, a student will be able to: Generate a research problem or gap in the knowledge Set the goal of the project Preparation of the project Defense of the project		
Credits: 5	Sixth Elective	
Max. Marks: 50+50	Min. Passing Marks: 40	
Every student shall be required to undertake a project and submit a detailed project report with the signature of the concerned faculty members to the Head of the Department. The marks awarded shall be based on the project report and the defense capability of the student.		

Program/Class: Master in Geology	Year: Second	Semester: IV
Subject: Geology		
Course Code: B091001T	Course Title: Petroleum and Coal Geology	
Course Objectives: The objectives of the course are to learn and understand the origin, distribution, exploration, development, and production of Petroleum and Coal.		
Course outcomes: After completion of this course, a student will be able to: Learn the process of formation of coal Understand the classification and characterization of coal Understand Distribution of coal in India Learn about the generation of coalbed methane and its reservoir Understand the process of formation of petroleum and its characterization Understand the types of reservoirs for the petroleum Learn about the petroliferous basins of India Understand the techniques for exploration of coal, petroleum and coal bed methane		
Credits: 5	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	Definition and origin of coal. Sedimentology of coal bearing strata, types of seam discontinuities and structures associated with coal seams. Chemical characteristics of coal. Coal Petrology – concept of 'Lithotype', 'Maceral' and 'Microlithotype'. Classification of macerals and microlithotypes. Techniques and methods of coal microscopy. Elementary knowledge of the application of reflectance and fluorescence microscopy. Application of coal petrology. Classification of coal in terms of Rank, Grade and Type. classification for coking and non-coking coals. Elementary idea about coal preparation, characterization of coal for carbonization, gasification-hydrogenation. Coal as a source rock in petroleum generation.	20
II	Coalbed methane – a new energy resource. Elementary idea about generation of methane in coal beds, coal as a reservoir and coalbed methane exploration. Underground Coal Gasification: definition, concept and development, environmental benefits. Geological and geographical distribution of coal and lignite deposits in India. Coal exploration and estimation of coal reserves. Indian coal reserves and production of coal in India.	20
III	Petroleum – its composition. Origin (Formation of source rocks-kerogen, organic maturation and thermal cracking of kerogen) and migration of petroleum. Reservoir rocks-porosity and permeability.	10
IV	Reservoir traps structural, stratigraphic and combination traps. Oilfield fluids – water, oil and gas. Methods of prospecting for oil and gas (geological modeling). Onshore and offshore petroliferous basins of India. Oil-shale and shale-oil.	10
Suggested Readings:		

1. Suárez-Ruiz, Isabel John Crelling (2008): Applied Coal Petrology: The Role of Petrology in Coal Utilization. Academic Press.
2. Taylor, G.H., Teichmuller, M., Davis, A., Diessel, C.F.K., Littke, R. and Robert P., (1998): Organic Petrology, Gebruder Borntraeger, Stuttgart.
3. Chandra, D., Singh, R.M. Singh, M.P., (2000): Textbook of Coal (Indian context). Tara Book Agency, Varanasi.
4. Singh, M.P. (Ed.) (1998): Coal and organic Petrology. Hindustan Publishing Corporation, New Delhi.
5. Scott, A.C. (1987): Coal and Coal-bearing strata: Recent Advances. The geological Society of London, Blackwell scientific Publications.
6. Stach, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichumullelr, M. and Teichmuller R. (1982): Stach Texbook of Coal petrology. Gebruder Borntraeger, Stuttgart.
7. Holson, G.D. and Tiratso, E.N. (1985): Introduction to Petroleum Geology. Gulf Publishing, Houston, Texas.
8. Tissot, B.P. and Welte, D.H. (1984): Petroleum Formation and Occurrence. Springer – Verlalg.
9. North, F.K. (1985): Petroleum Geology. Allen Unwin.
10. Selley, R.C. (1998): Elements of Petroleum Geology. Academic press.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: Second	Semester: IV
Subject: Geology		
Course Code: B091002T	Course Title: Engineering Geology and Geohydrology	
Course Objectives: The objectives of the course are to develop the ability to solve the problems related to the environment, to make them aware of various eco-friendly techniques and modern techniques to solve various environment-related problems.		
Course outcomes: After completion of this course, a student will be able to: Know the Importance of earth sciences in engineering. Understand mechanical properties of rocks and soils Know the types of earth movements, causes and remedial measures Understand the landslides and their remedial measures Know the hydrology cycle and ground water		
Credits: 5	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	Engineering geology- Importance of earth sciences in engineering. Mechanical Properties of Rocks and Soils: Elastic, An-elastic and Plastic behavior of material, Stress and Strain state in rocks, Longitudinal strain, Shear strain, young's modulus, Rigidity modulus, Bulk modulus, Compressibility, Poisson's ratio. Earth Movements, types, causes and remedial measures, Landslides in clayey rocks, sliding movement in hard rocks, Stabilization of slopes in slide areas and other preventive measures, Construction Materials, Geological criteria for selection of construction material for various uses, viz. Concrete aggregate rip-rap, Rigid and Flexible Pavements, Facing, Roofing and Raving, Environmental impact on materials.	12
II	Foundation of Building, Industrial Structures and Bridges: Mechanical behavior of foundation rocks and soils. Geological investigation of the building or bridge sites. Tunnels and Underground Power Plants: Types of tunnels, Tunnelling methods, Geological investigations along tunnel alignments. Potential geological hazards and suggested remedial measures. Hydraulic Structures: Types of Dams. Basic considerations of forces on dams, Geological and geomorphological criteria for selection of dam sites. Dam sites on igneous, Metamorphic and Siltation of reservoirs.	12
III	Hydrology cycle, Precipitation, Evaporation, Evapotranspiration, Seepage, Infiltration and runoff, Availability of water in the world, Origin of groundwater, Subsurface distribution of water, Springs. Hydrology Properties of Water Bearing Materials: Porosity, Types of porosity, Permeability, Transmissivity, Storativity, Specific yield, Specific retention. Mode of occurrence of groundwater. Classification of rock with respect to their water bearing characteristics, Aquifers, Aquicludes, Aquifuge, Aquitards, Classification of aquifers and groundwater provinces.	12

IV	Movement of groundwater: Darcy's law, Reynolds number, and range of validity of Darcy's law, theory of groundwater flow under steady and unsteady conditions, Hydraulic conductivity and Intrinsic permeability, Determination of permeability, Transmissivity and Storativity (Storage coefficient) by discharging pump tests. General flow equation.	12
V	Hydro-geochemistry: Physical and Chemical characteristics of groundwater, Classification of groundwater in respect to domestic, irrigation and industrial use, Pollution of groundwater. Ground Water Exploration and Management: Natural and Artificial recharge of groundwater, Water balance, Analysis of hydrograph, Conjunctive and Consumptive use of groundwater.	12

Suggested Readings:

1. Chow (1964): Handbook of Applied Hydrology. McGraw-Hill.
2. Karanth, K.R. (1987): Ground Water Assessment, Development and Management of Water Resources. McGraw-Hill.
3. Krynine, D.H. and Judd, W.R. (1998): Principles of Engineering Geology., C.B.S. Publishers.
4. Raghunath, H.M. (2002): Hydrology: Principles, Analysis and Design. Publisher: New Age International Publishers.
5. Schultz, J.R. and Cleaves, A.B. (1951): Geology in Engineering. John Willey and Sons, New York.
6. Singh, Prabin (2013): Engineering and General Geology. S.K. Kataria and Sons.
7. Todd, David K. and Mays, Larry W. (2005): Groundwater Hydrology (3rd edition). Wiley India Pvt Ltd
8. Ward, R.C. and Robinson, M. (1999): Principles of Hydrology (4th edition). McGraw-Hill Education.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: Second	Semester: IV
Subject: Geology		
Course Code: B091003T	Course Title: Environmental Geology	
Course Objectives: The course is designed to make the students understand the concept and basic steps of Environmental Geology		
Course outcomes: After completion of the course, a student will be able to understand the: Time scales of global changes in the ecosystems and climate Environmental hazards- prevention and precautions. Earthquakes and seismic zones Global warming Disaster management		
Credits: 5	Seventh Elective	
Max. Marks: 25+75	Min. Passing Marks:40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	Time scales of global changes in the ecosystems and climate. Concepts and principles of environmental geology, Environmental hazards- prevention and precautions.	12
II	Earthquakes: seismic waves, Ray-path geometry in layered ground, loss of seismic energy, seismic energy sources, detection and recording of seismic waves, applied seismology. Distribution, magnitude and intensity of earthquakes, Precaution and prevention measures of following hazards: Floods: their causes and control. Landslides: Landslide hazards: causes and investigations; Coastal erosion: causes and related engineering structures	12
III	Global warming: caused by CO_2 increase in present atmosphere due to indiscrete exploitation of fossil fuels, deforestation. Water: Impact assessment of degradation and contamination of surface water and groundwater quality due to industrialization and urbanization. Soil: Soil profiles and soil quality degradation due to irrigation, use of fertilizers and pesticides. Population increase: Urbanization and land use changes and related hazards.	12
IV	Disaster management: Evaluating hazards, past history, linkages between hazardous events, precursor events, prediction, probability of occurrence, risk determination, acceptable risk, problems and opportunities in risk assessment, human response to hazard and disaster, artificial control of natural processes	12
V	Milankovitch cycle, Sea level rise, climate change, Eutrophication and Acid rain, Biogeochemical cycle of carbon; Geological investigations of nuclear waste disposal sites; Application of remote sensing and geographic information systems (G.I.S.) in environmental geology.	12

Suggested Readings:

1. Bell, F.G. (1999): Geological Hazards. Routledge London.
2. Bryant, E. (1985): Natural Hazards, Cambridge University Press.

3. Keller, E.A. (1978): Environmental Geology. Bell and Howell, U.S.A.
4. Patwardhan, A.M. (1999): The Dynamic Earth System. Prentice Hall.
5. Reynolds J. M. (1998): An introduction to Applied and Environmental Geophysics. John Wiley and sons, England.
6. Subramaniam, V. (2001): Textbook in Environmental Science. Narosa International.
7. Valdiya, K.S. (1987): Environmental Geology – Indian Context. Tata McGraw Hill.

This course can be opted as an elective by the students of following subjects: M.Sc., Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography

Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 15 Marks

Subject paper presentation: 5 Marks

Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: Second	Semester: IV
Subject: Geology		
Course Code: B091004T	Course Title: Exploration Geophysics	
Course Objectives: The objective of the course is learning and understanding the fundamentals principles of geophysical investigation of the Earth interior.		
Course outcomes: After completion of this course, a student will be able to understand the: Basic principles of geophysical techniques and their application to explore the mineral, water, and hydrocarbon reserves.		
Credits: 5	Seventh Elective	
Max. Marks: 25+75	Min. Passing Marks:40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	Basic principles of geophysical exploration. Gravity Method: Gravity force and potential, Stable and unstable gravimeters, field procedure and reduction of gravity data. Various types of corrections applied to gravity data, preparation of gravity anomaly maps. Gravity effect of spherical body.	12
II	Magnetic Method: Basic Theory, inverse square law, concept of potential, magnetism on atomic scale, Dia- para- ferro magnetic materials, susceptibilities and densities of various rocks and minerals, magnetic properties of rocks. Basics of Magnetometer.	12
III	Electrical methods: Electrical resistively, current distribution in homogeneous ground due to single electrode and dipoles. Resistively method: Basic principles, various types of electrode configurations, Wenner, and Schlumberger configurations, Elements of S.P. and I.P. method.	12
IV	Seismic Method: Elementary principle of reflection and refraction methods. Ray parameter. Geometry for seismic wave paths: Reflection from single-horizontal interface, normal-move-out. Different methods for velocity estimation. Dipping reflector, Dip-move-out.	12
V	Geometry of Seismic refraction paths. Head waves, single-horizontal refractor, method of estimation of velocity of layers and depth of the interface. Estimation of velocity and thickness of layers. Intercept time, delay time. Geophones, Electromagnetic geophones. Hydrophones.	12

Suggested Readings:

1. Dobrin, Milton B. and Savit, Carl H. (1988); Introduction to Geophysical Prospecting (4th Edition). McGraw-Hill Education.
2. Gadallah, M.R., Fisher, R. and Fisher, R.L. (2008); Exploration Geophysics. Springer.
3. Lowrie, William (2007): Fundamentals of Geophysics (2nd Edition). Cambridge University Press.
4. Robinson, Edwin S. (1988); Basic Exploration Geophysics. John Wiley and Sons.
5. Telford, W.M., Geldart, L.P., Sheriff, R.E. and Keys, D. A., (1990): Applied Geophysics, Cambridge University Press.

This course can be opted as an elective by the students of following subjects: M.Sc, Environmental Science, Chemistry, Botany, Zoology, Geophysics, Geography
Continuous Internal Evaluation Methods: Total Marks: 25 House Examination/Test: 15 Marks Subject paper presentation: 5 Marks Class performance/Participation: 5 Marks

Program/Class: Master in Geology	Year: Second	Semester: IV
Subject: Geology		
Course Code: B091005P	Course Title: Research Project/ Dissertation	

Course Objectives:

The objective of this course is to apprise the student with various research and development techniques used in different branches of Geology.

Course outcomes:

After completion of the course, a student will be able to:

Identify the potential research problem

Prepare synopsis of a defined research problem.

Perform the bench work.

Interpret the acquired data.

Prepare the dissertation thesis.

Summarise the dissertation work in the form of a presentation.

Get exposure of vigorous laboratory training which will help students to boost their research carrier.

Credits: 10	Research Project/ Dissertation
Max. Marks: 50+50	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-6	

Every student shall be required to attend the dissertation work and submit a detailed report, properly labelled and arranged collected specimens, and field diary with the signature of guide faculty members to Head of the Department. The marks awarded for the work shall be on the basis of these records, collection, viva voce, and performance in the dissertation work.