Pt. Ravishankar Shukla University,
Raipur (C.G.), India 492010

CURRICULUM and Syllabus
(Based on CBCS and LOCF)

M.Sc. - Geology
(Semester System)
Semester: I-IV

Session: 2025-27

Approved by:
Board of Studies : **SoS in Geology and WRM**

Dates : ----------

Name of Chairman : ----------

Name of Member's : ----------

M.Sc. Geology

The Master of Science in Geology program is a two-year, four-semester program designed to provide students with a comprehensive understanding of advanced principles and their applications in geology. Through a balanced curriculum covering diverse areas, students establish a strong foundational knowledge during the initial semesters. As the program progresses, students have the flexibility to tailor their learning by choosing specialized electives that align with their interests and career goals. Geology is an inter-disciplinary subject which enables to understand the earth processes and its treasures. It incorporates inputs from almost all science disciplines. Geologists are mainly involved in the exploration and extraction of natural resources viz., minerals, rocks, fossil fuel and water. As it is a fast growing area geologists will have to play a vital role in building the nation. Upon completion of the program, students will be well-prepared for diverse career paths, including academia, research and other industrial sectors.

Program Outcomes:

Upon successful completion of the Master of Science in Geology program, students will be able to:

PO-1	**Knowledge:** Demonstrate a deep understanding of advanced geological concepts, theories, and techniques in various subfields of Geology.
PO-2	**Critical Thinking and Reasoning:** Exhibit advanced critical thinking skills by analyzing and evaluating arguments, theories, and proofs, and by making reasoned judgments about geological concepts and their implications.
PO-3	**Problem Solving:** Work ethically and professionally alone and as part of a team, complying with applicable legislation and managing time and other resources efficiently and effectively and manage, execute their geological plans to meet desired goals
PO-4	**Employability Skill:** Inculcate contemporary business practices to enhance employability skills in thecompetitive environment
PO-5	**Effective Communication skill**: Communicate geological information concisely and accurately using written, visual, and verbal means appropriate to the situation
PO-6	**Social/ Interdisciplinary Interaction**: Integrate mathematical concepts and techniques into interdisciplinary contexts, collaborating effectively with professionals from other fields to address complex problems.
PO-7	**Self-directed and Life-long Learning**: Recognize the importance of ongoing professional development and lifelong learning in the rapidly evolving geological fieldand will exhibit the ability to continue learning independently or in formal educational settings.
PO-8	**Effective Citizenship**: **Leadership and Innovation:** Lead and innovate in various mathematical contexts, contributing to advancements in the field and applying geological insights to emerging challenges.
PO-9	**Ethics**: Demonstrate ethical and responsible conduct in geological research, teaching, and collaboration, adhering to professional standards and best practices.
PO-10	**Further Education or Employment:** Engage for further academic pursuits, including Ph.D. programs in Geology or related fields. Get employment in academia, research institutions, industry, government, and other sectors.
PO-11	**Global Perspective**: Recognize the global nature of geological research and its impact, appreciating diverse cultural perspectives in geologicalpractices.

PROGRAMME SPECIFIC OUTCOMES (PSOs): At the end of the program, the student will be able to:

PSO1	Prepare the students to demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.
PSO2	Apply the knowledge of geological concepts in interdisciplinary fields and draw the inferences by finding appropriate solutions.
PSO3	Pursue research in challenging areas of pure/applied Geology.
PSO4	Employ confidently the knowledge of software and tools for treating the geological problems and scientific investigations.
PSO5	Effectively communicate and explore ideas of Geology for the propagation of knowledge and popularization of Geology in society.

M. Sc. GEOLOGY

Specification of Course	Semester	No. of Courses	Credits
Core	I-IV	20	90
Elective	III-IV	02	10
Total		22	100
Additional Courses (Qualifying in nature, for Student admitted in School of Studies only)			
Generic Elective	II-III	02	06
Skill Enhancement (Value Added Courses)	III	01	02
Indian Knowledge System	I	01	02
Internship Programme	II	01	02

M.Sc. Geology

PROGRAMME STRUCTURE

Semester	Course Nature	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
							CIA	ESE	Total
Semester-I	Core	GEOL110	Structural Geology	T	6	5	30	70	100
	Core	GEOL120	Mineralogy and Crystallography	T	6	5	30	70	100
	Core	GEOL130	Geochemistry	T	6	5	30	70	100
	Core	GEOL140	Geodynamics, Climatology and Oceanography	T	6	5	30	70	100
	Core	GEOL150	Lab 1: Structural Geology Practical	P	6	3	30	70	100
	Core	GEOL160	Lab II: Crystallography, Crystal optics and Mineralogy Practical	P	6	3	30	70	100
Semester-II	Core	GEOL210	Igneous petrology	T	6	5	30	70	100
	Core	GEOL220	Metamorphic Petrology	T	6	5	30	70	100
	Core	GEOL 230	Sedimentology and Elements of Stratigraphy	T	6	5	30	70	100
	Core	GEOL 240	Indian Geology Paleontology	T	6	5	30	70	100
	Core	GEOL 250	Lab III: Petrology and Stratigraphy Practical	P	6	3	30	70	100
		GEOL260	Lab IV: Field work and Report writing	P	6	3	30	70	100
Semester-III	Core	GEOL 310	Economic Geology	T	6	5	30	70	100
	Core	GEOL 320	Geomorphology and Remote sensing	T	6	5	30	70	100
	Core	GEOL 330	Mineral Exploration and Mining Geology	T	6	5	30	70	100
	Elective- (Select any one)	GEOL340	Environmental and Engineering Geology	T	6	5	30	70	100
		GEOL341	Recent Trends in Paleontology	T	6	5	30	70	100
		GEOL342	Geoheritage and Geotourism	T	6	5	30	70	100
	Core	GEOL350	Lab V: Ore Geology and Mineral Exploration Practical	P	6	3	30	70	100
	Core	GEOL360	Lab VI: Geomorphology and Remote sensing Practical	P	6	6	30	70	100
Semester-IV	Core	GEOL410	Hydrogeology	T	6	5	30	70	100
	Elective- (Select any one)	GEOL420	Fuel Geology	T	6	5	30	70	100
		GEOL421	Disaster Management	T	6	5	30	70	100
		GEOL422	Gemology	T	6	5	30	70	100
	Core	GEOL430	Lab VII: Hydrogeology Practical	P	6	3	30	70	100
	Core	GEOL440	Dissertation	P	18	9	60	140	200

Note:

1. In place of Elective Course Student can choose paper(s) from MOOC Courses (Swayam Portal) subject to the following conditions:
   a. The chosen paper will be other than the papers offered in the current course structure.
   b. The paper will be PG level with a minimum of 12 weeks' duration.
   c. The list of courses on SWAYAM keeps changing, the departmental committee will finalize the list of MOOC courses for each semester.
   d. The paper(s) may be chosen from Swayam Portal on the recommendation of Head of the Department.
2. The candidates who have joined the PG Programme in School of Studies (University Teaching Department), shall undergo Generic Elective Courses (only qualifying in nature) offered by other departments/SoS in Semester II and Semester III.

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
II	GEOL510	Fundamentals of Geology	T	4	2	30	70	100
III	GEOL520	Fundamentals of disaster management	T	4	2	30	70	100

3. The candidates who have joined the PG Programme in School of Studies in Geology and WRM (University Teaching Department), the following Value Added Course (only qualifying in nature) in Semester II.

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
I	GEOL530	Indian Knowledge System	T	4	2	30	70	100
II	GEOL550	Internship Programme	P	2	2	30	70	100

4. The candidates who have joined the PG Programme in School of Studies (University Teaching Department), shall undergo Skill Enhancement Course/Value Added Course (only qualifying in nature) in Semester III.

Skill Enhancement/Value Added Courses: (Offered to the PG students of SoS in Geology)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
III	GEOL540	Thin and polished section preparation	P	4	2	30	70	100

Programme Articulation Matrix:

Following matrix depicts the correlation between all the courses of the programmeand Programme Outcomes

Course Code	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
GEOL110	√	√	√	×	√	√	√	×	√	√	√	√	√	√	×	√
GEOL 120	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√
GEOL 130	√	√	√	√	√	×	√	√	√	√	√	√	×	√	×	√
GEOL 140	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
GEOL 150	√	√	√	√	√	√	√	×	×	√	√	√	√	√	×	×
GEOL 160	×	√	√	√	√	√	√	×	√	√	√	√	√	√	√	√
GEOL 210	√	√	√	√	√	√	√	√	×	√	√	√	√	√	×	√
GEOL 220	√	√	√	√	√	×	√	√	√	√	√	√	×	√	×	×
GEOL 230	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√
GEOL 240	√	√	√	√	√	√	√	√	×	√	√	√	√	√	×	×
GEOL 250	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×
GEOL 260	√	√	√	√	√	√	√	√	×	√	√	√	√	√	×	√
GEOL310	×	√	×	√	√	√	√	√	√	×	×	×	√	×	√	×
GEOL320	√	√	√	√	√	√	√	√	×	√	√	√	√	√	×	×
GEOL330	√	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√
GEOL340	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
GEOL341	√	√	√	×	√	×	√	√	√	√	√	√	√	√	×	√
GEOL342	√	√	√	√	√	√	√	√	√	√	√	√	√	×	√	×
GEOL350	√	√	√	×	√	×	√	√	√	√	√	√	√	√	√	×
GEOL360	√	√	√	×	√	√	√	√	×	√	√	√	√	√	×	√
GEOL410	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	√
GEOL420	√	√	√	√	√	√	√	√	×	√	√	√	√	√	×	√
GEOL421	×	√	×	√	√	√	√	×	√	×	×	√	×	×	√	×
GEOL422	√	√	√	√	√	√	√	√	×	√	√	√	√	√	×	×
GEOL430	√	×	√	√	√	√	√	√	√	√	√	√	√	√	√	×
GEOL440	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
No. of courses mapping the PO/PSO	23	25	24	22	25	22	26	22	16	24	24	25	23	23	12	15

M.Sc. (Geology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Geology	1	I
Course Code	Course Title		Course Type
GEOL110	**STRUCTURAL GEOLOGY**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	1	0
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course to provide students the Elementary ideas about rock deformation in various stress conditions, basic modes of strain in rocks and basic concepts of development of folds, faults and joints and apply the knowledge in structural mapping and interpretations

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Discuss elementary ideas about rock deformation in various stress conditions	U
2	Describe basics modes of strain in rocks and basic concepts of development of folds	Ap
3	Discuss the dynamics and kinematics of major structural features faults and joints	U
4	Discuss concepts of development of various structural features in different stress condition	Ap
5	Describe basic concepts of stereographic projection of various structural features and its interpretation, development of structural features in different settings.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	1	3	2	1	3	2	3	2	1	2	1	3	2	1	3	2
CO2	3	2	1	3	2	3	2	1	2	1	-	2	3	2	2	3
CO3	2	1	3	2	1	1	1	3	1	2	3	1	2	3	3	2
CO4	1	3	2	1	2	2	3	2	3	1	2	3	1	-	2	1
CO5	2	1	1	3	1	3	2	3	1	2	3	1	2	1	1	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Rock deformation: definition, components of deformation; types of deformation: rigid, non-rigid, homogeneous, heterogeneous. Factors controlling rock deformation. Progressive deformation. Stress: definition, components, various types; compressive stress, shear stress, tensile stress, biaxial and triaxial stress. Mohr's Circle and failure criteria. Methods for stress measurements.	15	1
II	Definition, components, types of strain; strain ellipse; strain ellipsoid. Methods for strain measurements in deformed rocks. Geological application of strain theory. Rheology: Stress-strain relationships for elastic, plastic and viscous materials. Fold: Definition, components, mechanism of folding, various types and classifications of Fold. Superimposed fold and their outcrop patterns. Fault related folding.	15	2
III	Fault: Definition, components, dynamics and kinematics of faulting, various types and classifications of faults. Anderson and non-Anderson theories of faulting. Joints and fractures: definition, classification and types; their analysis and relation with major geological structures. Shear zone: definition, types. Microstructures related with shear zones. Shear sense indicators.	15	3
IV	Petrofabric Analysis: Field and laboratory techniques. Preparation of Petrofabrics diagrams and their interpretation. Definition, types, mode of development, relationship with major geological structures: lineations, foliations, cleavage, schistosity, boudinage, and Plutons. Deformation at microscale dynamic and static recrystallisation. Paleo-stress analysis.	20	4
V	Principles and application: stereographic projections. Stereographic projections of linear and planner structures: folds, faults, and joints. Principles of geological mapping. Structure associate with plate-boundaries: extensional, compressional and strike-slip regimes. Orogeny and Orogenic Cycles, Geodynamics of Indian plate	15	5

Books Recommended:

Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Development. Pergamon Press.

Hobbs, B.E., Means, W.D. and Williams, P.F. (1976): An outline of Structural Geology, John Wiley and Sons, New York.

Park, R. (1997): Foundation of structural geology, Routledge.

Ramsay, J.G. (1967): Folding and fracturing of rocks, McGraw Hill.

Ramsay, J.G. and Huber, M.I. (1983): Techniques of Modern Structural Geology, Vol. I Strain Analysis, Academic Press.

Ramsay, J.G. and Huber, M.I. (1987): Techniques of Modern Structural Geology, Vol. II, Folds and Fractures, Academic Press.

Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology, Vol. III (Application of continuum mechanics), Academic Press.

Twiss, R.J. and Moores, E.M. (2007).Structural Geology.

W.H.Freeman and Company, New York. 2nd Edition. ISBN: 10: 0-7167-4951.

Haakon Fossen (2010): Structural geology, Cambridge University Press, New York.

Turner, F.J. and Weiss, L.E. (1963): Structural analysis of Metamorphic Tectonites, McGraw Hill.

Windley B. (1973): The Evolving continents, John Wiley and Sons, New York.

M.Sc. (Geology)Semester-I

Program	Subject	Year	Semester
M.Sc.	Geology	1	I
Course Code	Course Title		Course Type
GEOL120	MINERALOGY AND CRYSTALLOGRAPHY		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	1	0
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course to provide students the concepts of mineralogy, physical and chemical behavior of minerals, crystal systems, symmetry elements and in depth knowledge of various mineral groups

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Describe the basic concepts of mineralogy, physical and chemical behavior of minerals	**U**
2	Explain the basic concepts of mineralogy, physical and chemical behavior of minerals	**U**
3	Explain the symmetry and crystal forms of major crystal system and basic of optical mineralogy.	**U**
4	Describe the properties and identification of minerals and crystals under polarizing microscope.	**An**
5	Discuss the characterization of mineral and mineral group using physical, chemical and optical parameters	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	1	2	3	1	2	3	1	2	3	2	1	3	1	2	3
CO2	2	3	1	2	3	1	2	3	1	2	1	3	2	2	3	1
CO3	1	2	3	1	2	-	3	2	3	1	3	2	1	3	1	2
CO4	2	1	3	2	3	2	2	1	-	3	2	1	2	1	3	2
CO5	3	2	1	3	1	3	1	3	2	2	1	2	1	2	3	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Minerals and Mineraloids. Properties of minerals: physical, chemical, electrical, magnetic, radioactive, luminescence, diaphaneity. Enantiotropy and Monotropy. Pauling's rules and Coordination polyhedra. Ionic radius, Unit cell, different types of bonds in minerals. Polymorphism, polytypism, pseudomorphism, and isomorphism. Solid solution and Exsolution	15	1
II	Structure of Silicates: definition, types of silicate structure, and characteristics. Crystal and crystal growth. Symmetry elements, laws of crystallography, motif, Miller indices; concept of unit cell and Bravais lattices, Space lattices and point systems, 32 crystal classes. Crystal imperfections- defects, twinning and zoning. Crystal Projections – Spherical, Gnomonic and Stereographic	15	2
III	Symmetry and forms of crystals of isometric, tetragonal and hexagonal systems. Symmetry and forms of crystals of orthorhombic, monoclinic and triclinic systems. Principles of transmission and reflection of light from crystals. Polarizing microscope and uses. Optical properties of minerals: Birefringence, retardation, pleochroism, interference colour, double refraction, isotropic, anisotropic, polarization. R.I. of minerals and determination of R.I.	15	3
IV	Optical orientation of minerals: extinction, extinction angle. Dispersion in mineral optic axial angle and Optical anomalies. Accessory plate and its application. Sign of elongation, interference figure and optic sign of minerals. Indicatrix and optical characteristics of: uniaxial, biaxial, and isotropic minerals.	15	4
V	Structure, mineral composition, classification, physical and optical properties of major rock-forming minerals: Olivine group, Garnet group, Al2SiO5 group, Zircon, Topaz, Staurolite, Sphene. Epidote, Pyroxene group, Amphibole group, Mica group, Feldspar group, Clay mineral group, Quartz group, feldspathoid group and Spinel group. Mineralogy of mineral non-silicate mineral groups: Carbonate, Phosphate, Oxide, sulphide, Sulphate, Chlorite group of minerals	18	5

Books Recommended:

Cornelis Klein: Mineral Science, 22nd Edition, John Wiley.

Berry, L.G., Mason, B. and Dietrich, R.V. (1982): Mineralogy, CBS Publ.

Dana, E.S. and Ford, W.E. (2002): A textbook of Mineralogy (Reprint).

Kerr, P.F. (1977): Optical Mineralogy, McGraw Hill. Moorhouse, W.W. (1951): Optical Mineralogy, Harper and row Publ.

Nesse, D.W. (1986): Optical Mineralogy, McGraw Hill.

Perkins, D. (1998): Mineralogy, Prentice Hall.

Winchell, E.N. (1951): Elements of Optical Mineralogy, Wiley Eastern

M.Sc. (Geology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Geology	1	I
Course Code	Course Title		Course Type
GEOL130	**GEOCHEMISTRY**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	1	0
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course is to make students proficient in understanding of advanced concepts in geochemistry and isotope geology. The students will learn the role of geochemical elements in petrogenesis and controls of various geochemical factors in dissolution, precipitation and distribution of elements and compounds

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Discuss elementary ideas about geochemistry of earth and solar system with geochemical behavior of elements	**Ap**
2	Explain role of geochemical elements in petrogenesis, and its distribution within the Earth	**U**
3	Discuss basic concepts of unstable isotopes and application in petrogenesis and dating	**U**
4	Discuss basic concepts of stable isotopes and application	**Ap**
5	Explain aquatic geochemistry and controls of various geochemical factors in dissolution, precipitation and distribution of elements and compounds	**An**

CL: Cognitive Levels Cognitive Level: **R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; B-Evaluate; **C**-Create.

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	1	2	3	2	1	3	2	1	3	2	3	1	3	2	1	3
CO2	3	1	2	3	2	1	3	2	1	3	1	3	2	3	2	1
CO3	2	3	1	2	3	2	1	3	2	1	2	2	1	2	3	2
CO4	1	2	3	1	2	3	-	1	3	2	3	3	3	1	2	3
CO5	2	1	2	3	1	2	3	2	-	1	2	1	2	3	1	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Introduction to Geochemistry. Cosmic Abundance of the Elements and Nucleosynthesis. Formation of Solar System and Planets. Chemical composition and Classification and characteristics of: Meteorites, atmosphere, lithosphere, hydrosphere. Geochemical cycles. Geochemical classification of elements: Gold Schmidt's classification, Major, Minor, Trace (REE, HFSE, Y), Volatile, Semi-volatile, Alkali and Alkaline, Transition and Noble elements	15	1
II	Compatible and incompatible elements: Nernst's partition coefficient, Nernst-Berthelot partition coefficient and bulk partition coefficient. Fick's laws of diffusion Roult's and Henry's law. Geochemical behavior of elements in Fractional Crystallization and partial melting. Application of trace elements in petrogenesis. Laws of Thermodynamics. Gibb's free energy and phase rule. Thermodynamics of magmatic Crystallization. Eh and pH diagrams and mineral stability.	15	2
III	Geochemistry of island arcs, Continental arc, Crust, and Mantle. Mineralogy and phase transition within the mantle. Radiogenic isotopes: Decay scheme, Laws of decay, half-life period. Decay scheme of K-Ar, Sm-Nd, U-Pb and Rb-Sr. Application of radiogenic isotopes in petrogenesis, age determination, and in isochron calculations and evolution of the Earth. Isotopic reservoirs, Depleted mantle (DM), HIMU Mantle, Enriched Mantle, PREMA, Bulk Silicate Earth (BSE), Continental crustal source.	20	3
IV	Stable isotope geochemistry. Isotope fractionation, application Oxygen isotope in geothermometry, use of oxygen isotope together with radiogenic isotope in correlation diagrams Study of crustal contamination, Carbon isotope. Carbon isotope studies in association with Oxygen isotope for Carbonate rocks, Carbon isotope thermometry. Aquatic Chemistry-Acid Base reactions, Dissolution and Precipitation of $CaCO_3$. Solubility of Mg, SiO_2 and $Al(OH)_3$.	20	4
V	Geochemical properties of clays - Kaolinite, Pyrophyllite and Chlorite Groups. Ion exchange properties of clays Redox in Natural Waters. Eutrophication. Factors controlling Weathering. Soil profile. Chemical and biogeochemical cycling in the soil. Composition of Rivers. Composition of Seawater- Temperature variation. Density structure and deep circulation, Distribution of CO_2 in Ocean. Sources and sinks of Dissolved matter in seawater.	15	5

Books Recommended:

Drever, J. I., 1988. The Geochemistry of Natural Waters, Prentice Hall, Englewood Cliffs, 437 p.

Garrels, R. M. and C. L. Christ. 1965. Solutions, Minerals and Equilibria. New York: Harper and Row.

Burns, R. G. 1970. Mineralogical Applications of Crystal Field Theory. Cambridge: Cambr Univ. Press.

Henderson, P. 1986. Inorganic geochemistry. Oxford: Pergamon Press.

Brownlow, A. H. 1996. Geochemistry. New York: Prentice Hall.

Krauskopf, K. B. and D. K. Bird. 1995. Introduction to Geochemistry. New York: McGraw-Hill.

Bowen, R. 1988. Isotopes in the Earth Sciences, Barking (Essex): Elsevier Applied Science Publishers.

Condie, K. C. 1989. Plate Tectonics and Crustal Evolution. Oxford: Pergamon.

Rollinson Hugh R. Using Geochemical Data: Evaluation, Presentation, Interpretation

Faure, G., 1986. Principles of Isotope Geology, 2nd ed., Wiley and Sons, New York, 589p.

Hoefs Jochen: Stable Isotope Geochemistry

Dickin Alan P.: Radiogenic Isotope Geology

White,W.M. Geochemistry.

M.Sc. (Geology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Geology	1	I
Course Code	Course Title		Course Type
GEOL140	**Geodynamics, Climatology and Oceanography**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	1	0
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

This course aims to impart knowledge to students on origin of earth and solar system, major geodynamic theories, evolution of supercontinents and major tectonic features associated with vertical and lateral movement of plates, composition, structure and processes in the atmosphere and climate change and general properties of oceanic water

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Discuss origin of earth and solar system and study of major geodynamic theories	An
2	Describe elementary ideas of evolution of supercontinents and major tectonic features associated with vertical and lateral movement of plates	Ap
3	Discuss components, composition, structure and processes in the atmosphere	U
4	Discuss climatic classification, climate change and general properties of oceanic water	U
5	Explain oceanic processes and their impact on Earth	U

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	1	3	2	3	1	2	3	2	1	-	-	1	2	3	2	1
CO2	3	2	1	2	-	3	2	1	1	2	3	3	1	2	1	3
CO3	2	1	3	1	-	1	3	2	3	1	2	1	2	3	1	2
CO4	1	3	1	2	3	1	2	3	2	3	1	3	1	1	3	1
CO5	3	2	3	1	2	3	1	2	3	2	3	2	3	2	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Earth and Solar system. Planetary evolution of Earth and its internal structure. Sea floor spreading: evidence and mechanism. Paleomagnetism: normal and reversal magnetism, magnetic time-scale. Paleomagnetism of ocean floors. Continental Drift: Taylor and Wegner's concept. Geological and geophysical evidence, mechanics. Concept of Polar Wandering. Hot spot, Mantle plume. Wilson cycles. Plate tectonics: plates and their reconstruction, Wilson cycles.	20	1
II	Supercontinent Cycle. Evolutionary history of major supercontinents throughout the geological ages. Mechanism and causes of Global Tectonic phenomenon: Contraction and Expansion hypothesis, thermal convection hypothesis. Geosynclines: Geosynclinal theory, evolution of mountains. Ring of Fire: Relationship of volcanoes and earthquake with plate margins	15	2
III	Definition and scope of Climatology and Oceanography. Elements of Climate: Temperature, Pressure, Wind and Precipitation. Atmospheric turbulence and boundary layer. Structure and chemical composition of the atmosphere. Cloud formation, air- sea interactions. Insolation and heat budget, radiation balance, general circulation of the atmosphere and ocean. Climatic changes: Coupled ocean-atmosphere system, El Nino and La Nino. Indian Climate: monsoon system, cyclone and jet stream, distribution of precipitation.	15	3
IV	Climate Classifications: Koppen's and Thornthwaite classification systems. Cause and Impact of Climate change. Global warming, Ozon depletion, Greenhouse effect, Global warming and Retreating of Himalayan glaciers. Hypsography of the continents and ocean floor – continental shelf, slope, rise and abyssal plains. Physical and chemical properties of sea water and their spatial variations. Properties and characteristics of Ocean currents, Wave and tides. Marine Ecosystem and Biodiversity. Marine Organism and Productivity.	15	4
V	Thermohaline circulation and the oceanic conveyor belt. Major water masses of the world's oceans. Oceanic processes and Phenomenon: Upwelling and Downwelling. Coral reef and its significance. Ocean circulation and its impact on Climate. Cause and Impact of Pollution on climate and ocean water	20	5

Books Recommended:

1. Condie, K. C. 1989. Plate Tectonics and Crustal Evolution. Oxford: Pergamon.
2. Philip Kearey, Keith A. Klepeis, Frederick J. Vine,2009. Global Tectonics.Wiley-Blackwell.
3. Beloussov, V.V. (1962). Basic Problems in Geotectonics. McGraw-Hill Book Co., New York.
4. Badgeley, P.C. (1965). Structural and Tectonic Principles. Harper and Row Publishers, New York. ASIN: BOOBXTMTK6.
5. A. Trujillo, Harold Thurman, 2011. 10th ed. Essentials of oceanography. Egypt, Red Sea, Manta Ray.

6. Paul R. Pinet. 2009. 5th ed. Invitation to oceanography. Jones and Bartlett Publishers, LLC.
7. Edition C. Donald Ahrens and Robert Henson. 2018. Essentials of Meteorology AnInvitation to the Atmosphere. Cengage Learning.
8. Lutgens, Frederick K. 2013. The atmosphere: an introduction to meteorology. Pearson Education, Inc.

M.Sc. (Geology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Geology	1	I
Course Code	**Course Title**		**Course Type**
GEOL150	**Lab I: Structural Geology Practical**		Core
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
3	0	0	6
Maximum Marks	**CIA**		**ESE**
100	30		70

Learning Objective (LO):

The aim of this course is to equip students about the concept of line and plane, attitude of plane and line. Bedding plane, dip and strike, and their measurement, Preparation and interpretation of geological maps, preparing stereographic projection and Three point problem

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Concept of line and plane, attitude of plane and line. Bedding plane, dip and strike, and their measurement	U
2	Criteria for determination of top and bottom of strata in structurally deformed terrain and its study in hand specimen.	U
3	Preparation and interpretation of geological maps for simple structure contour maps, as well as, for fold, fault and unconformity	Ap
4	Stereographic projection – problems in angular relationship true dip, apparent dip plunge and rake of the intersection of planes	An
5	Three point problems: Geometric solutions for three-point problems	E

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

P / OCO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	2	1	3	2	1	-	3	2	3	1	2	3	-	-	1	3
CO2	3	2	2	1	2	3	1	3	1	2	3	1	2	3	3	2
CO3	1	3	1	3	3	2	2	1	2	1	1	2	3	2	2	1
CO4	3	2	3	2	2	1	1	2	1	2	2	3	2	1	1	3
CO5	2	3	2	1	1	2	3	1	3	3	2	1	1	2	3	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Concept of line and plane, attitude of plane and line. Bedding plane, dip and strike, and their measurement	24	1
II	Criteria for determination of top and bottom of strata in structurally deformed terrain and its study in hand specimen.	24	2
III	Preparation and interpretation of geological maps for simple structure contour maps, as well as, for fold, fault and unconformity	24	3
IV	Stereographic projection – problems in angular relationship true dip, apparent dip plunge and rake of the intersection of planes	12	4
V	Three point problems: Geometric solutions for three-point problems	12	5

Books Recommended:

Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Development. Pergamon Press.

Hobbs, B.E., Means, W.D. and Williams, P.F. (1976): An outline of Structural Geology, John Wiley and Sons, New York.

Park, R. (1997): Foundation of structural geology, Routledge.

Ramsay, J.G. (1967): Folding and fracturing of rocks, McGraw Hill.

Ramsay, J.G. and Huber, M.I. (1983): Techniques of Modern Structural Geology, Vol. I Strain Analysis, Academic Press.

Ramsay, J.G. and Huber, M.I. (1987): Techniques of Modern Structural Geology, Vol. II, Folds and Fractures, Academic Press.

Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology, Vol. III (Application of continuum mechanics), Academic Press.

Twiss, R.J. and Moores, E.M. (2007).Structural Geology. W.H.Freeman and Company, New York. 2nd Edition. ISBN: 10: 0-7167-4951.

Haakon Fossen (2010): Structural geology, Cambridge University Press, New York.

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M.Sc. (Geology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Geology	1	I
Course Code	Course Title		Course Type
GEOL160	**Lab II: Crystallography, Crystal optics and Mineralogy Practical**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
3	0	0	6
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course is to equip students with meagscopic and microscopic details of minerals, calculation of mineral formulae,

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Megascopic study of common rock forming minerals. Microscopic study of common rock forming minerals.	**U**
2	Calculation of mineral formulae	**U**
3	Morphological study of crystal models and twins	**Ap**
4	Stereographic projection of crystals.	**An**
5	Determination of Interference figure and optic sign, Scheme of pleochroism, Anorthite content (Michel Levy's method)	**E**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	1	3	2	1	3	2	1	2	-	3	2	1	2	1	2	3
CO2	3	1	3	2	1	3	2	1	2	2	3	3	1	3	1	2
CO3	1	3	1	3	2	1	3	3	1	3	1	2	-	2	3	1
CO4	2	1	3	1	1	2	-	2	3	2	2	1	2	1	2	3
CO5	3	2	2	3	3	1	2	3	1	1	3	2	1	3	2	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Megascopic study of common rock forming minerals. Microscopic study of common rock forming minerals.	24	1
II	Calculation of mineral formulae from the major oxide wt% of minerals	12	2
III	Morphological study of crystal models and twins	24	3
IV	Stereographic projection of crystals.	24	4
V	Determination of Interference figure and optic sign, Scheme of pleochroism Determination of An content (Michel Levy's method) of plagioclase	12	5

Books Recommended:

Berry, L.G., Mason, B. and Dietrich, R.V. (1982): Mineralogy, CBS Publ.

Dana, E.S. and Ford, W.E. (2002): A textbook of Mineralogy (Reprint).

Kerr, P.F. (1977): Optical Mineralogy, McGraw Hill. Moorhouse, W.W. (1951): Optical Mineralogy, Harper and row Publ.

Nesse, D.W. (1986): Optical Mineralogy, McGraw Hill.

Perkins, D. (1998): Mineralogy, Prentice Hall.

Winchell, E.N. (1951): Elements of Optical Mineralogy, Wiley Eastern

M.Sc. (Geology) Semester-II

Program	Subject	Year	Semester
M.Sc.	Geology	1	II
Course Code	Course Title		Course Type
GEOL210	IGNEOUS PETROLOGY		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	1	0
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course is to provide students a deep understanding of the composition of magma, fundamentals of various magmatic processes, various classification schemes for igneous rocks,plate tectonics in magma generation, phase diagrams and its applications and petrogenesis of various rock types.

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Discuss the composition of magma and fundamentals of various magmatic processes	**Ap**
2	Discuss various classification schemes for igneous rocks and variation diagrams	**U**
3	Describe control of plate tectonics in magma generation	**Ap**
4	Discuss phase diagrams and its application in petrogenesis	**An**
5	Explain petrogenetic, classification and distribution of the major igneous rocks	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	2	1	3	2	1	3	2	1	2	3	2	2	1	3	2	1
CO2	3	2	2	3	3	2	1	3	1	1	3	3	2	2	3	2
CO3	2	1	1	1	2	1	3	2	2	2	1	1	3	1	1	3
CO4	1	3	1	2	-	-	2	1	3	3	1	2	1	2	3	1
CO5	2	2	3	1	1	2	1	3	2	1	3	1	2	1	1	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Viscosity, temperature and pressure relationships in magmas. Composition of primary magma. Nucleation and growth of minerals in magmatic rocks. Development of various types of igneous textures. Partial melting, mantle melting models. Magmatic differentiation processes. Behavior of major and trace elements during fractional crystallization and partial melting.	15	1
II	Zone melting, Magma mixing and mingling, Liquid immiscibility. Various classification schemes of igneous rocks. IUGS classification of plutonic and volcanic rocks. Petrographic Province and its significance. Different variation diagrams and their applications. Crystallization of basaltic magmas.	15	2
III	Generation of magma with reference to plate tectonics. Magmatism associated with subduction related igneous activity-continental and island arcs. Mid-ocean ridge volcanism and oceanic intra-plate volcanism. Magmatism in Large Igneous Plutons and continental alkaline magmatism	15	3
IV	Study the petrogenetic significance of phase diagrams and relevance to magmatic crystallization: Silica system and H_2O system albite-anorthite, forsterite-silica and diopside-anorthite albite-orthoclase Diopside-Albite-Anorthiteand Diopside-forsterite-silica Nepheline-kalsilite-silica. Dioside-Forsterite-Anorthite	14	4
V	Petrogenetic study, classification of the following rock types and their distribution in India: Basalt and Ophiolite, Peridotite, Ultramafite Granite, Anorthosite Komatiite, Kimberlite and Lamproite Carbonatite, Lamprophyre	16	5

Books Recommended:

Bose, M.K. (1997): Igneous Petrology, World Press, Kolkata.

Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology, Prentice Hall, New Jersey.

Phillpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology, Prentice Hall of India.

Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science.

Cox, K.G., Bell, J.D.and Pankhurst, R.J. (1993):The Interpretation of Igneous Rocks, Champman and Hall, London.

Faure, G. (2001): Origin of Igneous Rocks, Springer.

Hall, A. (1997): Igneous Petrology, Longman.

LeMaitre R.W. (2002): Igneous Rocks: A Classification and Glossary of Terms, Cambr University Press.

McBirney (1994): Igneous Petrology, CBS Publ., Delhi.

Sood, M.K. (1982): Modern Igneous Petrology, Wiley-Interscience Publ., New York.

Srivastava, Rajesh K. and Chandra, R., (1995): Magmatism in Relation to Diverse Tectonic Settings, A.A. Balkema, Rotterdam.

Wilson, M. (1993): Igneous Petrogenesis, Chapman and Hall, London.

M.Sc. (GEOLOGY) Semester-II

Program	Subject	Year	Semester
M.Sc.	Geology	1	II
Course Code	**Course Title**		**Course Type**
GEOL220	METAMORPHIC PETROLOGY		Core
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
5	5	1	0
Maximum Marks	**CIA**		**ESE**
100	30		70

Learning Objective (LO):

This course aims to impart knowledge to students about the Concepts, processes and structures of metamorphism, fundamentals of metamorphic textures, structures and mineral assemblage, estimation of P-T conditions using mineral reactions and thermodynamic system, development of metamorphic mineral assemblages during metamorphism of various rock types and petrogenetic significance of metamorphic rocks and characterization of UHP-UHT metamorphism

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Discuss the Concepts, processes and structures of metamorphism	**Ap**
2	Explain fundamentals of metamorphic textures, structures and mineral assemblage	**An**
3	Explain the estimation of P-T conditions using mineral reactions and thermodynamic system.	**U**
4	Describe development of metamorphic mineral assemblages during metamorphism of various rock types	**Ap**
5	Explain petrogenetic significance of metamorphic rocks and characterization of UHP-UHT metamorphism	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	1	3	2	2	3	1	-	-	3	2	1	2	3	1	2	-
CO2	3	1	3	1	2	2	3	3	-	-	3	1	2	3	1	1
CO3	-	-	1	3	1	3	1	2	2	1	2	3	1	2	3	3
CO4	2	2	3	1	3	2	2	1	3	2	-	-	2	1	1	2
CO5	1	-	-	2	2	1	1	2	1	3	1	1	1	2	3	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Metamorphism and Metasomatism. Agents of metamorphism. Significance of metamorphic rocks. Fabric of metamorphic rocks. Concept of zones, facies, isograds and facies series:Barrovian and Abukuma zones of metamorphism. Metamorphic phase rule and its application in metamorphism. Grade of metamorphism: Prograde and Retrograde metamorphism.	15	1
II	Structure and texture of metamorphic rocks and their significance. Classification of metamorphic rocks. Representation of metamorphic assemblages: ACF, AKF and AFM diagrams. Equilibrium concept in thermodynamics. Thermodynamics in metamorphic system. Phase rule and mineralogical phase rule in multi-component system.	20	2
III	Metamorphic mineral reaction and their types. Tracing the chemical reactions in P-T space. Claussius-Clapeyron equation and slopes of metamorphic reactions. Pressure – temperature – time paths. Metamorphic differentiation. Polymetamorphism and paired metamorphicbelts.Granitization, Anataxis, Palingenesis. Origin of migmatites in the light of experimental studies.	15	3
IV	General Characters of thermal and regional metamorphism of pelitic, calcareous, and basic igneous rocks. General Characters of thermal and regional metamorphism of impure carbonates and ultramafic igneousrocks. Metamorphism in relation to magma and orogeny. Mass and energy change during fluid-rock interactions: charnockites problem, formation of skarns.	15	4
V	Geothermometer and geobarometer and their importance in metamorphic petrology. Ultra-high temperature and ultra-high pressure and ocean floor metamorphism. Layering in metamorphic rocks. Petrogenetic significance of following rocks with special reference to Indian occurrences: charnockite, amphibolite, Khondalite, Gondite, Eclogite, and Blue-schist.	15	5

Books Recommended:

Winter, J.D. (2001): An introduction to Igneous and Metamorphic Petrology, Prentice Hall.

Yardley, B.W.D., Mackenzie, W.S. and Guilford, C. (1995): Atlas of Metamorphic Rocks and their textures, Longman Scientific and Technical, England.

Yardlley, B.W.D. (1989): An introduction to Metamorphic Petrology, Longman Scientific and Technical, New York.

Philpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology, Prentice Hall.

Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman and Co., NewYork.

Bucher, K. and Martin, F. (2002): Petrogenesis of Metamorphic Rocks (7th Rev. Ed.), Springer–Verlag.

Kerr, P.F. (1959): Optical Mineralogy, McGraw Hill Book Company Inc., New York.

Powell, R. (1978): Equilibrium thermodynamics in Petrology: An Introduction, Harper and Row Publ.,

London.

Rastogy, R.P. and Mishra, R.R. (1993): An Introduction to Chemical Thermodynamics, Vikash Publishing House.

Spear, F. S. (1993): Mineralogical Phase Equilibria and pressure – temperature – time Paths, Mineralogical Society of America.

Spry, A. (1976): Metamorphic Textures, Pergamon Press.

Wood, B.J. and Fraser, D.G. (1976): Elementary Thermodynamics for Geologists, Oxford University Press, London

M.Sc. (Geology) Semester-II

Program	Subject	Year	Semester
M.Sc.	Geology	1	II
Course Code	**Course Title**		**Course Type**
GEOL230	SEDINENTOLOGY AND ELEMENTS OF STRATIGRAPHY		Core
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
5	5	1	0
Maximum Marks	**CIA**		**ESE**
100	30		70

Learning Objective (LO):

This course aims to impart knowledge to students on the sedimentary processes and formation of sedimentary rocks. structures and textures, classification of sedimentary rocks. Study of sedimentary environments and facies with its application in paleo-current and paleo-slope analysis, diagenesis and lithification. Through this, the student will be able to learn about sedimentary basins and sequence stratigraphy, and their application in sedimentary petrogenesis

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Discuss elementary idea sedimentary processes and formation of sedimentary rocks. structures and textures.	**Ap**
2	Discuss basic concepts of development of sedimentary structures and textures.	**U**
3	Explain classification of sedimentary rocks. Study of sedimentary environments and facies with its application in paleo-current and paleo-slope analysis	**Ap**
4	Explain diagenesis and petrogenesis of sedimentary rocks.	**An**
5	Explain fundamentals of sedimentary basins and sequence stratigraphy, and their application in sedimentary petrogenesis	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	2	3	1	2	3	1	2	3	2	1	3	2	3	1	2	3
CO2	1	2	3	2	1	2	3	1	1	2	1	3	1	2	1	2
CO3	1	1	2	3	2	3	1	2	3	3	2	1	2	3	-	-
CO4	3	2	2	1	-	2	2	1	1	2	1	2	1	1	2	3
CO5	2	1	1	2	3	1	1	3	2	1	2	3	3	1	3	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Earth surface system: liberation and flux of sediments. Sedimentary processes: diagenesis and lithification. Transportation and deposition of sediments: fluid and sediment gravity flows regims, laminar and turbulent flows. Reynold's number, Froude number, grain entrainment, Hjulstrom diagram, bed load and suspension load transport.	15	1
II	Sedimentary Textures: grain size, roundness, sphericity, shape and fabric; quantitative grain size analysis. Graphical and statistical representation. Significance of sedimentary textures. Sedimentary structures: origin and types; penecontemporaneous deformation structure; biogenic structures.	15	2
III	Paleocurrent and paleo-slope. Application of sedimentary structures in paleocurrent analysis and top and bottom criteria. Stromatolites: formation and their significance. Classification of sandstone and carbonate rocks. Dolomite and dolomitization. Volcaniclastics. Evaporites. Deep-sea basins. basin analysis. Sedimentary environments and facies: Terrestrial, Transitional, and Marine environment and facies.	15	3
IV	Shallow coastal clastic and shallow water carbonates. Clastic Petro-facies. Paleoclimates and paleoenvironment analysis. Diagenesis of sandstone and carbonate rocks – changes in mineralogy, fabric, and chemistry. Petrogenesis of arkoses, greywacke and quartz arenites. Maturity of sandstone: Compositional maturity and Textural maturity. Application of Trace, REE and stable isotopes geochemistry to sedimentological problems.	15	4
V	Principles of stratigraphic: scales and its divisions, dual classification, stratigraphic nomenclature. Stratigraphic units: lihtostratigraphic, biostratigraphic and chronostratigraphic, and magnetostratigraphy. Principles of Stratigraphic correlation. Principles of sequence stratigraphy- concepts and factors controlling base level changes. Para-sequence, chinoform, systems tract, unconformity and sequence boundary.	20	5

Books Recommended:

Sam Boggs, 2006. Principles of sedimentology and stratigraphy. Pearson Education Inc.

Sengupta, S. M. 2007. Introduction to sedimentology. CBS Publishers and Distributors.

Selley, R. C. (2000) Applied Sedimentology, Academic Press.

Pettijohn;, F.J. (1975): Sedimentary Rocks (3rd Ed.), Harper and Row Publ., New Delhi.

Blatt, H., Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks, Prentice-Hall Inc.

Collins, J.D., and Thompson, D.B. (1982): Sedimentary Structures, George Allen and Unwin, London.

Lindholm, R.C. (1987) A Practical Approach to Sedimentology, Allen and Unwin, London.

Miall, A.D. (2000): Principles of Basin Analysis, Springer-Verlag.

Reading, H.G. (1997): Sedimentary Environments and facies, Blackwell Scientific Publication.

Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments, Springer-Verlag.

Tucker, M.E. (1981): Sedimentary Petrology: An Introduction, Wiley and Sons, New York.

Tucker, M.E. (1990): Carbonate Sedimentolgy, Blackwell Scientific Publication.

Allen P. A. and J.R.L. Allen (2005): Basin Analysis: Principles and Application, Blackwell Publ.

Perry, C.T. and Taylor, K.G. (2006): Envoronmental Sedimentology, Blackwell Publ., U.K.

Bird, J.M. (1980): Plate Tectonics, American Geophysical Union, Washington D.C.

Briggs, J.C. (1987): Biogeography and Plate Tectonics, Elsevier.

Lieberman, B. L.(2000): Paleobiogeography: using fossils to study Global Change, Plate Tectonics and Evolution, Plenum Publ., New York.

Jacquelyne Kious, J. and Tilling, R.I. (2007): This Dynamic Earth: The story of Plate Tectonics, USGS Information Services.

Gass I.G. (1982): Understanding the Earth. Artemis Press (Pvt) Ltd.U.K.

Windley B. (1973): The Evolving continents, John Wiley and Sons, New York.

M.Sc. (Geology) Semester-II

Program	Subject	Year	Semester
M.Sc.	Geology	1	II
Course Code	**Course Title**		**Course Type**
GEOL240	INDIAN GEOLOGY AND PALEONTOLOGY		Core
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
5	5	1	0
Maximum Marks	**CIA**		**ESE**
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the stratigraphic units and its application, Precambrian and Phanerozoic stratigraphic divisions and sequences of Indian Shield, principles of paleontology and major invertebrates and vertebrates in geological time

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Discuss elementary idea of stratigraphic units and its application	**U**
2	Explain Precambrian stratigraphic divisions and sequences of Indian Shield	**Ap**
3	Explain Phanerozoic stratigraphic divisions and sequences of Indian Shield	**AP**
4	Discuss principles of paleontological study and with detailed study of various microfossils and paleo-plant life.	**An**
5	Explain major invertebrates and vertebrates in geological time	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	1	2	3	2	1	1	2	3	-	-	3	2	1	2	1
CO2	1	2	3	1	1	3	3	1	2	3	1	2	3	2	3	2
CO3	3	1	1	2	3	2	2	3	1	2	3	1	1	3	1	3
CO4	2	3	2	3	1	1	3	1	2	-	1	2	3	1	3	1
CO5	1	2	3	2	2	3	1	2	3	1	2	3	2	1	1	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Definition of Shield, Craton and Platforms. Physiographic subdivisions of Indian Shield. Stratigraphic characteristics of Archean green-stone belts. Archean stratigraphy of Indian shield: Distribution and Economic importance of Dharwar craton, Bastar craton, Singhbhum craton, Bundelkhand craton, and Aravalli craton.	15	1
II	Proterozoic mobile belts of India: Eastern Ghats Mobile Belt, Southern Granulite Terrain, Central Indian Tectonic Zone, Aravalli-Delhi Belt, North Singhbhum Mobile Belt. Proterozoic sedimentary basins of India: Distribution and Economic importance of Cuddapah and Vindhyan Supergroup, Chhattisgarh Group, Indravati Group and Khairagarh Group	15	2
III	Paleozoic stratigraphy of India: Gondwana Supergroup and its Distribution and Economic importance. Spiti, Kashmir and Kumaon. Mesozoics of India: Spiti, Kutch, Narmada Valley and Trichinopoly. Cenozoics of India: Assam, Bengal basins, Garhwal-Shimla Himalayas, Siwalik Himalayas. Boundary problems in Indian stratigraphy: Permo-Triaassic and Cretaceous-Palaeocene. Fossil record and geological time scale; modes of preservation of fossils and concept of taphonomy	20	3
IV	Ichno-fossils, species concept, organic evolution, Ediacara Fauna. Major mass extinctions in geological past. Micropaleontology: methods of preparation of microfossils, morphology of microfossil groups; Foraminifera, Ostracoda, fossil spores, pollen and dinoflagellates. Gondwana plant fossils and their significance.	20	4
V	Invertebrate paleontology: Morphology, evolution and geological time range of major invertebrates; Graptolites, Trilobites, Brachiopods, Lamellibranches, Gastropods, Cephalopods, Echinoids and Corals. Vertebrate paleontology: Vertebrate life through ages. Evolutionary history of Proboscidea, Equidae and Hominidae. Applications of paleontological data in stratigraphy, paleoecology and paleoclimatology	15	5

Books Recommended:

Ramakrishnan M. and Vaidyanadhan R. 2008. Geology of India (Volume 1). Geological Society of India.

Vaidyanadhan R.and Ramakrishnan M. 2010. Geology of India (Volume 2). Geological Society of India.

Valdiya K.S. 2016. The Making of India: Geodynamic Evolution. Springer.

Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.

KrishnanM.S. (1982): Geology of India and Burma, C.B.S. Publ. and Distributors, Delhi.

Naqvi, S.M. and Rogers, J.J.W. (1987): Precambrian Geology of India, Oxford University Press.

Henry Woods (1958). Invertebrate Paleontology. Cambridge, University Press.

Amal Dasgupta (2012). Introduction to Paleontology. The World Press Pvt. Ltd. Kolkata.

Jain P.C. and Anantharaman M.S. 2015. Paleontology Evolution and Animal Distribution. Vishal Publishing Co.

Armstrong, Howard. 1957. Microfossils. Blackwell Publishing Ltd.

M.Sc. (Geology) Semester-II

Program	Subject	Year	Semester
M.Sc.	Geology	1	II
Course Code	Course Title		Course Type
GEOL250	Lab III: PETROLOGY, STRATIGRAPHY AND PALAENTOLOGY PRACTICAL		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
3	0	0	6
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

After studying this course, the student will learn physical and optical characteristics of igneous, metamorphic and sedimentary rocks, variation diagrams, NORM calculations, ACF, AKF and AFM diagrams and also morphological features of various fossils

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Explain physical and optical characteristics of igneous, metamorphic and sedimentary rocks	**Ap**
2	Explain about variation diagrams and NORM calculation	**U**
3	Explain metamorphic ACF, AKF and AFM diagrams	**Ap**
4	Discuss graphical representation of sediments and its application in petrogenesis.	**U**
5	Explain various fossils and their geological importance	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	1	2	3	1	2	3	2	3	1	2	1	2	3	-	1
CO2	1	3	3	1	2	3	1	2	2	3	1	2	3	1	-	3
CO3	2	2	1	3	1	1	3	1	1	2	3	3	1	2	3	2
CO4	1	1	2	1	3	1	2	3	1	1	2	1	3	1	2	3
CO5	3	2	3	2	1	2	1	1	3	1	3	2	2	3	1	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Megascopic description and identification of igneous, metamorphic and sedimentary rocks. Study of textures and structures of igneous, metamorphic and sedimentary rocks.	24	1
II	Microscopic identification of igneous, metamorphic and sedimentary rocks	24	2
III	C.I.P.W. Norm calculations and classification of igneous rocks. Constructions of variation diagrams of igneous suits of rocks.	16	3
IV	Construction of A.C.F., A.K.F. and A.F.M. diagrams	16	4
V	Plotting the Geographical distribution of igneous, metamorphic and sedimentary types in and outline map of India. Graphic representation of sedimentary data and interpretation. Study and identification of important invertebrate, vertebrate and plant fossils. Drawing of neat sketches of fossils	12	5

Books Recommended:

Bose, M.K. (1997): Igneous Petrology, World Press, Kolkata.

Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology, Prentice Hall, New Jersey.

Phillpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology, Prentice Hall of India.

LeMaitre R.W. (2002): Igneous Rocks: A Classification and Glossary of Terms, Cambr University Press.

McBirney (1994): Igneous Petrology, CBS Publ., Delhi.

Sood, M.K. (1982): Modern Igneous Petrology, Wiley-Interscience Publ., New York.

Wilson, M. (1993): Igneous Petrogenesis, Chapman and Hall, London.

Ramakrishnan M. and Vaidyanadhan R. 2008. Geology of India (Volume 1). Geological Society of India.

Vaidyanadhan R.and Ramakrishnan M. 2010. Geology of India (Volume 2). Geological Society of India.

Henry Woods (1958). Invertebrate Paleontology. Cambridge, University Press.

Amal Dasgupta (2012). Introduction to Paleontology. The World Press Pvt. Ltd. Kolkata.

Jain P.C. and Anantharaman M.S. 2015. Paleontology Evolution and Animal Distribution. Vishal Publishing Co.

M.Sc. (Geology) Semester-II

Program	Subject	Year	Semester
M.Sc.	Geology	1	II
Course Code	**Course Title**		**Course Type**
GEOL260	Lab IV: GEOLOGICAL FIELD WORK AND REPORT WRITING		Core
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
3	0	0	6
Maximum Marks	**CIA**		**ESE**
100	30		70

Learning Objective (LO):

After studying this course, the student will develop skills and gain knowledge about the field work using various techniques, sampling techniques, geological map preparation and report writing and presentation

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Develop skills and gain knowledge about the field work using various techniques.	**Ap**
2	Learn the basics of rock sampling technique	**U**
3	Learn to prepare geological map and how to plot various geological data on	**Ap**
4	Learn to preparation of thin sections and to carry out petrographic studies of rock samples	**U**
5	Learn art of skillful report writing as well as project presentation	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	1	3	2	1	3	2	1	2	3	1	2	3	2	3	1	2
CO2	3	2	1	3	2	1	3	1	2	3	1	1	3	2	2	3
CO3	2	1	2	3	1	3	2	3	1	2	3	2	1	1	3	1
CO4	1	2	3	1	2	1	3	2	2	1	2	1	2	3	2	2
CO5	3	-	-	2	1	2	1	3	3	2	3	3	1	2	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Geological mapping in type areas of India to study structural relations and stratigraphic formations in sedimentary, igneous and metamorphic terrains.	24	1
II	Collection and study of primary and secondary structures of rock bodies and their interpretation	16	2
III	Sampling of rocks, minerals and fossils in the field from study areas	16	3
IV	Preparation of geological maps and sections from the geological data obtained in the field. Preparation of thin sections. Petrographic studies of rock samples	24	4
V	Preparation of geological report based on field studies. Viva-Voce on fieldwork and geological report	16	5

Books Recommended:

Gokhale, N.W ; A Guide To Field Geology, CBS Publishers and Distributors Pvt. Ltd

Lahee, F,H ; Field Geology , McGraw-Hill Book Company, 1961

Ramakrishnan M. and Vaidyanadhan R. 2008. Geology of India (Volume 1). Geological Society of India.

Vaidyanadhan R.and Ramakrishnan M. 2010. Geology of India (Volume 2). Geological Society of India

M.Sc. (Geology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Geology	2	III
Course Code	Course Title		Course Type
GEOL310	ECONOMIC GEOLOGY		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	1	0
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the concepts or ore forming processes with associated textures and structures, concepts or ore forming processes with associated textures and structures, role of fluid inclusion and isotopes in ore genesis. Policies and rules for mineral conservation and nature and distribution of various economic mineral deposits of India

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Explain fundamental concepts or ore forming processes with associated textures and structures	**Ap**
2	Discuss concepts or ore forming processes with associated textures and structures	**U**
3	Explain sedimentary, metamorphic and supergene processes of mineral deposits	**Ap**
4	Explain role of fluid inclusion and isotopes in ore genesis. Policies and rules for mineral conservation	**U**
5	Discuss nature and distribution of various economic mineral deposits of India	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	1	3	2	1	3	1	2	1	3	2	1	3	2	1	2	3
CO2	3	2	1	2	1	2	3	2	1	3	1	2	1	2	3	1
CO3	2	1	3	3	2	3	1	3	2	1	3	1	3	3	1	2
CO4	1	3	2	-	-	2	3	1	3	2	2	1	2	2	3	3
CO5	3	2	1	2	1	3	1	2	1	3	1	3	3	1	1	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Modern concepts of ore genesis. Ore minerals and industrial minerals; physical and optical properties of ore minerals. Ore bearing fluids: concepts, origin and migration. Spatial and temporal distribution. Various ore forming processes. Texture, paragenesis and zoning in ores. Syngenetic and epigenetic deposits, forms of ore bodies, stratiform and strata-bound deposits.	20	1
II	Wall rock alteration. Structural, physico-chemical and stratigraphic controls of ore localization. Rock-ore association. Magmatic and pegmatitic deposits (chromite, Ti-magnetite, diamond, Cu-Ni-sulphide, PGE, REE, muscovite, rare metals). Hydrothermal deposits (porphyry Cu-Mo, greisen Sn-W, skarn, VMS and SEDEX type sulphide deposits, orogenic gold); Malanjkhand Type Cu-Mo deposits.	15	2
III	Sedimentary deposits (Fe, Mn, phosphorite, placer). Igneous ore deposits. Metamorphic and metamorphosed deposits (Mn, graphite). Ores related to weathered surfaces (Bauxite, Ni and Au laterite). Supergene deposits: Cu, Al, Ni and Fe. Placers and Paleo-placers deposits. Global tectonics and mineralization. Role of REE in ore genesis.	15	3
IV	Fluid inclusions in ore mineral assemblage, physical and chemical properties fluid inclusion,micro-thermometry. Stable isotope (S, C, O, H) in ore genesis- geothermometry, source of ore constituents. Strategic, critical and essential minerals. India's status in mineral production. Consumption, substitution and conservation of minerals, National Mineral Policy, Mineral Concession Rules,Marine mineral resources and laws of the sea.	15	4
V	Geological characteristics of important mineral and ore deposits in India. Distribution of industrial mineral deposits in Indian shield: Cu, Pb-Zn, Sn-W, Au, Ag, Fe, Mn, bauxite, chromite, diamond, muscovite. Distribution of mineral deposits used in: fertilizer, ceramic, cement, glass, paint industries. Distribution of mineral deposits used in: abrasive, filler; building stones.	15	5

Books Recommended:

Misra K.C. (1998). Understanding Mineral deposits. Kluwer Academic Publishers.

Robb, L.J. (2005). Introduction to ore-forming processes. Blackwell.

Ridley, John, (1957). Ore deposit geology. Cambridge University Press, New York.

Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.

Mineral Concession Rules 1960 (2021), IBM, Nagpur.

Gokhale K. V. G. K. and Rao T. C. (1978). Ore Deposits of India. Thomson Press Limited, India.

Umeshwer Prasad (2008). Economic Geology. CBS Publisher.

Branes, H.L. (1979): Geochemistry of Hydrothermal Ore Deposits, John Willey.

Cuilbert, J.M. and Park,Jr. C.F.(1986): The Geology of Ore Deposits, Freidman.

Wolf, K.H. (1976-1981): Hand Book of Stratabound and Stratiform Ore Deposits, Elsevier Publ.

M.Sc. (Geology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Geology	2	III
Course Code	Course Title		Course Type
GEOL320	GEMORPHOLOGY AND REMOTE SENSING		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	1	0
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the various geomorphic processes and Concept of drainage basin analysis, various geomorphic landforms, concepts of remote sensing and remote sensing techniques and application of remote sensing in solving various problems

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Discuss various geomorphic processes and Concept of drainage basin analysis	**U**
2	Explain various geomorphic landforms	**Ap**
3	Discuss concepts of remote sensing and remote sensing techniques	**U**
4	Discuss processes of data acquisition and interpretation using remote sensing techniques	**An**
5	Discuss application of remote sensing in solving problems	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	2	1	3	2	1	3	1	3	2	1	2	3	1	2	3	1
CO2	1	3	2	1	2	1	2	1	3	3	1	1	2	3	2	2
CO3	3	2	1	-	-	2	3	3	1	2	3	2	3	1	1	3
CO4	2	1	3	3	3	1	1	2	2	3	1	3	1	3	3	2
CO5	1	3	2	1	2	3	2	1	3	1	3	1	2	1	2	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Geomorphic processes – Weathering, soil formation, Mass-Wasting. Valley development, Cycle of erosion, rejuvenation. Major geomorphic features of India- coastal, peninsular and extra peninsular. Fluvial landforms and Glacial landforms. Various landforms associated with: Karst topography, Arid and Eolian environments.	24	1
II	Coastal and volcanic landforms. Drainage patterns and their significance. Terrain evaluation and concept of morphometric analysis. Geomorphic regions of India. Peninsular, Extra- Peninsular, and Indo-Gangetic Plains. Concept and physical basis of remote sensing. Platforms: Terrestrial, Aerial and Space platforms. Advantages and limitations.	24	2
III	Electromagnetic spectrum and principles of remote sensing. Interaction of EMR with atmosphere and earth surface features. Aerial photography, photographs and their geometry. Photogrammetry.	16	3
IV	Remote sensing sensors, data acquisition, visual interpretation and digital processing Techniques. GIS technique: definition, functions and components, vector data and raster data, and Its applications.	16	4
V	Interpretation of topographic and tectonic features. Application of remote sensing in geology. Application in Geomorphology. Application in groundwater evaluation, terrain evaluation and strategic purposes. Application of remote sensing and GIS in environmental managements	16	5

Books Recommended:

Savindra Singh (2014). Geomorphology. Pravalika Publications.

Summerfield Michael A. (2013). Global geomorphology. Routledge.

Thornbury, W.D. (1980): Principles of Geomorphology, Wiley Easton Ltd., New York.

Gupta, R.P. (1991): Remote Sensing Geology, Springer-Verlag.

Lillesand, T.M. and Kiefer, R.W. (1987): Remote Sensing and Image Interpretation, John Wiley.

Holmes,A.(1992): Holmes Principles of Physical Geology, Edited by P. McL. D. Duff. Chapman and Hall.

Sharma, H.S. (1990): Indian Geomorphology, Concept Publishing Co., New Delhi. Siegal, B.S. and

M.Sc. (Geology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Geology	2	III
Course Code	**Course Title**		**Course Type**
GEOL330	MINERAL EXPLORATION AND MINING GEOLOGY		CORE
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
5	6	0	0
Maximum Marks	**CIA**		**ESE**
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the prospecting and exploration tool and techniques for search of economic mineral deposits, various methods of sampling and drilling during prospecting of ores, various prospecting and exploration survey methods and mining methods and ore dressing and beneficiation

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Explain prospecting and exploration tool and techniques for search of economic mineral deposits.	**U**
2	Explain various methods of sampling and drilling during prospecting of ores	**Ap**
3	Discuss various prospecting and exploration survey methods	**An**
4	Discuss mining methods and selection of mining techniques	**Ap**
5	Explain concepts and methods of ore dressing and beneficiation	**E**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	2	1	1	3	2	2	1	2	2	2	2	2	2	2	3	1
CO2	2	1	-	3	2	2	1	2	2	2	2	3	1	1	3	2
CO3	1	1	2	3	2	2	2	3	2	1	1	2	2	3	3	1
CO4	2	1	3	3	2	2	1	1	2	2	2	2	3	1	3	2
CO5	3	1	3	3	2	2	3	3	2	2	-	2	2	2	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Prospecting and Exploration: Definition and characteristic features. Stages of prospecting, regional and detailed exploration; objectives of prospecting exploration. Geological, geochemical and geobotanical methods of exploration. Categorization of ore reserves. Ore guides: Regional, Physiographic, Stratigraphic, Lithological, Mineralogical and Structural guides.	15	1
II	Sampling: General principles, various methods and procedures. Drilling: General principles, various methods and procedures. Duty of geologists during sampling and drilling. Litho- geochemical, bio-geochemical, soil geochemical surveys, mobility and dispersion of elements, geochemical anomalies.	15	2
III	Principle, Instrumentation and anomaly related to geophysical methods: ground and airborne surveys; gravity, magnetic, electrical, seismic and radiometric methods of mineral exploration. Ore reserve estimation: Average grade, volume, specific gravity, tonnage factor. UNFC classification for ore reserve. Borehole logging: Different geophysical logs, Equipment; measurements and interpretation.	20	3
IV	Definition of mining terms: pitting, trenching, adits, tunnels, and shafts. Mining methods: Opencast, Underground, Alluvial mining, Coal mining methods. Factors affecting the selection of mining methods. Geological and geomorphic control on mining methods. Mine Subsidence and mines support. Rock bursts, Mine Ventilation. Mine Drainage.	15	4
V	Ore mineral Dressing and beneficiation: definition, general principles, classification and scope. Objectives, advantages and limitations of ore beneficiation. Methods of ore dressing and beneficiation: gravity Beneficiation, Flotation, Magnetic Beneficiation, Electric Beneficiation, and Chemical Beneficiation.	15	5

Reference Books:

Dobrin, M. B.; Savit, C. H. (1988): Introduction to Geophysical Prospecting, McGraw Hill.

Keary, P., Brooks, M. and Hill, I. (2002): An introduction to geophysical exploration, (3rd Ed.), Blackwell.

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

Bagchi,T.C.,Sengupta, D.K.,Rao, S.V.L.N. (1979):Elements of Prospecting and Exploration, Kalyani Publ.

Haldar S.K.. 2013. Mineral explorations: principles and applications. Elsevier Inc.

Gandhi S.M. Sarkar B.C.. 2016. Essentials of Mineral Exploration and Evaluation. Elsevier Inc.

Roger Marjoribanks. 2010. Geological Methods in Mineral Exploration and Mining. Springer-Verlag Berlin Heidelberg.

Rider, M. H. (1986): Whittles Publishing, Caithness. The Geological Interpretation of Well Logs, (Rev. Ed).

M.Sc. (Geology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Geology	2	III
Course Code	Course Title		Course Type
GEOL340	ENVRIONMENTAL AND ENGINEERING GEOLOGY		Elective
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	6	0	0
Maximum Marks	CIA		EA
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the concepts of environment geology, natural environmental hazards, management and their mitigation, natural environmental hazards and geological consideration during construction of engineering structures

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Explain concepts of environment geology and idea about its components and regimes	**U**
2	Discuss natural environmental hazards, management and their mitigation	**U**
3	Explain anthropogenic environmental hazards, management and their mitigation	**Ap**
4	Discuss natural environmental hazards, management and their mitigation	**An**
5	Discuss geological consideration during construction of engineering structures	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	2	1	2	3	2	1	3	1	3	2	1	2	3	1	3
CO2	2	1	3	1	2	1	2	1	2	2	1	2	3	1	2	2
CO3	1	2	2	3	1	3	3	2	3	1	2	3	1	3	3	1
CO4	3	2	1	2	2	-	-	1	1	2	3	2	2	1	2	2
CO5	1	3	3	1	3	1	2	3	2	3	2	1	3	2	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation2

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Definition, Scope and Basic concepts of Environmental Geology. Environment, Ecology, Ecosystems and habitat. Renewable and non-renewable natural resources. Role of geology in natural resources management and environmental planning. Landforms as ecosystem units.	15	1
II	Characteristics of various environmental regimes – fluvial, coastal, marine, Aeolian, desert, and glacial. Geological hazards: River Flooding, Lands slides, Volcanic activity, Earthquake, Tsunami, Cyclones, and Coastal erosion.Understanding their causes, types, Mitigation and Management. Draught and desertification, Measures of mitigation. Sea level changes. Measures of mitigation.	15	2
III	Biogeochemical cycle of carbon; geological investigations of nuclear waste disposal site. Ocean acidification, coral bleaching, Milankovitch cycle, eutrophication and acid rain. Human settlement and contamination of atmosphere, soil, surface water and groundwater. Environmental impacts of Urbanization.Measures of mitigation Environmental impacts of Human modifications related to mining activities.	20	3
IV	National Environmental Policy for air and water pollution. National Environmental Laws. Climate Change and global warming: Causes and Impact (Ozone layer depletion and ozone hole). Environment impact assessment report and preparation of environment Management plans. Application of remote sensing and geographic information systems (GIS) in environmental management.	15	4
V	Engineering properties of rocks and soil. Geologic considerations of construction materials: building stones and aggregate. Geological considerations for evaluation of Dam and reservoir sites. Dam foundation problems. Dam failure. Geotechnical evaluation of tunnel alignment and transportation routes. Methods of tunneling. geological investigations in construction of bridges, highways and coastal protection structures. Role of geologist in engineering projects.	15	5

Reference Books:

Keary, P., Brooks, M. and Hill, I. (2002): An introduction to geophysical exploration, (3rd Ed.), Blackwell.

Krynine, D.H. and Judd, W.R. (1998): Principles of Engineering Geology, CBS Publ.

Schultz, J.R. and Cleaves, A.B. (1951): Geology in Engineering, John Willey and Sons, New York.

Bell F G Engineering Geology, Second Edition by, 2007. Butterworth-Heinemann.

Valdiya, K. S. (1987): Environmental Geology – Indian Context, Tata McGraw Hill.

Keller, E. A. (1978): Environmental Geology, Bell and Howell, USA.

Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press.

Montgomery, C.W. Environmental Geology, Won. C. Brown, Publishers, Iowa, 1989.

M.Sc. (Geology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Geology	2	III
Course Code	Course Title		Course Type
GEOL341	Recent Trends in Paleontology (Elective)		Elective
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	6	0	0
Maximum Marks	CIA		EA
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the fossil record and geological time scale, the theory and origin of life, vertebrate and invertebrate paleontology and sampling methods and sample processing techniques in micropaleontology

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Explain fossil record and geological time scale	**U**
2	Discuss about the theory and origin of life	**U**
3	Explain vertebrate paleontology	**Ap**
4	Discuss invertebrate paleontology	**An**
5	Discuss sampling methods and sample processing techniques in micropaleontology.	**E**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	2	1	3	1	3	2	3	1	2	1	2	3	3	2	1	3
CO2	3	2	1	2	1	3	1	2	3	2	3	1	1	3	2	2
CO3	1	3	2	3	2	1	2	3	1	3	1	2	3	1	3	1
CO4	1	2	3	2	3	-	-	2	3	1	2	3	2	3	2	3
CO5	3	1	2	1	2	3	2	1	2	3	1	2	3	1	1	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Fossil record and geological time-scale. Evolutionary changes in molluscs and mammals in geological time. Principles of evolution. Use of species and genera in biostratigraphic correlation. Functional morphology, evolution and significance of Plant Fossils, Fishes, Horse, Elephant and Man. Taphonomy and environmental factors, Oxygen and Carbon isotope studies of fossils and paleoclimates – Palaeobiogeographic Provinces.	15	1
II	Theories on origin and evolution of life. Phylogenetic and Ontogenic Analysis. Species Concept – Types of Fossils and Types of Species – Palingensis – Coenogensis – Proterogenesis - Thanatocoenosis – Biocoenosis – Sidocoenosis – Biomineralisation. Trace Fossils – Fossils and their uses – Biometrics – Major events in the history of Precambrian and Phanerozoic life.	16	2
III	Vertebrate paleontology: Succession of vertebrate life through geologic time. Broad classification and study of some characteristic Indian vertebrate genera. Indian pre-Tertiary vertebrate - their distribution and paleogeographic implication; extinction of dinosaurs. Indian Tertiary vertebrate - Siwalik mammals; phylogeny - Equidae and Proboscidae. Indian fossil Hominoides and modern theories regarding human evolution.	15	3
IV	Invertebrate paleontology: an overview. Morphology, classification, evolutionary trend, composition and structure of shells of selected groups of organisms - Porifera, Bryozoa, Mollusca, Brachiopoda. Geological history, geographical distribution and description of important genera of Trilobita, Echinoides, Coelenterata and Graptoloidea.	20	4
V	Micropaleontology: Sampling methods and sample processing techniques. Types of microfossils. Calcareous Microfossils - Foraminifera - major morphologic groups; Benthic Foraminifera; depth biotopes, value in paleobathymetric determination. Larger foraminifera – their utility in Indian stratigraphy. Planktonic foraminifera and calcareous nannofossils. Ostracoda - outline morphology, paleoecology and geological history. Brief knowledge about Pteropods, Calpionellids, Calcareous algae, Siliceous algae, Radiolaria and Conodonts. Application of micropaleontology in hydrocarbon exploration	16	5

Books Recommended:

Palaeontology Evolution and animal distribution. .C. Jain and M.S. Anantharaman, (1996), Vishal Publications, Jalandhar.

Invertebrate Palaeontology - H.Woods, (1985), CBS Publishers and Distributors, New Delhi.

Agashe, S.N, Paleo botany, Oxford and IBH. Delhi(1995).

Stewart W.N. and G.W. Rothwell, Palaeobotany, Cambridge University Press. D 2005)

Moore R.C. et al., Invertebrate Fossils. CBS. Delhi (1952).

Principles of Invertebrate Palaeontology, Shrock R.R and Twenohofel W.H, (2005), CBS Publishers and Distributors, New Delhi.

Invertebrate Fossils. Moore R.C, Lalicker C.G and Fisher A.G (1952) McGraw Hill.

The Vertebrate Story, Romer A.S, (1959) University of Chicago Press, 4thEdt. Chicago.

Palaeontology An Introduction, E.W.Nield and V.C.T.Tucker (1985) Pergamon Press, Oxford.

Colbert E.H. et al., Evolution of the Vertebrates, Wiley. New Delhi 2002)

M.Sc. (Geology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Geology	2	III
Course Code	Course Title		Course Type
GEOL342	Geo-heritage and Geo-tourism		Elective
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	6	0	
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the concept of developing geoparks and geotourism, geological and geomorphologic features distributed throughout the country that constitutes its geoheritage and awareness and laws to preserve these national treasures

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Explain concept of developing geoparks and geotourism	**U**
2	Discuss to familiarize the geoparks and geotourism in common man	**U**
3	Discuss geological and geomorphologic features distributed throughout the country that constitutes its geoheritage	**Ap**
4	Discuss process obliterates many geopark and geoheritage features	**An**
5	Discuss about awareness and laws to preserve these national treasures	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	1	3	2	1	3	2	1	2	3	2	3	1	3	2	1	3
CO2	3	2	1	2	1	3	3	3	2	1	1	3	2	1	2	2
CO3	2	1	3	1	3	1	-	1	2	3	3	2	1	2	3	3
CO4	1	3	2	3	2	2	3	2	-	2	2	1	3	3	1	1
CO5	3	2	3	2	1	3	1	2	1	3	1	3	2	1	3	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Introduction and importance of Geodiversity, Geoheritage. Geoconservation; Geoparks and Geotourism. History of the concept of Geoheritage.	15	1
II	Geological outcrops and society; Threats to geodiversity. Conservation, protection, maintenance of geological sites and related features of National importance. Conservation of geosites as a tool to protect geoheritage.	15	2
III	Assessment: Hazard-prone areas identification. Application of remote sensing and GIS tools. Hazard mapping, Risk modeling, Risk zonation and case studies.	20	3
IV	Preparedness: Risk reduction concepts. Pre and post-disaster comparison and analysis. Understanding the disaster cycle – Stakeholders' participation and preparation of comprehensive management plans. Community-based disaster risk management. Participatory risk assessment. Coastal regulations, Coastal management in tsunami reconstruction, National and international scenarios.	15	4
V	Mitigation and recovery: Inter-relationship between mitigation and Process for developing hazards mitigation plan, implementation of comprehensive mitigation strategies. Disaster recovery planning, Disaster emergency preparedness and on recovery and reconstruction. Disaster Risk Reduction (DRR) approaches - Early warning systems.	15	5

Books Recommended:

Ranawat, P. S., George, S., 2016 Potential Geoheritage and Geotourism Sites in India International Journal of Scientific and Research Publications, Volume 9, Issue 6, June 2019

Ezzoura Errami, Margaret Brocx (Ed.) 2009. Geoheritage, Geoparks and Geotourism Conservation and Management Series Springer. P 268

M.Sc. (Geology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Geology	2	III
Course Code	Course Title		Course Type
GEOL350	Lab V: ORE GEOLOGY, MINERAL EXPLORATION PRACTICAL		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
3	0	0	6
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the physical and optical properties of ore forming minerals, methods ore reserve estimation and techniques of ore dressing and interpretation of geophysical and geochemical maps

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Discuss properties of ore forming minerals	**U**
2	Explain various ore forming minerals in hand specimen using physical properties.	**U**
3	Explain various ore forming minerals in microscope using optical properties.	**Ap**
4	Discuss methods ore reserve estimation and techniques of ore dressing	**An**
5	Discuss interpretation of geophysical and geochemical maps	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	1	3	2	3	1	2	3	1	2	1	3	2	1	3	1	3
CO2	3	2	1	2	3	1	2	3	3	2	2	3	3	2	2	1
CO3	2	1	3	1	-	3	1	2	1	3	1	1	2	1	3	2
CO4	1	3	2	3	2	1	-	3	2	1	3	2	1	3	2	3
CO5	3	2	1	3	1	2	2	1	3	2	2	1	3	3	1	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Megascopic study of metallic and nonmetallic economic minerals. Description and identification, uses and distribution in India. Description and identification of ore minerals in polished section of ores	24	1
II	Study of ore textures and structure under the microscope. Paragenetic study of ore minerals and construction of Paragenetic diagrams	24	2
III	Location of important metallic and non-metallic mineral compels in a map of India. Calculation of ore reserves and assay values.	16	3
IV	Preparation of core-logs and their Geotechnical interpretation from bore hole data. Study and interpretations of Isopach and Isograde maps. Evaluation of simple mining plans	16	4
V	Interpretation of Geophysical and geochemical anomaly maps. Numerical problems based on Geophysical and geochemical data. Concentration methods- with flow sheets of common types of mineral and ore dressing practices in India - Gold, copper, Lead-zinc, coal, beach sand, fluorite, iron, manganese, chromite and limestone	24	5

Books Recommended:

Misra K.C. (1998). Understanding Mineral deposits. Kluwer Academic Publishers.

Robb, L.J. (2005). Introduction to ore-forming processes. Blackwell.

Ridley, John, (1957). Ore deposit geology. Cambridge University Press, New York.

Gokhale K. V. G. K. and Rao T. C. (1978). Ore Deposits of India. Thomson Press Limited, India.

Umeshwer Prasad (2008). Economic Geology. CBS Publisher.

Cuilbert, J.M. and Park,Jr. C.F.(1986): The Geology of Ore Deposits, Freidman.

M.Sc. (Geology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Geology	2	III
Course Code	**Course Title**		**Course Type**
GEOL360	Lab VI: GEOMORPHOLOGY AND REMOTE SENSING PRACTICAL		
Credit	**Hours Per Week (L-T-P)**		
	L	**T**	**P**
3	0	0	6
Maximum Marks	**CIA**		**ESE**
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the geomorphological landforms and morphometric analysis, aerial photographs and satellite imageries

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Discuss various geomorphological landforms and morphometric analysis	**U**
2	Discuss interpretation of aerial photographs	**U**
3	Discuss interpretation of satellite imageries	**Ap**
4	Discuss slopes of landforms	**An**
5	Explain various landforms	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	2	1	3	2	3	1	2	3	1	3	2	2	-	1	2	2
CO2	3	3	2	1	3	2	3	1	2	1	1	3	2	3	3	1
CO3	1	2	1	3	2	2	2	2	3	2	3	2	3	-	2	3
CO4	2	1	3	1	3	2	2	2	1	2	2	3	2	2	1	3
CO5	3	2	1	2	1	3	2	3	2	1	3	1	1	3	1	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Identification and interpretation of drainage patterns	24	1
II	Drawing of labeled diagrams of landforms, Slope studies of landforms.	16	2
III	Determination of stream order, bifurcation ratio, drainage density, stream frequency, infiltration number	24	3
IV	Slope studies of landforms	16	4
V	Study of aerial photographs and satellite imageries and identification of landforms	24	5

Books Recommended:

Savindra Singh (2014). Geomorphology. Pravalika Publications.

Summerfield Michael A. (2013). Global geomorphology. Routledge.

Gupta, R.P. (1991): Remote Sensing Geology, Springer-Verlag.

Lillesand, T.M. and Kiefer, R.W. (1987): Remote Sensing and Image Interpretation, John Wiley.

M.Sc. (Geology) Semester- IV

Program	Subject	Year	Semester
M.Sc.	Geology	2	IV
Course Code	**Course Title**		**Course Type**
GEOL410	HYDROGEOLOGY		Core
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
5	6	0	0
Maximum Marks	**CIA**		**EA**
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the elementary idea of hydrogeology, groundwater and its distribution, water bearing formation, types and movement of groundwater, aquifer and basic of well hydraulics and quality criteria and utilization of groundwater

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Discuss elementary idea of hydrogeology, groundwater and its distribution	**U**
2	Explain properties of water bearing formation, types and movement of groundwater	**Ap**
3	Discuss the properties of aquifer and basic of well hydraulics	**An**
4	Explain different methods of groundwater exploration	**Ap**
5	Discuss quality criteria and utilization of groundwater	**An**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	2	3	1	2	1	3	1	3	2	1	2	1	3	1	2	3
CO2	1	2	3	1	3	1	2	1	3	2	1	3	1	2	3	1
CO3	3	1	2	3	2	1	3	2	-	3	2	2	3	3	2	1
CO4	2	3	1	2	2	3	1	3	2	1	-	1	2	1	3	3
CO5	3	1	2	3	1	2	2	1	3	2	3	2	1	3	1	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Scope of hydrogeology and its relation with hydrology, meteorology and their uses in the Hydrogeological investigation. Hydrologic cycle. Role of groundwater in the hydrologic cycle. Hydrograph, data collection and analysis. Water table and piezometric surface. Water table fluctuation. Water table contour maps, interpretation and uses.	15	1
II	Water bearing formation - aquifers, aquitard. aquiclude, aquifuge. Aquifer types: perched, unconfined, semi-confined and confined. Isotropic, anisotropic aquifers. Porosity, permeability: types and factors affecting the porosity and permeability of an aquifer. Ground water movement: Darcy's law and its applications.	20	2
III	Specific yield and specific retention. Storativity and transmissivity Steady and unsteady flow, leaky aquifers. Groundwater flow near aquifer boundaries. Bounded aquifers. Image wells. Water wells and their types. Construction of wells. Various methods of Well Development and completion. Pumping test and Yield of wells.	15	3
IV	Geological and Hydrogeological methods of groundwater exploration. Geophysical methods – Electrical resistivity method for groundwater exploration Application of remote sensing in groundwater exploration. Basin wise development of groundwater with special reference to Chhattisgarh region.	12	4
V	Groundwater provinces of India. Sources of dissolved constituents in groundwater. Groundwater quality standards-drinking, domestic, agriculture and industry. Groundwater pollution. Groundwater management. Safe yield, overdraft and spacing of wells. Conservation of Groundwater; conjunctive use of water. Artificial recharge.	18	5

Books Recommended:

Todd D.K. (1995): Groundwater Hydrology, John Wiley and Sons.

Tolman C.F. (1937): Groundwater, McGraw Hill, New York and London.

Driscoll F.G. (1988): Groundwater and Wells, UOP, Johnson Div.St.Paul. Min. USA.

Raghunath H.M. (1990): Groundwater, Wiley Eastern Ltd.

Nagabhushaniah H.S. (2001): Groundwater in Hydrosphere (Groundwater hydrology), CBS Publ.

Karanth K. R. (1989): Hydrogeology, Tata McGraw Hill Publ.

Davies S.N. and De Wiest R.J.N. (1966): Hydrogeology, John Wiley and Sons, New York

M.Sc. (Geology) Semester- IV

Program	Subject	Year	Semester
M.Sc.	Geology	2	IV
Course Code	**Course Title**		**Course Type**
GEOL420	FUEL GEOLOGY		Elective
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
5	6	0	0
Maximum Marks	**CIA**		**EA**
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the elementary idea of fuels, origin and migration of petroleum, accumulation of petroleum, special reference to India, processes of formation of coal and its composition and constituents and geographical distribution of fuel and energy resources in India

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Discuss elementary idea of fuels, origin and migration of petroleum.	**U**
2	Explain accumulation of petroleum, special reference to India	**Ap**
3	Explain processes of formation of coal and its composition and constituents	**An**
4	Explain radioactive resources of energy	**Ap**
5	Explain the geographical distribution of fuel and energy resources in India	**An**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	2	1	3	2	3	1	3	2	3	1	2	1	3	1	2	3
CO2	3	2	1	3	2	3	-	3	2	2	3	-	2	3	1	2
CO3	1	3	2	1	3	2	3	1	-	3	1	2	1	2	3	1
CO4	2	1	3	2	1	3	1	2	3	1	2	3	3	1	2	3
CO5	3	2	1	3	2	1	2	3	1	2	1	1	2	3	3	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Fuel geology: Concept of fuel minerals, their role in national productivity. Conservation and exploration policy of fuel minerals: Coal, Petroleum and Radioactive Minerals. Petroleum system: Concepts ad definition. Composition and origin of Petroleum. Theories of origin of Petroleum: organic and inorganic.	15	1
II	Migration and accumulation of petroleum: primary and secondary migration. Factors affecting migration and accumulation of petroleum. Kerogen: Definition, types and their significance. Oil window. Characteristics and properties of Source, reservoir and cap rocks. Structural, stratigraphic and mixed trapes for petroleum accumulation	14	2
III	Definition, composition and various types of origin of coal. Rank, Grade and type of coal. Coalification: definition and process. Factor affecting coalification. Macroscopic and Microscopic constituents of coal. Chemical characterization of coal Proximate and Ultimate analysis. Stratigraphy of Coal measures	20	3
IV	Principle and processes of Coal liquification. Fundamental of coal petrology. Industrial uses of coal petrology. Elementary ideas of Origin of Coal Bed Methane and Gas hydrates. Radioactive minerals: Mineralogy, Origin, Occurrence, Distribution in India.	16	4
V	Geographical and geological distribution of onshore and offshore petroliferous basins of India and their significance. Geographical and geological distribution of Coal Fields in India and their characteristics. Geographical and geological distribution of radioactive mineralsin India and their characteristics. Status and distribution of Coal Bed Methane in India.	18	5

Books Recommended:

Chandra,D., Singh, R.M., Singh,M.P.(2000):Textbook of Coal (Indian context), Tara Book Agency, Varanasi.

Chandra, D. and R. M. Singh, (2003): Petroleum (Indian context), Tara Book Agency, Varanasi.

Selley, R.C. (1998): Elements of Petroleum Geology, Academic Press.

Singh, M.P. (1998): Coal and organic Petrology, Hindustan Publishing Corporation, New Delhi.

Texbook of Coal petrology, Gebruder Borntraeger,Stuttgart.

Van Krevelen, D. W. (1993): Coal, Typology-Physics-Chemistry-Constitution), Elsevier Science, Netherlands.

North, F.K. (1985): Petroleum Geology, Allen Unwin.

M.Sc. (Geology) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Geology	2	IV
Course Code	Course Title		Course Type
GEOL421	Disaster Management		Elective
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	6	0	0
Maximum Marks	CIA		EA
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the significance of studying disaster management, the different types of disasters and causes for disasters, impacts of disasters on environment and society and various methods of risk reduction measures and risk mitigation

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Explain the significance of studying disaster management	**An**
2	Discuss the different types of disasters and causes for disasters	**Ap**
3	Explain impacts of disasters on environment and society	**U**
4	Discuss vulnerability of a geographical area	**Ap**
5	Explain various methods of risk reduction measures and risk mitigation	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	1	2	3	1	2	3	1	2	3	2	1	3	1	2	3
CO2	2	3	1	2	3	1	2	3	1	2	1	3	2	2	3	1
CO3	1	2	3	1	2	-	3	2	3	1	3	2	1	3	1	2
CO4	2	1	3	2	3	2	2	1	-	3	2	1	2	1	3	2
CO5	3	2	1	3	1	3	1	3	2	2	1	2	1	2	3	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	General introduction to natural hazards and disasters: Physical and geodynamic characteristics of earthquakes, tsunamis and storm surges, tropical cyclones, monsoonal floods, landslides. Droughts - different types – monitoring and management and wildfires – Worldwide trends in natural catastrophes and occurrence.	15	1
II	Global Climate Change: Global warming and environmental change. Threat of sea level changes on global coasts - Impact on natural resources, environment. Social impact of disasters: Gender, food security, poverty and Climate Change Adaptation	15	2
III	Assessment: Hazard-prone areas identification. Application of remote sensing and GIS tools. Hazard mapping, Risk modeling, Risk zonation and case studies.	15	3
IV	Preparedness: Risk reduction concepts. Pre and post-disaster comparison and analysis. Understanding the disaster cycle – Stakeholders' participation and preparation of comprehensive management plans. Community-based disaster risk management. Participatory risk assessment. Coastal regulations, Coastal management in tsunami reconstruction, National and international scenarios.	20	4
V	Mitigation and recovery: Inter-relationship between mitigation and Process for developing hazards mitigation plan, implementation of comprehensive mitigation strategies. Disaster recovery planning, Disaster emergency preparedness and on recovery and reconstruction. Disaster Risk Reduction (DRR) approaches - Early warning systems	15	5

Reference Books:

Handbook of Disaster Research Eds. H. Rodriguez et al., (2006).

Rajib Shaw and Krishnamurthy, R.R. (2008) Disaster Management – The Global Challenges and Local Solutions, Universities Press, Hyderabad, pp. 560.

Groundwater Assessment Development and Management, Karanth.K.R. (1987) Tata McGraw Hill Publishing Company, Ltd.

Miller T.G. Environmental Science. Wadsworth Publishing.US(2004).

Coates,D.R. Environmental Geology. McGraw Hill.NewYork(1984).

M.Sc. (Geology) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Geology	2	IV
Course Code	Course Title		Course Type
GEOL422	**GEMOLOGY**		Elective
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	6	0	0
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the fundamental concepts about the nature, quality, rarity of gemstones, physical and optical properties and origin, classification of gemstones and elementary knowledge and to provide skills to become a successful gemologist

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Explain fundamental concepts about the nature, quality, rarity of gemstones	**Ap**
2	Explain physical and optical properties of gemstones	**An**
3	Discuss concepts of the origin, classification of gems	**E**
4	Discuss gem testing instruments	**Ap**
5	Discuss elementary knowledge and to provide skills to become a successful gemologist	**An**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	1	3	2	1	2	3	2	1	3	1	2	3	2	3	1	2
CO2	3	1	3	2	3	1	3	2	1	2	3	1	3	2	3	1
CO3	2	3	1	3	1	-	1	1	2	3	1	2	1	-	2	3
CO4	1	2	3	2	3	2	-	3	1	2	3	3	2	1	3	2
CO5	3	1	2	1	2	3	2	1	3	1	2	1	3	2	1	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Introduction to Gems - Basic properties of gems. Formation of gem stones. Nature of gem material: quality necessary in gems-beauty, rarity, durability. Distinction between crystalline, amorphous and metamict materials. Crystal form and habit. Classification of gem stones. Observations with hand lens (10x)-importance and uses. Units of measurement: metric scale, carat, pearl and grain	15	1
II	Nature of crystals: distinction between crystalline and amorphous material. Crystal symmetry, Twinning, parallel growth, crystal form, crystal habit, seven crystal system. Identification of rough stones. Imitation stones	15	2
III	Physical properties: hardness its applications in gemmology and limitations. Cleavage, Fracture, parting, and their importance in gemology and lapidary work. Specific gravity, utility and determination by hydrostatic weighing, heavy liquids, floation and pycnometer. Inclusions and other features of gemstones. Generalities, Description, Properties and Identification of Biogenic Gem Materials	15	3
IV	Optical properties: The electromagnetic spectrum, reflection and its importance in gemology-lustre, aventurescence, sheen, chatoyancy, asterism, luminescence, play of colors, labradorescence, inclusions etc.. Laws of refraction, refractive index (R.I), total reflectionin design of refractometer. Construction and use of refractometer. Polariscope-construction and use in gemology. Dichroscope-construction, use of Chelsea colour filter, Infra-red ultraviolet and x-rays in gem identification	20	4
V	Enhancement and treatments- enhancement methods - coloured and colourless impregnation, dyeing, bleaching and its identification. Methods of treatment – laser drilling, irradiation, heat treatment, surface modifications, diffusion treatment and its identification. Composites - types, classification and identification.	15	5

Reference books

Karanth K.V.(2000),Gem and gem industry in India, Memoir 45,Geological Society of India, Bangalore.,

Anderson,B.W(1990).Gem testing (10th edition),Butterworth Scientific, London.,

Babu,T.M.(1998) Diamonds in India. Geological society of India, Bangalore.,

Hall,C.(1994).Gemstone, Dorling Kingsley, London.

Deer,W.A., Houre,R.A abd Zussman.S.(1992). An introduction to rock forming minerals, ELBS, London.

Kerr, P.F.(1997).Optical mineralogy,4th Ed. McGraw Hill Book and Co New York., Gemmology 2nd Ed.-Peter Read (1991) Butter worth-Heinemann Ltd.Lundu., Gems 5th Ed. Peter Read. Butterworth, London

Richard Laddicoat (1987), Hand book of gem identification- G.I.A.

Santa Monica., Edward Gubelin (1986) Photo Atlas of Including in Gem Stones- ABC Edition Zurich., Gem Testing 10th Ed.

Anderson B.W. (1990) Butterworth Scientific London., Gemstone Enhancement 2nd Edition,

M.Sc. (Geology) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Geology	2	IV
Course Code	Course Title		Course
GEOL430	**Lab VII: HYDROGEOLOGY PRACTICAL**		Core
Credit	Hours Per Week (L-P)		
	L	T	P
3	0	0	6
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The objective of this course is to provide students with a solid understanding of fundamental concepts of hydrogeological properties of rocks, interpretation of water table map and solving various hydrogeological problems and learn about Resistivity survey, data collection, interpretation and solving hydrogeological problems

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Discuss about Hydrogeological properties of rocks	**Ap**
2	Discuss about the interpretation of water table map and solving various hydrogeological problems.	**An**
3	Interpret hydrogeochemical data and quality of water for various purposes.	**E**
4	Explain sieve analysis and screen gravel pack design	**U**
5	Explain about Resistivity survey, data collection, interpretation and solving hydrogeological problems	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	1	2	3	1	2	3	1	2	3	2	1	3	1	2	3
CO2	2	3	1	2	3	1	2	3	1	2	1	3	2	2	3	1
CO3	1	2	3	1	2	-	3	2	3	1	3	2	1	3	1	2
CO4	2	1	3	2	3	2	2	1	-	3	2	1	2	1	3	2
CO5	3	2	1	3	1	3	1	3	2	2	1	2	1	2	3	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

M.Sc. (Geology) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Geology	2	IV
Course Code	Course Title		Course
GEOL440	**DISSERTATION**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
9	3	0	15
Maximum Marks	CIA		ESE
200	60		140

Learning Objective (LO):

The aim of this course is to develop profound understanding on the geological field work and study of various geological features, sampling techniques, thin and polished section preparation and petrographic studies and art of skillful report writing as well as project presentation

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Perform geological field work and study of various geological features	**Ap**
2	Learn sampling techniques	**An**
3	Carry out thin and polished section preparation and petrographic studies	**E**
4	Prepare geological map and how to plot various geological data on it	**U**
5	Learn art of skillful report writing as well as project presentation	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	1	3	2	1	3	2	3	2	1	2	1	3	2	1	3	2
CO2	3	2	1	3	2	3	2	1	2	1	-	2	3	2	2	3
CO3	2	1	3	2	1	1	1	3	1	2	3	1	2	3	3	2
CO4	1	3	2	1	2	2	3	2	3	1	2	3	1	-	2	1
CO5	2	1	1	3	1	3	2	3	1	2	3	1	2	1	1	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Literature survey of the assigned topic, followed by preparation for field work. Geological mapping in type areas of India to study structural relations and stratigraphic formations in sedimentary, igneous and metamorphic terrains.	24	1
II	Collection of representative samples as well as structural data in the field followed by detailed geological mapping	18	2
III	Preparation of thin and polished sections of the selected samples. Analyses of structural data followed by its Interpretation	15	3
IV	Preparation of geological maps, Detailed petrographic study of the rocks. Interpretation of the results generated from structural and petrographical studies	24	4
V	Preparation of geological report based on field and laboratory studies followed by viva voce.	18	5

Books Recommended:

Gokhale, N.W ; A Guide To Field Geology, CBS Publishers and Distributors Pvt. Ltd

Lahee, F,H ; Field Geology , McGraw-Hill Book Company, 1961

Ramakrishnan M. and Vaidyanadhan R. 2008. Geology of India (Volume 1). Geological Society of India.

Vaidyanadhan R.and Ramakrishnan M. 2010. Geology of India (Volume 2). Geological Society of India

Generic Elective Courses
M.Sc. (Geology) Semester-II

Program	Subject	Year	Semester
M.Sc.	Geology	1	II
Course Code	Course Title		Course
GEOL510	FUNDAMENTALS OF GEOLOGY		Generic Elective Course
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	4	0	4
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course is to develop fundamental knowledge on geology and its perspectives, solar system, interior of Earth, various geological processes, minerals, rocks, structures, fossils, fossil fuels etc.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Learn solar system, interior of Earth, age of earth	**Ap**
2	Explain Earthquakes and Volcanoes. Continental Drift, Fundamentals of Plate Tectonics and Plate boundaries, Tectonic divisions of India	**An**
3	Discuss important rock forming minerals, Classification of rocks. Igneous rocks and their types. Sedimentary and Metamorphic rocks and their types. Deformation in rocks. Folding and Faulting	**E**
4	Explain weathering and agents of weathering. geomorphic features. geomorphic features developed due to wind, water and ice	**U**
5	Discuss occurrence and distribution of Iron, Manganese, Copper, Lead, Zinc and Bauxite and fossil Fuels	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	1	3	2	1	3	2	3	2	1	2	1	3	2	1	3	2
CO2	3	2	1	3	2	3	2	1	2	1	-	2	3	2	2	3
CO3	2	1	3	2	1	1	1	3	1	2	3	1	2	3	3	2
CO4	1	3	2	1	2	2	3	2	3	1	2	3	1	-	2	1
CO5	2	1	1	3	1	3	2	3	1	2	3	1	2	1	1	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Geology and its perspective. Earth in the Solar System Age of the earth. Interior of the earth and its manifestation. Hydrologic Cycle	24	1
II	Earthquakes and Volcanoes. Continental Drift, Fundamentals of Plate Tectonics and Plate boundaries, Tectonic divisions of India	18	2
III	Definition and classification of minerals, important rock forming minerals, Classification of rocks. Igneous rocks and their types. Sedimentary and Metamorphic rocks and their types. Deformation in rocks. Folding and Faulting	15	3
IV	Weathering and agents of weathering. Salient geomorphic features. Major geomorphic features developed due to wind, water and ice, Fossils and their applications	24	4
V	Occurrence and distribution of Iron, Manganese, Copper, Lead, Zinc and Bauxite in India. Fossil Fuels: Coal and Petroleum- mode of occurrence and distribution in India. Conservation of energy and mineral resources.	18	5

Books Recommended:

Mukherjee, P. K. (2005). Text Book of Geology, The World Press Pvt. Ltd.

Roy, A. B. (2010). Fundamentals of Geology, Narosa Pub. House Pvt. Ltd.

Rogers and Adams (1966), Fundamentals of Geology, Harper and Row

Generic Elective Courses
M.Sc. (Geology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Geology	2	III
Course Code	Course Title		Course
GEOL520	FUNDAMENTALS OF DISASTER MANAGEMENT		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	4	0	4
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course is to develop profound understanding of the significance of studying disaster management, the different types of disasters and causes for disasters, impacts of disasters on environment and society and various methods of risk reduction measures and risk mitigation

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Explain natural Disasters, Causes and impact of Floods, droughts, Causes and impact of Cyclone, Landslides, Causes and impact of Earthquake and Tsunamis	**Ap**
2	Discuss Man-made Disasters, Causes and impact of Nuclear, Industrial accidents,	**An**
3	Explain Risk Analysis, Risk Assessment and Risk Reduction and Vulnerability	**E**
4	Discuss Disaster Preparedness, Disaster Mitigation	**U**
5	Explain disaster management plan, Disaster Response Plan.	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create)

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	1	3	2	1	3	2	3	2	1	2	1	3	2	1	3	2
CO2	3	2	1	3	2	3	2	1	2	1	-	2	3	2	2	3
CO3	3	1	3	2	1	1	1	2	1	2	3	1	2	3	1	2
CO4	1	2	2	1	2	2	3	2	3	1	2	3	1	-	2	1
CO5	2	1	1	3	1	3	2	3	1	2	3	1	2	1	1	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Introduction to natural Disasters, Causes and impact of Floods, Droughts, Causes and impact of Cyclone, Landslides, Causes and impact of Earthquake and Tsunamis	24	1
II	Introduction to Man-made Disasters Causes and impact of Nuclear, Industrial accidents, Causes and impact of Environmental disasters, fires, rail accidents, road accidents, Causes and impact of Air accidents and sea accidents	18	2
III	Risk: Its Concept and Elements. Risk Analysis, Risk Assessment and Risk Reduction. Resource Analyses and Mobilisation. Vulnerability: Its concept and analyses, Strategic Developments for Vulnerability Reduction	15	3
IV	Disaster Preparedness: Concept and Nature. Disaster Preparedness Plan and Disaster Mitigation. Concept of Search and Rescue operations. Use and Applications of Emerging Technologies in Disaster Preparedness.	24	4
V	Disaster Management Plan, Disaster Response Plan. Communication, Participation, and Activation of Emergency Preparedness Plan. Logistics Management.	18	5

Books Recommended:

Bell, F.G. (1999): Geological Hazards, Routledge, London.

Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press.

Keller, E.A. (1978): Environmental Geology, Bell and Howell, USA.

Lal, D. S. (2007): Climatology, Sharda Pustak Bhawan, Allahabad.

Patwardhan, A.M. (1999): The Dynamic Earth System, Prentice Hall.

Smith, K. (1992): Environmental Hazards, Routledge, London.

Subramaniam, V. (2001): Textbook in Environmental Science, Narosa International.

Valdiya, K.S. (1987): Environmental Geology – Indian Context, Tata McGraw Hill.

INDIAN KNOWLEDGE SYSTEMS

M.Sc. (Geology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Geology	1	I
Course Code	Course Title		Course
GEOL530	INDIAN KNOWLEDGE SYSTEMS		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	4	0	0
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course to provide students the basic knowledge about culture, language, Text, knowledge system of society and individual, uses of mineral, gems, metals and their exploitation, irrigation and water exploration tools and techniques.

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Discuss the rare and unique natural endowments of India.	U
2	Describe basics and history of Indian cultures, languages and texts.	U
3	Discuss the minerals and their uses and exploitation throughout in the history of India.	U
4	Discuss the history and evolution of mining and manufacturing of important metals.	U
5	Describe basic concepts of various irrigation techniques as well as tools and techniques of water exploration in the ancient India.	U

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	The Bharatavarsha: A Land of Rare Natural Endowments; Largest cultivable area in the world. Himalayas. The Sindhu-Ganga plain and the great coastal plains. The great rivers of India. Climate, vegetation, animals and mineral wealth of India. Population of India, uniqueness of Indian culture.	18	1
II	Indian Knowledge Systems: Indian civilization and knowledge. Indian knowledge tradition of Individual and Society. Texts of the Oral Tradition. Monism and Dualism approach to analyse a literature or language. Reflections on the Interpretation of Texts in the Indian Tradition. Different Text renewal mechanisms. Recontextualized of a Culture and Text. Eight forms of exposition.	18	2
III	Ancient and Pre-modern India: Minerals and their Exploitation. Minerals and metals in the Harappa, transitional period and Vedic period. Iron age. Mines, gems and minerals (600 BC to 600 AD). Taxila and the primacy of India in brass and zinc metallurgy. The Ratnagastra texts and the Indo-Roman Trade on gems, other minerals and metals. Minerals in pre-modern India: Iron and crucible steel	15	3
IV	Indian Metallurgy: Vedic references to metals and metal working. Mining and manufacture in India of Zinc, Iron, Copper, Gold, etc., from ancient times. Indian texts which refer to metallurgy. Important specimens of metal workmanship preserved/found in different parts of India. The significance and wide prevalence of ironsmith and other metal workers in the pre-modern era. European observers on the high quality and quantity of Indian iron and steel in the 18^{th} and 19^{th} centuries	18	4
V	History of irrigation in ancient India: Tools and techniques. Water indicator parameters: Indicator plants, Morphological and physiological changes. Concepts of irrigation from Sanskrit texts or literatures. Geobotanical Content in Brihat Samhita: water exploration practices in ancient time. Water Harvesting and Conservation in Ancient Agricultural Texts. Vedic approach to environmental science. Ancient knowledge of universe, earth, air, water etc.	18	5

References:

1. Baladev Upadhyaya, Samskrta Śāstrom ka Itihās, Chowkhambha, Varanasi, 2010.
2. D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., A Concise History of Science in India, 2nd Ed., Universities Press, Hyderabad, 2010.
3. Astāngahrdaya, Vol. I, Sūtrasthāna and Śarīrasthāna, Translated by K. R. Srikantha Murthy, Vol. I, Krishnadas Academy, Varanasi, 1991.
4. Dharampal, Some Aspects of Earlier Indian Society and Polity and Their Relevance Today, New Quest Publications, Pune, 1987.

Thin and polished section preparation

M.Sc. (Geology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Geology	2	III
Course Code	Course Title		Course
GEOL540	Thin and polished section preparation		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	0	0	4
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course to provide students the basic knowledge about culture, language, Text, knowledge system of society and individual, uses of mineral, gems, metals and their exploitation, irrigation and water exploration tools and techniques.

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Discuss the thin section of a mineral/rock	U
2	Describe basics of thin section preparation.	U
3	Discuss methods of cutting rock/mineral	U
4	Discuss rock mounting.	U
5	Preparation of final section.	U

Detailed Syllabus:

Unit No.	Topics	No. of Practical	CO No.
I	Basic idea of rock, mineral and mineral orientation	10	1
II	Basic idea of hard, medium and soft rocks. Method for proceeding for thin section preparation of soft rock.	12	2
III	Basic idea of cutting of rock, cutting of minerals in oriented way. Methods for preparing polished section. Different abrasive materials and its uses during thin section preparation	12	3
IV	Grinding of rock and mounting of rock or mineral using various adhesive materials. Various polishing methods for the preparation of ore/opaque minerals	12	4
V	Final thin section preparation and judging the proper thickness of the prepared thin section.	12	5