Appendix I

मोहनलाल सुखाड़िया विश्वविद्यालय, उदयपुर

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

Syllabus of M.Sc. Tech (Applied Geology)

for

One– Year

Post Graduate M.Sc. Tech Applied Geology Program

As per the Choice Based Credit System (CBCS)

designed in accordance with Learning Outcomes – Based Curriculum Framework (LOCF) of National Education Policy (NEP-2020)

I to II Semester M.Sc. Tech (Applied Geology) Courses

for Academic Year 2023-24

(Effective for the Academic Year 2024-25)

Faculty of Earth Sciences

(PG403XX)

Applied Geology in M.Sc. Tech Program: Semester wise course types, Course codes, Course title, Delivery type, Workload, Credits, Marks of Examination, and Remarks if any.

Level	Sem	Course Type	Course Code	Course Title	Delivery Type			Total Hours	Credit	Total Credit	Internal Assessment	EoS Exam	M.M.	Remarks
					L	T	P							
9	I	DCC-C1	GEO9003T	Applications of Tectonics and Structural Geology	L	T		60	4	4	20	80	100	
	I	DCC-C2	GEO9004T	Applications of Palaeontology and Stratigraphy	L	T		60	4	4	20	80	100	
	I	DCC-C3	GEO9005T	Applications of Remote Sensing	L	T		60	4	4	20	80	100	
	I	DCC-C4 Practical	GEO9001P	Applications of Tectonics and Structural Geology and Palaentology – Stratigraphy			P-8	60	4	4	20	80	100	
	I	DSE-E1	GEO9115T	Mineral Technology, Economics and Policies	L	T		60	4 + 2	6	20	80	100	
			GEO9116T	Exploration Geochemistry - Geophysics & Legislations in Mineral Industry										
	I	DSE-E2 Practical	GEO9103P	Application of Remote Sensing & Mineral Technology, Economics and Policies And Exploration Geochemistry - Geophysics & Legislations in Mineral Industry			P-8	60	4	4	20	80	100	
	II	DCC-C5	GEO9006T	Advanced Mineral Exploration and Mining	L	T		60	4	4	20	80	100	
	II	DCC-C6	GEO9007T	Applied Hydrogeology	L	T		60	4	4	20	80	100	
	II	DCC-	GEO9002P	Advanced			P-	60	4	4	20	80	100	

		C7 Practical		Mineral Exploration and Mining and Applied Hydrogeology			8							
	II	DSE-E3	GEO9117T	Natural Resource Management & Geoenvironment, Geohazards and Disaster management	L	T		60	4	4	20	80	100	
			GEO9118T	Palaeooceanography and Palaeoclimatology & Dissertation										
	II	DSE-E4	GEO9119T	Geoenvironment, Geohazards and Disaster management & Natural Resource Management	L	T		60	4	4	20	80	100	
			GEO9120T	Dissertation & Palaeooceanography and Palaeoclimatology				120	4	4	-	-	100	
	II	DSE-E5 Practical	GEO9104P	Natural Resource Management & Geoenvironment, Geohazards and Disaster management And Palaeooceanography and Palaeoclimatology & Dissertation			P-8	60	4	4	20	80	100	
Exit with M.Sc. Tech Certificate														

	Semester 1	Semester 2
Core 28 Cr	DCC-C1 (4Cr) Applications of Tectonics and Structural Geology DCC-C2 (4Cr) Applications of Palaeontology and Stratigraphy DCC-C3 (4Cr) Applications of Remote Sensing DCC-C4 (4Cr) Practical 1. Applications of Tectonics and Structural Geology & Applications of Palaeontology and Stratigraphy	DCC-C5 (4Cr) Advanced Mineral Exploration and Mining DCC-C6 (4Cr) Applied Hydrogeology DCC-C7 (4Cr) Practical 1. Advanced Mineral Exploration and Mining & Applied Hydrogeology
Elective 20 Cr	DSE-E1 (4Cr) 1. Mineral technology, Economics and Policies Or Exploration Geochemistry - Geophysics & Legislation in Mineral Industry DSE-E2 (4Cr) Practical 1. Applications of Remote Sensing & Mineral technology, Economics and Policies Or Applications of Remote Sensing & Exploration Geochemistry - Geophysics & Legislation in Mineral Industry	DSE-E3 (4Cr) 1. Natural Resource Management Or Palaeooceanography and Palaeoclimatology DSE-E4 (4Cr) 1. Geoenvironment, Geohazards and Disaster Management Or *Dissertation DSE-E6 (4Cr) Practical 1. Natural Resource Management / Palaeooceanography and Palaeoclimatology Or Geoenvironment, Geohazards and Disaster Management / *Dissertation
48 Cr	16+8=24 Cr	12+12= 24 Cr

1. For DSE paper to commence in an academic session there should be at least 33% of the strength of the semester.
2. **The courses provided as an option in DSE will be allotted to students on the availability of infrastructure and faculty members in that particular semester.**
3. Dissertation and Summer Internship reports will be submitted by the candidate as per the University guidelines. Evaluation of dissertation/summer internship reports will be done as per

the guidelines of NEP of MLS University. Dissertation/ Summer Internship under category of special types of delivery of course.

EOES (For Theory):

1. External Exam

a.	Section A	20 Marks
b.	Section B	40 Marks
c.	Section C	20 Marks
	Total	**80 Marks**

2. Internal Exam **20 Marks**

Pass Percentage-40%

EOSE (For DSE Practical):	**80 Marks**
1. Practical - 45 Marks	
2. Viva – Voce - 15 Marks	
3. Record - 20 Marks	
4. Internal Exam - i. Exam - 10 Marks ii. Assignment/ Seminar/Quiz – 10 Marks	**20 Marks**

M.Sc. Tech Program	
First Semester	
Applied Geology	
Code of the course	GEO9003T
Title of the course	Applications of Tectonics and Structural Geology
QualificationLevel of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Centric Core Course (DCC)
Delivery type of the course	Theory& Lecture
Prerequisites	M.Sc. with Geology
Co-requisites	None
Objectives of the Course	• Accurate geometric description of the structures observed in naturally deformed rocks. Understanding deformation mechanisms at macroscopic and micro- meso scales.
Learning outcomes	• Students are supposed to learn the techniques of recording and analyzing structural data and to map rock sequences in the field and interpret a region to determine how it formed and what has happened to the area since formation. To come out with the application of structural geology in various diverse fields of Geology.
Syllabus	
UNIT I	**Plate Tectonics** Precambrian plate tectonics. Orogenic Belts. Supercontinent Cycle. Mechanism of Plate Tectonics. Plate boundaries in relation to extensional, compressional and transpressional tectonics. Implications of Plate tectonics: Environmental change, Mineral deposits, sedimentary basins, geothermal power, natural hazards.
UNIT II	**Seismology** Seismic waves, earthquake mechanism, tomography, Inter-plate and Intra-plate seismicity. Reservoir induced Seismicity. Seismic Hazards.Himalayan Earthquakes.Neotectonic: Evidences with examples.
UNIT III	**Deformation Processes** Deformation in relation to strain and stress. Behaviour of rocks under stress, Finitehomogenous deformation, Progressive Deformation. Strain measurements.Role of fluids in deformation processes.
UNIT IV	**Microstructures** Types, Orientation, Slip & Rotation. Static and Dynamic Recrystallization and their effects. Lattice Preferred Orientation, Dilation sites, Porphyroblasts and Reaction rims. Controls of strain rate and temperature on microstructures.
UNIT V	**Structural Analyses** Time relation between crystallization and deformation. Basement Cover relationship. Criteria of recognition of polyphase deformation.

	Rotation of structural elements and interfering patterns of folds on outcrop scale.
Books suggested for reading	1. Hobbs, B.E., Means, W.D. and Williams, P.F. John Wiley, 1976, An outline of Structural Geology. 2. Ramsay, J.G. and Mc Graw Hill, 1967, Folding and Fracturing of Rocks. 3. Davis, H., Stephen J. Reynolds and Chuck Kluth, Structural Geology of Rocks and Regions/George, 3rd edition. 4. Park, R.G., 1997, Foundations of Structural Geology, 3rd edition. 5. Haakon Fossen, 2010, Structural Geology. 6. Ghosh, S.K., 1993, Structural Geology– Fundamentals and Modern development. 7. Passchier, C.W. and Trouw, R.A.J., 2005, Microtectonics. 8. Billings, M.P., 2001, Structural Geology, Prentice Hall of India Pvt. Ltd., Delhi, 606p. 9. Ramsay, J.G. and Huber, M.L., 1987, Modern Structure Geology, Vol. I & II. Academic Pres. 10. James, Mc.Calpin, 1996, PaleoseismologyAcadamic Academic Pres.
Suggested E-resources	1. egyankosh.ac.in 2. http://egyankosh.ac.in//handle/123456789/53276 3. BGYCT-131 Physical and Structural Geology 4. https://egyankosh.ac.in › handle 5. https://epgp.inflibnet.ac.in › epgp_content 6. https://ocw.mit.edu/courses/12-113-structural-geology-fall-2005/pages/lecture-notes

M.Sc. Tech Program	
First Semester	
Applied Geology	
Code of the course	GEO9004T
Title of the course	Applications of Palaeontology And Stratigraphy
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Centric Core Course (DCC)
Delivery type of the course	Theory & Lecture
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	• It is aimed to make understand the application and Significance of paleofauna's and paleoflaura. • It is aimed to make understand of Earth's geological history through this paper by pertaining knowledge of lithology, crustal evolution and geochronology.
Learning outcomes	• Students are expected to carry with them knowledge based upon geochronological sequence of rock layers all over during the earth's history. The knowledge imparted will bear characterization of Stratigraphic rocks with respect to lithology, structure, extension, location, age & life preserved , if any. • Students are expected to get knowledge to find fauna and flaura in the stratigraphic sequence and able to put these in an evolutionary trend.
Syllabus	
UNIT I	**Organic Evolution** Origin of Life, Punctuated equilibrium and Phyeletic Gradualism Models. Palaeoecology, Palaeobiogeography. Taphonomic considerations. Mass extinctions
UNIT II	**Applications of Microfossils** Microfossils: Types & Significance. Usage in seafloor tectonism, Oxygen and Carbon isotope studies of microfossils. Palaeoclimatic and Paleogeographic inferences from microfossils.
UNIT III	**Palyonology** Geological history and morphology of pollen grains. Palyonology in Petroleum, Coal and CBM exploration.
UNIT IV	**Stratigraphic applications** Magneto-stratigraphy, Chemostratigraphy, Bio-stratigraphy, Methods of Palaeogeographic reconstruction. Sequence stratigraphy through Carbon, Oxygen and Sulphur stable isotopes.
UNIT V	**Geochronology** Pb-Pb, U-Pb, Sm-Nd, K-Ar, Ar-Ar and Rb-Sr dating methods and their applications. Quaternary dating methods: Radiocarbon dating,

	luminescence, uranium series & amino acids
Books suggested for reading	1. Vaidyanadhan, R. and Ramakrishnan, M., 2010, Geology of India vol. I & II, Geol. Soc. of India, Bangalore. 2. Roy, A.B., Purohit, R. and Elsevier, 2018, Indian Shield. 3. Kumar, Ravindra., 1988, Fundamentals of Historical Geology and Stratigraphy of India. 4. Gupta, V.J., 1973, Indian Palaeozoic Stratigraphy, Hindusthan Publishing Corporation 5. Gupta,V.J., 1975, Indian Mesozoic Stratigraphy, Hindusthan Publishing Corporation 6. Gupta, V.J., 1976, Indian Cenozoic Stratigraphy, Hindusthan Publishing Corporation 7. Krishnan, M.S., Geology of India and Burma, Higginbothams (P) Ltd. 8. Pomerol, C., 1982, The Cenozoic Era: Tertiary and Quaternary, Ellis Harwood Ltd. 9. Black, R.M., 1988, The Elements of Palaeontology, Cambridge Univ. 10. Clarkson, E.N.K., 1986, Invertebrate Palaeontology and Evolution, Allen and Unwin Publ. 11. Saraswati, P.K. and Srinivasan, M.S., 2016, Micropaleontology: Principles and Applications, Springer. 12. Arnold, Haslett and Ed. Simon K, 2002, Quaternary Environmental Micropaleontology., Oxford Haq, B. U., Boersma, A. and Elsvier, 1998, Introduction to Marine Micropaleontology,
Suggested E-resources	1. https://egyankosh.ac.in/bitstream/123456789/69603/1/Block-2.pdf 2. https://en.wikipedia.org/wiki/Geology_of_India 3. https://www.researchgate.net/publication/248552540_Stratigraphic_setting_of_the_Phanerozoic_rocks_along_the_northern_boundary_of_the_Indian_Plate 4. https://www.youtube.com/watch?v=5ALNHhocXZY&list=PLtmeb20f7jz-Q5YwTpgUefo4N3X9bkiC8 https://www.futurelearn.com/courses/extinctions-past-present/19/steps/1312906

M.Sc. Tech Program	
First Semester	
Applied Geology	
Code of the course	GEO9005T
Title of the course	Applications of Remote Sensing
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Centric Core Course (DCC)
Delivery type of the course	Theory & Lecture
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	• To develop concepts and applications of Remote Sensing and GIS in Geology.
Learning outcomes	Upon successful completion of course the students would be able to: • To understand the characteristics of various sensors and satellite missions. • To understand the role of remote sensing and GIS in Geological studies. • To understand the concepts of Microwave, Thermal and Hyperspectral Remote Sensing and its applications. • To develop concepts of GIS and its applications.
Syllabus	
UNIT I	**Introduction to Remote Sensing** Principles and significance; Electromagnetic Radiation – Characteristics and Remote Sensing Regions and bands; Spectra of common natural objects – soil, rock, water and vegetation; General Orbital characteristics of satellites; Concepts of radiometric, spectral, spatial and temporal resolutions of satellite sensors.
UNIT II	**Microwave and Thermal Remote Sensing** Sensor characteristics of remote sensing satellites: Landsat, IRS, ASTER, Quickbird, Microwave remote sensing, Thermal and infrared remote sensing and their applications.
UNIT III	**Hyperspectral Remote Sensing** Introduction to Hyperspectral Remote Sensing, Imaging Spectrometers, Spectral Libraries, Hyperspectral Sensors, Applications of Hyperspectral Remote Sensing in Geology.
UNIT IV	**Digital Image Processing** Image rectification and restoration; Image enhancement, contrast stretching, filtering, Image rationing; Image classification and accuracy assessment - supervised & unsupervised classification, error estimation; Data merging and GIS integration.
UNIT V	**Concept of GIS** Definition and components of GIS; Raster, vector, Spatial and non

	spatial data structures; Digital Elevation Model (DEM); Utility of GIS in Geosciences.
Books suggested for reading	1. Sabbins, F.F.,1985 Remote Sensing-Principles and Applications. Freeman 2. Lillesand, T.M. and Kieffer, R.W., 1987, Remote Sensing and Image Interpretation- John wiley 3. Demers, M., Fundamentals of GIS 4. Finkiel, 104, Encyclopedia of Applied Geology 5. Reddy, M. Anji., Remote Sensing and Geographical Information System 6. Chandra, A.M., Remote sensing and Geographic Information System 7. Jensen, A.R., Remote Sensing of Environment 8. Joseph , George., Fundamentals of Remote Sensing
Suggested E-resources	1. https://vidyamitra.inflibnet.ac.in/index.php/search?subject%5B%5D=Geology&course%5B%5D=Remote+sensing+and+GIS+%28GEL11%29&domain%5B%5D=Physical+%26+Basic+Sciences 2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=8zYwEsyFCoiPyJlPmzHDxg==

M.Sc. Tech Program	
First Semester	
Applied Geology	
Code of the course	GEO9001P
Title of the course	Applications of Tectonics and Structural Geology and Applications of Palaeontology
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Centric Core Course (DCC)
Delivery type of the course	Practical
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	• To learn the practice of theoretical knowledge for applying at ground observation in field and to learn essential observational and practical skills • Students with physically observed the rocks, it will help them to identify rocks in the field and build a tectonic model. • Students get idea about the fauna and learn to calculate the age through isotopes.
Learning outcomes	• To train the students for adaptation in field work environment in certain professional and scientific organizations. Students will have knowledge which will be imparted through field trips. Students are expected to learn different deformational structures. • Study will help students in the field to work on rocks. • Faunal study will help them to identify fauna in the field and to put these in the evolutionary sequence.
Syllabus	
	Applications of Tectonics and Structural Geology 1. Solution of structural problems by stereographic and orthographic projections / Plot Series Maps. 2. Identification of structural elements and their chronology in hand specimen. 3. Structural analysis with stereonet: S- pole and beta- pole diagrams; Fold axis and axial plane; Countoured diagrams; Methodology and interpretation of patterns. 4. Interpretation of complex geological maps and drawing of cross section. **Applications of Palaeontology and Stratigraphy** 1. Age calculation exercise through various Isotope dating methods 2. Lab Study of rocks

	3. Lab study of Microfauna 4. Isotope study of faunas for age calculation exercises.
	Compulsory Field Training Program: Geological Field Training mainly based on Structural Mapping.- 10 days duration. Note: **Compulsory field training program at the end of every semester will be value added part of the practical syllabus which will be of 10 days duration and students opting out of it will loose proportional marks from the practical credit score. The student will have chance to improve the score by doing the field training at his/her own expenses before the commencement of final practical exam and after producing valid certificate from the recognized institute/company duly approved by the field training mentor/ faculty member.**
Books suggested for reading	1. Ramsay, J.G.,and Hill, Mc. Graw., 1967, Folding and Fracturing of rocks 2. Park, R.G., 1997, Foundations of Structural Geology, 3rd edition. 3. Ghosh, S.K.,1993, Structural Geology– Fundamentals and modern development. 4. Passchier, C.W. and Trouw, R.A.J., 2005, Microtectonics. 5. Billings, M.P., 2008, Structural Geology, 3rd Edition,. Prentice Hall of India Pvt. Ltd., Delhi, 606p. 6. Ramsay, J.G. and Huber, M.L., 1987, Modern Structure Geology- Vol. I & II, Academic Pres. 7. Gokhale, N.W., 2001, A Guide to Field Geology. 8. Platt. John I., Selected Exercises upon Geological Maps, London WCI. 9. Ragan, Practical Structure Geology. 10. Jensen, J.R., 1996, Introductory Digital Image Processing, A Remote Sensing Perspective, Springer- Verlag. 11. Lillesand, T. M. and Kiefer, R.W., 2007, Remote Sensing and Image Interpretation, Wiley. 12. Richards, J.A. and Jia, X., 1999, Remote Sensing Digital Image Analysis, Springer-Verlag 13. Gupta, R.P., 1990, Remote Sensing Geology, Springer Verlag 14. Vaidyanadhan, R. and Ramakrishnan, M., 2010, Geology of India vol. I & II, Geol. Soc. of India, Bangalore. 15. Roy, A.B., Purohit, R. and Elsevier, 2018, Indian Shield. 16. Gupta V.J., 1973, 1975, 1976, Indian Palaeozoic Stratigraphy. Hindusthan Publishing Corporation 17. Krishnan, M.S., Geology of India and Burma. Higginbothams (P) Ltd.

	18. Black, R.M., 1988, The Elements of Palaeontology, Cambridge Univ. 19. Clarkson, E.N.K., 1986, Invertebrate Palaeontology and Evolution, Allen and Unwin Publ. 20. Saraswati, P. K. and Srinivasan, M. S., 2016, Micropaleontology,Principles and Applications, Springer.
Suggested E-resources	1. egyankosh.ac.in 2. http://egyankosh.ac.in//handle/123456789/53276 3. BGYCT-131 Physical and Structural Geology 4. https://egyankosh.ac.in › handle 5. https://epgp.inflibnet.ac.in › epgp_content 6. https://ocw.mit.edu/courses/12-113-structural-geology-fall-2005/pages/lecture-notes 7. https://egyankosh.ac.in/bitstream/123456789/69603/1/Block-2.pdf 8. https://en.wikipedia.org/wiki/Geology_of_India 9. https://www.researchgate.net/publication/248552540_Stratigraphic_setting_of_the_Phanerozoic_rocks_along_the_northern_boundary_of_the_Indian_Plate 10. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000010ES/P001694/M020138/ET/1494502494046.N011.ES07-273BiostratigraphyANReddy.pdf 11. https://igntu.ac.in/eContent/MSc-Geology-02Sem-DrVikramSingh-MICROPALEONTOLOGY.pdf 12. https://vidyamitra.inflibnet.ac.in/index.php/search?subject%5B%5D=Geology&course%5B%5D=Remote+sensing+and+GIS+%28GEL11%29&domain%5B%5D=Physical+%26+Basic+Sciences 13. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=8zYwEsyFCoiPyJlPmzHDxg==

EOSE:	
1. Practical - 45 Marks	**80 Marks**
2. Viva – Voce - 15 Marks	
3. Record - 20 Marks i. Field Tour Report – 10 Marks ii. Practical Record – 10 Marks	
4. Internal Exam - i. Exam - 10 Marks ii. Assignment/ Seminar/Quiz – 10 Marks	**20 Marks**

M.Sc. Tech Program	
First Semester	
Applied Geology	
Code of the course	GEO9115T
Title of the course	Mineral Technology, Economics and Policies
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Specific Elective (DSE)
Delivery type of the course	Theory & Lecture
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	The objectives of this course are to: • To acquire knowledge of applied concept of mineral processing and economics of mineral resources. • To understand how and why different types of mineral deposits are formed. • Understand the importance of mineral processing technology. • Understand techniques of mineral processing for concentration of ore minerals economically. • To understand various government mineral policies, rules and regulations for conservation of minerals.
Learning outcomes	• Upon successful completion of course the students would be able to • Understand the technology of the minerals processing and implication of the mineral resources in different industries. • Students gain the knowledge about different government policies and regulations of minerals. • Students will be able to know how economy is governed by various type of minerals.
Syllabus	
UNIT I	**Principles of ore dressing** Ore dressing: Comminution-breaking, crushing and grinding. Principles and methods of screening and classification. Filtration. Methods of Concentration - Hand sorting, Washing, Gravity concentration, Heavy media separation, Flotation, Magnetic, Electrical methods.
UNIT II	**Metallic minerals** Metallic minerals: State-wise distribution of the resources, production, consumption and uses, specifications of the important metallic minerals (Iron, Copper, Lead-Zinc, Chromium, Manganese and Aluminum) of India and their world scenario. Study of mineral dressing processes of important metallic ores in India.
UNIT III	**Non-Metallic minerals** Non-Metallic minerals: State-wise distribution of the resources, production, industrial uses and specifications of the important non-metallic minerals (Asbestos, Gypsum, Mica, Baryte, Fluorite, Rock-

	Phosphate, talc, Clay, Quartz and Feldspar) of India and their world scenario. Study of mineral dressing processes of important non-metallic ores in India.
UNIT IV	**Energy and fuel minerals** State-wise distribution, production, consumption and uses of the important energy and fuel minerals of India and their world scenario. Study of mineral dressing processes of important energy and fuel minerals in India.
UNIT V	**Mineral rules and regulations** Mineral concession rules of India. National Mineral Policy. Mineral Policy of Rajasthan: Granite and Marble Policy. Strategic, and critical Mineral Policy of India.
Books suggested for reading	1. Wills, B. A., Mineral processing technology. 2. Gaudin, A.M., Principles of Mineral Dressing. 3. Taggart, A. F., Elements of Ore Dressing. 4. Wills, Barry A., Mineral Processing Technology, An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery. 5. Dahlkamp, F.J., 1993, Uranium Ore Deposits, Springer Verlag. 6. drzymala, Jan, 2007, Mineral Processing. 7. Fuerstenau, Maurice C., 2008, Principles of mineral processing. 8. Evans, A.M., 1993, Ore Geology and Industrial Mineral, Blackwell 9. Guilbert, J.M. and Park, Jr. C.F., 1986, The Geology of Deposits. Freeman 10. Holson, G.D. and Tiratsoo, E.N., 1985, Introduction to Petroleum Geology, Gulf Publ. Houston, Texas. 11. Jansen, M.L. and amp, Bateman, A.M., 1981, Economic Mineral Deposits, John Wiley & amp; Sons, Singapore. 12. Klemm, D.D. and Schneider, H.J., 1977, Time and Strata Bound Ore Deposits, Springer Verlag. 13. Mookherjee, A., 2000, Ore Genesis – a Holistic Approach, Allied Publisher. 14. Selley, R.C., 1998, Elements of Petroleum Geology, Academic Press. 15. Singh, M.P., 1998, Coal and Organic Petrology. Hindustan Publ., New Delhi. 16. Policy related documents of Govt. of India and Govt. of Rajasthan
Suggested E-resources	1. https://assets.cambridge.org/97811070/74910/frontmatter/9781107074910_frontmatter.pdf 2. https://www.researchgate.net/publication/342465286_An_Introduction_to_Mineral_Economics_Role_of_Geologist 3. https://ibm.gov.in/

M.Sc. Tech Program	
First Semester	
Applied Geology	
Code of the course	GEO9116T
Title of the course	Exploration Geochemistry - Geophysics & Legislation in Mineral Industry
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Specific Elective (DSE)
Delivery type of the course	Theory & Lecture
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	The objectives of this course are to: • Familiarize with procedures and techniques of mineral exploration. • Understand the geochemical and geophysical methods applied in mineral exploration. • Understand various rules and regulations related with mineral industry in India, and. • Increase and update the knowledge and skills required by geoscientists for the exploration and exploitation of mineral deposits.
Learning outcomes	On completion of this course, students will be able to: • Understand the principles, techniques and application of geochemical and geophysical methods in mineral exploration • Understand the various applicable rules and regulations which are related to mineral industry in the country
Syllabus	
UNIT I	**Introduction** Introduction to Mineral Exploration, Mineral Policies across the world, Classification of mineral deposits, Industry Specifications.
UNIT II	**Exploration Geology** Introduction to Exploration Geology, Regional Planning and Organization, Surface Guides, Survey and Mapping. Geological exercises in mineral exploration.
UNIT III	**Exploration Geochemistry** Exploration Geochemistry: Distribution and dispersion of elements, Background and threshold values, Orientation Survey, Standard Operation Procedures in Geochemical Exploration, AnalyticalMethods, Data Interpretation and Geochemical Methods of Mineral Exploration.
UNIT IV	**Exploration Geophysics** Exploration Geophysics: Introduction to geophysical methods, Seismic survey (Reflection and Refraction methods), Gravity survey,

	Magnetic survey, Electrical survey (Resistivity, IP and SP methods).
UNIT V	**Mineral Policy** UNFC Mineral Auctions Rules; Current Mineral Policy of Rajasthan (MMCR-2017)Act/ Rules of Obtaining Prospecting License (PL), Reconnaissance Permit (RP), Composite License (CL), Mining Lease (ML) and Quarry License (QL). Environment and Forest Legislations/regulations applicable to mineral and mining sectors and amendments thereupon. MMDR Act-1957 and Amendment Act-2015, National Mineral Exploration Policy (NMEP), Mineral concession Rules-1960 and 2016, Mineral Evidence Rules-2016, Mineral Auction Rules-2015.
Books suggested for reading	1. Kearey, Philip., Brooks, Michael and Hill, Ian, 2002, An Introduction to Geophysical Exploration, 3rd Edition, ISBN: 978-0632049295Publisher Wiley-Blackwell, Importer CBS Publishers. 2. Mamdouh, R., Ray, Gadallah. and Fisher, 2008, Exploration Geophysics, Science & Business Media, ISBN 3540851607, 9783540851608. 3. Macheyeki , Athanas S., Kafumu, Peter, Dalaly., Li, Xiaohui., Yuan Feng and Elsevier, 2020, Applied Geochemistry, Advances in Mineral Exploration Techniques 1st Edition, ISBN: 978-0128194959. 4. Charles, Moon., Michael, Whateley, K.G., and Anthony, M. Evans., 2009, Introduction to Mineral Exploration, 2nd Edition, ISBN: 978-1-444-30912-6 March 2009 Wiley-Blackwell. 5. Reedman, J. H., Techniques in Mineral Exploration, 1st Edition, ISBN: 978-94-009-9229-0, Springer Dordrecht, XII. 6. Haldar, S.K. and Elsevier, 2018, Mineral Exploration, Principles and Applications, Second Edition, ISBN 9780128140222.
Suggested E-resources	1. https://nptel.ac.in/courses/105103182 2. https://ocw.mit.edu/courses/12-201-essentials-of-geophysics-fall-2004/ 3. https://ibm.gov.in/writereaddata/files/07172017104116Elements%20of%20Mineral%20Exploration.pdf 4. https://earthresources.vic.gov.au/community-and-land-use/understanding-exploration 5. https://onlinecourses.nptel.ac.in/noc22_ce35/preview

M.Sc. Tech Program	
First Semester	
Applied Geology	
Code of the course	GEO9103P
Title of the course	Applications of Remote Sensing
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Specific Elective (DSE)
Delivery type of the course	Practical
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	• To impart an understanding of the basics of aerial photography and photogrammetry. • To impart an understanding of the fundamentals of remote sensing components. • To gain knowledge of Geographic Information Systems (GIS)
Learning outcomes	• Understanding the basic components of Remote Sensing • Students may be able to understand the functioning, data acquisition, and orbit operations of missions. • Students will able to understand the various components of GIS software and its applications
Syllabus	
	Applications of Remote Sensing 1. Interpretation of satellite imaginary. 2. Hands on exercises on applications of GIS in the field of Geosciences using QGIS/ Arc GIS.
Books suggested for reading	1. Jensen, J.R., 1996, Introductory Digital Image Processing, A Remote Sensing Perspective, Springer- Verlag. 2. Lillesand, T. M. and Kiefer, R.W., 2007, Remote Sensing and Image Interpretation, Wiley. 3. Richards, J.A. and Jia, X., 1999, Remote Sensing Digital Image Analysis, Springer-Verlag 4. Gupta, R.P., 1990, Remote Sensing Geology, Springer Verlag
Suggested E-resources	1. https://vidyamitra.inflibnet.ac.in/index.php/search?subject%5B%5D=Geology&course%5B%5D=Remote+sensing+and+GIS+%28GEL11%29&domain%5B%5D=Physical+%26+Basic+Sciences 2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=8zYwEsyFCoiPyJlPmzHDxg==

EOSE (Practical):	**80 Marks**
DSE	
Practical - 45 Marks	
Viva – Voce - 15 Marks	
Record - 20 Marks	
Internal Exam - i. Exam - 10 Marks ii. Assignment/ Seminar/Quiz – 10 Marks	**20 Marks**

M.Sc. Tech Program	
First Semester	
Applied Geology	
Code of the course	GEO9103P
Title of the course	Mineral Technology, Economics and Policies
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	2
Type of the course	Discipline Specific Elective (DSE)
Delivery type of the course	Practical
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	Objectives of this course include • To acquire knowledge of ore beneficiation • To understand and acquire knowledge of industrial specifications of minerals
Learning outcomes	Upon successful completion of the course student will: • Appreciate the ore beneficiation techniques and its importance • Understand the necessities of industrial specification of minerals
Syllabus	
	Mineral Technology, Economics and Policies 1. Flow sheets of beneficiation of important ore minerals. 2. Industrial specification of important industrial minerals. 3. Study of important metallic and non- metallic minerals in hand specimen.
Books suggested for reading	1. Wills, Barry A., Mineral Processing Technology, An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery. 2. Drzymala, Jan, 2007, Mineral Processing. 3. Jansen, M.L., amp, and Bateman, A.M., 1981, Economic Mineral Deposits, John Wiley & Sons, Singapore 4. Klemm, D.D. and Schneider, H.J., 1977, Time and Strata Bound Ore Deposits, Springer Verlag. 5. Mookherjee, A., 2000, Ore Genesis – a Holistic Approach, Allied Publisher. 6. Selley, R.C., 1998, Elements of Petroleum Geology, Academic Press.
Suggested E-resources	1. https://assets.cambridge.org/97811070/74910/frontmatter/9781107074910_frontmatter.pdf 2. https://www.researchgate.net/publication/342465286_An_Introduction_to_Mineral_Economics_Role_of_Geologist 3. https://ibm.gov.in/

EOSE (Practical):	
DSE 1	
Practical - 45 Marks	**80 Marks**
Viva – Voce - 15 Marks	
Record - 20 Marks	
Internal Exam - iii. Exam - 10 Marks iv. Assignment/ Seminar/Quiz – 10 Marks	**20 Marks**

M.Sc. Tech Program	
First Semester	
Applied Geology	
Code of the course	GEO9103P
Title of the course	Exploration Geochemistry - Geophysics & Legislation in Mineral Industry
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	2
Type of the course	Discipline Specific Elective (DSE)
Delivery type of the course	Practical
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	• As per the objectives defined in theory paper with the aim to develop practical skills.
Learning outcomes	• As per the outcomes defined in theory paper with relevance to practical aspects.
Syllabus	
	1. Literature review and/or Field based exploration project. End term examination will be based on project report and viva voce.
Books suggested for reading	1. Kearey, Philip., Brooks, Michael and Hill, Ian, 2002, An Introduction to Geophysical Exploration, 3rd Edition, ISBN: 978-0632049295 Publisher Wiley-Blackwell, Importer CBS Publishers. 2. Mamdouh, R., Ray, Gadallah. and Fisher, 2008, Exploration Geophysics, Science & Business Media, ISBN 3540851607, 9783540851608. 3. Macheyeki , Athanas S., Kafumu, Peter, Dalaly., Li, Xiaohui., Yuan Feng and Elsevier, 2020, Applied Geochemistry, Advances in Mineral Exploration Techniques 1st Edition, ISBN: 978-0128194959. 4. Charles, Moon., Michael, Whateley, K.G., and Anthony, M. Evans., 2009, Introduction to Mineral Exploration, 2nd Edition, ISBN: 978-1-444-30912-6 March 2009 Wiley-Blackwell. 5. Reedman, J. H., Techniques in Mineral Exploration, 1st Edition, ISBN: 978-94-009-9229-0, Springer Dordrecht, XII. 6. Haldar, S.K. and Elsevier, 2018, Mineral Exploration, Principles and Applications, Second Edition, ISBN 9780128140222.
Suggested E-resources	1. https://nptel.ac.in/courses/105103182 2. https://ocw.mit.edu/courses/12-201-essentials-of-geophysics-fall-2004/

	3. https://ibm.gov.in/writereaddata/files/07172017104116Elements%20of%20Mineral%20Exploration.pdf 4. https://earthresources.vic.gov.au/community-and-land-use/understanding-exploration 5. https://onlinecourses.nptel.ac.in/noc22_ce35/preview

EOSE (Practical):	**80 Marks**
DSE 1	
Practical - 45 Marks	
Viva – Voce - 15 Marks	
Record - 20 Marks	
Internal Exam - i. Exam - 10 Marks ii. Assignment/ Seminar/Quiz – 10 Marks	**20 Marks**

M.Sc. Tech Program	
Second Semester	
Applied Geology	
Code of the course	GEO9006T
Title of the course	Advanced Mineral Exploration and Mining
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Core Course (DCC)
Delivery type of the course	Theory & Lecture
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	• This course is designed to enable students to acquire understanding of the advance concepts of mineral exploration, exploration techniques including ground and aero geophysical surveys, geochemical exploration, etc., knowledge of application of ore petrography.
Learning outcomes	• Upon successful completion includes development of ability to apply knowledge-based approach for mineral exploration and capacity to judge better use of specific tools for mineral targeting unique to the selected mineral under consideration.
Syllabus	
UNIT I	**Mineral Exploration** Ore search and guides. Drilling for geological information, Planning of drill holes and logging of drill hole data.Different types of techniques for delineating potential alteration zones for mineral exploration and rock identification.
UNIT II	**Sampling** Sampling ore bodies and Estimation of ore reserves. Examination and evaluation of prospects and mines. Fundamentals of geostatistic applications. Consulting Geologists: Certificates and courses from various govt and autonomous organizations
UNIT III	**Exploration Geophysics** Fundamentals of geophysical prospecting, Methods and Application. Air borne and Ground geophysical surveys, Planning and coordinating geophysical work.
UNIT IV	**Exploration Geochemistry** Principles of geochemical prospecting. Exploration geochemistry sequence, Methods and application. Field and Laboratory analytical methods (Assaying methods.) Treatment of geochemical data.
UNIT V	**Mining Geology** Gathering and presenting geological data including geologic mapping in underground mines. Mining Methods: Open Cast and Underground
Books suggested for reading	1. Charles, Moon., Michael, Whateley, K.G., and Anthony, M. Evans., 2009, Introduction to Mineral Exploration, 2nd Edition, ISBN: 978-1-444-30912-6 March 2009 Wiley-Blackwell. 2. Reedman, J. H., Techniques in Mineral Exploration, 1st

	Edition, ISBN: 978-94-009-9229-0, Springer Dordrecht, XII. 3. Haldar, S.K. and Elsevier, 2018, Mineral Exploration, Principles and Applications, Second Edition, ISBN 9780128140222.
Suggested E-resources	1. https://ibm.gov.in/writereaddata/files/07172017104116Elements%20of%20Mineral%20Exploration.pdf 2. https://earthresources.vic.gov.au/community-and-land-use/understanding-exploration 3. https://onlinecourses.nptel.ac.in/noc22_ce35/preview

M.Sc. Tech Program	
Second Semester	
Applied Geology	
Code of the course	GEO9007T
Title of the course	Applied Hydrogeology
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Core Course (DCC)
Delivery type of the course	Theory & Lecture
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	• To impart applied knowledge of groundwater resources and its occurrence, movement, exploration and management.
Learning outcomes	• On successful completion of the course, students will be able to understand the role of groundwater and its occurrence, movement, exploration & management.
Syllabus	
UNIT I	**Introduction to Groundwater** Ground water Geology: Elements of ground water hydrology. Source of ground water and origin. Hydrologic cycle. Occurrence and distribution of ground water. Hydrological properties of water bearing materials. Porosity, Permeability, Transmissibility, Storage coefficient, Specific yield, Specific retention.
UNIT II	**Occurrence of Groundwater** Occurrence of ground water in different types of rocks-igneous, metamorphic and sedimentary (Soluble, non-soluble and non-indurated sedimentary).
UNIT III	**Water Table Fluctuations** Water table; Important causes of fluctuation. Water table maps, methods of their construction and their interpretation. Fresh and Salt water relationship in coastal areas.
UNIT IV	**Exploration of Groundwater** Exploration of ground water by various methods: Geological methods, Hydrological methods, Geophysical methods. Wells – Different types of wells and equipment of their construction. Use of well hydraulics; Well characteristics and their determination.
UNIT V	**Conservation and Management of Groundwater** Use and conservation of ground water. Artificial recharge of ground water. Basin-wise development of groundwater in Indian subcontinent. Groundwater provinces of India and Rajasthan.
Books suggested for reading	1. Alley, W.M., 1993, Regional Groundwater Quality, VNR, New York. 2. Black, W.and Others (ED)., 1989, Hydrogeology. Geol. Soc. Of America Publ. 3. Davies, S.N. and De Wiest, R.J.M., 1966, Hydrogeology, John

	wiley. 4. Freeze, R. A. and Cherry, J.A., 1979, Groundwater. Prentice Hall 5. Karanth, K.R., 1987, Groundwater Assessment – Development and Management. 6. Tata McGraw Hill Raghunath, N.M., 1982: Groundwater. Wiley Eastern 7. Subramaniam, V., 2000, Water. Kingston Publ. London 8. Todd, D.K., 1980, Groundwater Hydrology. John Wiley 9. Fetter, C.W., 1990, Applied Hydrology
Suggested E-resources	**1.** https://vidyamitra.inflibnet.ac.in/index.php/search?subject%5B%5D=Geology&course%5B%5D=&domain%5B%5D=Physical+%26+Basic+Sciences **2.** https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=8zYwEsyFCoiPyJlPmzHDxg==

M.Sc. Tech Program	
Second Semester	
Applied Geology	
Code of the course	GEO9002P
Title of the course	Applied Hydrogeology and Advanced Mineral Exploration and Mining
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Core Course (DCC)
Delivery type of the course	Practical
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	• To give students, practical aspects of the groundwater resource and its management. • As per the objectives defined in Advanced Mineral Exploration theory paper with the aim to develop practical skills.
Learning outcomes	• On successful completion of the course, students will be able to understand the role of groundwater and its occurrence movement, exploration and management and also about advance mineral exploration procedure and mining methods. • As per the outcomes defined in Advanced Mineral Exploration theory paper with relevance to practical aspects.
Syllabus	
	Applied Hydrogeology 1. Groundwater Contouring: Preparation of water table contour maps; Calculation of porosity, permeability, yield; Pumping test exercises; Exercises on Graphical representation of chemical quality of groundwater. **Advanced Mineral Exploration and Mining** 1. Survey and leveling by Theodolite and related problems. 2. Estimation of ore reserves. 3. Site selection for bore-holes. 4. Basic knowledge and handling of GPS.
	Viva – Voce Field work Record
	<u>Compulsory Field Training Program:</u> Geological Field Training mainly based on Hydrogeology and Mineral exploration. Note:**<u>Compulsory field training program at the end of every semester will be value added part of the practical syllabus which will be of 10 days duration and students opting out of it will loose proportional marks from the practical credit score. The student</u>**

	will have chance to improve the score by doing the field training at his/her own expenses before the commencement of final practical exam and after producing valid certificate from the recognized institute/company duly approved by the field training mentor/ faculty member.
Books suggested for reading	1. Alley, W.M., 1993, Regional Groundwater Quality, VNR, New York. 2. Black, W.and Others (ED)., 1989, Hydrogeology. Geol. Soc. Of America Publ. 3. Davies, S.N. and De Wiest, R.J.M., 1966, Hydrogeology, John wiley. 4. Freeze, R. A. and Cherry, J.A., 1979, Groundwater. Prentice Hall 5. Karanth, K.R., 1987, Groundwater Assessment – Development and Management. 6. Tata, Mc Graw, Hill and Raghunath, H.M., 1982, Groundwater, Wiley Eastern 7. Subramaniam, V., 2000, Water. Kingston Publ. London 8. Todd, D.K., 1980, Groundwater Hydrology. John Wiley 9. Fetter, C.W., 1990, Applied Hydrology
Suggested E-resources	1. https://vidyamitra.inflibnet.ac.in/index.php/search?subject%5B%5D=Geology&course%5B%5D=&domain%5B%5D=Physical+%26+Basic+Sciences 2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=8zYwEsyFCoiPyJlPmzHDxg=

EOSE (Practical):	**80 Marks**
Practical - 45 Marks	
Viva – Voce - 15 Marks	
Record - 20 Marks i. Field Tour Report – 10 Marks ii. Practical Record – 10 Marks	
Internal Exam - i. Exam - 10 Marks ii. Assignment/ Seminar/Quiz – 10 Marks	**20 Marks**

M.Sc. Tech Program	
Second Semester	
Applied Geology	
Code of the course	GEO9117T
Title of the course	Natural Resource Management
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Specific Elective (DSE)
Delivery type of the course	Theory & Lecture
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objective of the Course	• To understand the natural resources, their significance, policies, management, conservation and sustainable development
Learning outcomes	• Upon successful completion of this course, the student will be able to integrate and apply technical knowledge in the following key areas • Appraise the types of natural resources available and their relation with geology • Invent new ideas to conserve, manage and develop the Earth's natural resources available • Evaluate the validity and limitations of scientific theories and claims about the environment. • Appraise the interactions among physical, biological, chemical, and human components of the environment
Syllabus	
UNIT I	**Natural resources** Definition; Resource and Reserve; Classification of natural resources; natural resource degradation and conservation; Significance of natural resources. Environmental impacts of resource depletion.
UNIT II	**Mineral resource** Type of mineral resources, reserve, policy and management. Rock and other building materials. Ocean resources, International territorial policy and geopolitics. Mineral resource management using Geo-spatial technologies. Sustainable Development Goals.
UNIT III	**Water Resources** Surface, ground water, marine and brackish water resources - assessment and utilization; Rivers and Lakes in India; hydrological cycle; Ground water depletion; Water logging and salinity; Water Conservation and management techniques; Rain water harvesting; Watershed management; Eutrophication; Restoration of Lakes; River cleaning, River action plans - Ganga and Yamuna action plan, Interlinking of rivers; conflicts over water.
UNIT IV	**Land resources**

	Land degradation due to mining, exploration, industrialization, irrigation and natural disasters; Soil Erosion, Loss of soil fertility, Restoration of soil Fertility, Soil Conservation Methods; restoration of degraded land; Wasteland reclamation, Organic farming, green manuring, Wetland – definition, classification, functions, ecological importance and conservation.
UNIT V	**Renewable Resources** Wind resources, Solar energy resources, Geothermal energy resources, Coastal wave energy (Tidal) resources, Bio-fuel resources, hydro-electric resources Forest based resources: Their applicability and current scenario in India with special reference to Rajasthan
Books suggested for reading	1. David, A., 2013, Environmental economics and natural resource management, Routledge. 2. Singh, Gurdev and Ahuja,Vinod, 1992, Land resource management, Oxford & IBH Pub. Co. 3. Peacock, Wilson, Kathy., 2008, Natural resources and sustainable developments, Facts on file Inc. 4. Daniel, R. L., 2009, Sustainable natural resource management for scientists and engineers, Cambridge University press 5. Jaidev, Somesh, 2010, Natural resources in 21st century, ABD Publisher. 6. Panday, S.N. and Misra, S.P. (Eds.), 2008, Essential Environmental Studies, CRC Press.
Suggested E-resources	1. https://www.icar.org.in/content/natural_resource_management_division 2. https://www.india.gov.in/topics/environment-forest/natural-resources 3. https://www.youtube.com/watch?v=ZFD13WoyUGw 4. https://indiawris.gov.in/wris https://fsi.nic.in/

M.Sc. Tech Program	
Second Semester	
Applied Geology	
Code of the course	GEO9118T
Title of the course	Palaeooceanography& Palaeoclimatology
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Specific Elective (DSE)
Delivery type of the course	Theory &lecture
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	• The objective of this course is to develop an understanding of the field of paleoceanography and paleoclimatology. • The student will develop an understanding about the mechanism of global climate change. • This course will also deliver the insight about the proxies used for paleoceanographic and paleoclimatic studies.
Learning outcomes	• Students will learn about the proxies used for paleoceanographic and paleoclimatic studies • The students will be able to interpret the paleoceanographic and paleoclimatological data • The student will also learn about the various sampling techniques used in such studies.
Syllabus	
UNIT I	**Weather & Climate** Weather, Climate, Components of climate, Climate classification. Insolation, short and long-term changes in Insolation. Aerosols: Definition, origin, role in climate change. Greenhouse gases: Introduction, causes of changing concentration, role in climate change.
UNIT II	**Ocean** Origin and evolution of Oceans. Oceanic sediments, Terrigenous, biogenic sediments and their distribution.
UNIT III	**Ocean Climate Linkage** Sea-level: factors affecting sea-level changes, Short and long-term sea-level variability, evidences of sea-level change from marine sediments. Ocean-climate linkage. Effect of topography/tectonics on climate. Natural variability in climate. Human influence on climate change
UNIT IV	**Dating Methods** Historical evidences of climate change. Effects of climate change on

	mankind. Sampling methods for retrieving archives of climate/oceanographic change. Various dating methods, merits and demerits of various dating methods.
UNIT V	**Proxies** Paleoclimatic/paleoceanographic reconstruction from clay, ice, pollens and spores, diatoms, radiolarian, foraminifera, organo-geochemical proxies, corals, speleothems, loess-paleosols. Geomorphologic changes and climate. Elemental and isotopic analysis for paleoclimatic/paleoceanographic reconstruction, Instruments used for paleoclimatic/paleoceanographic studies.
Books suggested for reading	1. Bignot, G., 1985, Elements of Micropaleontology, London: Graham and Trotman Ltd. 2. Bradley, R.S., Paleoclimatology, Reconstructing Climates of the Quaternary, Academic. Press. 3. Brasier, M.D., Allen, Geogrge and Unwin, 1980, Microfossils. 4. Cronin, T.M., 1999, Principles of Paleoclimatology, Columbia UniversityPress. 5. Fischer, G. and Wefer, G., 1999, Use of Proxies in Paleoceanography, Examples from the South Atlantic, Springer. 6. Haq., Boersma and Elsevier., 1978, Introduction to Marine Micropaleontology, 7. kennett, J.P., 1982, Marine Geology, Prentice-Hall Inc. 8. North, G.R. and Crowley, T.J., 1995, Paleoclimatology, Oxford University Press 9. Schopf, T.J.M., 1980, Plaleoceanography, Harvard University Press. 10. Tolmazin, D., Allen and Unwin, 1985, Elements of Dynamic Oceanography
Suggested E-resources	1. http://ocean.stanford.edu/courses/bomc/chem/lecture_17.pdf 2. https://ocw.mit.edu/courses/12-740-paleoceanography-spring-2008/pages/lecture-notes/ 3. https://www.whoi.edu/sbl/liteSite.do?litesiteid=20812&articleId=53807 4. http://condor.wesleyan.edu/ethomas/ees123/index.htm

M.Sc. Tech Program	
Second Semester	
Applied Geology	
Code of the course	GEO9119T
Title of the course	Geoenvironment, Geohazards and Disaster Management
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Specific Elective
Delivery type of the course	Theory & Lecture
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	• To impart knowledge of environmental geology, natural hazards, their causes and mitigation factors
Learning outcomes	• Students will be able to understand the interaction of humans with the geological environment. It will lead to having basic knowledge related to occurrence, causes, impact and mitigation of natural hazards. The role of anthropogenic activities on natural environment will be given to students.
Syllabus	
UNIT I	**Introduction to Environmental Geology** Concepts and scope of Environmental Geology; Earth System Science; The Gaia hypothesis; Global Biogeochemical cycle; Environmental Protection Law
UNIT II	**Environmental Impacts of Mining and Urbanization** Environmental impacts of mining and urbanization.Environmental impacts of hydropower projects; water pollution, water logging and soil erosion.
UNIT III	**Geological Investigation to Natural Hazards** Geological investigations of nuclear waste disposal sites; ozone hole depletion, ocean acidification, coral bleaching, Milankovitch cycle, sea level rise, eutrophication and acid rain
UNIT IV	**Causes and Consequences of Natural Hazards** Natural hazards; Floods, their type and distribution; flood hazard zonation; Mitigation of flood-prone areas; Tsunamis: Causes and distribution; Tsunami-prone zones of India. Consequences of volcanoes.
UNIT V	**Causes and Consequences of Landslides and Earthquakes** Landslides: their types and controlling factors; Landslide hazard zonation mapping; Earthquakes: Their types and controlling factors, Seismic Zonation map of India.
Books suggested for reading	1. Bryant, E., 1985, Natural Hazards, Cambridge University Press. 2. Bell, F. G., 1999, Geological Hazards. Routledge, London. 3. Keller, E. A., 1978, Environmental Geology, bell and Howell, USA.

	4. Patwardhan, A. M., 1999, The Dynamic Earth System. Prentice Hall. 5. Smith, K., 1992, Environmental Hazards. Routledge, London . 6. Subramaniam, V., 2001, Text Book in Environmental Science, Narosa International. 7. Valdiya, K.S., 1987, Environmental Geology – Indian Context, Tata McGraw Hill.
Suggested E-resources	1. https://epgp.inflibnet.ac.in 2. e-PG Pathshala - INFLIBNET Centre 3. http://www.oas.org › dsd › unit CHAPTER 11 - GEOLOGIC HAZARDS

M.Sc. Tech Program	
Second Semester	
Applied Geology	
Code of the course	GEO9120T
Title of the course	Dissertation
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Specific Elective (DSE)
Delivery type of the course	Special type of Course
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives & Outcomes of the Course	• Student will be able to work independently on a geological project.
Dissertation can be under any subject teacher on topic related to M.Sc Tech (Applied Geology) and the proposed topic (Applied Geology) and plan will have pre-approval of Mentor and HoD as per the university guidelines.	

M.Sc. Tech Program	
Second Semester	
Applied Geology	
Code of the course	GEO9104P
Title of the course	Natural Resource Management
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	2
Type of the course	Discipline Specific Elective (DSE)
Delivery type of the course	Practical
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objective of the Course:	• As per the objectives defined in theory paper with the aim to develop practical skills.
Learning outcomes	• As per the outcomes defined in theory paper with relevance to practical aspects.
Syllabus	
	1. Project work will be allocated to students opting this DSE according to the theory syllabus mentioned for this DSE.
Suggested Readings	1. David, A., 2013, Environmental economics and natural resource management, Routledge. 2. Singh, Gurdev and Ahuja,Vinod, 1992, Land resource management, Oxford & IBH Pub. Co. 3. Peacock, Wilson, Kathy., 2008, Natural resources and sustainable developments, Facts on file Inc. 4. Daniel, R. L., 2009, Sustainable natural resource management for scientists and engineers, Cambridge University press 5. Jaidev, Somesh, 2010, Natural resources in 21st century, ABD Publisher. 6. Panday, S.N. and Misra, S.P. (Eds.), 2008, Essential Environmental Studies, CRC Press.
Suggested E-resources	1. https://www.icar.org.in/content/natural_resource_management_division 2. https://www.india.gov.in/topics/environment-forest/natural-resources 3. https://www.youtube.com/watch?v=ZFD13WoyUGw 4. https://indiawris.gov.in/wris 5. https://fsi.nic.in/

EOSE (Practical):	
Practical - 45 Marks	**80 Marks**
Viva – Voce - 15 Marks	
Record - 20 Marks	
Internal Exam - i. Exam - 10 Marks ii. Assignment/ Seminar/Quiz – 10 Marks	**20 Marks**

M.Sc. Tech Program	
Second Semester	
Applied Geology	
Code of the course	GEO9104P
Title of the course	Geoenvironment, Geohazards and Disaster Management
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Specific Elective
Delivery type of the course	Practical
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	• To impart knowledge of environmental geology, natural hazards, their causes and mitigation factors
Learning outcomes	• Students will be able to understand the interaction of humans with the geological environment. It will lead to having basic knowledge related to occurrence, causes, impact and mitigation of natural hazards. The role of anthropogenic activities on natural environment will be given to students.
Syllabus	
• Project work related to this DSE paper will be given to students according to the theory syllabus.	
Books suggested for reading	1. Bryant, E., 1985, Natural Hazards, Cambridge University Press. 2. Bell, F. G., 1999, Geological Hazards. Routledge, London. 3. Keller, E. A., 1978, Environmental Geology, bell and Howell, USA. 4. Patwardhan, A. M., 1999, The Dynamic Earth System. Prentice Hall. 5. Smith, K., 1992, Environmental Hazards. Routledge, London . 6. Subramaniam, V., 2001, Text Book in Environmental Science, Narosa International. 7. Valdiya, K.S., 1987, Environmental Geology – Indian Context, Tata McGraw Hill.
Suggested E-resources	https://epgp.inflibnet.ac.in e-PG Pathshala - INFLIBNET Centre http://www.oas.org › dsd › unit CHAPTER 11 - GEOLOGIC HAZARDS

M.Sc. Tech Program	
Second Semester	
Applied Geology	
Code of the course	GEO9104P
Title of the course	Palaeooceanography& Palaeoclimatology
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	2
Type of the course	Discipline Specific Elective (DSE)
Delivery type of the course	Practical
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives of the Course	• As per the objectives defined in theory paper with the aim to develop practical skills.
Learning outcomes	• As per the outcomes defined in theory paper with relevance to practical aspects.
Syllabus	
	1. Exercise on establishing chronology 2. Interpretation of various types of paleoclimatic and paleoceanographic data 3. Identification of microfossils used for paleoceanographic and paleoclimatic reconstructions 4. Sampling techniques used for collecting paleoceanographicand paleoclimatic studies.
Books suggested for reading	1. Bignot, G., 1985, Elements of Micropaleontology, London: Graham and Trotman Ltd. 2. Bradley, R.S., Paleoclimatology, Reconstructing Climates of the Quaternary, Academic. Press. 3. Brasier, M.D., Allen, Geogrge and Unwin, 1980, Microfossils. 4. Cronin, T.M., 1999, Principles of Paleoclimatology, Columbia University Press. 5. Fischer, G. and Wefer, G., 1999, Use of Proxies in Paleoceanography, Examples from the South Atlantic, Springer. 6. Haq., Boersma and Elsevier., 1978, Introduction to Marine Micropaleontology, 7. Kennett, J.P., 1982, Marine Geology, Prentice-Hall Inc. 8. North, G.R. and Crowley, T.J., 1995, Paleoclimatology, Oxford University Press 9. Schopf, T.J.M., 1980, Plaleoceanography, Harvard University Press.

	10. Tolmazin, D., Allen and Unwin, 1985, Elements of Dynamic Oceanography
Suggested E-resources	1. http://ocean.stanford.edu/courses/bomc/chem/lecture_17.pdf 2. https://ocw.mit.edu/courses/12-740-paleoceanography-spring-2008/pages/lecture-notes/ 3. https://www.whoi.edu/sbl/liteSite.do?litesiteid=20812&articleId=53807 4. http://condor.wesleyan.edu/ethomas/ees123/index.htm

EOSE (Practical):	**80 Marks**
Practical - 45 Marks	
Viva – Voce - 15 Marks	
Record - 20 Marks	
Internal Exam - i. Exam - 10 Marks ii. Assignment/ Seminar/Quiz – 10 Marks	**20 Marks**

M.Sc. Tech Program	
Second Semester	
Applied Geology	
Code of the course	GEO9104P
Title of the course	Dissertation
Qualification Level of the course	NHEQF Level 7.0
Credit of the course	4
Type of the course	Discipline Specific Elective (DSE)
Delivery type of the course	Special type of Course
Pre requisites	M.Sc. with Geology
Co - requisites	None
Objectives & Outcomes of the Course	• Student will be able to work independently on a geological project.
Dissertation can be under any subject teacher on topic related to M.Sc Tech (Applied Geology) and the proposed topic (Applied Geology) and plan will have pre-approval of Mentor and HoD as per the university guidelines.	