Department of Geology
IGNTU, Amarkantak

SYLLABUS
M.Sc. Geology

2019

SEMESTER I	
GEOT 101	Mineralogy, Optical Mineralogy and Crystallography
GEOT 102	Sedimentology
GEOT 103	Igneous Petrology and Crustal Evolution
GEOT 104	Metamorphic Petrology
GEOP 101	Practical I
GEOP 102	Practical II
GEOP 103	Practical III
GEOP 104	Practical IV
GEOGEN 101	Generic Elective
SEMESTER II	
GEOT 201	Geomorphology and Remote Sensing
GEOT 202	Structural Geology and Tectonics
GEOT 203	Micropaleontology, Geological Oceanography and Invertebrate Paleontology
GEOT 204	Stratigraphy and Geology of India
GEOT 205	Geological Field Training
GEOP 201	Practical V
GEOP 202	Practical VI
GEOP 201	Practical VII
GEOP 202	Practical VIII
GEOGEN 201	Generic Elective
SEMESTER III	
GEOT 301	Fuel Geology
GEOT 302	Hydrogeology and Engineering Geology
GEOT 303	Ore Geology and Mining
GEOT 304	Geological Field Training
GEOP 301	Practical IX
GEOP 302	Practical X
GEOP 302	Practical XI
DSEGEO 301	Environmental Geology and Natural Hazards
DSEGEO 302	Paleoceanography and Paleoclimatology
SEMESTER IV	
GEOT 401	Geochemistry and Isotope Geology
GEOT 402	Project Oriented Dissertation
GEOP 401	Practical XII
DSEGEO 401	Geology of the Central India
DSEGEO 402	Mechanism of Crustal Deformation

FIRST SEMESTER EXAMINATION

Nomenclature of Paper	Credits	Contact Hrs./ Week	Maximum Marks	Internal Assessment (40 marks)	End Semester Examination Marks	Min. Pass Marks in End Sem. Exam.
				20x2 tests		
GEOT 101: Mineralogy, Optical Mineralogy and Crystallography	4	4 hrs.	100	40	60	24
GEOT 102: Sedimentology	4	4 hrs.	100	40	60	24
GEOT 103: Igneous Petrology and Crustal Evolution	4	4 hrs.	100	40	60	24
GEOT 104: Metamorphic Petrology	4	4 hrs.	100	40	60	24
GEOP 101: Practical I	2	1½ hrs	50		50	20
GEOP 102: Practical II	2	1½ hrs	50		50	20
GEOP 103: Practical III	2	1½ hrs	50		50	20
GEOP 103: Practical IV	2	1½ hrs	50		50	20
GEOGEN 101: Generic Elective	3	2 hrs.	100	40	60	24
Total	27		700			

Detailed Syllabus

M.Sc. GEOLOGY

SEMESTER-I

GEOT 101: Mineralogy, Crystallography and Optical Mineralogy

Unit-I

Mineralogy: Concepts and example of Isomorphism, Polymorphism, solid solutions. Structure and classification of silicates; detailed study of important silicates groups (Nesosilicates/Orthosilicates, Sorosilicates, Cyclosilicates, Inosilicates, Phyllosilicates and Tectosilicates) with reference to general and structural formulae, atomic structure, structural states/polymorphs, solid solution, stability of the minerals and modes of occurrence and alterations.

Unit-II

Structure, relation of chemical composition with reference of optical, physical properties, alteration, and paragenesis of following group of minerals: Olivine, Pyroxene, Amphiboles, Garnet, Mica, Epidote etc.

Unit-III

Crystallography: 32 classes of symmetry; concept of Space Group- Symmorphic and Asymomorphic space group; Concept of Miller Indices, Hermann-Mauguin notation; Types of crystal projection and their uses-Spherical and stereographic; X-ray Diffraction methods in mineralogical investigations-Bragg's Law, Ewald's sphere;

Unit-IV

Principles of optical mineralogy: polarized light; optical mineralogy; behavior of isotropic and anisotropic minerals in polarized light: Birefringence, refractive index, double refraction, sign of elongation, Pleochroism, extinction angle, 2V, dispersion in minerals and pleochroic scheme.

Unit-V

Uniaxial and Biaxial minerals. Concept of optical Indicatrix-Uniaxial Indicatrix and Biaxial Indicatrix. Use of Indicatrix, relation between crystallographic axes and the Indicatrix axes, Interference figures, Determination of 2V from Interference figures.

List of Books Recommended:.

- Cornelis Klein and Barbara Dutrow, The manual of Mineral Science, Wiley Publication 2007.
- Dana, E.S. and Ford, W.E.: A textbook of Mineralogy. Wiley Eastern Limited.
- Deer, W. A. , Howie, R. A. and Zussman, J., An introduction to the rock forming
- Kerr,P.F. Optical Mineralogy. McGraw Hill Book Company
- Minerals, ELBS publication,1962-1963.
- Nesse W.D., Introduction to Optical mineralogy, 2008
- P. F. Kerr, Optical Mineralogy,1959
- P. K. Verma , Optical mineralogy, CRC press 200
- Putnis, Andrew. 1992: Introduction to Mineral Sciences. Cambridge Univ. Press
- Spear, F. S. (1993) : Mineralogical phase equilibria and Pressure- Temperature-Time paths
- Berry, L.G., Mason, B. and Dietrich, R.V., 1983. Mineralogy CBS Publishers. .

GEOT 102: Sedimentology

Unit-I

Sediment types and generation; Sediment transport and deposition, fundamentals of fluid dynamics; Sedimentary textures: grain size, sorting, shape; Sedimentary structures: lamination, ripples, cross-bedding etc.; Methods of textural analysis, textural parameters and their significance

Unit-II

Siliciclastic sedimentary rocks, classifications; Siliciclastic diagenesis; Siliciclastic marine environments; Fluvial depositional environments; Petrogenesis of sandstones, Graywacke and graywacke problem; plate tectonics and sandstones composition; Argillaceous rocks, their classification and genesis

Unit-III

Carbonate sedimentary rocks, classification and diagenesis; Carbonate marine environments; Limestones, their modes of formation, petrography and classification; Dolomites, their petrographic characteristics and models of dolomitization; Study of evaporites such as gypsum, anhydrite and halite; Diagenesis - physical and chemical, processes and evidences of diagenesis in sandstones, mud rocks and carbonate rocks

Unit-IV

Eolian and lacustrine environments; Glacial environment; Deltaic and beach barrier island environments; Estuarine, lagoonal and tidal environments

Unit-V

Implication of facies in environmental interpretation and basin analysis; Concept of Sequence Stratigraphy

List of recommended books:

- Blatt, H., Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks, Prentice-Hall Inc.
- Catuneanu, O. (2006): Principles of Sequence Stratigraphy, Elsevier.
- Collins, J.D., and Thompson, D.B. (1982): Sedimentary Structures, George Allen and Unwin, London.
- Miall, A.D. (2000): Principles of Basin Analysis, Springer-Verlag.
- Nichols Gary (2009): Sedimentology and Stratigraphy, Wiley India.
- Pettijohn, F.J. (1975): Sedimentary Rocks (3rd Ed.), Harper and Row Publ., New Delhi.
- Reading, H.G. (1997): Sedimentary Environments and facies, Blackwell Scientific Publication.
- Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments, Springer Verlag.
- Selley, R. C. (2000) Applied Sedimentology, Academic Press.
- Tucker, M.E. (1990): Carbonate Sedimentolgy, Blackwell Scientific Publication.
- Tucker, M.E. (2001): Sedimentary Petrology: An Introduction, Wiley and Sons, New York.

- Sam Boggs (2006): Principles of Sedimentology and Stratigraphy, Pearson Prentice Hall.

GEOT 103: Igneous Petrology and Crustal Evolution

Unit-I

Nature and evolution of magma; Mantle petrology and mantle heterogeneities; Magmatism in relation to plate tectonics; Partial melting (batch and fractional melting); Crystal fractionation (equilibrium and fractional (Rayleigh) crystallization)

Unit-II

Phase equilibrium - binary systems (Ab-An, Ab-Or, Di-An, Fo-Si) and their relations to magma genesis; Ternary systems (Di-Ab-An, Di-Fo-Si, Di-Fo-An, Fo-An-Si) and their relations to magma genesis; Interpretation of igneous textures in terms of rate of nucleation and crystal growth.

Unit-III

IUGS classification of the igneous rocks; CIPW norm; Petrology and petrogenesis of major igneous rock types with Indian examples of ultramafics, komatiite, basalt, granite, alkaline rocks, ophiolite, bornite, carbonatite, lamprophyre, lamproite, and kimberlite.

Unit-IV

Application of major, trace and Rare Earth elements in petrogenesis. Classification of Trace element. Geological controls of trace elements distributions. Understanding of trace element partition coefficient (kds). Magma generation in different tectonic scenario: minor elements finger printing (through spider-diagram and rare earth elements patterns) for source characterization and magma tectonics.

Unit-V

Chemical characteristics of igneous rocks in the following tectonic setting: Mid Oceanic Ridge, Island Arcs, Oceanic plateaus, Continental Margins, Continental Rifts and Continental intraplates; Plume magmatism and hot spots; Large igneous provinces, mafic dyke swarms.

List of recommended books:

- Marjorie Wilson, 1989. Igneous petrogenesis
- Cox, KG, Bell, JD and Pankhurst, RJ, 1993. The Interpretation of Igneous Rocks. Chapman & Hall, London
- Rollinson, HR 2007. Using geochemical data-evaluation, presentation and interpretation. 2nd edition. Longman Scientific & Technical
- Blatt H., Tracy R.J. and Owens B.E. (2006): Petrology – Igneous, sedimentary and Metamorphic (3rd Edition), W.H. Freeman and Company, New York.
- Bose M.K. (1997): Igneous Petrology. The World Press Pvt. Ltd.
- Bowen N.L. (1928): The evolution of Igneous Rocks. Princeton Univ. Press. N. J.
- Ehlers, E.G. and H. Blatt (1982): Petrology, Igneous, Sedimentary and Metamorphic, Freeman and company.

- Hatch F.H., Wells A.K and Wells M.K. (1984): Petrology of the igneous rocks, CBS.
- Philpotts A.R. (1994): Principles of igneous and metamorphic Petrology, Prentice Hall of India.
- Philpotts, A and Ague, J (2009): Principles of igneous and metamorphic petrology, Cambridge University Press Publishers,
- Turner F.J & Verhoogen J. (1951): Igneous and Metamorphic Rocks, McGraw Hill.
- Williams H, Turner F.J & Gilbert C.M. (1955): Petrography, W.H. Freeman and company. San Francisco.
- Winkler Helmut G.F. (1987): Petrogenesis of Metamorphic Rocks (Fifth Edition), Narosa Publishing House, New Delhi.
- Winter J. D. (2001): An Introduction to Igneous and Metamorphic Petrology, Prentice
- Winter, John D. (2010): Principles of igneous and metamorphic petrology, PHI learning Pvt. Ltd.
- Robin Gill. (2011): Igneous Rocks and Processes: A Practical Guide, Willey Blackwell.
- Myron G. Best. (2013): Igneous and Metamorphic Petrology, Willey Blackwell.

GEOT 104: Metamorphic Petrology

Unit-I

Metamorphism and its controlling factors; Metamorphism and its limits; metamorphic agents and changes: Role of temperature, pressure, stress and fluids; Types of metamorphism; Types of protolith; Classification of metamorphic rocks; Structures and textures of metamorphic rocks.

Unit-II

Mineralogical phase rule for closed and open systems; Nature of metamorphic reactions; Concept and classification of metamorphic facies and facies series; Introduction to ultrahigh temperature and ultrahigh pressure metamorphism; metamorphic reactions and pressure – temperature conditions of metamorphism.

Unit-III

Phase rule and phase diagram; ACF, AKF and AFM diagrams: Basic concepts and common diagrams in metamorphic petrology; Isograds and reaction isograds; Schrienmakers rule and construction of petrogenetic grids; Metamorphic differentiation, anatexis and origin of migmatites; Regional metamorphism; Paired metamorphic belts; P-T-t paths.

Unit-IV

Metamorphism of carbonate rocks; Metamorphism of mafic rocks; Metamorphism of granitoids; Charnockites; Metamorphism of pelitic rocks.

Unit-V

Regional Metamorphism and Paired Metamorphic belts with reference of plate tectonics.

List of recommended books

- Mason Roger (1984): Petrology of the Metamorphic Rocks, CBS Publishers and Distributors, New Delhi.
- Miyashiro A. (1998): Metamorphism and Metamorphic Belts, George Allen & Unwin, New York.
- Passicher C.W, Myers J.S and Kroner A. (1990): Field geology of high grade gneiss terraines; Narosa Publishing house, Springer Verlag and IUGS
- Yardley Bruce W.D. (1989): An Introduction to Metamorphic Petrology, Longman Singapore Publishers (Pvt.) Ltd.
- Winter, John D. (2010): Principles of igneous and metamorphic petrology, PHI learning Pvt. Ltd.
- Turner, F.J., 1980: Metamorphic Petrology, Mc Graw Hill.
- Spear, F. S. 1993: Mineralogical Phase equilibria and pressure-temperature-time paths, Mineralogical Society of America
- Spry, A. 1976: Metamorphic Textures, Pergamon Press.

GEOGEN 101

The Department of Geology hereby offers the Generic Elective paper in the Semester-I Postgraduate courses. Interested candidates are required to meet the Head with an application which is forwarded by their HoD. The syllabus is listed below as follows:

Generic Elective-Semester I for PG Courses

Paper title: Introduction to Geological Sciences (GEOGEN-101)

Unit 1

PHYSICAL GEOLOGY: Origin of the Earth- solar system, theories of the origin of Earth, Age of the Earth- calculation of the Earth's age, radioactivity, geological time scale: Structure of the Earth's interior- mechanical and compositional layering of the Earth

Unit 2

STRUCTURAL GEOLOGY: Measuring orientation of planer and linear features-Dip, Strike, Pitch, Plunge; Geometry and Classification of Faults-Normal fault, reverse fault, strike slip fault, Geometry and Classification of Folds.

Unit 3

EARTH'S ATMOSPHERE: Composition and Structure of the atmosphere; Atmospheric circulation- wind belts of the Earth, wind circulation; Earth's Climate

Unit 4

OCEANOGRAPHY: oceanography-properties of ocean water; Ocean Tides and waves; Ocean Circulation Origin and significance of mid oceanic ridges and trenches.

List of recommended books

- Holmes, Arthur (1992): Principles of Physical Geology. Vol. 1, Chapman and Hall, London.
- Leet, L.D. and Judson, S. (1969): Physical Geology. Prentice Hall.
- McBride, N. and Gilmour, I (2003): An Introduction to the Solar System, Cambridge Univ. Press.
- Ruhe, R.V. (1975): Geomorphology, Houghton Mifflin Co.. Boston.
- Sparks (1960): Geomorphology, Longmans.
- Singh, Savindra (2004): Physical Geography. Prayag Pustak Bhawan, Allahabad.

GEOP 101: Practical I

On the basis of theory paper GEOT 101

GEOP 102: Practical II

On the basis of theory paper GEOT 102

GEOP 103: Practical III

On the basis of theory paper GEOT 103

GEOP 104: Practical IV

On the basis of theory paper GEOT 104

SECOND SEMESTER EXAMINATION

Nomenclature of Paper	Credits	Contact Hrs./ Week	Maximum Marks	Internal Assessment 40 Marks 20x2 tests	End Semester Examination Marks	Min. Pass Marks in End Sem. Exam.
GEOT 201: Geomorphology and Remote Sensing	4	4 hrs.	100	40	60	24
GEOT 202: Structural Geology and Tectonics	4	4 hrs.	100	40	60	24
GEOT 203: Micropaleontology, Geological Oceanography and Invertebrate Paleontology	4	4 hrs.	100	40	60	24
GEOT 204: Stratigraphy and Geology of India	4	4 hrs.	100	40	60	24
GEOT 205: Geological Field Training	4	5-7 days	100		100	40
GEOP 201: Practicals V	2	1½ hrs	50		50	20
GEOP 202: Practicals VI	2	1½ hrs	50		50	20
GEOP 203: Practicals VII	2	1½ hrs	50		50	20
GEOP 204: Practicals VIII	2	1½ hrs	50		50	20
GEOGEN 201: Generic Elective	3	2 hrs.	100	40	60	24
Total	31		800	200	600	

Detailed Syllabus

M.Sc. GEOLOGY

II SEMESTER

GEOT 201: Geomorphology and Remote Sensing

Unit-I

Basic concepts and significance of geomorphology; Weathering and Erosion; Cycle of erosion. Wind as a geological agent; Wind erosion, transportation and deposition; Aeolian landforms: formation, types and evolution. Deserts: types and associated landforms. Glaciers: types, formation and morphology; Glacial erosion, transportation and deposition; Glacial landforms: formation, classification and evolution Karst Topography: formation, classification and evolution;

Unit-II

Streams as geological agents; Rivers: evolution of a river system and drainage patterns; Strahler's method of stream ordering; Stream erosion, transportation and deposition; Fluvial landforms: types, formation and evolution. Coastal Geomorphology; Marine landforms: formation, classification and evolution.

Unit -III

Morphometric analysis; Neotectonics - geomorphological indicators, active faults, responses of drainages with respect to tectonic activity. Morphochronology: OSL, IRSL, Radio nuclide Dating

Unit-IV

Electromagnetic radiation – characteristics, remote sensing regions and bands; General orbital and sensor characteristics of remote sensing satellites; Spectra of common natural objects – soil, rock, water and vegetation. Aerial photos – types, scale, resolution, properties of aerial photos, stereoscopic parallax, relief displacement; Digital image processing - characteristics of remote sensing data, preprocessing, enhancements, classification; Elements of photo and imagery pattern and interpretation, application in Geology; Remote sensing applications in interpreting structure and tectonics; Lithological mapping, mineral resources, groundwater potentials and environmental monitoring.

Unit-V

Principles and components of GIS, remote sensing data integration with GIS, applications of GIS in various geological studies. Concept of Geo-Spatial referencing, Projection Systems, Working principle of GPS.

List of recommended books:

- Butz S. (2007): Science of Earth Systems., 2nd edn., Thomas Delmar.
- Gass I.G. (1982): Understanding the Earth. Artemis Press (Pvt) Ltd. U.K.
- Halis, J.R. (1983): Applied Geomorphology.
- Holmes A. (1993): Principles of Physical Geology., ed by David Duff, Nelson Thornes Ltd.
- Holmes, A.(1992): Holmes Principles of Physical Geology, Edited by P. McL. D. Duff. Chapman and Hall.

- Lillesand, T.M. and Kiefer, R.W. (1987): Remote Sensing and Image Interpretation, John Wiley.
- Sharma, H.S. (1990): Indian Geomorphology, Concept Publishing Co., New Delhi.
- Singh, Savindra (2006): Geomorphology, Prayag Pustak Bhavan, Allahabad.
- Skinner B.J., Porter S.C. and Botkin D.B. (1999): The Blue Planet., 2nd edn. J. Wiley & Sons.
- Thornbury, W.D. (1980): Principles of Geomorphology, Wiley Easton Ltd., New York

GEOT 202: Structural Geology and Tectonics

Unit-I

Mechanical principles related to structural deformations, properties of rocks and their controlling factors; Concept of stress; Two-dimensional stress analyses; Faulting: Causes and dynamics; Types of faults: normal faults, reverse faults, thrust faults, strike-slip faults; Decollement.

Unit-II

Concept of strain, two dimensional strain analysis; Types of strain ellipses and ellipsoids, their properties and geological significance; Strain measurements in naturally deformed rocks;

Unit-III

Shear Zones: Brittle and ductile; Geometry and products of shear zones; Mylonites and cataclasites; Planar and linear fabrics in deformed rocks, their origin and significance.

Axial plane foliation- fracture cleavage, crenulation cleavage, slaty cleavage and schistosity; Origin of axial plane foliations; Transposed foliation; Cleavage bedding relationship; Structural association of gently dipping schistosity; Recognition of shear zones; Kinematic classification of shear zones; Fabric distribution in shear zones

Unit-IV

Mechanics of folding and buckling superposed folding patterns, fold development and distribution of strains in folds.

Basic idea about petrofabrics; Stereographic and equal area projections for representing different types of fabrics, π and β diagrams; Geometrical analysis of simple and complex structures on macroscopic scale.

Unit-V

Paleomagnetism, polar wandering and reversal of earth's magnetic field; Geomagnetic time scale; Concept of plate tectonics, nature and types of plate margins, geometry and mechanism of plate motion; Island arcs and mountain chains, their global distribution and evolution; Orogenic and epeirogenic phases; Plate tectonic evolution of Indian sub-continent.

List of recommended books:

- Condie, Kent. C. (1982): Plate Tectonics and Crustal Evolution, Pergamon Press Inc.
- Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Development. Pergamon Press.
- Grohong, R.H (2006): 3-D Structural Geology, Springer-Berlin-Hydelberg-New York Fossen, H. (2010): Structural Geology, Cambridge University Press
- Hatcher Jr. R.D. (1990): Structural Geology, Merrill Publishing Company.
- Leyshon, P. R. And Lisle, R.J (2004): Stereographic projection techniques for geologists and civil engineers, Cambridge University Press
- Ramsay J.G. and Huber M.I. (2002): The Techniques of modern structural geology, 2nd ed., Vol. 2, Elsevier Science Ltd.
- Ramsay, J.G. (1967): Folding and fracturing of rocks, McGraw Hill.
- Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology, Vol. III (Application of continuum mechanics), Academic Press.
- 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.
- Gokhale, N. W. (2009): A Manual of Problems in Structural Geology, CBS Publications.
- Bose, N. and Mukherjee, S. (2017): Map Interpretation for Structural Geologists, Elsevier.

GEOT 203: Micropaleontology, Geological Oceanography and Invertebrate Paleontology

Unit-I

Oceans of the Earth; Sampling of modern ocean; Temperature and salinity distribution (horizontal and vertical) in ocean waters; Dissolved gases in sea water; Biological - chemical - physical interactions in the oceans; Oxygen minimum layer in the ocean. Scientific ocean floor drilling and its major accomplishments. Concept of mixed layer, thermocline, halocline, and pycnocline; Coriolis force and Ekman spiral, upwelling, El Niño and La Nina; Atmospheric Circulation: concept of wind belts of the Earth; Ocean circulation- surface circulation; deep ocean circulation; Waves and Tides. Ocean-Atmosphere interaction; Inter-ocean exchange.

Unit-II

Definition and scope of micropaleontology and its relation with ocean sciences; Modern field and laboratory techniques in the study of microfossils. Role of micropaleontology in marine geology and oceanography; Types of Microfossils- Calcareous Microfossils: (i)

Foraminifera, (ii) Coccolithophores, (iii) Pteropoda, (iv) Ostracoda; Siliceous Microfossils- (i) Radiolaria and (ii) Diatoms; Phosphatic Microfossils- Conodonts; Organic Walled Microfossils: (i) Spores and Pollens

Unit-III

Applications of Micropaleontology in petroleum exploration; Environmental significance of microfossils; Geochemical study of microfossil tests and its application in paleoceanography and paleoclimatology; Application of palynology in identifying ancient coast lines.

Unit-IV

Fossils: definition, characteristics, types (body and trace fossils); Taphonomy; Modern systematics; Concept and kind of type specimens; Approaches to paleoecological and paleoenvironmental studies; Micro and macro-evolution; Distribution, migration and dispersal of organisms applied to paleobiogeography and plate-tectonics.

Unit-V

Chief characteristics, Evolutionary trends and geological history of invertebrate fossils: Brachiopoda; Mollusca- Bivalvia, Gastropoda, Cephalopoda; Echinoidea; Trilobites; Corals; Graptoloidea.

Ichnofossils, their modes of preservation, behavioral classification and ichnofacies.

List of recommended books:

- Benton, Michael J. and Harper, David A.T. (2009): Introduction to Paleobiology and fossil record, John-Wiley & Sons.
- Clarksons, E.N.K. (1998): Invertebrate Paleontology and Evolution, Allen and Unwin, London.
- Mayr, E. (1971): Population, Species and Evolution, Harvard.
- Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill.
- Raup, D.M. and Stanley, S.M. (1985): Principles of Paleontology, CBS Publ
- Shrock, Robert R. and Twenhofel, William H. (2002): Principles of Invertebrate Paleontology, (McGraw Hill) Dist. CBS Publishers.
- Smith, A.B. (1994): Systematics and Fossil Record – Documenting Evolutionary Patterns, Blackwell.
- Woods, Henry (1926): Invertebrate Paleontology
- Armstrong, H.A. and Brasier, M. (2005): Microfossils, Blackwell Publishing, Australia. Arnold (2002): Quaternary Environmental Micropaleontology (Ed. Simon K. Haslett), Oxford University Press, New York.
- Bignot, G., Grahm and Trottman (1985): Elements of Micropaleontology, Micropaleontology Press, London.
- Garrison, T. (2007): Oceanography: An invitation to marine sciences, Cengage Learning.
- Haq, Bilal and Boersma, Anne (Ed.) (1998): Introduction to Marine Micropaleontology
- Jones, T.P. and Rowe, T.P. (1999): Fossil plants and spores, Modern Techniques, Geological Soc. of London.

- Kennett, J.P. and Srinivasan, M.S. (1983): Neogene Planktonic Foraminifera- a phylogenetic atlas, Hutchinson Ross Publishing Company.
- Pinet, Paul R. (2006): Invitation to Oceanography, Jones & Bartlett Learning.

GEOT 204: Stratigraphy and Geology of India

Unit-I

Development of stratigraphic concepts; Stratigraphic classification & nomenclature, study of stratigraphic elements; Lithostratigraphy and its units; Stratification: processes controlling stratification- physical, chemical and biological; Vertical succession, lithological uniformity, heterogeneity, patterned succession, alternations, varves, cycles (symmetrical and asymmetrical); Lateral variations and facies concept; Unconformity; Chronostratigraphy and its units; Biostratigraphy and its units; inter-relationship between lithostratigraphic, chronostratigraphic and biostratigraphic units; Brief ideas of magneto-seismo- chemo-stratigraphy; Geological Time Scale.

Unit-II

Precambrian Stratigraphy; Precambrian geochronology; Archean Geology of India: (i) Dharwar Craton, (ii) Singhbhum Craton; Proterozoic Geology of India: (i) Central Indian Tectonic Zone, (ii) Vindhyan Supergroup, (iii) Cuddapah Supergroup; Precambrian-Cambrian boundary.

Unit-III

Paleozoic Stratigraphy; Igneous activities and paleogeography during the Paleozoic Era; Paleozoic of Kashmir; Permian-Triassic Boundary Concept, classification, fauna, flora and age limits of Gondwana Supergroup and related paleogeography, paleoclimate, and depositional characteristics.

Unit-IV

Mesozoic Stratigraphy; Classification, depositional characteristics, fauna, and flora of: Triassic of Spiti, Jurassic of Kutch, Cretaceous of Trichinapalli; Deccan Volcanic Province; Cretaceous- Tertiary Boundary.

Unit-V

Cenozoic Stratigraphy; Paleogene Systems of India; Neogene Systems of India; Evolution of Himalayas; Siwalik Supergroup; Pleistocene-Holocene Boundary; Concept of Meghalayan.

List of recommended books:

- Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.
- Danbar, C.O. and Rodgers, J. (1957): Principles of Stratigraphy, John Wiley and Sons.
- Doyle, P. and Bennett. M.R. (1996): Unlocking the Stratigraphic Record, John Wiley and Sons.
- Harold L. Lewis (1987): Earth through Time; 3rd Edition. Saunders College Publishing, New York
- K. S. Valdiya (2010): The Making of India-Geodynamic Evolution; Macmillan Publishers India Ltd.

- Krishnan, M.S. (1982): Geology of India and Burma, C.B.S. Publ. and Distributors, Delhi.
- M. Ramakrishnan and R. Vaidyanadhan (2008): Geology of India (Vol. I and II); Geological Society of India, Bangalore.
- M. S. Krishnan (1982), Geology of India and Burma; 6th Ed. CBS Publishers and Distributors (India).
- Naqvi, S.M. and Rogers, J.J.W. (1987): Precambrian Geology of India, Oxford University Press.
- Pascoe, E.H. (1968): A Manual of the Geology of India and Burma (Vols. I-IV), GSI, Govt. of India Press, Delhi.
- Pomerol, C. (1982): The Cenozoic Era? Tertiary and Quaternary, Ellis Harwood Ltd., Halsted Press. Schoch,
- Robert, M. (1989): Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.
- Roy, R. Lemon (1990): Principles of Stratigraphy; Merrill Publishing Company, Ohio
- Wadia, D.N. (1984), Geology of India; 4th edition. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

GEOT 205: Geological Field Training

Compulsory field work in geologically significant terrains, viva-voce and field report.

GEOGEN 201

Generic Elective-Semester II for PG Courses

Paper Title: Components of Earth Systems (GEOGEN-201)

Unit-I

MINEROLOGY- Physical properties of minerals and rocks-Form, hardness, colour, luster, streak, cleavage, fracture, parting etc.; Rock forming minerals of the earth crust; Ore minerals; Classification of silicate minerals.

Unit-II

RHEOLOGY & PLATE TECTONICS- Rheology of the earth crust, Rock deformation. Earth forces Relationship between Stress and Strain in rocks. Concepts of plate tectonics-convergent and divergent plate margins sea floor spreading and geosynclines. Mountain building- Orogenic and epeirogenic phases, evidence of continental drift, and sea floor spreading:

Unit-III

STRATIGRAPHY- Geological Time Scale; Definition of Stratigraphy, Branches of Stratigraphy and its relation with other branches of Geology, Principles of Stratigraphy Law of Uniformitarianism, Law of order of superposition. Geological Record and its nature Eon, Era, Period. Classification of Standard Stratigraphic scale. Nomenclature and units like Litho. Bio and Chrono stratigraphic units, correlation- Litho-stratigraphic and Biostratigraphic.

Unit-IV

PALEONTOLOGY- Introduction, Definition of Paleontology, Classification of Plants, Invertebrate and Vertebrate fossils. Fossils Taphonomy (Burial Law), Types of Fossilization Mode of preservation - Mummification, Carbonization Silification Casts. Moulds. Tracks and trails. Application of Fossils. General morphological characters and Geological age of the following Invertebrate and Plant Fossils: Brachiopods, Cephalopods, Pelecypoda and Trilobita. Plant fossils: Glossopteris, Gangamopteris, Ptillophylum, Calamites and Lepidodendron

List of recommended books:

- Stratigraphic Principles and Practice-Weller
- Stratigraphy- Kumberlein and Sloss
- Paleontology of the Invertebrates-Tasch Publ.John Wiley and Sons
- Paleontology - Henry Wood
- Fossils Plants- Arnoled
- The Elements of Paleontology Black. R.M Pub. Cambridge university press
- Condie, Kent. C. (1982): Plate Tectonics and Crustal Evolution, Pergamon Press Inc

GEOP 201: Practical V

On the basis of theory paper GEOT 201

GEOP 202: Practical VI

On the basis of theory paper GEOT 202

GEOP 203: Practical VII

On the basis of theory paper GEOT 203

GEOP 204: Practical VIII

On the basis of theory paper GEOT 204

THIRD SEMESTER EXAMINATION

Nomenclature of Paper	**Credits**	**Contact Hrs./ Week**	**Maximum Marks**	**Internal Assessment 40 marks**	**End Semester Examination Marks**	**Min. Pass Marks in End Sem. Exam.**
				20x2 tests		
GEOT 301: Fuel Geology	4	4 hrs.	100	20x2	60	24
GEOT 302: Hydrogeology and Engineering Geology	4	4 hrs.	100	20x2	60	24
GEOT 303: Ore Geology and Mining	4	4 hrs.	100	20x2	60	24
GEOT 305: Geological Field Training	4	5-7 days	100		100	60
GEOP 301: Practical IX	2	1½ hrs	50		50	20
GEOP 302: Practical X	2	1½ hrs	50		50	20
GEOP 303: Practical XI	2	1½ hrs	50		50	20
DSEGEO 301: Environmental Geology and Natural Hazards OR **DSEGEO 302**: Paleoceanography and Paleoclimatology	3	2 hrs.	100	20x2	60	24
Total	**25**		**650**		490	

Detailed Syllabus
M.Sc. GEOLOGY

SEMESTER-III

GEOT 301: Fuel Geology

Unit-I

Definition and origin of coal; Sedimentology of coal bearing strata; Types of seam discontinuities and structures associated with coal seams; Chemical analysis of coal (proximate and ultimate analysis). Classification of coal in terms of rank, grade and type; Indian classification for coking and non-coking coals.

Unit-II

Coal Petrology– concept of 'lithotype', 'maceral' and 'microlithotype; Techniques and methods of coal microscopy; Applications of coal petrology

Unit-III

Petroleum– its composition, origin (formation of source rocks- kerogen, organic maturation and thermal cracking of kerogen); Migration of petroleum; Reservoir rocks-petrology of reservoir rocks, porosity and permeability; Reservoir traps – structural, stratigraphic and combination traps.

Unit-IV

An outline of the oil belts of the world; Onshore and offshore petroliferous basins of India; Geology of productive oilfields of India; Elements of unconventional petroleum systems.

Unit-V

Coal Bed Methane (CBM)– An unconventional petroleum system; Elementary idea about generation of methane in coal beds; coal as a reservoir and coal bed methane exploration; Coal as a source rock for oil and gas; Geological and geographical distribution of coal and lignite deposits in India; Coal exploration and estimation of coal reserves; Indian coal reserves and production of coal in India. Petroleum exploration; Identification and characterization (petrographic and geochemical) of petroleum source rocks; Amount, type and maturation of organic matter; Oil and source rock correlation. Well logging techniques.

List of recommended books:

- Chandra, D., Singh, R.M. and Singh, M.P. (2000): Textbook of Coal (Indian context), Tara Book Agency, Varanasi.
- Holson, G.D. and Tiratso, E.N. (1985): Introduction of Petroleum Geology, Fulf Publishing, Houston, Texas.
- Hunt, J.M. (1996): Petroleum Geochemistry and Geology (2nd Ed.), Freeman, San Francisco.
- Jahn, F., Cook, M. and Graham, M. (1998): Hydrocarbon exploration and production, Eslevier Science.
- Leverson, A.I (2006): Geology of Petroleum, CBS publications. enton,

- North, F.K. (1985): Petroleum Geology, Allen Unwin.
- Selley, R.C. (1998): Elements of Petroleum Geology, Academic Press.
- Singh, M.P. (1998): Coal and organic Petrology, Hindustan Publishing Corporation, New Delhi.
- Stach, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichumullelr, M. and Teichmuller R. (1982): Stach's Texbook of Coal petrology, Gebruder Borntraeger, Stuttgart.
- Thomas, Larry (2002): Coal Geology, John Wiley and Sons Ltd., England.
- Tissot, B.P. and Welte, D.H. (1984): Petroleum Formation and Occurrence, Springer–Verlag.
- Van Krevelen, D. W. (1993): Coal: Typology-Physics-Chemistry-Constitution, Elsevier Science, Netherlands.

GEOT 302: Hydrogeology and Engineering Geology

Unit I

Origin and occurrence of groundwater; Groundwater in Hydrologic Cycle; Vertical Distribution of Groundwater; Aquifers: definition and classification; Properties of geological formations as aquifers; Groundwater distribution of India; Movement of groundwater: Origin and types of springs and hot springs; Darcy's law; Permeability Determination of Hydraulic Conductivity, storage coefficient and specific capacity.

Unit II

Well Hydraulics: Pumping test Field and lab analysis of hydraulic conductivity; Saline water intrusion in Aquifers- Ghyben-Herzberg relation; Groundwater contamination and problems of arsenic, fluoride and nitrates. Surface and subsurface methods for investigation of groundwater: Resistivity Method, Seismic Method, Gravity and Magnetic Method, Resistivity Logging, Spontaneous Potential Logging.

Unit III

Engineering Properties of Rocks: Specific Gravity, Porosity, Sorption, Compressive Strength, Tensile Strength, Elasticity of Rocks, Residual Stress and Shear Stress in Rocks. Engineering properties of soil; Soil classification; Soil gradation; Compressive and shear strength; Atterberg limits; Consolidation and swelling of clays Rocks as Construction Materials: Types of Rocks used in construction

Unit IV

Geological and Geotechnical investigations for Civil Engineering Projects: Tunnels: Terminology, Geological conditions for tunnel sites, Tunnels in folded rocks and bedded rocks. Influence of divisional planes, Effects of faults, Crushed zones, Tunnels near slopes, Role of Groundwater in tunneling.

Unit V

Dams and Reservoirs: Geological conditions for the selection of dam and reservoir sites.

Terminology associated with dams. Types of dams: Masonary Dams (Gravity Buttress and Arch types), Earthen dams. Types of spillways. Locations of all the important dams and Hydro – electric projects in India. Dam failures-causes and case studies.

List of recommended books:

- Bouwer, Herman (1978): Groundwater Hydrology. McGraw Hill, Inc., New Delhi.
- C.F. Tolman (1937): Groundwater, McGraw Hill, New York and London.
- D.K. Todd (1995): Groundwater Hydrology, John Wiley and Sons.
- F.G. Driscoll (1988): Groundwater and Wells, UOP, Johnson Div. St. Paul. Min.
- USA. H.M. Raghunath (1990): Groundwater, Wiley Eastern Ltd.,
- Fetter, C.W., (1994): Applied Hydrogeology MacMillan Pub. Comp. New York.
- H.S. Nagabhushaniah (2001): Groundwater in Hydrosphere (Groundwater
- hydrology), CBS Publ.
- Ingebritsen, Steve, Stanford, Ward & Neuzil, Chris (2006): Groundwater in
- Geologic
- K. R. Karanth (1989): Hydrogeology, Tata McGraw Hill Publ.
- Micheal, P., (1985): Introduction to Groundwater George Allen & Unwin, London.
- Ragunath, H.M., (1992): Groundwater Wiley Eastern Ltd. New Delhi.S.N. Davies and R.J.N. De Wiest (1966): Hydrogeology, John Wiley and Sons, New York.
- Sharma P.V., Environmental and Engineering Geophysics
- Krynine D.P. and Judd W.R., Principles of Engineering Geology and Geotechniques
- Bell F.G., Fundamental of Engineering Geology
- Jeger C., Rock Mechanics and Engineering

GEOT 303: Ore Geology and Mining

Unit-I

Introduction to ore microscopy, techniques, methods, textures and microstructures of ores, interpretation of ore texture; optical properties of common sulphide and oxide ore minerals; Concept of ore bearing fluids, their origin and migration; Wall rock alteration; Structural, physicochemical and stratigraphic controls of ore localization; Fluid inclusions in ore - principles, assumptions, limitations and applications.

Unit-II

Classification and genesis of ore deposits associated with orthomagmatic ores of ultramafic-mafic rocks; Ores of felsic-silicic igneous rocks; Ores of sedimentary affiliation; biochemical, chemical and clastic sedimentation, placers and residual concentration deposits; Ores of metamorphic affiliations. Global distribution of Ore deposits in relation to plate tectonics.

Unit-III

Study of ore minerals related to the following metals with special reference to their mineralogy, genesis, specification, uses and distribution in India: Iron, Manganese, Base Metals, Chromium, Gold, Tin and Tungsten. Study of important Indian ore deposits with reference to their geology, stratigraphy and reserves.

Unit IV

Mineral Exploration: Geochemical prospecting for Metallic Mineral Deposits; exploration methods; surface and subsurface exploration methods. Sampling and assaying. Assessment of grade; Reserve estimation; Basic pattern of Mineral economy and changing mineral requirements. Application of remote sensing in mineral exploration.

Unit V

Classification of mining methods; Surface mining methods; placer mining methods and open pit methods, ground sluicing, hydraulic mining, dredging, drift mining, shovel mining and multi bench, lateral advance mining method. Underground mining methods; open stopes mining methods, supported stopes mining methods, shrinkage, cut and fill and square set mining methods. Mine safety and ventilation.

List of recommended books:

- Branes, H.L. (1979): Geochemistry of Hydrothermal Ore Deposits, John Wiley.
- Craig, J.R. and Vaughan, D.J. (1994): Ore Microscopy and Petrography.
- Cuilbert, J.M. (1986): The Geology of Ore Deposits, Freidman.
- Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
- Jensen M.R. and Bateman A.M. (1981), Economic mineral deposits, John Wiley & Sons.
- Klemm, D.D. and Schnieder, H.J. (1977): Time and Strata Bound Ore Deposits, Springer-Verlag.
- Mookherjee, A. (1999): Ore Genesis- A Holistic Approach, Allied Publishers.
- Wolf, K.H. (1976-1981): Handbook of Stratabound and Stratiform Ore deposits, Elsevier.
- Arogyaswami, R.P.N. (1996): Courses in Mining Geology, IV Ed. Oxford IBH.
- Bateman, A.M. (1952): Economic Mineral Deposits, The University of Chicago Press.

GEOT 304: GEOLOGICAL FIELD TRAINING

Compulsory field work in geologically significant terrains, Viva-voce and Report

GEOP 301: Practical IX

On the basis of theory paper GEOT 301

GEOP 302: Practical X

On the basis of theory paper GEOT 302

GEOP 303: Practical XI

On the basis of theory paper GEOT 303

DEPARTMENT SPECIFIC ELECTIVES

The students of M.Sc. Semester III have to choose one of the two DSE papers.

DSEGEO 301: ENVIRONMENTAL GEOLOGY AND NATURAL HAZARDS

Unit I

Fundamentals of environmental geology; Domains of environment and its relationship with earth system; Earth surface processes – weathering and erosion; Composition and characteristics of terrestrial and marine environment; Types of supra-crustal rocks and their interaction with surface and ground water; Surface and ground water pollution and their major causes; Time scales of global changes in the ecosystem and climate. Impact of circulations in atmosphere and oceans on climate and rain fall. Levels of Present and past atmospheric carbon-dioxides. Global warming caused by CO_2 increase in the present atmosphere. Carbon Sequestration.

Unit II

Earthquakes and tsunamis – causes of occurrence, distribution, intensity and their impact as natural hazard; Seismic hazard zones. Volcanoes, Natural hazard associated with volcanic eruptions. Landslide- causes, impact as natural hazards and control. Major river belts of India, flood hazards and their mitigation

Unit III

Soils: Introduction to soils, soil profiles, colour texture and structure of soils, soil properties, soil fertility, water in soil, soil classification, Parameters influencing weathering, development of soils and soil profiles. Soil pollution and its effects on ecosystem. Coastal erosion its causes and control.

Unit V

Role of physical, chemical and biological parameters influencing environment. Riverine and marine environments and their important characteristics. Environmental pollution as a consequence of mining, processing and utilization; Consequences of over-withdrawal of groundwater: lowering of water table, compaction and surface subsidence, and salt-water intrusion.

List of Recommended Books:

- Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press.
- Keller, E.A.(1978): Environmental Geology, Bell and Howell, USA.
- Nagabhushaniah, H.S. (2001): Goundwater in Hydrosphere, CBS Publ.
- Perry, C.T. and Taylor, K.G. (2006): Environmental Sedimentology, Blackwell Publ.
- Singh, S. (2001): Geomorphology, Pustakalaya Bhawan, Allahabad.
- Todd, D.K. (1995): Groundwater Hydrology, John Wiley and Sons.
- Valdiya, K.S.(1987): Environmental Geology – Indian Context, Tata McGraw Hill.

DSEGEO 302: Paleoceanography and Paleoclimatology

Unit- I

Approaches to Paleoceanography; Deep sea sediments properties; Magnetic Stratigraphy of deep sea sediments; Cenozoic Paleoceanographic Events and related Tectonic Events.

Unit- II

Biological Tracers in Paleoceanography. Stable oxygen and carbon isotopic ratios in paleoceanography. Applications of Mg/Ca analysis in paleoceanography. Dating methods (radio isotopic dating; paleomagnetism; biological dating).

Unit- III

Introduction to climate and climate systems; Global climate pattern; Factors controlling climate; Plate tectonics and climate change; Milankovitch cycles; Atmosphere and Ocean interaction and its effect on climate. Introduction to the Paleoclimatic reconstruction; Late Cenozoic Paleoclimatic Events.

Unit- IV

Proxies in paleoclimatic studies; Ice cores in paleoclimatology; Dendroclimatology; Marine sediment records in paleoclimatology; Non-marine geological evidences in paleoclimatology; Non-marine biological evidences in paleoclimatology.

List of recommended books:

- Bradley, R.S. (Ed.) (1999): Paleoclimatology (2nd Ed.), Elsevier.
- Haq, Bilal and Boersma, Anne (Ed.) (1998): Introduction to Marine Micropaleontology, Elsevier.
- Marcel, C.H. and Vernal, A.D. (Ed.) (2007): Proxies in Late Cenozoic Paleoceanography,
- Sinha, D.K. (Ed.) (2006): Micropaleontology: Application of Stratigraphy and Paleoceanography, Narosa Publishers, New Delhi.

M.Sc. GEOLOGY
FOURTH SEMESTER EXAMINATION

Nomenclature of Paper	Credits	Contact Hrs./ Week	Maximum Marks	Internal Assessment 40 Marks	End Semester Examination Marks	Min. Pass Marks in End Sem. Exam.
				20x2		
GEOT 401: Geochemistry and Isotope Geology	4	4 hrs.	100	20x2	60	24
GEOT 402: Project Oriented Dissertation	6	One full semester	200		200	80
GEOP 401: Practicals XII	2	1½hrs.	50		50	20
DSEGEO 401: Geology of the Central India OR **DSEGEO 402:** Mechanism of Crustal Deformation	3	2 hrs.	100	20x2	60	24
Total	**15**		**450**	**80**	**370**	

Detailed Syllabus

M.Sc. GEOLOGY

SEMESTER-IV

GEOT 401: Geochemistry and Isotope Geology

Unit I

Introduction and principles of geochemistry; chemical composition and properties of atmosphere, hydrosphere and lithosphere; Geochemical cycles; meteorites-types and composition; Geochemical classification of elements; fractionation of elements in minerals/rocks; Nernst's partition coefficient (compatible and incompatible elements).

Unit II

Sampling procedures and introduction to analytical techniques used in geochemical analysis (XRF, ICPMS, AMS and EPMA).

Unit III

Trace and Rare Earth Element (REEs) geochemistry. Application of spider/REE patterns in petrogenesis. Mineral stability in Eh-Ph diagrams; a brief introduction to geochemistry of natural waters and sedimentary rocks; geochemical processes involved in rock weathering and soil formation.

Unit IV

Stable Isotope geochemistry of Carbon and Oxygen and their application in Geological Studies; Monazite chemical dating; Half-life and decay equation; dating of minerals and rocks with Rb-Sr, U-Pb and Sm-Nd isotopes; petrogenetic implications of Sm-Nd and Rb-Sr systems.

Unit V

Ocean Geochemistry; $CaCO_3$ Cycles; Geochronometry of Marine Deposits; Geochemical evidence of quaternary sea-level changes. Elemental and isotopic proxies for past ocean temperature estimations; Tracers of past ocean circulation; Geochemical Indicators of Ice sheet dynamics during Glacial and Interglacial periods.

List of recommended books:

- Bloss, F.D. (1971): Crystallography and Crystal Chemistry, Holt, Rinehart, and Winston, New York.
- Brownlow, A. (1996): Geochemistry, 2nd edition, Prenctice Hall.
- Elderfield, H. (1985): The Oceans and the Marine Geochemistry, 1st Edition, Elsevier.
- Evans, R.C., (1964): Introduction to Crystal Chemistry, Cambridge Univ. Press.
- Faure, G. (1998): Principles and Application of Geochemistry, 2nd edition, Prentice Hall.
- Mason, B. and Moore, C.B. (1985): Principles of Geochemistry, 4th edition, Wiley Eastern Limited.
- Hoefs, J. (1980): Stable Isotope Geochemistry, Springer-Verlag.
- Klein, C. and Hurlbut, C.S. (1993): Manual of Mineralogy, John Viley and Sons, New York.
- Krauskopf, K.B. (1967): Introduction to Geochemistry, McGraw Hill.
- Mason, B. and Moore, C.B. (1991): Introduction to Geochemistry, Wiley Eastern.

- Rollinson, H.R. (1993): Using geochemical data: Evaluation, Presentation, and Interpretation. Longman U.K.
- Gopalan, K. (2017): Principles of Radiometric Dating, Cambridge University Press.

GEOT 402: Project Oriented Dissertation

A project oriented dissertation in consultation with the faculty in-charge.

* Criteria for the allotment of Project Oriented Dissertation: The students will be allotted dissertation as per the following criteria:
a. Merit list of the M.Sc.-I (Semester I & II) examination
b. Available facilities and expertise in the department
c. The mode of project (field work, lab analysis, review work) shall be decided by the faculty and shall be abided by the students

DEPARTMENT SPECIFIC ELECTIVES

The students of M.Sc. Semester IV have to choose one of the two DSE papers.

DSEGEO 401: Geology of the Central India

Unit-I

The Archean geological record; Tectonic, petrological and geochemical evolution of different Archean Cratons situated in the Central India. Bastar Craton: Tectonic boundaries, deformation pattern, Sukma Group, Bengpal Group, Bailadila Group, Bhopalpatanam Granulite, Mafic dykes. Bundelkhand Craton: Evolution of the Craton, Boundaries of Craton, Banded Gneissic Complex, Sandmata Complex, Mafic dykes, Bundelkhand Granite.

Unit-II

Paleoproterozoic Mobile Belts in Central India; Chhotanagpur Gneiss Complex. Bhandara Group; Sakoli Basin: structural boundaries, tectonic setup, mineralization. Dongargarh Domain: tectonic boundaries and Bimodal Volcanism. Sausar Basin: tectonic setup, mineralization. Malanjkhand Granite: Geological setting, Copper deposit.

Unit-III

Geochemical and crustal evolution of the different tectonic Zones**:** Central Indian Tectonic Zone (CITZ) **-** Kotri-Dongargarh Belt. Gneissic Complex: Amgaon Gneiss, Bengpal Gneisses, Tirodi Gneisses. Supracrustal belts: Mahakoshal Supracrustal Belt, Betul Supracrustal Belt, Sausar Supracrustal Belt.

Unit-IV

Major Shear Zones: Son-Narmada North Fault (SNNF), Son-Narmada South Fault, Tan Shear Zone, Balrampur fault. Granulite Terrain: Balaghat-Bhandara Granulite Belt (BBG), Ramakona-Katangi Granulite Belt (RKG), Makrohar Granulite Belt (MGB).

List of recommended books:

- J. Halla, M.J. Whitehouse, T. Ahmad , Z. Bagai (2017): Crust–Mantle Interactions and Granitoid Diversification: Insights from Archaean Craton. Geological Society of London.
- K. S Valdiya (2010): The making of India Geodynamic Evolution. Macmillan Publishers India Ltd.
- S.M. Naqvi (2005): Geology and Evolution of the Indian Plate (From Hadean to Holocene-4Ga to 4Ka). Capital Publishing Company.
- R. Vaidyanadhan and M. Ramakrishnan (2008): Geology of India. Geological Society of India Bangalore.

DSEGEO 402: Mechanism of Crustal Deformation

Unit-I

Behaviour of rocks under stress: elastic, plastic, viscous and viscoelastic responses and their geological significance. Stress and Strain in rocks, 2-D stress and strain analysis; Strain ellipses of different types and their geological significance. Mechanics of rock fracturing: fracture initiation and propagation; coulomb's criterion and Griffith's theory.

Unit-II

Recrystallisation mechanism: Grain Boundary Migration, subgrain rotation, Bulging recrystallisation. Deformation of rock forming minerals and polymineralic rocks.

Unit-III

Introduction to ductile shear zones and development mechanism of mylonites, characteristics and classifications of mylonite fabric. Introduction to cohesive and incohesive brittle fault rocks, pseudotachylytes: formation and its geological importance.

Unit-IV

Kinematics of deformation: Introduction to Experimental Structural Geology; High P-T experiments with rock samples: basic concepts and important examples. Analogue modelling of deformational structures and its geological importance: concept of experimental scaling. Published examples of sandbox/shear box experiments and their extrapolation to natural situations.

Books recommended:

- Condie, Kent. C. (1982): Plate Tectonics and Crustal Evolution, Pergamon Press Inc.
- York Fossen, H. (2010): Structural Geology, Cambridge University Press
- Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Development. Pergamon Press.

- Passchier, Cees W., and Rudolph AJ Trouw. *Microtectonics*. Vol. 2. Berlin: Springer, 1996.
- Bayly, B., 1992. *Mechanics in Structural Geology,* Springer
- Rams ay, J.G. and Huber, M. l., 1983. Techniques of Modern Structural Geology: Vol. I & Il. AcadeJnic Press
- Ramsay, J. G., 1967. Folding and Fracturing of Rocks, McGraw-Hill Book Company, New York
- Mukherjee, M. (2013). Deformation, Microstructure in Rocks, Springer.