REVISED CURRICULUM OF
M. Sc. PROGRAMME IN APPLIED GEOLOGY
(w.e.f. Dec., 2020)

Department of Earth Science
Aryabhatta School of Earth Sciences
Assam University, Silchar
2020

M.Sc. (Applied Geology): Programme Summary

First Semester

Course No.	Course Title	Mark Distribution			Credit
		Semester	Sessional	Total	
ESCCC - 101	Geomorphology, Remote Sensing and Solid Earth Geophysics	70	30	100	6
ESCCC - 102	Palaeontology	70	30	100	6
ESCCC - 103	Mineralogy	70	30	100	6
ESCCC - 104	Igneous Petrology	70	30	100	6
ESCCC - 105	Practical on ESCC-101,102,103 and 104	70	30	100	6
	Total	**350**	**150**	**500**	**30**

Second Semester

Course No.	Course Title	Mark Distribution			Credit
		Semester	Sessional	Total	
ESCCC - 201	Structural Geology and Tectonics	70	30	100	6
ESCCC - 202	Sedimentology	70	30	100	6
ESCOC - 203	Open course*	70	30	100	6
ESCOC - 204	Open course**	70	30	100	6
ESCCC - 205	Practical on ESCCC -201, 202 and Field Work	70	30	100	6
	Total	**350**	**150**	**500**	**30**

Third Semester

Course No.	Course Title	Mark Distribution			Credit
		Semester	Sessional	Total	
ESCCC - 301	Principles of Stratigraphy and Indian Stratigraphy	70	30	100	6
ESCCC - 302	Petroleum Geology	70	30	100	6
ESCCC - 303	Hydrogeology and Environmental Geology	70	30	100	6
ESCCC - 304	Metamorphic Petrology and Geochemistry	70	30	100	6
ESCCC - 305	Practical on ESCCC– 301, 302, 303 and 304	70	30	100	6
Total		**350**	**150**	**500**	**30**

Fourth Semester

Course No.	Course Title	Mark Distribution			Credit
		Semester	Sessional	Total	
ESCCC - 401	Ore Geology and Mining Geology	70	30	100	6
ESCCC - 402	Seismology and Exploration	70	30	100	6
ESCCC - 403	Project Oriented Dissertation	140	60	200	12
ESCCC - 404	Practical on ESCCC-401, 402 and Field Work	70	30	100	6
Total		**350**	**150**	**500**	**30**

* Know Your Planet (**For Non-Geology students**)

** (i) Treasures of Earth (**For Non-Geology students**); (ii) Geology, Tectonics and Mineral Resources of Northeast India (**For Geology students**)

The Course Structure:

Candidates who have passed Three Years Degree Course (Science) examination with *Honours in Geology* will be considered eligible for admission to the M.Sc. (Applied Geology). Students admitted to the Program shall be required to pursue their studies for two consecutive academic sessions involving four semesters; each of six months duration. They will be examined and evaluated on grade basis at the end of each semester in respective courses of theory and practical as per credits assigned. The programme shall consist of (a) Core Courses (b) Open courses (c) Geological Field Training and (d) Project Oriented Dissertation involving a total of 120 credits distributed equally over the four semesters (30 credits per semester) as detailed below:

a. The Core courses will be compulsory for all the students admitted to M.Sc. (Applied Geology). There will be twelve core Theory courses, each of 6 credits and four core Practical courses including two field works each of 6 credits covering major branches of Geology.

b. There shall be two open courses (Theory) each of 6 credits in 2nd semester. A student is required to complete at least one open course (6 credits) from other departments of the University.

c. Two compulsory geological field trainings each of two weeks duration are to be carried out by the students in the 2nd and 4th semester. The field work in 2nd semester will be conducted under the supervision of a faculty where as the one in 4th semester will be undertaken by the student independently as assigned by the Department. Following each field work the student will submit a report for evaluation and shall undertake corresponding viva-voce examination at the end of respective semester.

d. There shall be a compulsory Project Oriented Dissertation of 12 credits in the 4th semester. The area of Dissertation shall be assigned to the students based on the preference and merit of the student as well as expertise available within the Department. Students are required to submit their findings in the form of a Thesis followed by an open seminar presentation for the purpose of evaluation at the end of the semester.

Programme Objectives

The Programme (MSc. in Applied Geology) aims to provide a comprehensive knowledge on different branches of Geology with special focus on the applied aspect of the subject.
Prime objectives of the Programme are as follows:

- ♣ To provide in-depth knowledge on different thrust areas of Applied Geology.
- ♣ To provide hands-on training to students for making them independent to work
- ♣ To provide exposures to new technologies and to motivate students to take up new challenges.
- ♣ Motivate and train the students for scientific research to generate, communicate and apply new ideas for betterment of society.
- ♣ To implant self-learning, discipline and leadership qualities to the students.

Programme Outcomes

The M.Sc. in Applied Geology program in the Department covers a full spectrum of the subject necessary to build human resources in the field of Geological Science. Various programme outcomes are as follows

- ❖ Meticulously designed courses provide a thorough knowledge on the subject
- ❖ Gain skills in geological field work and mapping, identification of rocks, minerals, ores and fossils.
- ❖ Ability to identify, analyse and interpret geological data in multiple perspectives.
- ❖ Awareness about natural hazards and mitigation.
- ❖ Competence in use of modern technical tools in different fields of geology.
- ❖ Able to identify and formulate research problems and to adapt scientific approach to reach substantiated conclusions.
- ❖ Recognize and comprehend professional ethics, community living and Nation Building initiatives.

Individual Course Outcomes

FIRST SEMESTER

Course Code: ESCCC-101
Course Title: Geomorphology, Remote Sensing and Solid Earth Geophysics

- Understandings on the control of geological structures on geomorphological features; Soil development and role of soil in geomorphology
- Understandings on Geomorphic processes and landform evolution models
- Basic understandings on Solid Earth Geophysics.

Course Code: ESCCC-102
Course Title: Palaeontology

- Detailed identifying character of different Invertebrate, vertebrate, plant and Microfossils.
- Understandings of Palaeobiogeography, Evolution, Taphonomy etc.
- Application of different fossils.

Course Code: ESCCC-103
Course Title: Mineralogy

- Understandings on crystal chemistry and bonding in minerals
- Understandings on internal atomic structures and classification of minerals
- Detailed study of different mineral groups
- Optical properties of minerals and their uses in identification of minerals under microscope

Course code: ESCCC-104
Course title: Igneous Petrology

- Understandings of various processes associated to magma genesis and magmatic activity.
- Portraying magmatic processes in Phase diagrams.
- Understandings on Internal dynamics of the earth and its evolution through time.
- Relation of magmatic activity with plate tectonics.

Course Code: ESCCC-105
Course Title: Practical on ESCCC-101, 102, 103 and 104

- Calculation/analyses of various entities like drainage network, slopes etc. using aerial photographs, toposheets etc.
- Identification, morphological description, functional morphology and interrelation of different fossils
- Identification of minerals in hand and under microscope.
- Graphical analyses of magmatic processes portrayed in phase diagrams
- Identification of igneous rocks in hand and under microscope

SECOND SEMESTER

Course Code: ESCCC-201

Course Title: Structural Geology and Tectonics

- Understandings of behaviour of rocks under variable stress, strain and surrounding conditions
- Geometric characterization, classification and types of structural elements like fracture, joint, fault, fold, shear zone etc.
- Understandings of geological structures in terms of mechanism involved.
- Spatio-temporal relationship of geological structures with tectonic movements
- Broad knowledge on geodynamic evolution of Indian sub-continent with special reference to Himalayan Orogenic Belt

Course Code: ESCCC-202

Course Title: Sedimentology

- Understandings on earth's surface system, Fluid flow mechanics and flow regimes Sedimentary Environments and Facies
- Petrogenesis of sandstones; sandstones composition and plate – tectonics
- Diagenesis of sandstones and carbonate rocks.
- Heavy minerals and their uses in provenance studies

Course Code: ESCOC-203

Course Title: Know Your Planet (*For Non-Geology students*)

- Basic understandings on interior of earth
- Positions of different continents in geological time
- Journey of Indian plate over geological time and evolution of Himalaya
- Basics of radioactive age dating of earth materials
- Basics of identification of fossils, importance and application of fossils
- Basic idea of plate tectonics, seismicity and different types of seismic waves
- Theory and evidences on Earthquake and Tsunami

Course Code: ESCOC-204

Course Title: Geology, Tectonics and Mineral Resources of NE India *(For Geology students)*

- Understandings on the geology and stratigraphy of Assam, Meghalaya, Manipur, Mizoram and Tripura
- Idea on tectonic settings of Assam, Meghalaya, Manipur, Mizoram and Tripura.
- Knowledge on mineral resources of Assam, Meghalaya, Manipur, Mizoram and Tripura.

Course Code: ESCCC-205

Course Title: Practical on ESCCC–201, 202 and Field work

- Structural map interpretation and preparation;
- analyses of different Structural elements by Geometrical methods and Stereonet
- Identification of sedimentary rocks in hand and under Microscope
- Geological Field Training

THIRD SEMESTER

Course Code: ESCCC-301

Course Title: Principles of Stratigraphy and Indian Stratigraphy

- Principle of different Stratigraphic techniques.
- Building up stratigraphy of any area by using different principles.
- Broad knowledge of Indian Stratigraphy.

Course Code: ESCCC-302

Course Title: Petroleum Geology

- Knowledge on origin and composition of petroleum.
- Characteristics of reservoir rocks and traps.
- Methods and stages in the development of oil fields.
- Detailed knowledge of Onshore and offshore petroliferous basins of India.
- Understandings on Geophysical exploration for hydrocarbon
- Estimation of oil and gas reserves
- Drilling of Oil wells; Know-how of Primary and enhanced oil recovery methods

Course Code: ESCCC-303

Course Title: Hydrology and Environment Geology

- Understandings on occurrences of groundwater and its flow
- Broad knowledge on well hydraulics
- Development and management of presently available water resources for future
- Natural and man-made Environmental changes

Course Code: ESCCC-304

Course Title: Metamorphic Petrology and Geochemistry

- Understandings on the processes of metamorphism and characteristics of metamorphic rocks; Relation of metamorphism with plate tectonics
- Applications of trace and rare earth elements in understanding magmatic processes. Applications of stable and radiogenic isotopes in understanding earth processes including an age determination of earth materials.

Course code: ESCCC-305

Course Title: Practical on ESCCC-301, 302, 303 and 304

- Constraints of bio-, Litho-, Sequence- and Seismic-Stratigraphy etc.
- Evaluation of hydro-chemical constituents for quality aspects of different uses of water
- Practical understanding of groundwater flow movement through subsurface layers
- Practical understanding on Characteristics of reservoir rocks and traps
- Practical understandings on Geophysical data
- Graphical exercises on trace and rare earth elements data in understanding magmatic processes
- Use of radio-isotopes data for age determination of earth materials
- Identification of metamorphic rocks in hand and under Microscope

Course code: ESCCC-401
Course title: Ore Geology and Mining Geology

- Be able to understand ore forming processes and characteristics of various types of ore deposits.
- Be familiar with metallic and non-metallic ore deposits of India.
- Be able to understand opencast and underground mining processes.
- Be familiar with mining activities of Indian mineral deposits.

Course code: ESCCC-402
Course Title: Seismology and Exploration

- To render understandings of seismicity and Indian seismotectonics
- Strategies for the exploration of economic mineral deposits
- Detailed insights into geological and geochemical techniques for mineral prospecting and exploration

Course code: ESCCC-403
Course Title: Project Oriented Dissertation

Be able to 1) identify problem, 2) survey literature, 3) carryout field investigation, 4) Preparation of samples for lab studies/analysis and 5) Writing of thesis.

Course code: ESCCC-404
Course Title: Practical on ESCCC- 401, 402 and Field work

- Identification of ore minerals in hand and under microscope
- Estimation of ore reserves in an ore deposit
- Graphical determination of epicenter of earthquake based on seismic data
- Handling of Geophysical data (graphical and numerical) for understanding sub-surface geological structures
- Field investigation and writing report on a chosen geological site

FIRST SEMESTER

ESCCC-101: Geomorphology, Remote Sensing and Solid Earth Geophysics
Total Credit: 6
Full Marks: 100 (Semester 70+ Sessional 30)

UNIT I: Introduction to Geomorphology; Control of geomorphological features by geological structure, lithology and climate. Physical, chemical, and biological processes in weathering; Soil profiles and nomenclature of horizons. Classification of soils, Role of soil in geomorphology.

UNIT II: Geomorphic processes; Fluvial, Glacial, Coastal landforms; Models of Landform evolution, Davis' Model, Penk's Model, King's Model; Tectonic Geomorphology; geomorphic markers; Geomorphic indices of active tectonics

UNIT III: Mass movement and hill-slope evolution, Classification of mass movements. Morphometric analysis of basins. Concept of basin morphometry. Laws of drainage composition. Linear aspects aerial aspects, relief aspects.

UNIT IV: Electromagnetic spectrum; electromagnetic bands in remote sensing; spectral signatures of soil, rock, water and vegetation; thermal, near infra-red and microwave remote sensing; digital image processing; LANDSAT, IRS and SPOT- characteristics and use; aerial photos- types, scale, parallax, relief displacement; elements of image interpretation.

UNIT V: Significance and limitations of π- and β- diagrams. Geometrical analysis of simple and complex structures on macroscopic scale. Palaeomagnetism, polar wandering and reversal of earth's magnetic field.

Books recommended:

Miller, V.C. 1961: Photogeology. McGraw Hill.
Jim Ellis and Floyd Sabins, F.F. 2020: Remote Sensing Principles and Applications 4th edition. Waveland Press
Drury, S.A. 1987: Image Interpretation in Geology. Allen & Unwin.
Lillesand, T.M. and Kieffer, R.W. 1987: Remote Sensing and Image Interpretation. John Wiley
Paine, D.P. 1981: Aerial Photography and Image Interpretation for Resource Management. Wiley
Thornbury, 2nd Edition: Principles of Geomorphology, CBS
H.S. Sharma, 1991: Indian Geomorphology, Concept Publishing Co, New Delhi
Singh, S., 2001: Geomorphology, Pustakalaya Bhawan, Allahabad.

ESCCC-102: Palaeontology
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

Unit I: Principles of palaeontology: Species concept and speciation, Species problem in palaeontology, bio-, chrono-, and morpho-species; Origin and diversity of life; Morphodynamics; Adaptation and functional morphology; Mechanism of evolution; Palaeobiogeography,Taphonomy, Major mass extinction events of earth's history.

Unit II: Functional morphology and evolutionary history of Brachiopoda, Mollusks and Echinoids. Trace fossils: kinds, classification and their significance in palaeo-environmental analysis. Variations in pedicle opening in brachiopods; variation in occulo-genital system and ambulacral plates in echinoids.

Unit III: Foraminifera: brief morphology and classification. Morphology and classification of Ostracoda, Radiolaria, Conodonts and their significance; Introduction to dinoflaggellates and its significance. Palynology including spore/pollen morphology and their applications.

Unit IV: Plant diversity through time, significance of Gondwana Flora. Vertebrate body plan, major evolutionary events of vertebrates; evolution of Horses, Elephants, and Hominids

Unit V: Application of micropaleontology in hydrocarbon exploration. Oxygen and Carbon isotope studies of microfossils and their use in paleoceanographic and paleoclimatic interpretation.

Books Recommended:

Alfred R. Loeblich, Jr. and Helen Tappan (1998): Foraminiferal Genera and their classification: Van Nostrand Reinhold Company, New York
Arnold (2002): Quaternary Environmental Micropaleontology (Ed. Simon K. Haslett), Oxford
University Press, New York
Benton, M.J. (1990): Vertebrate Paleontology. Unwin Hyman, London
Bignot, G., Grahm and Trottman (1985): Elements of Micropaleontology, London
Boardman, R.S., Cheethan, A.M. and Rowell, A.J. (1988): Fossil Invertebrates, Blackwell
Clarksons, E.N.K. (1998): Invertebrate Paleontology and Evolution, Allen and Unwin
Colbert, E.H. (1984): Evolution of Vertebrates. Willey Eastern Ltd
Haynes, J.R. (1981): Foraminifera, John Wiley
Jones, Robert Wynn. (1996): Micropaleontology in Petroleum Exploration,Clarendon Press
Prothero, D.R. (2004): Bringing Fossil to Life An Introduction toPaleontology (2nd Ed.), McGraw Hill
Raup, D.M. and Stanley, S.M (2008): Earth System History, Blackwell Publ.
Raup, D.M. and Stanley, S.M. (1985): Principles of Paleontology ,CBS Publ.
Romer, A.S. (1966): Vertebrate Paleontology (3rd Ed.) Chicago University Press
Strean, C.W. and Carroll, R.L. (1989): Paleontology the record of life, John Wiley

ESCCC-103: Mineralogy
Total Credit: 6
Full Marks: 100 (Semester 75 + Sessional 30)

UNIT I: Introduction to crystal chemistry: bonding in minerals, solid solution, exsolution, polymorphism, isomorphism, pseudomorphism, polytipism, polysomatism; Atomic and Ionic radii, Pauling's rules governing the ionic structures; Spheres in closest packing: Cubic closest packing, Hexagonal closest packing, Body centered cubic packing. Voids in closest packing.

UNIT II: Structure & Classification of Silicate minerals. Detailed study of following mineral groups with reference to their general formulae, classification, atomic structure, chemistry, diagnostic physical and optical properties, P-T stability, alteration and occurrences: a. Nesosilicates: Olivine Group, Garnet Group, Aluminosilicate Group (Kyanite, Andalusite, and Sillimanite) b. Cyclosicates: Beryl.

UNIT III: Detailed study of following mineral groups with reference to their general formulae, classification, atomic structure, chemistry, diagnostic physical and optical properties, P-T stability, alteration and occurrences: a. Inosilicates: Pyroxene Group; Amphibole Group, b. Phyllosilicates: Kaolinite Group; Serpentine Group; Mica Group; Chlorite Group, c. Tectosilicates: Feldspar Group; Cordierite.

UNIT IV: Twinning and twin laws; common types of twins and their examples in minerals. Concept of Crystal Field Theory and mineralogical spectroscopy; Liquid crystals and their applications

UNIT V: Light – mineral interactions, Refractive index determinations; Pleochroism; Isotropism vs Anisotropism, Interference color; Birefringence; Extinction - types and determination. Optical Indicatrix- Uniaxial and Biaxial Interference Figures and Optic sign determination, 2V and 2E.

Books Recommended:

Berry, L.G., Mason, B. and Dietrich, R.V.: Mineralogy, CBS Publishers
Dana, E.S. and Ford, W.E.: A textbook of Mineralogy. Wiley Eastern Limited
Deer, W.A., Howie, R.A. & Zussman, J.: An Introduction to the rock forming minerals,
Longman Guillman: Art and Science of Crystal Growth
Kerr,P.F. Optical Mineralogy. McGraw Hill Book Company
Klein, C. and Huburt, Jr., C.S., 1993: Manual of Mineralogy. John Wiley
Moorhouse, W.W.: Optical Mineralogy.
Nesse, D.W.: Optical Mineralogy, McGraw Hill
Philips, Wm, R. and Griffen, D.T. 1986: Optical Mineralogy, CBS Edition
Putnis, Andrew. 1992: Introduction to Mineral Sciences. Cambridge Univ. Press
Spear, F. S. (1993) : Mineralogical phase equilibria and Pressure- Temperature- Time paths
Winchell: Elements of Optical Mineralogy part I and II

ESCCC-104: Igneous Petrology
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

UNIT I: Magma: its concept, Origin and source. Physical properties of magma: Factors influencing physical properties of magma, ascent and emplacement of magma; differentiation and evolution of magma; Classification of ultramafic, mafic and acid igneous rocks; Forms, textures and of igneous rocks and their significance.

UNIT II: Phase rule and phase diagrams. Phase relations in Binary and Ternary systems, Application of phase rule in the study of silicate systems Binary: Diopside-Anorthite; Albite-Anorthite; Leucite-Quartz and Ternary: Diopside-Albite-Anorthite; Diopside-Forsterite-Anorthite; Forsterite-Anorthite-Silica

UNIT III: Petrogenesis, mode of occurrences, and tectonic setup of the following magmatic rock series:
a. Basalt and andesite
b. Granite-Granodiorites, Tonalite-Diorite
c. Tholeiite - alkali-olivine basalt
d. Gabbro-Peridotite-Dunite
e. Alkaline rocks and Carbonatites

UNIT IV: Mantle heterogeneities; Partial melting processes in the upper mantle and basaltic magma genesis; Basaltic magma spectrum in relation to partial melting processes; Concept of Enriched and Depleted mantle (EM and DM); Plume magmatism and hot spots.

UNIT V: Magmatism in relation to global tectonic processes. Characteristic magma series associated with specific tectonic settings. Igneous activity related to convergent plate boundary and divergent plate boundary environments; Intracontinental hot spots and anorogenic magmatism; Ophiolites.

Books Recommended:
Best, Myron G., 2002: Igneous and Metamorphic Petrology, Blackwell Science.
Bose, M.K., 1997: Igneous Petrology, World Press, Kolkata.
Carmichel, Turner and Verhoogen: Igneous Petrology, Mc.Graw Hill.
Cox, K.G., Bell, J.D. and Pankhurst, R.J., 1993: The Interpretation of Igneous Rocks.
Faure, G.: Origin of Igneous Rocks, Springer.
Mc Berney, 1993: Igneous Petrology
Middlemost. E.A.K.: Igneous Petrology
Philpotts, A.R. 1994: Principles of Igneous and Metamorphic Petrology, Prentice Hall.
Sood, M.K., 1982: Modern Igneous Petrology. Wiley Publ., New York.
Wilson, M., 1993: Igneous Petrogenesis. Chapman and Hall, London.
Winter John D., 2009: Principles of Igneous and Metamorphic Petrology (2nd Edition)

ESCCC-105: Practical on ESCCC-101, 102, 103 and 104
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

Section A:
Morphometric analysis in different river basins. Interpretation of structures from contour maps. Study of nature of aerial photographs: resolution, mosaics, symbols, gully pattern, drainage analysis, and image parallax. Determination of scale, height, dip, slope, vertical exaggeration, and image distortion. Interpretation from imageries.

Section B:
Study of vertebrate fossils, pollens, foraminifers, ostracods and Trace fossils of India. Coiling geometry in Gastropoda, cephalopoda. Application and interpretation in sedimentary depositional environment. Techniques of separation of microfossils from matrix; SEM applications in micropaleontology; Study of surface ultrastructures of foraminifera; Study of larger benthic foraminifera useful in Indian stratigraphy with special reference to Cenozoic petrolliferous basins of India; Important palynomorphs of Cretaceous and Paleogene age.

Section C:
Handspecimen study of minerals. Thin section study of minerals.

Section D:
Megascopic and microscopic study of igneous rocks. Exercises on calculation of modal mineralogy and assigning name to rocks; Calculation of CIPW Norms; Exercises on Binary and Ternary Phase diagrams.

SECOND SEMESTER

ESCCC - 201: Structural Geology and Tectonics
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

UNIT I: Mechanical principles and properties of rocks and their controlling factors, Concept of stress; Theories of rock failure; Two-dimensional stress analyses; Concept of strain, two-dimensional strain analysis; Types of strain ellipses and ellipsoids, their properties and geological significance; Strain markers in naturally deformed rocks.

UNIT II: Mechanics of folding and buckling. Fold development and distribution of strain in folds. Morphological & Geometrical classification of folds. Causes and dynamics of faulting with special reference to stress and strain, strike-slip faults, normal faults, over thrust and nappe and their characteristics; Fractures and joints.

UNIT III: Brittle and ductile shear zones, geometry and products of shear zones; Mylonites and cataclasites; Planar and linear fabrics in deformed rocks, their origin and significance. Concept of petrofabrics, Planar and linear fabrics in deformed rocks, graphic treatment, Types of fabrics, fabric elements and interpretation of fabric data on microscopic and mesoscopic scale. Use of universal stage.

UNIT IV: Plate Tectonics: recent advances, pros and cons. Dynamic evolution of continental and oceanic crust. Tectonic features of extensional-, compressional-, and strike-slip-terrains and relevance to plate boundaries. mantle plumes, Salt tectonics.

UNIT V: Study of large-scale tectonic features of the Earth. Tectonics of Precambrian Orogenic Belts of India. Formation of mountain roots. Anatomy of orogenic belt. Structure and origin of the Alpine-Himalayan belt, the Appalachian-Caledonian belt and the Andes. Plate tectonic evolution of India.

Books Recommended:

Condie, Kent. C. (1982): Plate Tectonics and Crustal Evolution, Pergamon Press Inc.
Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Developments. Pergamon Press.
Hobbs, B.E., Means, W.D. and Williams, P.F. (1976): An outline of Structural Geology, John Wiley and Sons, New York.
Ramsay, J.G. (1967): Folding and fracturing of rocks, McGraw Hill.
Ramsay, J.G. and Huber, M.I. (1983): Techniques of Modern Structural Geology, Vol. I, Strain Analysis, Academic Press.
Ramsay, J.G. and Huber, M.I. (1987): Techniques of Modern Structural Geology, Vol. II, Folds and Fractures, Academic Press.
Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology, Vol. III (Application of continuum mechanics), Academic Press.
Turner, F.J. and Weiss, L.E. (1963): Structural analysis of Metamorphic Tectonites, McGraw Hill.
G.H. Davies, (1996): Structural geology of rocks and regions, Wiley, New York
Twiss, R.J. and Moores E.M. (1992): Structural Geology, W.H. Freeman.

ESCCC-202: Sedimentology
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

UNIT I: Earth Surface System: liberation of flux of sediments. Sedimentary structures: classification, significance and field recording. Fluid flow mechanics and formation of sedimentary bedforms, Concept of Flow Regime.

UNIT II: Sedimentary Environments and Facies; Walther's law of facies succession, Processes and characteristics of fluvial, estuarine, deltaic, lagoonal, barrier beach, tidal flats and deep-sea environments.

UNIT III: Marine and continental evaporate. Shallow water carbonates. Volcanoclastic: on-land and marine. Palaeocurrent properties and indicators, Palaeocurrent analysis. Significance of ichnofossils in sedimentological studies, Cyclic sedimentation.

UNIT IV: Petro genesis of sandstones, Graywacke and graywacke problem; plate - tectonics and sandstones composition, Sedimentary basins in relation to Plate tectonics, Clastic petrofacies, Palaeoclimate indicators.

UNIT V: Diagenesis and fluid flow. Diagenesis of mudstones, sandstones and carbonate rocks: changes in mineralogy, fabric and chemistry. Heavy minerals and their uses in provenance studies.

Books Recommended:

Allen, J.R.L. 1985: Principles of Physical Sedimentation. George Allen & Unwin.
Allen, P. 1997: Earth Surface Processes. Blackwell.
Nichols, G. 1999: Sedimentology and Stratigraphy. Blackwell.
Reading, H.G. 1996: Sedimentary Environments. Blackwell.
Davis, R.A. Jr. 1992: Depositional Systems. Prentice Hall.
Einsele, G. 1992: Sedimentary Basins. Springer Verlag.
Prothero, D.R. and Schwab, F. 1996: Sedimentary Geology. Freeman.
Miall, A.D. 2000: Principles of Sedimentary Basin Analysis. Springer Verlag.
Pettijohn, F.J., Potter, P.E., and Siever, R. 1990: Sand and Sandstone. Springer Verlag.
Blatt, H., Murray, G.V., and Middleton, R.C. 1980: Origin of Sedimentary Rocks.
Bhattacharya, A. and Chakraborti, C. 2000: Analyses of Sedimentary Successions. Oxford -IBH.
Boggs, Sam Jr. 1995: Principles of Sedimentology and Stratigraphy. Prentice Hall.
Sengupta, S. 1997: Introduction to Sedimentology. Oxford - IBH.
Reineck, H.E. and Singh, I.B. 1980: Depositional Sedimentary Environments. Springer Verlag.
Collins, J.D., and Thompson, D.B. (1982): Sedimentary Structures, George Allen and Unwin, London.
Lindholm, R.C. (1987) A Practical Approach to Sedimentology, Allen and Unwin, London.
Selley, R. C. (2000) Applied Sedimentology, Academic Press.
Tucker, M.E. (1981): Sedimentary Petrology: An Introduction, Wiley and Sons, New York.
Tucker, M.E. (1990): Carbonate Sedimentolgy, Blackwell Scientific Publication.

ESCOC - 203: Know Your Planet
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

UNIT I: Solar system, origin of earth, Bing bang theory, Distribution of crust, mantle and core, Interior of the earth: density, heat budget, magnetism, gravity, isostasy. Geological Time Scale.

UNIT II: Basic idea of plate tectonic: different types of plates and plate boundaries, evidences and results. Positions of different continents in geological time. Journey of India and origin of Himalaya.

UNIT III: Seismicity. Different types of seismic wave, Earthquake and Tsunami: theory, evidences and results. Major Earthquakes and Tsunami of India: causes and results

UNIT IV: Origin of life, Evolution of life: mechanism and major trend, Fossil: basic and application, Major Mass extinction Events of Earth s history.

UNIT V: Basic idea of geochronology, Parent-daughter isotopes; Radioactivity, Half-life, Decay Equation; Isotope dating: basics and applications, Dating of Rocks.

Books Recommended:

Bott, M.H.P., 1982: The interior of the earth its structure, constitution and evaluation.
Condie, K. C. : Plate tectonics and crustal evolution
Kearey, P. & Brooks, M., 1991: Introduction to Geophysical Prospecting, Osney Mead, Oxford.
Nagata, T.: Rock Magnetism, Maruzen Co., Ltd., Tokyo
Parkinson, W.D., 1983: Introduction to Geomagnetism, Scottish Acad., Press, Edinburgh
Pick, M., Picha, J. & Vyskocil, V. 1973: Theory of the Earth s Gravity Field, Elsevier.
Tarling, D.H. 1983: Palaeomagnatism, Chapman and Hall, London
Telford, W. M., Geldart, C.P., Sheriff, R.E. & Keys, D.A., 1976: Applied Geophysics, Cambridge University Press
Walther, JV, 2009: Essentials of Geochemistry.

ESCOC-204 (i): Treasures of Earth
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

UNIT I: Definition of energy: primary and secondary energy; difference between energy, power and electricity; renewable and non-renewable sources of energy; potential of hydroelectric power, solar energy, wind, wave and biomass-based power and energy.

UNIT II: Scope of water resources: past, present and future; distribution of water resources in the Earth; introduction to surface and groundwater resources; major rivers of India and their potential for generation of energy; groundwater prospect zones of India and its future requirement.

UNIT III: Mineralogy, genesis, classification, uses and distribution of metallic ores: Fe, Cu, and Zn; Mineralogy, origin, classification, uses and distribution of radioactive minerals and precious and semi-precious ores minerals.

UNIT IV: Petroleum: its different states of natural occurrence, chemical composition and physical properties of crudes in nature; origin and migration of oil.

UNIT V: Coal and its properties: different varieties and ranks of coal and origin of coal; mineral and organic matter in coal; geology and petrography of coalfields of India.

Books Recommended:

Evans, A.M. 1993. Ore Geology and Industrial Minerals. Blackwell Sc. Publ.
Gokhale, K.Y.GK. and Rao, T.C. 1978. Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi
Deb, S. 1980. Industrial minerals and rocks of India, Allied Publishers
Todd, D.K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons,
N.Y. Karanth K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co.
Fetter, C.W. 2001. Applied Hydrogeology, Prentice Hall Inc., U.S.A.
Larry Thomas, 2002. Coal Geology, Wiley and Sons.
E.E. Somermier 2008. Coal: it's composition, analysis, utilisation and valuation, Mc GrawHill
F.K. North, I986. Petroleum Geology, Allen and Unwin
B.P.Tissot and D.H.Welte 1978. Petroleum Formation and Occurrence, Springer-Verlag
R.C. Shelley 1998. Elements of petroleum Geology, Academic press
KDMIPE, ONGC, 1986. Petroliferous basins of India
Nebojsa Nakicenovic 1998. Global Energy Prospectives, Cambridge University Press.
Tushar K. Ghosh and M. A. Prelas. 2009. Energy Resources and Systems: Fundamentals and Non-Renewable Resources, Springer
Hermann-Josef Wagner and Jyotirmay Mathur. 2009. Introduction to Wind Energy Systems, Springer Bent Sorensen, 2007. Renewable Energy Conversion, Transmission and Storage, Springer
C.E. Brown. 2001. World Energy resources, Springer

ESCOC-204 (ii): Geology, Tectonics and Mineral Resources of N. E. India
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

UNIT I: Detailed Stratigraphic succession, Lithology, Structure and Tectonics, Fossil content and Mineral Resources of Nagaland

UNIT II: Detailed Stratigraphic succession, Lithology, Structure and Tectonics and Mineral Resources of Meghalaya

UNIT III: Detailed Stratigraphic succession, Lithology, Structure and Tectonics, Fossil content and Mineral Resources of Assam

UNIT IV: Detailed Stratigraphic succession, Lithology, Structure and Tectonics, Fossil content and Mineral Resources of Folded belt of Nagaland-manipur including Ophiolites.

UNIT V: Detailed Stratigraphic succession, Lithology, Structure and Tectonics, Fossil content and Mineral Resources of folded belts of Cachar-Mizoram-Tripura

Books Recommended:

Karunakaran, C.1972: Geology and Mineral Resources of the states of India, Misc. Publ., Geol. Surv. India
Dasgupta, A.B. and Biswas, A.K. 2000: Geology of Assam. Geol Soc. India, Bangalore.
D. N. Wadia, 1957: Geology of India (3rd ed) . Mc Millan, London, 536p.
E. H. Pascoe, 1968. A manual of the Geology of India & Burma (Vols. 1 – 1v) Govt. of India Press, Delhi.
M.S. Krishnan, 1982. Geology of India and Burma (6th ed) CBS Publishers & Distributors, Delhi, 536p.
S.M. Naqvi, 2005. Geology and Evolution of the Indian plate (from Hadean to Holocene-4 Ga to 4ka) Capital publishing co., 450p.
S.M. Naqvi, and J.J.W. Roger, 1987. Precambrian Geology of India, Oxford Univ. Press 223p

ESCCC- 205: Practical on ESCCC-201, 202 and Field Work
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

Section A:
Preparation and interpretation of geological maps and sections; Structural problems concerning economic deposit based on orthographic and stereographic projections; Recording and plotting of the field data; Study of deformed structures in hand specimens; Strain estimation from the data collected from the field; Study of dip-isogons from the fold profiles; Preparation of geotectonic maps.

Section B:
Megascopic study of clastic and non-clastic rocks. Studies of primary, secondary, and biogenic sedimentary structures in hand specimens, in photographic atlases, field photographs, and wherever possible on outcrops. Exercises related to palaeocurrent analysis and interpretation of depositional sedimentary environments. Microscopic examination of important rock-types. Heavy mineral separation and microscopic examination. Grain-size analysis by sieving method; Plotting of size-distribution data as frequency and cumulative curves, computation of statistical parameters and interpretation.

Section C (Field work):
Students are compulsorily required to carry out field work of two weeks duration on various components of Field Geology. Each student is required to submit a report duly certified by the Teachers in-Charge of the Field tour and the Head of Department and have to take a viva- voce examination at the end of semester.

THIRD SEMESTER

ESCCC-301: Principles of Stratigraphy and Indian Stratigraphy
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

UNIT I: Controls on the development of stratigraphic records. Completeness/incompleteness of stratigraphic records. Lithostratigraphy: correlation and stratigraphic code. Global Stratotype Section and Point (GSSP). Biostratigraphy: controlling factors, zonation, time significance, quantitative stratigraphy. Geochronology and chronostratigraphy

UNIT II: Sequence stratigraphy and its correlation with sea level changes, controlling factors. Brief ideas of magneto- seismic- chemo- and event stratigraphy; Stratigraphic correlations. Glacial-interglacial cycles, eustatic changes with a special reference to Quaternary. Quaternary dating methods, –radiocarbon, Luminescence, Amino-acid

UNIT III: Classification and correlation of Precambrian crystalline rocks of India with particular reference to Singbhum, Aravalli; Mobile belts: Eastern Ghats. Stratigraphic classification and correlation of Purana Basin with a special reference to Vindhyan and Cuddapah.

UNIT IV: Classification, lithology, correlation and fossils of Palaeozoic rocks of India with particular reference to Tethyan basins, Spiti, Kashmir and Peninsular India. Classification, lithology, correlation and fossils of Gondwana Super Group

UNIT V: Classification and correlation of Mesozoic rocks of India with particular reference to Triassic of Kashmir and Spiti, Jurassic of Kutch and Cretaceous of Trichinopally. Deccan Volcanism. Classification, lithology, correlation and fossils of Cenozoic rocks of India with particular reference Assam- Meghalaya; Quaternary stratigraphy of India; Neogene-Quaternary boundary problem.

Books Recommended:

Pomerol, C. 1982: The Cenozoic Era: Tertiary and Quaternary. Ellis Harwood Ltd.
Goodwin, A.M. 1991: Precambrian Geology: The Dynamic Evolution of Continental Crust. Academic Press.
Doyle, P. and Bennet, M.R. 1996: Unlocking the Stratigraphic Record. John Wiley
Brenner, R.E. and McHargue, T.R. 1988: Integrative Stratigraphy: Concepts and Applications. Prentice Hall.
Naqvi, S.M. and Rogers, J.J.W. 1987: Precambrian Geology of India. Oxford University Press
Naqvi, S.M. 2005. Geology and Evolution of the Indian Plate: From Hadean to Holocene-4 Ga to 4 Ka. Capital Pub., New Delhi.
Miall, A.D., 1999. Principles of Sedimentary Basin Analysis 3rd Ed Springer Verlag, New York
Nichols, G., 1999. Sedimentology and Stratigraphy, Blackwell publishing
Octavian Catuneanu, 2006. Principles of Sequence Stratigraphy, Elsevier
Schoch,R.M., 1989. Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.
Vaidyanathan, R & Ramakrishnan, M. 2008. Geology of India, Geological Society of India
K.S. Valdiya, 2016. The Making of India: Geodynamic Evolution, Springer

ESCCC-302: Petroleum Geology
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

UNIT I: Petroleum its composition and origin. Migration of petroleum and natural gas. Reservoir properties: porosity and permeability, fluid saturation, relative permeability and fluid flow. Characteristics of reservoir rocks and traps (structural, stratigraphic and combination). Pressure condition in the reservoir. Identification and characterisation of Source rock.

UNIT II: Geophysical exploration for hydrocarbon: Gravimetric and Seismic surveys-principles and interpretation. Oil well drilling and drilling fluids. Estimation of oil and gas reserves.

UNIT III: Wireline logging: principles and interpretations of Spontaneous Potential log, Natural gamma ray log, Porosity logs-sonic, density, neutron logs, Resistivity log, Conventional electric log, Induction logging, Resistivity and water saturation.

UNIT IV: Development of oil fields-aims, methods and stages, Primary and enhanced oil recovery-stimulation of initial recovery, water flooding, thermal recovery method, miscible flood method, polymer flooding, MEOR.

UNIT V: Onshore and offshore petroliferous basins of India; Geology of productive oil and gas fields of India with special reference to NE India; Elements of unconventional petroleum systems; Basin-centered gas, fractured-shale gas system, shallow biogenic gas and natural gas hydrates.

Books Recommended:

F.K. North, I986. Petroleum Geology, Allen and Unwin
B.P.Tissot and D.H.Welte 1984. Petroleum Formation and Occurrence, Springer-Verlag
R.C.Shelley 1998. Elements of petroleum Geology, Academic press
KDMIPE, ONGC, 1986. Petroliferous basins of India
Leverson: Geology of Petroleum

ESCCC-303 Hydrology and Environment Geology
Total Credit: 6
Full marks: 100 (Semester 70+ Sessional 30)

UNIT I: Hydrologic cycle, Groundwater in hydrological cycle, distribution of water in the Earth's crust, hydrographic analysis, water balance studies. Springs (Including thermal); Origin and movement of water. Geologic structures favoring groundwater occurrence. Method of identification of groundwater reservoir properties.

UNIT II: Force of laws of groundwater movement. Darcy's law. Groundwater recharge; artificial and natural Factors controlling recharge, conjunctive and consumptive use of groundwater. Fluctuation of groundwater level, cone of depression.

UNIT III: Groundwater in arid and semiarid, coastal and alluvial regions. Intrusion of saline water in coastal rocks. Groundwater in hard rocks and limestone terrain with reference to Indian situation. Role of remote sensing and GIS in groundwater prospecting. Well types, drilling methods, construction, design, development and maintenance of wells.

UNIT IV: Principles of environmental geology, orientation to environmental studies, global environmental issues in Environmental Geology. Time scales of global changes in the ecosystems and climate. Earth resources – Conservation, management, concept of sustainable development.

UNIT V: Environmental geologic mapping. Environmental change- natural and man-made; Prediction of environmental changes and areas of human concern and impact indicators. Environment impact analysis of dams, building, highways and tunnels. EIA methods. Scales of interest in EIA and EIA models. – Steady state and time dependent.

Books recommended:

Chow, V.T, 1988; Advances of Hydroscience . McGraw Hill.
Walton, W.C, 1988; Ground Water Resource Evaluation. McGraw Hill.
Black, W.et al (Eds), 1989; Hydrogeology Geol. Soc. Am. Publications.
Mahajan, G, 1990; Evaluation and Development of Ground Water, D.K Publishers.
Raghunath, N.M, 1982; Groundwater , Wiley Eastern.
Todd, D.K, 1980 Groundwater Hydrology. John Wiley.
Davies, S.N, and Dewiest, R.J.M. 1966; Hydrogeology. John Wiley.
Freeze, R.A and Cherry,J.A,1979; Groundwater, Prentice Hall
Fetter, C.W. 1990; Applied Hydrogeology, Merrill Publishing
Alley, W.M. 1993; Regional Groundwater Quality. VNR, New York.
Subramaniam. V . 2000; Water. Kingston Publications, London
Valdiya K.S. 1987; Environmental Geology-Indian Context. Tata McGraw Hill.

ESCCC- 304: Metamorphic Petrology and Geochemistry
Total Credit: 6
Full Marks: 100 (Semester 75 + Sessional 30)

UNIT I: Kinetics of metamorphism. Metamorphic textures and structures. Types of metamorphic equilibrium reactions. Graphical representation of mineral assemblages in composition diagrams (ACF AKF and AFM diagrams). Progressive metamorphism of pelites and basic rocks. Metamorphism in relation to plate tectonics.

UNIT II: Concept of Barrovian and Buckan type of metamorphism. Metamorphic facies; Classification of metamorphic facies. Description of each facies of regional metamorphism with special emphasis on characteristic minerals, mineral assemblages and P-T conditions of metamorphism.

UNIT III: Meteorites: classification, mineralogy, origin, significance; Major and trace elements geochemistry of igneous rocks; Concept of distribution coefficients; Geochemical fractionation of trace elements in magmatic processes; applications of trace elements and REE in application in igneous patrogenesis and as tectonic discriminants.

UNIT IV: General characteristics of isotopes. Stable isotopes: fundamentals and principles; nature, abundance and fractionation of stable isotopes. Isotopes of Oxygen, Hydrogen, Carbon and Sulphur, Application of stable isotopes in geological studies.

UNIT V: Radiogenic isotopes: Criteria for useful radioactive nuclides, Radioactive decay mechanisms. Srontium, Lead and Neodymium isotopes. Radioactive decay schemes, growth of daughter isotopes and radiometric dating. Geochronology: Rb-Sr, U-Pb and Sm-Nd isotope systematization

Books Recommended:

Mason, B. & Moore, C.B. 1991: Introduction to Geochemistry
Krauskopf, K.B. 1967: Introduction to Geochemistry.
Faura, G. 1986: Principles of Isotope Geology.
Hoets, J. 1980: Stable Isotope Geochemistry. Springer Verlag.
Marshal, C.P. & Faibridge, R.W. 1999: Encyclopedia of Geochemistry.
Nordstorm, D.K. and Munoz, J.L. 1986: Geochemical Thermodynamics.
Henderson, P.1987: Inorganic Geochemistry
Rollinson, H. 1993: Using geochemical data: evaluation, presentation and interpretation. Longman.
Winkler: Metamorphic Petrology
Turner, F. J., 1980: Metamorphic Petrology, Mc Graw Hill.
Bucher, K. and Martin, F. 2002: Petrogenesis of Metamorphic Rocks, Springer-Verlag
Walther, 2009: Essentials of Geochemistry

ESCCC-305: Practicals on ESCCC- 301, 302, 303 and 304
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

Section A:
Study of rocks in hand specimens from known Indian stratigraphic horizons and type localities; Exercises on stratigraphic classification and correlation, sequence-, magneto- and seismic stratigraphic interpretations; Study and understanding of plate-movements through important periods during Phanerozoic eon; Study of palaeogeographic maps of various geological periods.

Section B:
Preparation of lithostratigraphic sections from geophysical well logs and well data, study of wireline logs (SP, IEL, Porosity, Neutron, Gamma ray, CBL), Determination of Porosity and water saturation (for clean sand) from well log data, structure contour, isopay and isopach maps, estimation of Oil and gas reserves, preparation of geotechnical order for exploratory and development wells.

Section C:
Delineation of hydrological boundaries on water table contour maps and estimation of permeability; Hydrogeomorphic mapping. Analysis of hydrochemical facies and its evolution on Trilinear and Durov diagrams. Pumping test: time-drawdown and time recovery tests and evaluation of aquifer parameters. Vertical electrical resistivity.

Section D:
Megascopic and microscopic study of metamorphic rocks of different facies. Graphic construction of ACF, AKF and AFM diagrams. Plotting and interpretation of major elemental characteristics of igneous rocks. The uses and applications of major and trace element composition of igneous rocks as a means to understand the petrogenesis of the rocks. Exercies on isotopes: Stable; Radiogenic; Dating of earth materials using $^{235}U/^{207}Pb$ and $^{87}Sr/^{86}Sr$ ratio.

FOURTH SEMESTER

ESCCC-401: Ore Geology and Mining Geology
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

UNIT I: Concept of ore genesis; Spatial and temporal distribution of ore deposits; Metallogenic epochs and Metallogenic Provinces. Nature and morphology of principles types of ore deposits; Classification of ore deposits. Textures, paragenesis and zoning of ores and their significance

UNIT II: Concept of ore bearing fluids, their origin and migration. Wall rock alteration; Structural, physicochemical and stratigraphic controls of ore localization; Ore deposits in relation to Plate tectonics; Fluid inclusions in ore – principles and applications.

UNIT III: Mineralogy, 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.

UNIT IV: Study of ore minerals related to the following metals with special reference to their mineralogy, genesis, specification (if any), uses and distribution in India: Fe, Mn, Cr, Cu, Pb, Zn. Al, Sn, and W.

UNIT V: Classification and description of mining methods. Planning, exploration and exploratory mining of surface and underground mineral deposits. Exploration for placer deposits; Ocean bottom mining; Mining hazards: mine inundation, fire and rock burst.

Books Recommended:

Arrogyaswami, R.N.P. 1996: Courses in Mining Geology (IV ed). Oxford IBH.
Barnes, H.L. 1979: Geochemistry of Hydrothermal Ore Deposits. John Wiley.
Boyle, R.W. 1982: Geochemical Prospecting for Thorium and Uranium Deposits. Elsevier.
Clark, G.B. 1967: Elements of Mining (3rd ed). John Wiley.
Craig, J.M. and Vaughan, D.J. 1981: Ore Petrography and Mineralogy. John Wiley.
Dahlkamp, F.J. 1993: Uranium Ore Deposits. Springer Verlag.
Evans, A.M. 1993: Ore Geology and Industrial Minerals. Blackwell.
Guilbert, J.M. and Park, C.F. Jr. 1986: The Geology of Ore Deposits. Freeman.
Klemm, D.D. and Schneider, H.J. 1977: Time and Strata Bound Ore Deposits. Springer Verlag.
McKinstry, H.E. 1962: Mining Geology (2nd ed). Asia Publishing House.
Mookherjee, A. 2000: Ore Genesis A Holistic Approach. Allied Publishers.
Peters, W.C. 1978: Exploration and Mining Geology. John Willey and Sons.
Sawkins, F.J. 1984: Metal deposits in Relation to Plate Tectonics. Springer Verlag.
Stanton, R.L. 1972: Ore Petrology. McGraw Hill.
Torling, D.H. 1981: Economic Geology and Geotectonics. Blackwell.

ESCCC-402 Seismology and Exploration
Total Credit: 6
Full marks: 100 (Semester 70+ Sessional 30)

Unit I: Introduction to seismology; Types of Seismic waves and their characteristics, Earthquake and its effects; Elastic rebound theory; Classification of earthquakes; Seismicity and seismotectonics of India; Magnitude scales; Intensity scales.

UNIT II: Theory of elasticity; Generalized Hooke's law; Different types of elastic waves; Seismometers; Analysis of seismograms; Seismic networks and arrays; Earthquake prediction.

UNIT III: Mineral Stages and norms of exploration. Geological techniques and procedures of exploration. Geological criteria and guides to mineral search. Geological mapping phases and types. Sampling methods.

UNIT IV: Exploration of important economic mineral deposits. Exploration case histories. Study of geological maps and sections, stratigraphic columns, structure contour maps, isopach maps, facies maps.

UNIT V: Geochemistry in Mineral exploration. Geochemical dispersion, mobility and association of elements; various prospecting methods for geochemical rock sampling, soil, water, drainage, biogeochemical and geobotanical surveys and a brief description of geochemical anomalies developed in it.

Books recommended:

Thorne Lay & Terry C.: Wallace Modern Global Seismology, Academic Press
Peter M. Shearer: Introduction to Seismology, Cambridge University Press
Charles Moon, Charles J., Whatley Michael K.G. and Evans K.M. 2006; Introduction to mineral exploration, Blackwell publishing
Haldar S.K.; Mineral exploration, principle and exploration
Kuzbart M. and Bohmer M. 1978; Prospecting and exploration of mineral deposits. Elsevier Sci.
Levinson, A. A. 1974; Introduction to exploration geochemistry, Applied Pub.,
Calgary Peters, W.C. 1978; Exploration and mining geology. John Wiley & Sons, N.Y.

ESCCC- 403: Project Oriented Dissertation
Total Credit: 12
Full Marks: 200 (Semester 140+ Sessional 60)

Candidates admitted to the M.Sc. Programme in Applied Geology will be required to undergo a project-oriented dissertation on the problems assigned by the Department. The dissertation will be field/laboratory/data based and will be carried out under the guidance of a faculty member.
The dissertation findings shall be compiled and submitted in the form of a thesis for evaluation. In addition, candidates are also required to present their dissertation findings in the form of seminar followed by viva-voce before a duly constituted committee.
A certificate duly signed by the candidate and the supervisor has to be enclosed stating the genuineness of the work and it has NOT been submitted elsewhere for any degree.

Examiners and scheme of evaluation shall be as follows:

1. Board of Examiners:
   - i. Chairman : Head of Department
   - ii. Expert : External Examiner
   - iii. Member : Supervisor/ Internal Examiner
2. Evaluation Scheme:
   - i. Evaluation jointly by External and Internal Examiners : 100 Marks
   - ii. Seminar/Viva-Voce : 40 Marks

ESCCC-404: Practical on ESCC-401, 402 and Field work
Total Credit: 6
Full Marks: 100 (Semester 70 + Sessional 30)

Section A:
Megascopic study of metallic ores and industrial minerals in hand specimens; Study of ore structures in hand specimens; Study of optical properties and identification of important ore minerals under ore microscope; Preparation of maps showing distribution of metallic and industrial minerals in India and also classical world mineral deposits. Exercises on calculation of Clarke Concentration. Diagrammatic representation of open cast and underground mining.

Section B:
Construction of sub-surface maps using exploration data. Map exercises based on geological exploration methods. Techniques of trace element analysis in geochemical studies, preparation, decomposition, separation and estimation of various elements present in geological samples. Exercise on sampling, estimation of background and threshold value. Statistical analysis of sampling data.

Section C (Field work):
Students are compulsorily required to undergo independent field work of two weeks duration within the Northeast India as assigned by the Department. Each student is required to submit a report duly certified by the Head of Department and has to take a viva- voce examination at the end of semester.