।। सा विद्या या विमुक्तये ।।
स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड
"ज्ञानतीर्थ" परिसर, विष्णुपुरी, नांदेड - ४३१६०६ (महाराष्ट्र)
SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED
"Dnyanteerth", Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)
Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade
स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ,नांदेड.
25 1994 - 2019 SILVER JUBILEE YEAR
Phone : (02462) 229542 ACADEMIC (1-BOARD OF STUDIES) SECTION Website: srtmun.ac.in
Fax : (02462) 229574 E-mail: bos.srtmun@gmail.com

प्रस्तुत विद्यापीठाच्या संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचे CBCS Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०१९–२० पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, दिनांक ०८ जून २०१९ रोजी संपन्न झालेल्या ४४ व्या मा. विद्या परिषद बैठकीतील ऐनवेळचा विषय क्र.११/४४–२०१९ च्या ठरावानुसार प्रस्तुत विद्यापीठाच्या संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचे खालील विषयांचे C.B.C.S. (Choise Based Credit System) Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०१९–२० पासून लागू करण्यात येत आहेत.

1. Botany
2. Certificate Course in Industrial Safety, Health and Environmental Management (SHM)
3. Chemistry
4. Computer Application
5. Computer Network
6. Computer Science
7. Geophysics
8. Mathematics
9. M.C. A.
10. Microbiology
11. Physics
12. Zoology
13. Geology
14. Environmental Science

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या www.srtmun.ac.in या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड –४३१ ६०६
जा.क्र.:शैक्षणिक–१/परिपत्रक/संकुले/पदव्युत्तर–सीबीसीएस अभ्यासक्रम/२०१९–२०/**४६५**

दिनांक : ११.०७.२०१९

स्वाक्षरित
उपकुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :
१) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) मा. संचालक, सर्व संबधित संकुले, विद्यापीठ परिसर, प्रस्तुत विद्यापीठ.
४) साहायक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.
५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ

Swami Ramanand Teerth Marathwada University

M.Sc. Geology
2 Years (4 Semester Program)
Syllabus
With effective from 2019 – 2020

Department of Geology
School of Earth Sciences
SRTM University
NANDED

M.Sc. Geology
Syllabus Pattern

Syllabus of M.Sc. Geology program offered by the School of Earth Sciences has been prepared considering the syllabi for the UPSC Geologists examination, CSIR-NET examination and the requirements of the industry. The M.Sc. program in Geology is imparted to the students for two academic years consisting of four semesters. Candidates will be examined and evaluated on grade basis at the end of each semester in different theory and practical papers as per the credits offered by each course.

The M.Sc. Geology program consists of (i) Core Subjects (ii) Subject Electives and (iii) Open Elective Courses. The Core Subjects shall be **75%** of the program (***with a total of 100 credits***), which are mandatory for all the students. Students can choose one Subject Elective per semester from the list of Subject Electives provided. A student has to take 8 credits of Open Elective courses within the 2 year term of the program. The Open Electives can be selected from the Open Elective courses offered by the School of Earth Sciences *OR* offered by other Schools from the University Campus. Students are also encouraged to select Open Elective courses from National Educational Platforms such as MOOCS/NPTL/SWAYAM. If a student wishes, he/she can take a few extra courses, which will be considered as add-on credits.

In addition to class-room teaching and laboratory, the M.Sc. Geology program offers geological field training to the students. After completion of field training, students have to submit a filed report to the School. Intensive training/internships in the nationally reputed institutes shall also be provided to the M.Sc. Geology students. The semester breaks can also be utilized for the geological field training and internships.

Students will be assessed through Mid-Term and End-Term examinations. Mode of assessment in the Mid-Term examinations consists of Tutorials, Home Assignments, Seminars, Field studies, Quizzes and Oral presentations. The End-Term examinations will be based on paper-pen pattern and laboratory experiments/calculations.

Every M.Sc. Geology student has to mandatorily submit dissertation thesis. The dissertation work is based on either new data generated for the proposed scientific problem *OR* based on available large global data sets using innovative ideas. The thesis should be based on sound methodology and well defined objectives. Through dissertation work the student should be well-versed with the literature on the chosen topic, independently define a scientific problem, carry out focused study on a research topic, analyze and interpret large data sets, independently write thesis / project proposal and present and defend the dissertation work. The Dissertation must be submitted by the end of fourth Semester with a Seminar presentation in the presence of faculty members, students and external examiners for the purpose of evaluation. The School of Earth Sciences strongly encourages the M.Sc. Geology students to publish their dissertation work in SCI journals.

M.Sc. Geology
I Year - I Semester
Syllabus

M.Sc. Geology, I Year, I Semester (Total Credits = 25)								
Sr. No.	**Subject**	**Code**	**Theory Paper**	**Credits**	**Sr. No.**	**Code**	**Practical Paper**	**Credits**
1	**Core**	GEO-C101	Mineralogy	4	**1**	GEO-C105	Mineralogy	2
2	**Core**	GEO-C102	Structural Geology and Geotectonics	4	**2**	GEO-C106	Structural Geology and Geotectonics	2
3	**Core**	GEO-C103	Palaeontology	2	**3**	GEO-C107	Palaeontology	1
4	**Core**	GEO-C104	Geochemistry	2	**4**	GEO-C108	Geochemistry	1
5	**Subject Elective (Choose any One)**	GEO-E101	Stratigraphy	3	**5**	GEO-E104	Stratigraphy	1
		GEO-E102	Crystallography			GEO-E105	Crystallography	
		GEO-E103	Geology and Tectonic of India			GEO-E106	Geology and Tectonics of India	
6	**Open Elective (for students from all the Schools including School of Earth Sciences)**	GEO-OE101	Fundamentals of Geochemistry	2	**6**	GEO-C109	Seminar/Field Report	1
		GEO-OE102	Earth System Science					
		GEO-OE103	Origin and Evolution Of Life					
			Total	**17**			**Total**	**8**

Department of Geology
School of Earth Sciences
SRTM University
NANDED

GEO-C101: MINERALOGY
(Theory: 4 credits & Practical: 2 credits)

Pre-requisites:

Basic (10+2) knowledge of chemistry and physics + good observational skills.

Course objectives:

1. Minerals are the fundamental blocks of all Earth's solid material and also that of the inner planets of our Solar system. Mineralogy is essential for the courses in igneous, sedimentary and metamorphic petrology, economic geology and for interpretation of geophysical data.

2. This course in Mineralogy would help the students to understand distribution of minerals in different Earth's spheres, evaluate different processes of mineral formation, why some minerals are restricted to particular physic-chemical environments, identify and characterize the minerals based on their physical, crystal chemical and optical properties.

3. The student will study the basic principles behind the arrangement of atoms to form crystal structures, how these atoms are coordinated and bonded and how this is reflected in the external form, chemical composition, and physical properties of the crystals.

4. The student will study how to identify the most common minerals in hand specimen and, by using optical techniques, learn how to identify the common minerals in thin section.

5. The course introduces the minerals, which are of economic significance. The course also introduces the student to sophisticated instruments used in deciphering mineral structure and chemistry.

Course contents:

Unit I: Introduction and Scope

Mineralogy and its scope
Classification of Minerals
Processes of Mineral formation

Unit II: Physical Properties of Minerals

Properties under light
Electrical properties
Magnetic properties
Radioactive properties

Unit III: Chemistry and Structure of Minerals

Chemistry: Basic properties of Elements
Chemical and Geochemical Classification of Elements
Solid solution
Exsolution
Pauling's Rules
Goldschmidt's Rules
Principles and use of EPMA in Mineralogical Studies
Principles and use of ICP-MS in Mineralogical Studies

Structure: Silicate Structures
Polymorphism
Pseudomorphism

Unit IVA: Optical Properties of Minerals

Basic introduction to wave propagation
Isotropy and Anisotropy of Minerals
Petrological Microscope
Optical indicatrices
Orthoscopic properties
Conoscopic properties

Unit IVB: Descriptive Mineralogy

Silicates
Oxides
Carbonates
Sulphides
Precious and Semi-precious stones

GEO-C105: Practical based on GEO-C101 (2 Credits)

1. Study of Rock-forming minerals in Hand Specimen.
2. Study of Rock-forming minerals in Thin Section.
3. Conoscopic Observations of minerals.
4. Calculation of Mineral Chemical Formulae.

Course outcomes:

At the completion of the course students would be able to

1. Explain why different minerals have distinctly different structures.
2. Explain distribution of elements in different structural sites of the minerals.
3. Explain how the properties of chemical elements and their bonds determine the structure and composition of minerals.
4. Demonstrate how the internal structure of minerals affects the external structure and physical properties of minerals.

5. Explain the mineralogical concepts of isomorphism, polymorphism, isostructuralism, solid solution and exsolution.
6. Discuss which mineral identification method is appropriate for solving a mineralogical problem (e.g. polarizing microscope, x-ray diffraction, electron microprobe).
7. Recognize and describe the basic properties and chemistry of common rock-forming minerals.
8. Identify minerals based on megascopic and microscopic observations.
9. Able to calculate mineral formulae based on chemistry.

Prescribed and Reference Books

- ***An Introduction to the Rock-Forming Minerals** by **W.A. Deer, R.A. Howie and J. Zussman (Descriptive Mineralogy)**
- ***Crystallography** by **Walter Borchardt-Ott (X-Ray Diffraction and Crystal Chemistry)**
- ***Manual of Mineralogy** by **C. Klein and C.S. Hurlbut (Prescribed Text Book)**
- ***Rutley's Elements of Mineralogy** by **C.D. Gribble (An Elementary text Book)**
- **An introduction to Mineralogy for Geologists** by **Phillips and Phillips (Crystallography, Crystal Chemistry & Silicate Structures)**
- **Dana's New Mineralogy** by **Gaines, Skinner, Ford, Mason, Rosenzneig (Descriptive Mineralogy)**
- **Heavy Minerals in Colour** by **Mange and Maurer (Good Photographs & brief description of Heavy Minerals)**
- **Introduction to Mineralogy** by **William D Nesse**
- **Mineralogy** by **Berry Mason and Dietrich (Descriptive Mineralogy)**
- **Mineralogy** by **Perkins**
- **Minerals** by **G.W. Robinson (Good Photographs of Minerals)**
- **Optical Mineralogy** by **Paul F. Kerr**
- **Optical Mineralogy** by **P.R.J. Naidu**
- **Optical Mineralogy** by **Phillips andGriffen (Optical Mineralogy)**
- **Principles of Crystal Chemistry** by **E. Cartmell (Crystal Chemistry)**
- **Principles of Mineralogy** by **Blackburn and Denner (X-Ray Crystallography & Descriptive Mineralogy)**
- **Rock and Minerals** by **Dougel Dixon (Good Photographs)**
- **Rock-forming Minerals in Thin Section** by **H. Pichler and C. Schmitt-Riegraf (Thin Section Photographs)**
- **Rocks and Minerals** by **Basil Booth (Good Photographs)**
- **Rocks and Minerals** by **Chris Pellant (Good Photographs)**
- **The Illustrated Encyclopedia of Minerals and Rocks** by **J. Kourimsky (Good Photographs)**

- **Lecture hand-outs**
- **Research papers**

GEO-C102: STRUCTURAL GEOLOGY AND GEOTECTONICS
(Theory: 4 credits & Practical: 2 credits)

Pre-requisites:

Basic (10+2) knowledge of minerals and rocks. The course consists of field work on holidays; wherein student has to work independently. The field tour is a compulsory component of the course.

Course objectives:

1. To interpret the data and identify the structural features.
2. To train the students in identification of structural features, measurement of field data from the structures in the field, plotting and interpreting the data.
3. To train the students in understanding the mechanics of deformations.
4. Measurement of various orientation data from the structures, plotting them in suitable diagrams and make a quantitative analysis.
5. To develop the writing skills based on research pattern/report writing which is useful in research institutes, Government and private organizations.
6. To develop the skills of individual student so that he/she will be competent enough to get job in this field of specialization.

Course contents:

General Information about the Curriculum: This course looks at how one can recognize the structures, how rocks deform and use structures within the rocks to evaluate about the tectonic environment. Students will be introduced to techniques of collecting the field data and interpreting the structural data and plot it on a map. It will help students understand what has happened to the region since its formation. It will help students understand how part of the earth responded to the different types of forces.

Unit I: Stress-strain analysis:

Stress-strain relationships for elastic, plastic and viscous materials; measurement of strain in deformed rocks; Mohr's circle and criteria for failure of rocks; ductile and brittle shears in rocks; kinematic and dynamic analysis of deformation; measurement of strain in deformed rocks; structural analysis of fold, cleavage, boudin, lineation, joint, and fault; stereographic projection of linear and planar structures; calculation of paleostress. Time relationship between crystallization and deformation.

Various states of stresses and their representation by Mohr circles. Techniques of strain analysis, Role of fluids in deformation processes; Rock fabrics- origin, significance, metamorphic tectonites, petrofabrics at microscopic level; use of stereographic and equal area projections.

Unit II: Linear structures – Joints:

Tectonic and non-tectonic joints, columnar and release joints, joint initiation and its mechanics; rock cleavages-axial plane cleavages, their significance, mechanics of rock cleavages, foliations and lineations; boudinage-types and significance; shear zones: types of shear zones; brittle-ductile and ductile structures in shear zones and their kinematic significance, shear zone rocks-mylonite, breccias, etc; planar and linear fabrics in deformed rocks-origin and importance.

Unit III: Structural Features: Folds and Faults

Types and classification of Folds and Faults; identification of Folds and Faults in the field; mechanism of formation of Folds, Faults, Unconformities. application of structural features in other branches.

Unit IV: Geotectonics:

Continents and Oceans: features & origin; Werner's concept of Continental Drift; Wilson cycle; concept of plate, types of plates, plate driving forces, regional tectonic features: ridges, arcs and subduction zone with special reference to Indian examples, hot spots; plate collisions: types, products; tectonics of India with special reference to Himalaya plate convergence and Indian continental deformation; structures at macroscopic level; deformation pattern and magma associations and associated economically important deposits.

GEO-C106: Practical based on GEO-C102 (2 credits)

1. Importance of contour diagrams, investigation and interpretation of geological maps.
2. Stereographic analysis of structural data.
3. Structural problems related to borehole data.
4. Stress-strain analyses.
5. Strain ellipsoids and their significance.
6. Analysing deformations at microscopic level and mesoscopic level.
7. Identification and interpretation of deformations in Deccan Trap and Eastern Dharwar Craton.

Course outcomes:

Students who earn minimum grade should be able to

1. Interpret the field data and interpret structures and deformations.
2. Identify and describe the structures at macroscopic, mesoscopic and microscopic level using specific nomenclature.
3. Understand and describe geometric features formed in the naturally deformed rocks and interpret the type of stress that developed the structure(s).
4. Portray 3D structures on map using different field data.
5. Work individually in the field and produce structural map of a region.
6. Explain the structural features of the region and thereby the geological history of the region.

7. Develop writing skills in writing home assignment, report etc which will be useful in research institutes/govt. organisations/pvt organizations.
8. Understand the methodology of carrying out scientific research in the field of structural geology and geotectonics.
9. Present his/her research findings in the seminars/conferences etc. or publish the research papers at national and international level.

Prescribed and Reference Books

- **An Introduction to Structural Geology** by **A.K. Jain (Geological Society of India publication)**
- **An outline of Structural Geology** by **B.E. Hobbs, W.D. Means and P.F. Williams**
- **Analysis of Geological Structures** by **N.J. Price and J.W. Cosgrove**
- **Aspects of Tectonics -Focus on south central Asia** by **K.S. Valdiya**
- **Basic methods of Structural Geology** by **S. Marshak and G. Mitra**
- **Dynamic Himalaya by K.S. Valdiya**
- **Folding and fracturing of rocks** by **J.G. Ramsay**
- **Geological Structures of SEDVP** by **R.D. Kaplay, Md. Babar, P.R. Wesanekar and T. Vijay Kumar**
- **Geology, Vol. I, Strain Analysis, Academic Press.**
- **Geology, Vol. II, Folds and Fractures, Academic Press.**
- **Geology, Vol. III (Application of continuum mechanics), Academic Press.**
- **Geotectonics by V. V. Beloussov**
- **Global Tectonics. Third Edition (Reprint)** by **P. Keary, K.A. Klepeis and F.J. Vine**
- **Mapping of Geological Structures** by **K. McClay**
- **Mechanics in Structural Geology** by **B. Bayly**
- **Microtectonics** by **C.W. Passchier and R.A.J. Trouw**
- **Our Evolving Planet: Earths History in New Tectonics** by **K.N. Storetvedt**
- **Plate Tectonics and Crustal Evolution, 3rd Ed.** by **K.C. Condie**
- **Structural analysis of Metamorphic tectonites by F.J. Turner and L.E. Weiss**
- **Structural Geology** by **Marland P. Billings**
- **Structural Geology** by **H. Fossen (highly recommended)**
- **Structural Geology of Rocks and Region** by **G.R. Davis**
- **Structural Geology of Rocks and Regions** by **G.H. Davis and S.J. Reynolds**
- **Structural Geology: Fundamental and Modern** by **S.K. Ghosh**
- **Structure and Tectonics** by **P.C. Badgley**
- **Techniques of Modern Structural Geology: Folds and Fractures** by **J.G. Ramsay and M.I. Huber**
- **Tectonics and Structural Geology: Indian Context** by **Soumyajit Mukherjee**
- **Tectonics** by **Eldridge M. Moores and Robert J. Twiss**
- **The Dynamic Earth System** by **A.M. Patwardhan**
- **The Evolving Continents** by **B.F. Windley**
- **Understanding the Earth** by **I.G. Gass**

GEO-C103: PALAEONTOLOGY
(Theory: 2 credits & Practical: 1 credit)

Pre-requisites:

Basic (10+2) knowledge of biology.

Course objectives:

1. Study of paleontology with reference to animal and plant evolution.
2. Application of micropaleontology in oil industries.
3. To develop the writing skills based on research pattern/report writing which is useful in research institutes/govt. organizations/pvt.organizations.
4. To develop the skills of individual student so that he/she will be competent enough to get job in this field of specialization.

Course contents:

Unit I:

General classification of fossils
Evolution - evolutionary pattern based on fossil record
Stratigraphic range and distribution of invertebrate, vertebrate and plant fossils
Fossil record with special reference to India
Significance of marker fossils and fossil assemblages in stratigraphy

Unit II:

Definition and scope of Micropaleontology
Use of Micropaleontology in exploration of fossil fuels
Equipments for micro-paleontological studies
Foraminifera and Ostracoda - their morphology, orientations, growth, reproduction, ecology and palaeo-ecology, classification, evolutionary trends and stratigraphic distribution

GEO-C107: Practical based on GEO-C102 (1 Credit)

1. Megascopic identification and description of invertebrate and vertebrate fossil specimens in the laboratory.
2. Collection, identification and description of different fossils from the field.

Course outcomes:

At the completion of the course student would be able to

1. Identify fossils based on morphological observations.
2. Correlate different stratigraphic units based on fossil record.
3. Classify and characterize different fossils.
4. Better understand origin and evolution of life.
5. Better understand the Palaeo-geography of India.
6. Use microfossils in the exploration for fossil fuels.

Prescribed and Reference Books

- **A Concise Dictionary of Paleontology** by **R. L. Carlton**
- **An introduction to fossils and minerals** by **Jon Erickson**
- **Basic Palaeontology** by **Michael J. Benton and David A.T. Harper**
- **Dynamics of the Earth System: Evolution, Processes and Interactions (2020)** by **D. K. Pandey, (Ed), M. Ravichandran, (Ed) and N. Nair, (Ed)**
- **Elements of Micropaleontology** by **G. Bignot**
- **Fundamentals of Invertebrate Palaeontology** by **S. Jain**
- **Introduction to Marine Micropaleontology** by **Haq and Boersma**
- **Microfossils** by **M.D. Braiser**
- **Micropaleontology in Petroleum Exploration** by **R.W. Jones**
- **Micropaleontology: Principles and Applications** by **Pratul Kumar Sarswati and M.S. Srinivisan**
- **Nature through Time (2020)** by **Martinetto, E. (Ed), Tschopp, E. (Ed), Gastaldo, R. (Ed)**
- **Palaeontology (palaeobiology): Evolution and animal distribution** by **P.C. Jain and M.S. Anantharaman**
- **Principles of palaeontology** by **Stanley Raup**
- **Quaternary Environmental Micropaleontology** by **Simon K. Hasllett**
- **Vertebrate Palaeontology** by **Michael Benton**

GEO-C104: GEOCHEMISTRY
(Theory: 2 credits & Practical: 1 credit)

Pre-requisites:

Basic (10+2) knowledge of chemistry + good analytical skills.

Course objectives:

1. The science of Geochemistry deals with the primordial distribution of elements in different spheres, their migration one sphere to another sphere and the rules governing the distribution and migration of elements.
2. Quantitative estimation of the distribution and migration of elements, in space and time, as the earth evolved.
3. Elements are the fundamental unit of all earth's spheres and also that of the planets of our Solar system.
4. Geochemistry is essential for the courses in igneous, sedimentary and metamorphic petrology, economic geology and for interpretation of geophysical data.
5. This course in Geochemistry would help the students to understand origin of elements, cosmic abundance of elements, what makes Earth's chemical composition unique, primary distribution of elements in different Earth's spheres, evaluate different processes of element migration and how physic-chemical conditions control elemental migration.
6. The course introduces stable and radioactive isotope geochemistry.

Course contents:

Unit I: Introduction to Origin and Distribution of Elements

Origin of elements; Elements and the periodic table and Goldschmidt's classification; Cosmic abundance of elements, Structure and composition of Universe and Solar system; Meteorites-types and composition, Primordial distribution and chemical differentiation of the Earth; Thermodynamic classification of elements; Nernst-Berthelot partition coefficient and bulk partition coefficient; fractionation of elements in minerals/rocks; Fick's laws of diffusion and activity composition relation (Roult's and Henry's law); Geochemistry of different spheres of Earth.

Unit II: Introduction to Isotope Geochemistry

Half-life and decay equation; dating of minerals and rocks with potassium-argon, rubidium-strontium, uranium-lead and samarium-neodymium isotopes; Petrogenetic implications of samarium-neodymium and rubidium-strontium systems; Stable isotope geochemistry of carbon, oxygen and

sulphur and their applications in geology; monazite chemical dating; Geochemical Cycle.

GEO-C108: Practical based on GEO-C104 (1 Credit)

1. Graphical representation of geochemical data.
2. Practical based on Trace element geochemistry.
3. Practical based on Stable and Radiogenic Isotope geochemistry.

Course outcomes:

At the completion of the course student would be able to

1. Explain the origin of elements.
2. Explain distribution of elements in different spheres of the Earth.
3. Explain how the atomic properties of elements and their bonds determine the structure and composition of Earth's spheres.
4. Discuss the role of elements and their isotopes in evaluating Earth's processes.
5. Explain the geochemical processes controlling elemental distribution.
6. Graphical representation of element distribution.

Prescribed and Reference Books

- **Essentials of Geochemistry (2nd Edition)** by **J. Walther**
- **Geochemistry** by **M. White**
- **Geochemistry Pathways and Processes (2nd Edition)** by **H. Y. McSween, S. M. Richardson and M. Uhle**
- **Inorganic Geochemistry - Principles and Applications (3rd Edition)** by **G. Faure**
- **Introduction to Geochemistry** by **Francis Albarede**
- **Introduction to Geochemistry - Principles and Applications** by **K. C. Misra**
- **Inorganic Geochemistry** by **Henderson**
- **Introduction to Geochemical Modeling** by **Francis Albarede**
- **Principles of Geochemistry** by **Brain Mason and Carleton B. Moore**
- **Using Geochemical Data: Evaluation, Presentation, Interpretation** by **Hugh R. Rollinson**

GEO-E101: STRATIGRAPHY
(Theory: 3 credits & Practical: 1 credit)

Pre-requisites:

Basic (10+2) knowledge of geology.

Course objectives:

1. To understood the principles and concept of stratigraphy.
2. To train the students in identification of beds, formations, sedimentary structures, measurement of field, plotting and interpreting them.
3. To train the students to identify and correlate the formations.
4. Measurement of various orientation data from the structures, plotting them in suitable diagrams and make a quantitative analysis.
5. To develop the writing skills based on research pattern/report writing which is useful in research institutes/govt. organisations/Pvt. organizations.
6. To develop the skills of individual student so that he/she will be competent enough to get job in this field of specialization.

Course contents:

Unit I: Introduction

Geological Time Scale; Stratigraphy- development of concept and principles of stratigraphy, Facies Concept in Stratigraphy: Walther's Law of Facies; Concept of lithofacies and biofacies; Transgressions and regression.

Unit II: Methods of Stratigraphic Correlations

Stratigraphic correlation: litho-stratigraphy, bio-stratigraphy, chrono-stratigraphy and magneto-stratigraphy; High Resolution stratigraphic correlation methods (e.g. core and well logging, chemostratigraphy); Concept of Sequence Stratigraphy; Order and duration of sequences; Application of Sequence stratigraphy in hydrocarbon exploration;

Unit III: Stratigraphy of India

Stratigraphy of cratons (Dharwar, Bastar, Singhbhum, Bundhelkhand and Aravalli); Stratigraphy of mobile belts (Eastern Ghat belt, Singhbhum-Chotanagpur belt, Delhi belt Central Indian Tectonic Zone, and Southern Granulite belt); Stratigraphy of Proterozoic basins (Cuddapah and Kurnool basins, Vindhyan basin, Chattisgarh basin); Precambrian/Cambrian boundary. Stratigraphy of the marine Palaeozoic rock formations of India; Permian/Triassic boundary; Stratigraphy of Indian Gondwana basins; Cretaceous/Tertiary boundary; Stratigraphy of Palaeogene and Neogene systems in India; Epoch boundaries of the Cenozoic in India.

GEO-E104: Practical based on GEO-E101 (1 Credit)

In Laboratory:

Study of rocks in hand specimens from known Indian stratigraphic horizons and type localities; Preparation of Stratigraphic correlation maps. Preparation of magneto-stratigraphic and chemo-stratigraphic maps and interpretations.

In Field:

Identification of lithofacies and biofacies in the field.

Course outcomes:

At the completion of the course student would be able to

1. Understand principles of stratigraphic correlation
2. Correlate different strata based on different tools
3. Describe the utility of sequence stratigraphy in hydrocarbon exploration
4. Understand in detail the stratigraphy of India

Prescribed and Reference Books

- **A Manual of the Geology of India and Burma (Vols. I-IV)** by **E.H. Pascoe**
- **Depositional Sedimentary Environments** by **H.E. Reineck and I.B. Singh**
- **Fundamentals of historical geology and stratigraphy of India** by **G. R. Ravindra Kumar**
- **Geology of India and Burma** by **M.S. Krishnan**
- **Geology of India: Volume 1 and Volume 2** by **M. Ramakrishnan and R. Vaidyanathan**
- **Precambrian Geology of India** by **S.M. Naqvi and J.J.W. Rogers**
- **Principles of Sedimentology and Stratigraphy, (Fourth Edition)** by **Sam Boggs Jr.**
- **Principles of Sequence Stratigraphy** by **O. Catenuanu**
- **Principles of Stratigraphy** by **C.O. Danbar and J. Rodgers**
- **Seismic stratigraphy and global changes of sea level: American Association of petroleum Geologists** by **P.R. Vail, R. M. Mitchum, R. G. Todd, J. M. Widmier, S. Thompson, J.B. Sangree, J.N. Bubb and W.G. Hatlelid**
- **Seismic Stratigraphy- Applications to Hydrocarbon Exploration, Memoir of the American Association of Petroleum Geologists 26** by **C.E. Payton**
- **Sequence Stratigraphy** by **D. Emery and K.J. Myers**
- **Stratigraphy: Principles and Methods** by **Robert, M. Schoch**
- **The Cenozoic Era? Tertiary and Quaternary** by **C. Pomerol**
- **The Geology of Stratigraphic Sequences** by **A.D. Miall**
- **The Making of India: Geodynamic Evolution** by **K. S. Valdiya**
- **Unlocking the Stratigraphic Record** by **P. Doyle and M.R. Bennett**

GEO-E102: CRYSTALLOGRAPHY
(Theory: 3 credits & Practical: 1 credit)

Pre-requisites:

Basic knowledge of solid state physics, geology and good observational and analytical skills.

Course objectives:

Crystals are abundant in nature, especially in rock formations as minerals. Crystals enable us to study the structure of matter at the atomic level. The basic objective of this course is to make the student to understand basic concepts of crystal structure of minerals including lattices, symmetries, point groups, and space groups and their interrelationship with physical properties will be explained. The theory and applications of X-ray diffraction (XRD) will be also explained.

Course contents:

Unit I:

Historical development of crystallography and its importance in mineralogy
Crystallography: external and internal symmetry
Introduction to 32 classes of symmetry, description of holosymmetric class of various crystal systems
International system of crystallographic notation
Crystal growth

Unit II:

Symmetry of internal structures – Bravais lattices; Twinning and twin laws, common types of twins and their examples in minerals
Unit Cell, Lattice, Point groups and space groups
Indexing of the diffraction pattern
Liquid crystals and their applications
Group theory and its application
Different types of crystal projections – spherical and stereographic, and their uses

Unit III:

XRD: powder and single crystal diffraction, reciprocal lattice and mathematical crystallography
Diffraction of X-ray by atoms and ideal crystal: Reciprocal lattice and diffraction experiments; single crystal-and powder methods
Crystal defects and chemistry: colour, cause and enhancement techniques, crystal field, molecular orbital and band theories.
Electronic and vibrational spectroscopy methods

GEO-E105: Practical based on GEO-E102 (1 Credits)

1. Study of Classes of Symmetry
2. Study of Unit Cell and Space Lattice

Course outcomes:

At the completion of the course student would be able to

1. Define concepts such as lattice, point and space groups.
2. Recognize and describe the 32 classes of symmetry, description of holosymmetric class of various crystal systems, international system of crystallographic notation.
3. Explain the Unit Cell and Space Lattice.
4. Discuss which mineral identification method is appropriate for solving a mineralogical problem (e.g. x-ray diffraction).

Prescribed and Reference Books

- **An introduction to Mineralogy for Geologists** by **Phillips and Phillips (Crystallography, Crystal Chemistry & Silicate Structures)**
- **Crystallography and Mineralogy: Concepts and Methods** by **Ram S. Sharma and Anurag Sharma**
- **Crystallography** by **Walter Borchardt-Ott (X-Ray Diffraction and Crystal Chemistry)**
- **Heavy Minerals in Colour** by **Mange and Maurer (Good Photographs & brief description of Heavy Minerals)**
- **Manual of Mineralogy** by **C. Klein and C.S. Hurlbut**
- **Principles of Mineralogy** by **Blackburn and Denner (X-Ray Crystallography & Descriptive Mineralogy)**

GEO-E103: GEOLOGY AND TECTONICS OF INDIA
(Theory: 3 credits & Practical: 1 credit)

Pre-requisites:

Basic scientific thinking and geology terminology.

Course objectives:

1. Introduce the students to geotectonics.
2. To understand the geology of India.
3. Application of geotectonic in the making of India
4. To train the students in identification and understanding the Geological formation of India.
5. To train the students to identify and correlate different geologic formations in tectonic perspective.

Course contents:

Unit I: Tectonics of India

Introduction to plate tectonics
Horizontal *versus* Vertical tectonics
Concept of Supercontinentality
Formation of Cratons
Formation of Mobile Belts
Formation of Proterozoic Basins
Formation of Himalayas
India's neighbours in the Precambrian

Unit II: Geology of India: Precambrian

Basement problem
Classification and correlation of Precambrian crystalline rocks of India
Structure and Composition of Archaean crust
Archaean-Proterozoic boundary problem
Proterozoic Mobile belts
Main Proterozoic sedimentary and volcano-sedimentary successions in India

Unit III: Geology of India: Phanerozoic

Gondwana Supergroup
Mesozoic of Peninsular India
Deccan Basalt
Boundary problems: Permo-Triassic, K-T

Tertiary basins of India
Himalayas
Main Quaternary sediments in Peninsular India

GEO-E106: Practical based on GEO-E103 (1 Credit)

1. Preparation of Stratigraphic correlation maps with the help of field data.
2. Preparation and study of geological map on the basis of geological formations.
3. Identification and preparation of geological maps with the help of field surveys.

Course outcomes:

At the completion of the course student would be able to

1. Describe craton, mobile belt, intra-cratonic basins, orogen
2. Understand in detail different geologic domains of India
3. Correlate geology with tectonics.
4. Prepare a geological map.
5. Better understand origin and evolution of Indian subcontinent as a geologic entity.

Prescribed and Reference Books

- **A Manual of the Geology of India and Burma (Vols.I-IV)** by **E.H. Pascoe**
- **Fundamentals of historical geology and stratigraphy of India** by **G. R. Ravindra Kumar**
- **Geology of India and Burma** by **M.S. Krishnan**
- **Geology of India: Volume 1 and Volume 2** by **M. Ramakrishnan and R. Vaidyanathan**
- **Geotectonics** by **V. V. Beloussov**
- **Global Tectonics. Third Edition (Reprint)** by **P. Keary, K.A. Klepeis and F.J. Vine**
- **Precambrian Geology of India** by **S.M. Naqvi and J.J.W. Rogers**
- **The Making of India: Geodynamic Evolution** by **K. S. Valdiya**

GEO-OE101: FUNDAMENTALS OF GEOCHEMISTRY
(Theory: 2 credits)

Pre-requisites:

Basic knowledge of Geology and Chemistry.

Course objectives:

1. Introduce Earth's processes and their products.
2. To introduce student about element abundances in different spheres of earth.
3. To introduce about distribution of elements in Earth and processes controlling the abundance and distribution.
4. Geochemistry of Earth's surface.

Course contents:

Unit I: Introduction

Origin of elements
Elements and the periodic table
Cosmic abundance of elements
Structure and composition of Universe and Solar system
Primordial distribution and chemical differentiation of the Earth

Unit II: Geochemistry of Earth's spheres

Geochemistry of Solid Earth
Geochemistry of Atmosphere
Geochemistry of Hydrosphere
Geochemistry of Biosphere
Geochemical Cycle

Course outcomes:

At the completion of the course student would be able to

1. Explain abundance and distribution of elements in different spheres of Earth.
2. Explain how elements reflect past processes happened on the Earth.
3. Explain processes controlling chemistry of Earth's materials.

Prescribed and Reference Books

- **Earth Materials** by **Cornelis Klein and Anthony Philpotts**
- **Essentials of Geochemistry (2nd Edition)** by **J. Walther**
- **Geochemistry and the Biosphere: Essays** by **Vladimir Vernadsky**
- **Inorganic Geochemistry - Principles and Applications (3rd Edition)** by **G. Faure**
- **Inorganic Geochemistry** by **Henderson**
- **Introduction to Geochemistry - Principles and Applications** by **K. C. Misra**
- **Principles of Geochemistry** by **Brain Mason and Carleton B. Moore**
- **Textbook of Geochemistry** by **Shardendu Kislaya**
- **The Origin and Nature of Life on Earth: The Emergence of the Fourth Geosphere** by **Eric Smith and Harold Morowitz**
- **Using geochemical data: Evaluation, Presentation and Interpretation** by **Hugh R. Rollinson**

GEO-OE102: EARTH SYSTEM SCIENCES
(Theory: 2 credits)

Pre-requisites:

Basic scientific thinking and basic (10+2) knowledge of chemistry, physics and biology.

Course objectives:

1. To introduce student to what makes the planet Earth.
2. Introduce composition and structure of the Earth.
3. Introduce system approach to understand planet Earth.

Course contents:

Unit I: Universe, Solar System and Earth

General characteristics and origin of the Universe, Solar System and its planets
Earth as a planet: Holistic understanding of dynamic planet Earth through Astrophysics, Geology, Meteorology and Oceanography
Introduction to various branches of Earth Sciences
Earth: size, shape, internal structure and composition

Unit II: Lithosphere, Hydrosphere, Atmosphere and Biosphere

Lithosphere
Hydrosphere
Atmosphere
Biosphere
Continental Drift and Plate Tectonics and their consequences

Course outcomes:

At the completion of the course student would be able to

1. Understand origin of Earth.
2. Understand Earth internal structure and composition.
3. Understand different spheres of the Earth and their interaction.
4. Explain the loci of Earthquakes and volcanism on the planet Earth.

Prescribed and Reference Books

- **Blue Planet** by **Skinner and Porter**
- **Earth Materials** by **Cornelis Klein and Anthony Philpotts**
- **Physical Geology** by **Arthur Holmes**
- **The Earth** by **Press and Seiver**

GEO-OE103: ORIGIN AND EVOLUTION OF LIFE

(Theory: 2 credits)

Pre-requisites:

Basic knowledge of Geology and Biology.

Course objectives:

1. Introduce basic geological concepts
2. Introduce students with Fossils.
3. To introduce student to theories on origin and evolution of life on the earth.

Course contents:

Unit I:

Origin of the Universe; Formation of the Elements; Beginnings of Chemistry; Element Abundances of the Planets; Geologic, Hydrologic, and Atmospheric Evolution of the Earth; Earth's Materials and their formation (Minerals, Rocks and Soils); Different spheres of the Earth and their interaction; Geological time scale; Introduction to Fossils and their preservation.

Unit II:

Theories of origin of life (when, where and how?); The Miller-Urey experiment; Possible Roles of Clays and Minerals in the Origin of Life; Evolution of Life based on fossil records; Great Oxygenation event; Carbon fixation and emergence of Continental Life; Cambrian explosion; Entropy and Life.

Course outcomes:

At the completion of the course student would be able to

1. Understand basic geological processes and their products.
2. Comprehend interaction between different Earth spheres.
3. Explain formation and preservation of fossils.
4. Understand different theories of origin
5. Explain evolution of life on the Earth with respect to geological time scale
6. Develop an elementary understanding of relationship between entropy and life

Prescribed and Reference Books

- **Aquagenesis: The Origin and Evolution of Life in the Sea** by **Richard Ellis**
- **Comets and the Origin and Evolution of Life** by **Editors: P.J. Thomas, R.D. Hicks, C.F. Chyba, C.P. McKay**
- **Earth Materials** by **Cornelis Klein and Anthony Philpotts**
- **Evolution of Life: Fossils, Molecules and Culture** by **Editors: Osawa, Syozo, Honjo, Tasuku**
- **Geochemistry and the Biosphere: Essays** by **Vladimir Vernadsky**
- **Origins of Life: On Earth and in the Cosmos** by **Geoffrey Zubay**
- **Palaeontology (palaeobiology): Evolution and animal distribution** by **P.C. Jain and M.S. Anantharaman.**
- **The Origin and Early Evolution of Life** by **Tom Fenchel**
- **The Origin and Nature of Life on Earth: The Emergence of the Fourth Geosphere** by **Eric Smith and Harold Morowitz**

M.Sc. Geology
I Year - II Semester
Syllabus

M.Sc. Geology, I Year, II Semester (Total Credits = 25)								
Sr. No.	**Subject**	**Code**	**Theory Paper**	**Credits**	**Sr. No.**	**Code**	**Practical Paper**	**Credits**
1	**Core**	GEO-C201	Igneous Petrology	4	**1**	GEO-C205	Igneous Petrology	2
2	**Core**	GEO-C202	Thermodynamics and Metamorphic Petrology	4	**2**	GEO-C206	Thermodynamics And Metamorphic Petrology	2
3	**Core**	GEO-C203	Sedimentary Petrology	2	**3**	GEO-C207	Sedimentary Petrology	1
4	**Core**	GEO-C204	Environmental Geology	2	**4**	GEO-C208	Environmental Geology	1
5	**Subject Elective (Choose any One)**	GEO-E201	Computer applications in Geology	3		GEO-E204	Computer applications in Geology	
		GEO-E202 /	Geomorphology and Morphotectonics		**5**	GEO-E205	India as a Geological Entity	1
		GEO-E203	Geostatistics			GEO-E206	Geostatistics	1
6	**Open Elective (for students from all the Schools including School of Earth Sciences)**	GEO-OE201	Geology For Chemists	2	**6**	GEO-C209	Seminar/Field Report	1
		GEO-OE202	Geology For Biologists					
		GEO-OE203	Geology For Physicists					
			Total	**17**			**Total**	**8**

Department of Geology
School of Earth Sciences
SRTM University
NANDED

GEO-C201: IGNEOUS PETROLOGY
(Theory: 4 credits & Practical: 2 credits)

Pre-requisites:

Basic (10+2) knowledge of chemistry and physics + completion of courses GEO-C101 (Mineralogy) and GEO-C104 (Geochemistry).

Course objectives:

General Information about the Curriculum:

Igneous rocks are formed by crystallization of magmas derived from mantle and crust consequently they are the windows to deep Earth composition, structure and processes. Igneous rocks are also significant to understand planetary differentiation. Study of igneous rocks allows us to evaluate mantle-crust differentiation and interactions in space and time. Igneous rocks are fundamental to our understanding of vertical and horizontal tectonics of planet Earth. Volatiles exhaled from the magmas are the building blocks of Earth's primitive atmosphere and hydrosphere and eventually responsible for the origin of life. Finally, igneous rocks are abodes for many large-scale ore deposits.

This course in igneous petrology would help the students to understand

1. Origin of magmas in crust and mantle, evaluate different processes of magma generation
2. Role of temperature, pressure, depth and volatiles on magma composition
3. Application of thermodynamics in understanding igneous rocks
4. Evaluate the role of geochemistry in deciphering magma generation and evolution
5. Correlate magma compositions with plate boundaries
6. Identify and characterize the igneous rocks based on their physical and textural characteristics

Course contents:

Unit I: Igneous Petrology and its scope

From Planetary evolution to the evolution of Lithosphere, Hydrosphere and Biosphere
Major Structural Units of the Earth
Pressure Distribution within the Earth
Temperature Distribution within the Earth
Heat Sources for Magma Generation
Physical Properties of the Magma
Cooling/Crystallization of Magmas and Igneous Textures
Classification Igneous Rocks

Unit II: Magma Generation and Evolution

Sites of Magma Generation
Petrology and Geochemistry of Mantle
Partial Melting and types of mantle melting
Primary Melts
Magmatic differentiation, Zone melting, Contamination, Mixing of magmas
Magmas and Tectonic Environments
Role of Geochemistry in Igneous Petrogenesis

Unit III: Phase Equilibria

Gibb's and Mineralogical Phase Rule
One component system
Two component system
Three component system
Four component system
Role of Volatiles on Phase Equilibria

Unit IV: Petrogenetic Suites and Associations

Komatiites
Basalts
Anorthosites
Layered Complexes
Ophiolites
Lamprophyres, Lamproites, Kimberlites, Carbonatites and Alkaline Rocks
Andesites and Boninites
Granites

GEO-C205: Practical based on GEO-C201 (2 Credits)

1. Study of Igneous Rocks in Hand Specimen.
2. Study of Igneous Rocks in Thin Section.
3. Binary and Ternary Variation Plots.
4. Tectonic discrimination plots.
5. Rare Earth Element and Incompatible Element Normalized Plots.

Course outcomes:

At the completion of the course student would be able to

1. Explain generation of different mantle reservoirs.
2. Explain origin and differentiation of magmas.
3. Apply phase equilibria to the genesis of igneous rocks.
4. Utilize geochemistry in understating igneous processes.
5. Discriminate present- and palaeo-tectonic environments of igneous rocks.
6. Describe crust-mantle differentiation in space and time.
7. Decipher relationship between petrogenesis and ore genesis.

8. Identify and characterize igneous rocks based on megascopic and microscopic observations.
9. Graphically represent geochemical variations in magmas.

Prescribed and Reference Books

- **An Evolution of Igneous Rocks** by **N. L. Bowen (***Classical text based on Experimental Petrology***)**
- **Atlas Igneous Rocks and their Textures** by **McKenzie, Donaldson and Guilford (***Excellent book on texture illustrations***)**
- **Essentials of Igneous and Metamorphic Petrology** by **B. Ronald Frost and Carol D. Frost**
- **Igneous and Metamorphic Petrology** by **Best (***Rock Associations***)**
- **Igneous and Metamorphic rocks under Microscope** by **Shelly (***Good introductory book on petrography***)**
- **Igneous Petrogenesis and Global Tectonic Environments** by **Marjorie Wilson (***Advanced Text on rock associations and tectonic environments***)**
- **Igneous Petrology** by **Anthony Hall (***Phase Equilibria***)**
- **Igneous Petrology** by **D. S. Barker (***Good general text book***)**
- **Igneous Petrology** by **McBirney (***Textures & Rocks***)**
- **Igneous Rocks** by **Gupta (***With Indian examples***)**
- **Inorganic Geochemistry** by **Henderson (***Good introductory book on Geochemistry principles***)**
- **Introduction to Geochemical Modeling** by **Francis Albarede (***Advanced book on geochemical modeling)***)**
- **Petrography** by **William, Turner and Gilbert (***Good introductory book on petrography***)**
- **Petrologic phase equilibria** by **W.G. Ernst**
- **Petrology** by **Nockolds, Knox and Chinner (***Classic introductory book***)**
- **Petrology** by **Raymond (***Good introductory book***)**
- **Petrology of Igneous Rocks** by **Hatch, Wells and Wells (***Good introductory book***)**
- **Petrology of Igneous, Sedimentary and Metamorphic Rocks** by **Ehlers and Blatt (*Good introductory book*)**
- **Phase Diagrams** by **A. R. Morse (***Good introductory book on phase equilibria***)**
- **Principles of Geochemistry** by **G. Faure (***Advanced book on Geochemistry principles***)**
- **Principles of Igneous & Metamorphic Petrology** by **A. R. Philpotts (***physical properties of Magma***)**
- **Principles of Igneous and Metamorphic Petrology** by **Anthony Philpotts and Jay Ague**
- **Principles of Igneous and Metamorphic Petrology** by **John D. Winter**
- **Principles of Igneous Petrology** by **Maaloe (*Good Theoretical text*)**
- **The Principles of Petrology** by **G. W. Tyrrell (*Basic introductory book*)**

GEO-C202: THERMODYNAMICS AND METAMORPHIC PETROLOGY
(Theory: 4 credits & Practical: 2 credits)

Pre-requisites:

Basic (10+2) knowledge of chemistry and physics + completion of courses GEO-C101 (Mineralogy) and GEO-C104 (Geochemistry).

Course objectives:

This course in thermodynamics and metamorphic petrology would help the students to understand

1. Application of thermodynamics to understand metamorphic processes.
2. Formation of metamorphic rocks as controlled by pressure-temperature changes in the deep Earth consequently they are the windows to deep Earth composition, structure and processes.
3. Significance of metamorphic rocks to understand crustal differentiation. Study of metamorphic rocks to evaluate crust differentiation in space and time.
4. Significance of metamorphic rocks to our understanding of vertical and horizontal tectonics of planet Earth.
5. The role of volatiles consumed and released during formation of metamorphic rocks for the continuation of plate tectonics and subduction zone magmatism and formation of many ore deposits.
6. Metamorphism as the fundamental process of altering earlier minerals and formation of new minerals stable in the changed physico-chemical conditions.

Course contents:

Unit I: Thermodynamics

System, Phase, Component and Phase Rule
Enthalpy, Entropy and Gibb's Free Energy
1^{st}, 2^{nd} and 3^{rd} Laws of Thermodynamics
Reaction kinetics
Clausius - Clapeyron Equation and Calculation of Reaction Boundaries
Geothermobarometry
Psuedosections
P-T-t Paths

Unit II: Introduction to Metamorphism

Metamorphism as a process of Earth's differentiation
Metamorphic processes
Role of P/T conditions and fluids in metamorphism
Deformation associated with metamorphism

Migmatites and partial melting
Metamorphic structures and textures
Geochemistry of metamorphic rocks

Unit III: Metamorphic rocks: Grades, Zones and Facies

Types of metamorphism and their products
Metamorphic grades
Metamorphic zones
Metamorphic facies concept
Experimental studies on metamorphic reactions
Characteristics of important metamorphic reactions

Unit IV: Plate tectonics ad Metamorphic rocks

Zeolite- and lawsonite-bearing rocks
Greenstones
Amphibolites
Granulites
Glucophane schists
Eclogites
Paired metamorphic belts
Metamorphic rocks in space and time

GEO-C206: Practical based on GEO-C202 (2 Credits)

1. Study of Metamorphic Rocks in Hand Specimen.
2. Study of Metamorphic Rocks in Thin Section.
3. AKF, ACF and AFM projections.
4. Estimation of P-T conditions based on coexisting minerals.

Course outcomes:

At the completion of the course student would be able to

1. Apply principles of Thermodynamics to metamorphic processes.
2. Explain elemental diffusion and formation of new minerals.
3. Explain differentiation of continental crust.
4. Discriminate present- and palaeo-tectonic environments of metamorphic rocks.
5. Identify and characterize metamorphic rocks based on megascopic and microscopic observations.
6. Graphically represent mineralogical variations in metamorphic rocks.

Prescribed and Reference Books

- **An Introduction to Metamorphic Petrology** by **Bruce W.D. Yardley**
- **Atlas Metamorphic Rocks and their Textures** by **McKenzie, Donaldson and Guilford (***Excellent book on texture illustrations***)**
- **Essentials of Igneous and Metamorphic Petrology** by **B. Ronald Frost and Carol D. Frost**
- **Igneous and Metamorphic Petrology** by **Best (***Rock Associations***)**
- **Igneous and Metamorphic rocks under Microscope** by **Shelly (***Good introductory book on petrography***)**
- **Paired Metamorphic Belts** by **Miyashiro**
- **Petrography** by **William, Turner and Gilbert (***Good introductory book on petrography***)**
- **Petrology** by **Nockolds, Knox and Chinner (***Classic introductory book***)**
- **Petrology** by **Raymond (***Good introductory book***)**
- **Petrology of Igneous, Sedimentary and Metamorphic Rocks** by **Ehlers and Blatt (***Good introductory book***)**
- **Phase Diagrams** by **A. R. Morse (***Good introductory book on phase equilibria***)**
- **Principles of Igneous & Metamorphic Petrology** by **A. R. Philpotts (***Thermodynamics and Facies concept)*
- **Principles of Igneous and Metamorphic Petrology** by **Anthony Philpotts and Jay Ague**
- **Principles of Igneous and Metamorphic Petrology** by **John D. Winter**
- **Principles of Igneous and Metamorphic Petrology** by **John Winter (***Good discussion on all aspects of metamorphic rocks)*

GEO-C203: SEDIMENTARY PETROLOGY
(Theory: 2 credits & Practical: 1 credit)

Pre-requisites:

Basic geology terminology and courses GEO-C101 (Mineralogy).and GEO-C104 (Geochemistry)

Course objectives:

1. To train the students in identification of beds, formations, sedimentary structures, measurement of field, plotting and interpreting them.
2. To train the students to identify and correlate the formations.
3. To train the students in measuring various orientation data from the structures, plotting them in suitable diagrams and make a quantitative analysis.
4. To teach geochemistry of sedimentary rocks.
5. To develop the writing skills based on research pattern/report writing which is useful in research institutes/govt. organizations/ Pvt. Organizations.
6. To develop the skills of individual student so that he/she will be competent enough to get job in this field of specialization.

Course contents:

Unit I:

Classification of sedimentary rocks; Processes and products of sedimentation; Detrital sediments; Chemical precipitates; Volcano-clastic sediments; Sedimentary structures and textures; Particle size of detrital rocks: Definition, measurement, size parameters, grain size distribution and causal factors, grain size distributions and environmental analysis, Sphericity and roundness, Packing and fabric, Porosity and permeability

Unit II:

Depositional environments and the sedimentary products; Palaeocurrents and basin analysis; Basin shape, depth and sedimentation; Geochemistry of sediments and sedimentary rocks; Source and process control on composition of Sedimentary rocks; Plate tectonics and sedimentary rocks

GEO-C207: Practical based on GEO-C203 (1 Credit)

1. Study of Sedimentary Rocks in Hand Specimen.
2. Study of Sedimentary Rocks in Thin Section.
3. Grain size and grain shape analysis of sediments.

Course outcomes:

At the completion of the course student would be able to

1. Correlate different sedimentary strata.
2. Evaluate sedimentary environments.
3. Evaluate the geochemical variations in sedimentary rocks.
4. Understand the sedimentary rocks.
5. Carry out Palaeocurrent analysis.
6. Identify and distinguish different sedimentary rocks.

Prescribed and Reference Books

- **Applied Sedimentology** by **Richard C. Selly**
- **Atlas of Sedimentary Rocks Under the Microscope** by **A. E. Adams, C. Guilford, and W. S. MacKenzie**
- **Depositional Sedimentary Environments** by **H.E. Reineck and I.B. Singh**
- **Geochemistry of Sediments and Sedimentary Rocks: Evolutionary Considerations to Mineral Deposit- Forming Environments Edited** by **David Lentz**
- **Origin of sedimentary rocks** by **Harvey Blatt**
- **Petrography** by **William, Turner and Gilbert (***Good introductory book on petrography***)**
- **Petrology** by **Nockolds, Knox and Chinner (***Classic introductory book***)**
- **Petrology** by **Raymond (***Good introductory book***)**
- **Petrology of Igneous, Sedimentary and Metamorphic Rocks** by **Ehlers and Blatt (*Good introductory book*)**
- **Petrology of sedimentary rocks** by **Sam Boggs**
- **Physical Principles of Sedimentology** by **Kenneth J. Hsü**
- **Principles of Sedimentology and Stratigraphy** by **Sam Boggs**
- **Sedimentary geology** by **Donald Prothero**
- **Sedimentary Petrology: An Introduction to the Origin of Sedimentary Rocks** by **Maurice E. Tucker**
- **Sedimentary Provenance and Petrogenesis: Perspectives from Petrography and Geochemistry** (**GSA special paper)** by **José Arribas**, **Mark J. Johnsson** and **Salvatore Critelli**
- **Sedimentary Rocks** by **F.J. Pettiohn**
- **Sedimentary Rocks** by **Holly Cefrey**
- **Sedimentary Rocks** by **Rebecca Pettiford**
- **Sedimentary rocks in the field** by **Maurice Tucker**
- **Sedimentary Rocks in the Field: A Colour Guide** by **D. A. V. Stow**
- **Sedimentology and Stratigraphy** by **Gary Nichols**
- **Sedimentology** by **Michael McLane**
- **The Principles of Petrology** by **G. W. Tyrrell (*Basic introductory book*)**

GEO-C204: ENVIRONMENTAL GEOLOGY
(Theory: 2 credits & Practical: 1 credit)

Pre-requisites:

Basic (10+2) knowledge of geology, chemistry and physics

Course objectives:

1. Introduce environmental perspective to the geology students.
2. Introduce geology as a tool in the control of environmental pollution.
3. Equip the student with knowledge for societal needs.

Course contents:

Unit I: Introduction and Air Pollution

Introduction, Fundamental Concepts of Environmental Geology: Present is a key to the future, Concepts of Lithosphere, Hydrosphere and Atmosphere and their Physico-chemical characteristics, Ecology- its meaning and Scope, Ecosystem Concept, Energy Flow in Ecosystem, Food chain and Food web, Ecological pyramid.

Classification of Air Pollutants, Sources of Air Pollutants, Indoor Air Pollution, Air Pollution and Meteorology, Air Quality Monitoring, Consequences of Air Pollution- Acid Rain, Ozone Depletion, Green House Effect and Global Warming, Effects of Air Pollution on life.

Unit II: Water and Soil Pollution and Role of Geology in Pollution Control

Types of water pollutants- physical, chemical, biological, Classification of pollutants- Inorganic pollutants, organic pollutants, Biological pollutants, sediments, Oxygen demanding waste, Disease causing agents, Radioactive pollutants. Sources of water pollution- Point sources, Non point sources, Natural and Anthropogenic sources, Sewage and domestic waste, Industrial effluent, Agricultural discharges, Fertilizers, Pesticides, Detergents, Herbicides, Toxic metals, Thermal pollutants. Types of pollution- Groundwater pollution, Surface water pollution- Lake water pollution, River water pollution, Eutrophication, Marine pollution, Effect on life.

Definition, Composition of Soil, Soil formation, Soil profile, Types of Soils, Pedogenic processes, Texture of Soil, Soil pH, saline and alkaline Soil, Cation Exchange capacity, Soil pollution by- urban waste, agricultural practices, chemical and metallic pollutants, Industrial effluent, Detrimental effects on Soil, Integrated Pest Management.

Pollution Control for Air, Water and Soil- Decontamination Procedures and Methods, Remedial Measures and role of Geology, Solid, Liquid, Hazardous Waste Disposal and management, Geological solutions for environmental problems, Geological factors in selection of Sites for Disposal, Environmental Impact Assessment (EIA)

GEO-C208: Practical based on GEO-C204 (1 Credit)

1. Chemical analysis of Water.

Course outcomes:

At the completion of the course student would be able to

1. Understand Air, Water and Soil pollutants.
2. Apply geological methods in pollution control.
3. Select sites for geological disposal of pollutants.
4. Analyze Air, Water and Soil samples for their chemistry.

Prescribed and Reference Books

- **Air Pollution** by **B. K. Sharma**
- **An Introduction to Environmental Pollution** by **B. K. Sharma**
- **Environmental Geology** by **Carla W. Montgomery**
- **Environmental Geology** by **K. S. Valdiya**
- **Environmental Geology, Handbook of Field Methods and Case Studies** by **Klaus Knödel, Gerhard Lange and Hans-Jürgen Voigt**
- **Environmental pollution and control** by **P. Aarne Vesilind**
- **Environmental Pollution Monitoring and Control** by **Shripad Moreshwar Khopkar**
- **Fundamentals of Soil Science** by **Henry D. Foth**

GEO-E201: COMPUTER APPLICATIONS IN GEOLOGY
(Theory: 3 credits & Practical: 1 credit)

Pre-requisites:

Basic knowledge of Geology and Computer + Basic Software.

Course objectives:

1. Teach fundamental concepts in computer organization and growth.
2. Teach application of computers and software in geological sciences.
3. Teach Basic computer programming and software relevant to geology.

Course contents:

Unit I:

Computer organizations, architecture and peripherals, Types of computers; Computer generations, Concept of operating system, MS office – Word, Excel and Power point; Internet

Unit II:

Computer programmers useful for geoscientific studies: application of Surfer, Use of Grapher, Excel, etc.; Windows-based software applications, including word-processing, spreadsheets. Graphic image manipulation, drawing, presentations (MS-Excel, Power Point, Adobe Illustrator, CorelDraw, Photoshop). Elementary concepts on Knowledge Based Expert System, Decision Support System, Neural Network, Fuzzy Logic and Genetic Algorithm.

Unit III:

Use of computers and software as tools in the areas of geological problem-solving, report-writing, and presentations; Specific applications in Geological studies. Geological field data plotting software. Database - definition, structure, and types; Geological database. Construction of geological maps and sections using Adobe Illustrator and Coreldraw. Use of Software Packages in Geology.

GEO-E204: Practical based on GEO-E201 (1 Credits)

1. Mastering MS Office.
2. Processing Large Data Sets using relevant software.
3. Use of Adobe Illustrator and Corel Draw for geological maps and sections.
4. Geological data plotting and interpretation by using softwares.

Course outcomes:

At the completion of the course student would be able to

1. Use MS Office in processing and presenting geological data.
2. Prepare geological maps using Adobe Illustrator and CoralDraw.
3. Process large amount of geological data.
4. Apply ANN to evaluate geological data.

Prescribed and Reference Books

- **Computer Application in the Earth Sciences** by **Daniel Merriam**
- **Computer Applications in Petroleum Geology** by **Joseph E. Robinson**
- **Computer Applications in the Earth Sciences** by Merriam**, Daniel (Ed.)**
- **Computer Fundamentals** by **Pradeep K. Sinha and Preeti Sinha**
- **Computer Modeling of Geologic Surfaces and Volumes (AAPG computer applications in geology)** by **David E. Hamilton**
- **Fundamentals of Computer** by **V. Rajaraman**
- **Use of Microcomputers in Geology (Computer Applications in the Earth Sciences)** by **Hans Kürzl and Daniel F. Merriam (Editors)**

GEO-E202: GEOMORPHOLOGY AND MORPHOTECTONICS
(Theory: 3 credits & Practical: 1 credits)

Pre-requisites:

Basic (10+2) knowledge of surface geological processes, geographical landforms and Geotectonics + good observational skills.

Course objectives:

1. Identification of different geomorphological features and their mode of formation.
2. Exogenous processes and natural agents controlling the surface geology.
3. Concept of landform development and their stages of evolution with time.
4. Continental drift and plate tectonics on global scale.
5. Mode of formation of continental and oceanic crust and their interaction during plate movement.
6. Identification of different tectonic features globally.
7. Endogenous processes and driving forces controlling the tectonic features.
8. Drainage basin analysis and their application.
9. Morphometric and morphotectonic analyses to evaluate landform tectonically active or not.

Course contents:

General Information about the Curriculum:

This course helps students to understand the exogenous (surface geology) and endogenous (internal geology) processes operating on planet Earth; to understand the different geomorphological and tectonic features and their mode of formation. It will also help in understanding stages of landform development since the formation of planet Earth and evaluate whether certain landform is tectonically active or not.

Unit I: Surface Geology

Evolution of Earth; Principle of uniformitarianism; origin, differentiation and internal structure of the Earth and their reflections on surface geology; origin of atmosphere; weathering processes and products. geological action of rivers, wind, glaciers, waves; erosional and depositional landforms; major geomorphic features of India- coastal, peninsular and extra-peninsular. Formation of soil, physiographic features and river basins in India. Hydrographs and flood frequency analysis.

Unit II: Geotectonics

Concepts of Continental drift, sea-floor spreading, Isostasy, orogeny and plate tectonics; Earth's internal structure; earthquakes and volcanoes; hot spot and mantle plume; Concept of plate, types of plates, Plate driving forces, Plate collision: types, products; Wilson cycle; regional tectonic features of continents and ocean; Himalaya formation; Deccan trap formation.

Unit III : Tectonic Geomorphology

Geotectonic endogenous process and features: folds, faults, joints and fractures, volcanoes; global morphotectonics; local morphotectonics; drainage patterns; Morphometric and morphotectonic analyses; drainage basin morphometry; morphometric parameters; morphometric analysis case studies; Structural and lithological controls of landforms and drainage patterns; concept of neo-tectonics.

GEO-E205: Practical based on GEO-E202 (1 Credits)

1. Geomorphological landforms models
2. Introduction to topographical maps
3. Geomorphological and geological map symbols
4. Regional tectonic feature identification on tectonic maps
5. Drainage basin analysis
6. Morphometric analysis parameters
7. Morphotectonic analysis parameters
8. Structural features and their orientation
9. Strike and dip calculation.

Course outcomes:

Students who earn minimum grade should be able to

1. Identify of geomorphological features and their controlling natural agents.
2. Understand the processes of geological weathering and erosion and their acceleration rates at different climatic condition.
3. Understand the mechanism of soil formation and their types.
4. Lithospheric plate movement and their driving forces.
5. Lithospheric plate interaction and their products.
6. Regional tectonic features and their controlling mechanisms.
7. Morphometric analyses to evaluate surface geology.
8. Morphotectonic analyses to evaluate land surface tectonically active or not.
9. Different structural features and their orientation to understand tectonic correlation.

Prescribed and Reference Books

- **Aerial photographs in field geology** by **L.H. Lattman and R.G. Ray**
- **Geomorphology: A systematic Analysis of Late Cenozoic Landforms** by **A.L. Bloom**
- **Introducing Physical Geography** by **Alan Strahler**
- **Introduction to Physical Geology** by **Thompson and Turk.**
- **Morphotectonics** by **Adrian E. Scheidegger.**
- **Physical Geology** by **Diane H. Carlson, Charles C. Plummer and Lisa Hammersley**
- **Principles of Geomorphology** by **William D. Thornbury**
- **Process Geomorphology** by **D.F. Ritter, R.C. Kochel and J.R. Miller**
- **Tectonic Geomorphology** by **Douglas W. Burbank and Robert S. Anderson**
- **Terrain Analysis** by **D.S. Way**

GEO-E203: GEOSTATISTICS
(Theory: 3 credits & Practical: 1 credit)

Pre-requisites:

Basic (10+2) knowledge of Geology and Statistics.

Course objectives:

Basic objective of the course is to make student to

1. Gain knowledge of available statistical methods and their limitations and to make student be able to analyse and prepare the geological data for applying geostatistical models.
2. Characterize geological phenomena, which are complex in their interrelationships and vast in their Spatial and Temporal extension.
3. Utilize statistics in groundwater hydrology, petroleum reservoir characterization and modelling, and also in petrographical studies especially of sedimentary rocks.
4. Statistically analyse and interpret the geological data to unravel Earth's present and past processes.

Course contents:

Unit I: Introduction and Basic Statistics

Definition and scope of statistics; Limitations of statistics; Types of Data: Data collection, frequency distribution; Univariate analysis; Measures of Central tendency: Mean, Median, Mode, Merits and Demerits of Mean, Median and Mode; Measures of dispersion, standard deviation, variance, coefficient of variation.

Unit II: Bivariate and Multivariate Analysis

Bi-variate analysis: Correlation and regression; Types of correlation, correlation coefficient, regression analysis; Probability: Basic concepts; Statistical hypothesis and tests; Type I and Type II errors, F, t, and Chi-square tests; Multivariate analysis.

Unit III: Application of Statistics to Geology

Use of statistics in Petrology; Use of statistics in Geophysical-exploration and Mining Geology; Use of statistics in Hydrogeology; Use of statistics in Petroleum Geology.

GEO-E206: Practical based on GEO-E203 (1 Credit)

1. Study of Measure of Central Tendencies.
2. Study of Bi-variate analysis: Correlation and regression.
3. Study of different types of Errors and Tests.
4. Use of statistics in Geology.

Course outcomes:

At the completion of the course student would be able to

1. Explain and Practice different measures of central tendencies, standard deviation and variance.
2. Explain and Practice Bi-variate analysis of data (Correlation and Regression)
3. Explain and calculate different types of Errors (Type I and Type II Error) and Tests (F- test, T- test etc.)
4. Utilize statistics in Geology.

Prescribed and Reference Books

- **Applied multivariate statistical analysis** by **R.A. Johnson and D.W. Wichern**
- **Basic linear Geostatistics** by **M. Armstrong**
- **Geostatistics A Colloquium** by **Daniel F. Merriam**
- **Introduction to probability and statistics for engineers and scientists** by **S.M. Ross**
- **Mining Geostatistics** by **A.G. Journel and Ch. Huijbregts**
- **Probability and Statistics** by **M.R. Spiegel**
- **Probability and statistics for engineers and scientists** by **R.E. Walpole and R.H. Myers**
- **Statistical data analysis in geology** by **J.C. Davis,**
- **Statistical Methods** by **S.C. Gupta**

GEO-OE201: GEOLOGY FOR CHEMISTS
(Theory: 2 credits)

Pre-requisites:

Basic knowledge of Geology and Chemistry.

Course objectives:

1. Introduce Earth's processes and their products.
2. To introduce student about element abundances in different spheres of Earth.
3. To introduce about distribution of elements in Earth and processes controlling abundance and distribution.
4. Geochemical exploration technique, path-finding elements to ore.

Course contents:

Unit I:

Origin of the Universe; Formation of the Elements; Beginnings of Chemistry; Element Abundances of the Planets; Geochemical classification of elements; Thermodynamic classification of elements; Introduction to radioactive and stable isotopes;

Unit II:

Geochemistry of Lithosphere, Atmosphere, Hydrosphere and Biosphere; Distribution of elements in crust, mantle and core; Geodynamics and transfer of elements; Geochemical and biochemical processes on and near Earth's surface; Geochemical Cycles; Geochemical exploration techniques; Geochemical record of Palaeo-climatic conditions. Geochemistry and Life.

Course outcomes:

At the completion of the course student would be able to

1. Understand basic geological processes and their products.
2. Explain abundance and distribution of elements in different spheres of Earth.
3. Explain use of elements in exploration of ore bodies.
4. Explain how elements reflect Earth's past processes.
5. Explain Processes controlling chemistry of Earth's materials.
6. Explain the relationship between geochemistry and life

Prescribed and Reference Books

- **Comets and the Origin and Evolution of Life** by **Editors: P.J. Thomas, R.D. Hicks, C.F. Chyba and C.P. McKay**
- **Dynamics of the Earth System: Evolution, Processes and Interactions (2020) Edited** by **D. K. Pandey, M. Ravichandran, and N. Nair**
- **Earth Materials** by **Cornelis Klein and Anthony Philpotts**
- **Geochemistry and the Biosphere: Essays** by **Vladimir Vernadsky**
- **Inorganic Geochemistry - Principles and Applications (3rd Edition)** by **G. Faure**
- **Inorganic Geochemistry** by **Henderson**
- **Nature through Time (2020) Edited** by **E. Martinetto, E. Tschopp, and R. Gastaldo**
- **Principles of Geochemistry** by **Brain Mason and Carleton B. Moore**
- **The Origin and Nature of Life on Earth: The Emergence of the Fourth Geosphere** by **Eric Smith and Harold Morowitz**
- **Using geochemical data: Evaluation, Presentation and Interpretation** by **Hugh R. Rollinson**

GEO-OE202: GEOLOGY FOR BIOLOGISTS
(Theory: 2 credits)

Pre-requisites:

Basic knowledge of Geology and Biology.

Course objectives:

1. Introduce basic geological concepts.
2. Introduce students with Fossils.
3. To introduce student to formation and evolution of life on the earth.
4. To introduce with fossil fuels.

Course contents:

Unit I:

Origin of the Universe; Formation of the Elements; Element Abundances of the Planets; Geologic, Hydrologic, and Atmospheric Evolution of the Earth; Earth's Materials and their formation (Minerals, Rocks and Soils); Geological time scale; Introduction to Fossils and their preservation.

Unit II:

Elementary ideas about origin of life; evolution and fossil record; origin of fossil fuels and their exploration; Geodynamics and migration of organisms; Geobiolgical prospecting for mineral deposits; Tree rings and Palaeoclimates; Minerals and Human Health.

Course outcomes:

At the completion of the course student would be able to

1. Understand basic geological processes and their products.
2. Comprehend interaction between different Earth spheres.
3. Explain formation and preservation of fossils.
4. Explain evolution of life on the Earth with respect to geological time scale.
5. Utilize biological tools in exploring geological materials and processes
6. Understand relationship between biology (human) and Geology (minerals)

Prescribed and Reference Books

- **A Concise Dictionary of Paleontology** by **R. L. Carlton**
- **An introduction to fossils and minerals** by **Jon Erickson**
- **Aquagenesis: The Origin and Evolution of Life in the Sea** by **Richard Ellis**
- **Comets and the Origin and Evolution of Life** by **Editors: P.J. Thomas, R.D. Hicks, C.F. Chyba and C.P. McKay**
- **Dynamics of the Earth System: Evolution, Processes and Interactions (2020) Edited** by **D. K. Pandey, M. Ravichandran, and N. Nair**
- **Earth Materials** by **Cornelis Klein and Anthony Philpotts**
- **Evolution of Life: Fossils, Molecules and Culture** by **Editors: Osawa, Syozo, Honjo, Tasuku**
- **Micropaleontology in Petroleum Exploration** by **R.W. Jones**
- **Nature through Time (2020) Edited** by **E. Martinetto, E. Tschopp, and R. Gastaldo**
- **Palaeontology (palaeobiology): Evolution and animal distribution** by **P.C. Jain and M.S. Anantharaman**
- **Principles of palaeontology** by **Stanley Raup**

GEO-OE203: GEOLOGY FOR PHYSICISTS
(Theory: 2 credits)

Pre-requisites:

Basic knowledge of Geology and Physics.

Course objectives:

1. Introduce Earth's processes and their products.
2. Introduce students with simple physical principles for exploring planet Earth.
3. To use of geophysical methods in Ore and Groundwater prospecting.

Course contents:

Unit I:

Introduction to evolution of Universe and our planetary system; Internal structure of the Earth; Different spheres of the Earth and their interaction; Introduction to Geodynamics; Geological time scale.

Unit II:

Basic physical properties of the Earth's material. Polymorphism and phase transformations in Planet Earth; Introduction to Gravity, Electrical, Magnetic and Seismic methods of exploring planet Earth. Introduction to Geomagnetism and Paleo-magnetism; Geophysical methods in Ore and Groundwater prospecting. Physics, Geology and Life.

Course outcomes:

At the completion of the course student would be able to

1. Understand basic geological processes and their products.
2. Comprehend interaction between different Earth spheres.
3. Apply laws of physics in understanding planet Earth.

Prescribed and Reference Books

- **Applied Geophysics** by **W.M. Telford, L.P. Geldart R.E. Sheriff and D.A. Keys**
- **Basic Exploration Geophysics** by **Edwin S. Robinson and Cahit Coruh**
- **Earth Materials** by **Cornelis Klein and Anthony Philpotts**
- **General and Applied Geophysics (An introduction)** by **I.K. Kaul, S. Sengupta and A.K. Bhattacharya**
- **Geophysical Prospecting For Groundwater** by **Sankar Kumar Nath**
- **Global Tectonics. Third Edition (Reprint)** by **P. Keary, K.A. Klepeis and F.J. Vine**
- **Introduction to Geophysics** by **Howell**