Savitribai Phule Pune University

Pune, Maharashtra India

Structure and Syllabus of Three Years B.Sc. Program in Geology with Multiple Entry and Exit Option

THREE YEAR BACHLORS PROGRAMME IN SCIENCE

Subject: **GEOLOGY**

Under the Faculty of

Science and Technology

Effective from Academic year 2025– 2026

(As per NEP-2020)

Title of the Program: S.Y.B.Sc. Geology Syllabus.

Program Level: Second year of 3-years/4 years B.Sc. Geology Degree Program

Syllabus to be implemented from the Academic year: 2025-26

Introduction

The present syllabus is to meet the needs of students for building up their careers in Geology. Changing scenarios at local and global levels, and the very existence of the earth which has been threatened by calamities like earthquakes, volcanic eruptions, landslides, floods, tsunamis or droughts, are directly or indirectly related to geological action on the surface or subsurface. Awareness related to the modern concepts of Plate Tectonics, Remote Sensing, and Geographical Information System (GIS) etc. is a must for all Geology graduate students. Theoretical knowledge supplemented with extensive laboratory expertise and field training will help the students, to avail all opportunities available and even start their own consultancy firms. Therefore, revision and updating of the curriculum is an essential component and a continuous process of any university system.

A flexible curriculum with necessary re-orientations, additions and modifications introduced in it from time to time by the experienced teachers and experts. It should be able to provide placement opportunities for the students and also good avenues for research activities. Introduction of innovative concepts, providing a multidisciplinary profile in the concerned subject and an updated education to the students at large is the prime aim. In addition, field training will have a priority since geology being the field science and more practical exposure will benefit the student community at large and produce good geologists for the nation.

Course Learning Outcomes to be achieved:

1. To help students' build-up a progressive and successful career in Geology
2. To enrich students' knowledge and train them in the pure geological sciences.
3. To Provide an updated education.
4. To impart more field-oriented knowledge.
5. To inculcate sense of scientific, social responsibilities and environment awareness.
6. To introduce the concepts of application and research in Geology.
7. Create a sense of preservation and conservation of natural resources.
8. To study structural dynamics of the earth.
9. To study Stratigraphy and Palaeontology that encompasses the aspects of the age of the earth, chronological arrangement of rocks and appearance and evolution of life through the geologic time.
10. To study the changes that occurred in the history of the earth and relate them to their field observations and, in understanding the framework of the stratigraphy of India
11. To study basics of mineralogy and crystallography, which helps in understanding and building the overall knowledge in Geology.
12. To study the processes involved in the formation of igneous, sedimentary, and metamorphic rocks, their textures, structures, classifications and their importance.
13. To study the dynamic nature of the Earth processes.
14. To study the geodynamics of the lithosphere and concept of isostacy, ocean floor spreading,

continental drift and plate tectonics.

Faculty of the Program: Science

Credit Framework

Level	Qualification Title	Credit Requirement		Semester	Year
		Minimum	Maximum		
4.5	Undergraduate Certificate in Geology	40	44	2	1
5.0	Undergraduate Diploma in Geology	80	88	4	2
5.5	Bachelor of Science in Geology	120	132	6	3

Credit Framework for Undergraduate (UG) (2025-26) for GEOLOGY in faculty of Science and Technology (SPPU)

B. Sc. in Geology

Level/ Difficulty	Sem.	Course Type	Course Code	Course Title (Brief on contents/levels)	Theory/ Practical	Credit	Hrs
4.5/100	I	Subject -1, 2 or 3	GL-101-T	**Mineralogy and Crystallography**	Theory	2	30
			GL-102-P	**Practicals related to GL-101-T**	Practical	2	60
		Generic Elective (GE) / Open Elective (OE) - (Any one from basket)	OE-101-GL-P	**Minerals and Gems**	Practical	2	60
			OE-102-GL-T	**Introduction to Earth Science**	Theory	2	30
			OE-103-GL-T	**Introduction to Geohazards**	Theory	2	30
		Skill Enhancement Courses (SEC)	SEC-101-GL-T	**Earth System Science**	Theory	2	30
		Indian Knowledge System		**Generic**	Theory	2	30
		Ability Enhancement Course (AEC)	AEC 101	**English Language**	Theory	2	30
		Value Education Courses (VEC)	VEC-101-T	**Environmental Education I**	Theory	2	30
4.5/100	II	Subject	GL-151-T	**Petrology**	Theory	2	30
			GL-152-P	**Practicals related to GL-151-T**	Practical	2	60
		Generic Elective (GE) / Open Elective (OE) - (Any one from basket)	OE-151-GL-P	**Introduction to Rocks**	Practical	2	60
			OE-152-GL-T	**Study of Landforms**	Theory	2	30
		Skill Enhancement Courses (SEC)	SEC-151-GL-P	**Gemmology**	Practical	2	60
		Ability enhancement Course (AEC)	AEC- 102	**English Language**	Theory	2	30

		Value Education Courses (VEC)	VEC-151-T	**Environmental Education II**	Theory	2	30
		Curricular Course (CC)		**Select any one from Basket**			
Exit Option: Award of UG Certificate in Major with 44 credits core NSQF course/internship OR continue with Major and Minor. **Continue Option:** Student will select one subject (Subject1, 2 or 3) as major and another as minor and third subject will be dropped.							
5.0/200	**III**	**Major Core**	GL 201 T	**Introduction to Stratigraphy**	Theory	2	30
			GL 202 T	**Structural Geology**	Theory	2	30
			GL 203-P	**Practicals related to GL 201 T & 202 T**	Practical	2	60
		Vocational Skill Courses (VSC)	VSC 201 GL - T	**Hydrogeology**	Theory	2	30
		Field Project (FP)	FP 201 GL-P	**Mapping, Surveying and Field Project**	Practical	2	60
		Minor	MN 201 GL-T	**Introduction to Structural Geology**	Theory	2	30
			MN 202 GL-P	**Practicals related to** MN 201 GL-T	Practical	2	60
		Generic Elective (GE) / Open Elective (OE) (Any one from basket)	OE-201-GL-P	**Gemmology**	Practical	2	60
			OE-202-GL-T	**Introduction to Natural Resources**	Theory	2	30
		IKS (Major Subject Specific)	IKS 201 GL T	**Ancient Knowledge System in Geosciences**	Theory	2	30
		AEC (Ability Enhancement Course)	AEC 201	**Modern Indian Languages**	Practical	2	30
		Curricular Course (CC)	CC	**NCC/NSS/Sports/Cultural/Yoga Study**	T/P	2	30
5/200	**IV**	**Major Core**	GL 251 T	**Advance Petrology**	Theory	2	30
			GL 252 T	**Geotectonics**	Theory	2	30
			GL 253-P	**Practicals related to GL 251 T and GL 252 T**	Practical	2	60
		VSC	VSC 251 GL - T	**Optical Mineralogy**	Theory	2	30
		FP	CEP	**CEP**	T/P	2	30
		Minor Courses	MN 251 GL-T	**Dynamics of the Earth**	Theory	2	30
			MN 252 GL-P	**Practicals related to** MN 251 GL-T	Practical	2	60
		Skill Enhancement Courses (SEC)	SEC 251 GL - T	**Geophysical Prospecting**	Theory	2	30
		Curricular Course (CC)	CC	**NCC/NSS/Sports/Cultural/Yoga Study**			
		Ability Enhancement Program (AEC)	AEC	**Languages**	Theory	2	30
		Generic Elective (GE) / Open Elective (OE) - (Any one from basket)	OE-251-GL-P	**Introduction to GIS**	Practical	2	60
			OE-252-GL-P	**Water Resource Management**	Theory		30

Exit Option: Award of UG diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/Internship OR continue with Major and Minor							
5.5/300	**V**	**Major Core**	GL 301 MJ	**Geology of India**	Theory	4	60
			GL 302 MJ	**Engineering Geology**	Theory	2	30
			GL 303 MJ	**Palaeontology**	Theory	2	30
			GL 304 MJP	**Practicals related to GL 301 to GL 303 MJ**	Practical	4	120
		Major Elective Courses	GL 311 ME	**Micropalaeontology**	Theory (Select any One elective from the Basket)	2	30
			GL 312 ME	**Oceanography and Marine Geology**		2	30
			GL 313 ME	**Geomorphology**		2	30
			GL 314 ME	**Quaternary Geology**		2	30
			GL 315 MEP	**Elective Practical related to GL 311 MJ/ GL 312 MJ/ GL 313 MJ/ GL 314 MJ**	Practical	2	60
		Vocational Skill Courses (VSC)	GL 321 VSC	**Natural Disaster Management**	T/P	2	30
		FP/CEP	GL 331 FP	**Field Project and Scientific Report Writing**	T/P	2	30
		Minor	GL 341 M	**Petroleum Geology**	T	2	30
5.5/300	**VI**	**Major Core**	GL 351 MJ	**Remote Sensing in Geosciences**	Theory	2	30
			GL 352 MJ	**Economic Geology and Mineral Economics**	Theory	2	30
			GL 353 MJ	**Climatology**	Theory	2	30
			GL 354 MJ	**Petroleum and Coal Geology**	Theory	2	30
			GL 355 MJP	**Practicals related to GL 351 MJ & GL 352 MJ**	Practical	4	120
		Major Elective Courses	GL 361 ME	**Geotechnical Studies**	Theory (Select any One from the Basket)	2	30
			GL 362 ME	**Watershed Management**		2	30
			GL 363 ME	**Analytical Methods in Geology**		2	30
			GL 364 ME	**Introduction to GIS- Open Source**		2	30
			GL 365 MEP	**Elective Practical related to GL 361 to 365**	Practical	2	60
		VSC	GL 371 MN	**GIS and Geoinformatics**	T/P	2	30
		OJT	GL 375 OJT	**ON Job Training**		4	
Exit Option: Award of UG Degree inn Major with 132 credits OR Continue with Major and Minor							
6.0/400	**VII**	**Major Core**	GL 401 MJ	**Theory 1, Theory 2, Theory 3**		6	90
			GL 401 MJP	**Practicals related to theory**		4	120
		Major Elective Courses - (0C)	GL 411 ME	**Theory**		2	
			GL 412 P	**Practical**		2	
		FP/OJT/CEP/RP	GL 421 FP	**Research Project**		4	
		Research Methodology	GL 431 RM	**Research Methodology**		4	
6.0/400	**VIII**	**Major Core**	GL 451 MJ	**Theory1 , Theory 2, Theory 3**		6	90
			GL 452 MJP	**Practical**		4	120
				Theory		2	

		Major Elective Courses - (0C)		**Practical**		2	
		FP/OJT/CEP/RP	GL 461	**Research Project**		8	

Four Year UG Honours Degree in Major and Minor with 176 credits

Notes: OE to be compulsorily chosen from faculty other than that of Major

Abbreviations

OE: Open Elective
AEC: Ability Enhancement Course
VEC: value Education Courses
CC: Co-Curricular Courses
CEP: Community Engagement Project
IKS: Indian Knowledge System
OJT: On Job Training
FP: Field Project
VSC: Vocational Skill Courses

Semester III

GL 201 T- Introduction to Stratigraphy

Title of the Course and Course Code	**Introduction to Stratigraphy GL 201 T**	**Credits:2**
Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:		
CLO 1	The study of Stratigraphy encompasses the aspects of the age of the earth, chronological arrangement of rocks and appearance.	
CLO 2	To acquire the knowledge of the concepts in Stratigraphy and correlation	
CLO 3	To study evolution of life through the geologic time	
CLO 4	Stratigraphers study the composition and arrangement of layered or stratified rocks.	
CLO 5	To understand physiography of India	
CLO 6	To study Tectonic Elements	
CLO 7	To study World History with reference to Geological Time	

Unit/ Hour	**Course Contents**	**No of Lectures**
I/15	Principles of Stratigraphy and Stratification A) Introduction: Definition, Development of stratigraphic concepts, Importance of Stratigraphy, Various principles of Stratigraphy B) Stratigraphic Classification & Nomenclature: Study of stratigraphic elements, Lithostratigraphy, Chronostratigraphy, Biostratigraphy, Inter-relationship between lithostratigraphic, Chronostratigraphic and Biostratigraphic units. C) Methods of Collecting Stratigraphic Data: Outcrop and Subsurface procedures. D) Stratification: Introduction to concept of basin, Processes of stratification, Controlling factors-physical, chemical and biological, Vertical succession, alternations, varves, cycles. E) Stratigraphic Correlation: Definition and evidence for correlation-physical and palaeontological F) Geological Time Scale	**15**
II/15	**Introduction to Indian and World Precambrian History** **A)** Physiographic / Tectonic divisions of India and their comparisons **B)** a) Definition of Tectonic Elements of continents (cratons, shield, folded mountain belts) and oceans (mid oceanic ridges, trenches and transform faults) b) Cratons of India and associated Proterozoic basins c) General review of Indian Stratigraphy & Classification of the Indian litho-stratigraphic units, according to the Geological time scale. d) Earlier and current classification of Precambrian formations of India by- SirT.H.Holland,Sarkar et al(1976) and Ramkrishna and Vaidhyanathan (ICS, 2014) **C)** a) World Precambrian history in brief b) Cratons and mobile belts of the World **Precambrian – Cambrian boundary** **Study of following Geological systems:** Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous & Tertiary	**15**

Suggested Readings:
Books Recommended:

1. Thornbury W. D., (1997) Principles of Geomorphology Wiley Eastern Ltd., New Delhi.
2. K.S. Valdiya, The Making of India – Geodynamic evolution. Springer
3. Fundamentals of historical geology and Stratigraphy of India, Ravindra Kumar
4. Geology of India Volume I & II- Vaidyanathan and Ramakrishnan

GL 202 T Structural Geology

Title of the Course and Course Code	**Structural Geology GL 202 T**	**Credits:2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CLO1	Understand geological structures resulting from the action of various forces on rocks.	
CLO2	To gain the knowledge of the geometry of the rock structures	
CLO3	To understand the mechanism of the evolution of rock structures	
CLO4	Analyze the mechanism of the tectonic activities with reference deformation of rocks	
CLO5	Deliver the applications of Structural Geology in the field	

Unit/ Hour	**Contents**	**No of Lectures**
I/15	**Fundamental Principles of Structures** Attitude of a planar feature: a) Strike and dip (true dip and apparent dip). b) Strike-dip symbols for inclined, horizontal and vertical strata. c) Rake and plunge Brunton Compass, Clinometer Compass and GPS. a) Elements of a Brunton Compass and Clinometer Compass. b) Use of GPS. c) Strike direction, dip direction and dip amount, Fore-bearing and back-bearing. Stress and Strain. a) Definition and concept of stress and strain. b) Three stages of deformation (Hooke's Law). c) Understanding stress and strain with reference to elastic and plastic deformation. d) Brittle and ductile deformation. Factors controlling rock deformation. a) Factors controlling behaviour of materials such as – temperature time, pressure (confining pressure and pore pressure), solution and strain rate. Introduction to rock deformation and its mechanics. a) Definition of rock deformation. b) Components of rock deformation (Translation and Rotation) c) Definition and examples of plastic deformation.	**15**

	d) Mechanism of plastic deformation: Intergranular and intragranular movements, recrystallization with and without change in shape (Reckie's principle). **Unconformity:** Definition, development stages, structural classification, Recognition in the field	
II/15	**Deformation Structures:** **Folds.** a) Definition and parts of a fold. b) Nomenclature of folds. c) Plunging and non-plunging folds. d) Types of folds and mechanism (Flexure, shear and flow). e) Recognition of folds and plotting attitude of beds on a map. f) Determination of top of beds by Primary sedimentary structures. g) Classification of folds (Geometric and Genetic). h) Introduction to Flutey's Classification **Faults.** a) Terminologies associated with fault plane. b) Nature of movement along faults (Translational and Rotational). c) Effects on disrupted strata. d) Calculation of net slip. e) Concept of throw and heave. f) Classification of faults (Geometric and Genetic) g) Concept of mechanics of faulting h) Faulting along tension & shear fractures i) Direction of displacement along shear fractures **Fractures.** a) Concept of fracture. b) Genetic types of fracture (tension and shear fracture). c) Fracturing under differential forces. **Joints.** a) Definition and types of joints. b) Geometric and Genetic classification of Joints.	**15**

Suggested Readings:

Books Recommended:

1. Jain, A.K., (2014) An introduction to structural geology. Text Book series in Geological Sciences for Graduate Students. Geological Society of India, Bangalore.
2. Billings, M.P., (1972) Structural Geology. Prentice Hall. Fossen, H., (2010) Structural Geology. Cambridge University Press.
3. Davis, G.R., (1984) Structural Geology of Rocks and Region. John Wiley
4. Singh, R. P., (1995) Structural Geology: A Practical Approach. Ganga Kaveri Publ., Varanasi
5. Hills, E.S., (1963) Elements of Structural Geology. Farrold and Sons, London.

GL 203-P -Practicals related to GL 201 T & GL 202 T

Title of the Course and Course Code	**Practicals related to GL 201 T & GL 202 T GL 203-P**	**Credits:2**

Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:		
CLO 1	Understand Structural features in the field	
CLO 2	Gain knowledge about geometry of rock structure	
CLO 3	Analyze graphical representation of rock Structures of subsurface areas	
CLO 4	Understand the stratigraphic correlation	

Topics	No. of Practicals
Reading of toposheets with reference to toposheet number, latitude and longitude, state/districts, scale, adjacent toposheet number and conventional signs.	1
Study of Topographical and Geological Maps involving: Study of topographical maps involving topographical features like hill, valley, spur, saddle, etc. Study of Geological Maps involving one conformable series (horizontal and inclined beds) - Describing topography, geology and drawing vertical section along the given direction. **(4 Maps – 1 topographic map involving all features; 1 geological map with horizontal beds; 1 geological map with inclined beds; 1 geological map horizontal/inclined beds with dyke).**	4
Study of Geological Maps - involving two conformable series beds with unconformity (2 maps) - 1 with combination of inclined series of conformable beds and horizontal series of conformable beds and 1 map with both conformable series of inclined beds. **Study of Geological Maps - involving two conformable series beds with unconformity (2 maps)** - with combination of inclined series of conformable beds and horizontal series of conformable beds	3
Completion of outcrops: (At least 3 maps) Completion of an outcrop with the help of given topographic & lithological data	2
Structural problems A) Graphical problems- (To be solved by using method of descriptive geometry) **Type I** - Hill slope, attitude of the exposures of top & bottom of the bed on the hill slope along with true thickness of the bed given, finding out true dip direction, true dip amount & other geometrical parameters of the bed. With comment on normal or overturned bed. **Type II -** Problems involving a single planar feature containing a linear feature: **a)** Attitude of planar feature along with the bearing of a linear feature contained in it given, finding out plunge & rake of a linear feature in the given planar feature.	2
Three-point problems: Drill hole data for a hidden planar feature at three non-collinear points given in the form of location, elevation & absolute depth of planar feature, finding out strike, true dip direction & true dip amount of the planar feature. Also determining one of the three parameters (location, elevation & absolute depth) where the other two parameters are known.	1
Stratigraphy related practicals **Stratigraphic correlation:** **Lithostratigraphy:** Correlating rock units based on lithological characteristics helps establish the continuity of strata across different locations. **Biostratigraphy:** Correlating rock units using fossil content helps link and compare stratigraphic sequences. Data for minimum of three boreholes to be given.	2

Marking on outline map of India/world: Marking of Craton/ Mobile belts/ Platforms/ Sedimentary Basins of India	
Total No. of Practicals	15

VSC 201 GL – T - Hydrogeology

Title of the Course and Course Code	**Hydrogeology** **VSC 201 GL - T**	**Credits:02**
Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:		
CLO 1	To understand the basic principles in hydro-geology	
CLO 2	To study aquifers and related aspects	
CLO 3	To study hydrogeology chemistry, systematically hydrogeological survey	
CLO 4	To study water quality monitoring	

Unit/ Hour	**Contents**	**No of Lectures**
I/15	**Introduction and basic concepts in Hydrogeology** Definitions: Hydrology, Geo-hydrology, Hydrogeology Water bearing properties of rocks: a) Interstices and porosity, permeability, specific yield and specific retention, storativity, transmisivity and Hydraulic conductivity b) Aquifers,Geologic formations as aquifers- Aquicludes, Aquitard and Aquifuge. c) Vertical distribution of subsurface water-zone of saturation and zone of aeration. d) Types of aquifers – unconfined, confined, Perched. Groundwater Flow: a) Darcy's law and its validity b) Aquifer parameters-transmissivity, storage coefficient, hydraulic conductivity, Intrinsic permeability c) Groundwater flow rates and flow direction d) Laminar and turbulent groundwater flow **Field and laboratory methods used to characterize aquifer properties and hydrogeology of rocks** a) Field methods: Pumping tests and slug test - Principles – types of pumping tests, procedures, Determination of aquifer properties and well; Characteristics by Methods of Theim's equilibrium method. b) Laboratory methods: Grain sixe Analysis method (GSA) consolidated and unconsolidated sediments; Permeameter method. c) Well inventory: Water Well Construction – Selection of suitable site for well construction, Water well design criteria and specifications, maintenance of production wells and types of well.	**15**

	d) Hydrogeology of rocks	
II/15	**Groundwater chemistry** Groundwater chemistry: a) Chemical standards for drinking, and irrigational water b) Major ion and isotope analyses, chemical tracers in groundwater c) Physical and chemical properties of water and water quality. BIS, WHO standard; d) Groundwater contamination; natural (geogenic) and anthropogenic contaminants; e) Saline water intrusion in coastal aquifers-Ghyben Herzberg relation **Groundwater Resources of India, Groundwater Quality Hotspots in India** Groundwater Resources i.e. aquifers of India a) Unconsolidated sedimentary b) Consolidated sedimentary c) Sedimentary Aquitards d) Folded metamorphic e) Jointed Crystalline f) Fractured Crystalline Groundwater quality hotspots in India a) Hydrogeology in Maharashtra Groundwater quality hotspots in India- TDS, F, Ar, U, Fe	**15**

Suggested Readings:

Books Recommended:

1) Brassington, R. (2017) Field Hydrogeology, Wiley Blackwell
2) Pawar N.J, Das, S. And Duraiswami R.A (2012) Hydrogeology of Deccan Traps and associated Formations in Peninsular India, Geol. Soc. India, Bangalore
3) Hiscock, K. M. (2005) Hydrogeology: Principles and Practice, Blackwell Publishing
4) Todd, D.K. and Mays, L.W. (2004) Groundwater Hydrology, John Wiley & Sons.
5) Raghunath, H.M. (1987) Groundwater,New Age International
6) Freeze, R. A. and Cherry, J. A. (1979) Groundwater, Prentice Hall

FP 201 GL-P- Mapping, Surveying and Field Project

Title of the Course and Course Code	**Mapping, Surveying and Field Project** FP 201 GL-P	**Credits:02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CLO 1	To provide field experience about studying and identifying different geological features	
CLO 2	To study effectively collect and analyze data, demonstrate professional conduct in a field setting	
CLO 3	To foster collaboration and communication skills	
CLO 4	To build self-awareness through reflection on experiences within the field environment, structures and rocks	

Topic of Practical	No of Practicals
To study Field equipment	1
Measure readings using Brunton compass or clinometer compass(Fore bearing, Back bearing, Strike,Dip etc)	1
A Geological field tour to be conducted in an area of geological interest for at least 3 to 4 days and geological report to be submitted for the same. In addition to the requisite number of lectures and practicals, students are required to undertake geological excursion to study at first hand geological structures and lithology under the guidance of a teacher. The fieldwork helps in developing individual skills of observation, description and interpretation of geological features. Each student shall maintain a field – diary for this purpose and shall write area-wise report.	10
Total Practicals:	**12**

MN 201 GL-T- Introduction to Structural Geology

Title of the Course and Course Code	**Introduction to Structural Geology MN 201 GL-T**	**Credits:2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CLO1	Understand geological structures resulting from the action of various forces on rocks.	
CLO2	To gain the knowledge of the geometry of the rock structures	
CLO3	To understand the mechanism of the evolution of rock structures	
CLO4	Analyze the mechanism of the tectonic activities with reference deformation of rocks	
CLO5	Deliver the applications of Structural Geology in the field	

Unit/ Hour	**Contents**	**No of Lectures**
I/15	**Fundamental Principles of Structures** Attitude of a planar feature: a) Strike and dip (true dip and apparent dip). b) Strike-dip symbols for inclined, horizontal and vertical strata. c) Rake and plunge Brunton Compass, Clinometer Compass and GPS. a) Elements of a Brunton Compass and Clinometer Compass. b) Use of GPS. c) Strike direction, dip direction and dip amount, Fore-bearing and back-bearing. Stress and Strain. a) Definition and concept of stress and strain. b) Three stages of deformation (Hooke's Law). c) Understanding stress and strain with reference to elastic and plastic deformation. d) Brittle and ductile deformation. Factors controlling rock deformation. a) Factors controlling behaviour of materials such as – temperature time, pressure (confining pressure and pore pressure), solution and strain rate. Introduction to rock deformation and its mechanics.	**15**

	a) Definition of rock deformation. b) Components of rock deformation (Translation and Rotation) c) Definition and examples of plastic deformation. d) Mechanism of plastic deformation: Intergranular and intragranular movements, recrystallization with and without change in shape (Reckie's principle). **Unconformity:** Definition, development stages, structural classification, Recognition in the field	
II/15	**Deformation Structures:** **Folds.** a) Definition and parts of a fold. b) Nomenclature of folds. c) Plunging and non-plunging folds. d) Types of folds and mechanism (Flexure, shear and flow). e) Recognition of folds and plotting attitude of beds on a map. f) Determination of top of beds by Primary sedimentary structures. g) Classification of folds (Geometric and Genetic). h) Introduction to Flutey's Classification **Faults.** a) Terminologies associated with fault plane. b) Nature of movement along faults (Translational and Rotational). c) Effects on disrupted strata. d) Calculation of net slip. e) Concept of throw and heave. f) Classification of faults (Geometric and Genetic) g) Concept of mechanics of faulting h) Faulting along tension & shear fractures i) Direction of displacement along shear fractures **Fractures.** a) Concept of fracture. b) Genetic types of fracture (tension and shear fracture). c) Fracturing under differential forces. **Joints.** a) Definition and types of joints. b) Geometric and Genetic classification of Joints.	**15**

Suggested Readings:

Books Recommended:

6. Jain, A.K., (2014) An introduction to structural geology. Text Book series in Geological Sciences for Graduate Students. Geological Society of India, Bangalore.
7. Billings, M.P., (1972) Structural Geology. Prentice Hall. Fossen, H., (2010) Structural Geology. Cambridge University Press.
8. Davis, G.R., (1984) Structural Geology of Rocks and Region. John Wiley
9. Singh, R. P., (1995) Structural Geology: A Practical Approach. Ganga Kaveri Publ., Varanasi
10. Hills, E.S., (1963) Elements of Structural Geology. Farrold and Sons, London.

MN 202 GL-P - Practicals related to MN 201 GL- T

Title of the Course and Course Code	Practicals related to MN 201 GL- T MN 202 GL-P	Credits:2
Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:		
CLO 1	Understand Structural features in the field	
CLO 2	Gain knowledge about geometry of rock structure	
CLO 3	Analyze graphical representation of rock Structures of subsurface areas	
CLO 4	Understand the stratigraphic correlation	

Topics	No. of Practicals
Reading of toposheets with reference to toposheet number, latitude and longitude, state/districts, scale, adjacent toposheet number and conventional signs.	1
Study of Topographical and Geological Maps involving: Study of topographical maps involving topographical features like hill, valley, spur, saddle, etc. Study of Geological Maps involving one conformable series (horizontal and inclined beds) - Describing topography, geology and drawing vertical section along the given direction. **(4 Maps – 1 topographic map involving all features; 1 geological map with horizontal beds; 1 geological map with inclined beds; 1 geological map horizontal/inclined beds with dyke).**	4
Study of Geological Maps - involving two conformable series beds with unconformity (2 maps) - 1 with combination of inclined series of conformable beds and horizontal series of conformable beds and 1 map with both conformable series of inclined beds.	2
Completion of outcrops: (At least 3 maps) Completion of an outcrop with the help of given topographic & lithological data	2
Structural problems A) Graphical problems- (To be solved by using method of descriptive geometry) **Type I** - Hill slope, attitude of the exposures of top & bottom of the bed on the hill slope along with true thickness of the bed given, finding out true dip direction, true dip amount & other geometrical parameters of the bed. With comment on normal or overturned bed.	2
Three-point problems: Drill hole data for a hidden planar feature at three non-collinear points given in the form of location, elevation & absolute depth of planar feature, finding out strike, true dip direction & true dip amount of the planar feature. Also determining one of the three parameters (location, elevation & absolute depth) where the other two parameters are known.	2
Total No. of Practicals	13

OE 201 GL-P- Gemology

Title of the Course and Course Code	Gemology OE 201 GL-P	Credits:02
Course Outcomes (COs) On completion of the course, the students will be able to:		
CLO 1	Understand the fundamentals of various precious and semiprecious gemstones	
CLO 2	Know their formation, classifications, basic qualities of gemstones, description of their various physical properties	

CLO 3	Learn about the different techniques involved in identification of natural and synthetic gemstones
CLO 4	To learn Gem instruments and their use in gemstone identification

Topics	**No. of Practicals**
1) Study of Physical properties of gemstones (Colour, Lustre, Diaphaneity, Sheen)	1
2) Study of different types of cuts used for gemstones	1
3) Description of following gem species with respect to their varieties (colour wise), Chemical composition, Crystal system, Physical and optical properties, Characteristic inclusions and Geographical Occurrences. Corundum, Beryl, Garnet, Felspar, Silica, Tourmaline, Topaz	3
4) Detection of double refraction, by observing pleochroic colours with the Dichroscope (at least 5) Garnet, Sapphire, Kyanite, Iolite, Paste, Emerald, Peridot	1
5) Study of the fluorescent colour exhibited by various gemstones under Ultraviolet (long wave and short wave) light (at least 5) Fluorite, Citrine,Natural Ruby, Synthetic Ruby, Almandine Garnet, Iolite, Natural Sapphire, Synthetic Sapphire	1
6) Study of Inclusions in Gemstones under microscope (at least 5) Sapphire, Ruby, Amber, Peridot, Rock Crystal, Amethyst, Topaz, Iolite, Citrine, Tourmaline, Kyanite, Paste, Almandine Garnet, Aquamarine	1
7) Study of Organic Gemstones: Pearl, Coral and Amber	1
8) Study of Opaque Gem varieties: Turquoise, Lapis Lazuli, Jade, Malachite	1
9) Study of Rare Gem varieties: Peridot, Kyanite, Iolite, Sphene, Zircon, Apatite	1
10) Study of Imitations and Synthetic Gemstones	1
Total No. of Practicals	**12**

Title of the Course and Course Code	**Introduction to Natural Resources OE 202 GL-T**	**Credits:02**
Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:		
CLO 1	To classify the natural resources.	
CLO 2	To describe Polices and legislation concerning natural resources	
CLO 3	Discuss various natural resources and their conservation and management	
CLO 4	Explain the climate changes and its impact on humans and environment.	
CLO 5	Evaluate the targets and indicators, challenges and strategies for Sustainable Development Goals	

OE 202 GL-T Introduction to Natural Resources

Unit/ Hour	**Contents**	**No of Lectures**
I/15	Introduction to natural resources: Definition, types of natural resources:	**15**

	soil, water, minerals, Land, Floral and Faunal Resources Sustainable use of economically important deposits- metallic and non-metallic deposits with relevant case studies Introduction to water as a resource and its sustainability with prominent case studies	
II/15	Classification and types of resources: Renewable and Nonrenewable Conservation and development of Natural Resources Energy crises and Man: Crises faces by mankind with regards to conventional and non-conventional resources Conservation and development of resources Potential resources of energy: Solar, Tidal , Bio mass , Geothermal	**15**
Suggested Readings: **Books Recommended:**		

IKS 201 GL T- Ancient Knowledge System in Geosciences

Title of the Course and Course Code	**Ancient Knowledge System in Geosciences** **IKS 201 GL T**	**Credits:02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CLO 1		
CLO 2		
CLO 3		
CLO 4		

Unit/ Hour	**Contents**	**No of Lectures**
I/15		**15**
II/15		**15**
Suggested Readings: **Books Recommended:**		

SEMESTER IV

GL 251 T Advance Petrology

Title of the Course and Course Code	Advance Petrology GL 251 T	Credits:2
Course Outcomes (COs) On completion of the course, the students will be able to:		
CLO 1	To understand the process of evolution of magma & its types.	
CLO 2	Study of textures, structures & classification of rocks	
CLO 3	To study Sedimentary environments	
CLO 4	Understanding the concept of metamorphism	

Unit/ Hour	Contents	No of Lectures
I/15	**Magma:** **A) Characteristics and generation of magmas** a) Role of magma in geological processes: melting of rocks and generation of magmas, temperature- pressure conditions and volatile constituents. Generation of magmas in different tectonic settings. **B) Types of magma:** Primary and derivative **C) Crystallization of magmas:** Binary magma with an incongruent melting compound: Leucite – silica system **Igneous Petrology:** **A) Textures/structures in igneous rocks & their significance** **Textures:** Granitic, porphyritic, glomero-porphyritic, poikilitic, ophitic & sub-ophitic, inter-granular, inter-sertal, graphic, cummulate, glassy, corona/ reaction rim, myrmekitic, **Structures:** Orbicular, flow, expansion cracks, pyroclastic, xenolithic **B) Classification of igneous rocks** a) Complexity in classification b) Types of classification, ii) CIPW classification iii) IUGS (plutonic, volcanic) classifications	**15**
II/15	**SEDIMENTARY PETROLOGY** **Sedimentary Environments** A) Sedimentary environments: Depositional & Erosional B) Physical & Chemical parameters of depositional sedimentary environments C) Classification of depositional sedimentary environments **C)Texture & Structures of Sedimentary Rocks** Chemical structures: stylolites, concretions, nodules 7. Penecontemporaneous sedimentary Structures: Load-cast, flute-cast, mud-cracks, ball & pillow, clastic dykes, slump folds, Dewatering folds g) Study of organic sedimentary structures (in brief) **D) Classification of sandstones & limestones:** a) Dot's Classification of sandstones b) Dunham's classification of limestones **METAMORPHIC PETROLOGY**	**15**

	A) Definition & Characteristics of metamorphism The concept of metamorphic facies: Diagrammatic representation of pressure temperature conditions (with depth) of the different facies of contact, regional & Plutonic metamorphism B) Introduction to phase diagrams of metamorphic rocks- ACF, A'KF and AFM diagrams **B) Thermal Metamorphism** Thermal metamorphism of Pure and Impure Limestone **C)Dynamic/ Cataclastic metamorphism:** e) Mechanics of the formation of slaty cleavages **D) Regional Metamorphism & its products** d) Barrovian zones of regional metamorphism.	

Suggested Readings:

Books Recommended:

1) Igneous Petrology: Anthony Hall
2) Igneous rocks: McBirney
3) Igneous and Metamorphic Petrology: Myron Best
4) Principles of Petrology: GW Tyrrell.
5) Igneous, metamorphic and sedimentary Rocks: Elher and Blatt
6) Igneous and metamorphic Petrology: Turner and Verhoogen
7) Principles of Igneous & metamorphic Petrology: Philpotts and Ague
8) Petrology of the Igneous rocks: Hatch, Wells and Wells
9) Sedimentary Petrology by Pettijohn
10) Introduction to Sedimentology by Sengupta
11) Stratigraphy & Sedimentation by Krumbein & Sloss
12) Applied Sedimentology by R.K. Sukhatankar
13) J.D Winter- Igneous and Metamorphic Petrology

GL 252 T - Geotectonics

Title of the Course and Course Code	**Geotectonics** **GL 252 T**	**Credits:02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CLO 1	To understand the dynamic nature of the Earth processes.	
CLO 2	To understand the geodynamics of the lithosphere and concept of isostacy, ocean floor spreading, continental drift, plate tectonics.	
CLO 3	To develop the concepts of plate tectonics on a global scale	
CLO 4	To analyses the physical processes responsible for the formation and destruction of the plates	
CLO 5	To understand the structure of the continental crust vs. oceanic crust and their geodynamic.	
CLO 6	To analyze the modern concept of plate tectonics and its implications.	

Unit/ Hour	**Contents**	**No of Lectures**
I/15	**Global Tectonics:** a) Concept of Shield and Platform b) Early crustal evolution of the earth and Introduction to concepts of Cratons, Shields, Platform, Mobile belt with suitable Indian examples	**15**

	c)Concept of Continental drift d) Morphology of Ocean floor a) Ocean floor spreading b) Magnetic anomalies & sea floor Spreading- Mechanics & applications e) Plate tectonics a) Introduction to Wilson's cycle & Concept of plate tectonics b) Characteristic features of plate boundaries f) tectonic settings on Earth-Mid Oceanic Ridges, Rift valleys and Island arcs (compressional and extensional)	
II/15	**Geodynamics of the lithosphere:** **a) Evolution of earth** Composition, physical properties & characteristics of three spherical zones of the Earth namely crust, mantle and core **b) Structure of the lithosphere** lithosphere-asthenosphere interactions Concept of Lithosphere, Asthenosphere & Mesosphere **c)** Low Velocity Zone (LVZ) **d)** Continental crust and Oceanic crust **e)** Geotherms **f)** Concepts of isostacy **g)** Direct & indirect observations in exploration of Earth's interior	**15**

Suggested Readings:

Books Recommended:

1. Patwardhan, A.M. (2012) The dynamic Earth System, PHI Learning Pvt. Ltd.,
2. Moores E.M. and Twiss R.J. (1995) Tectonics, W. H. Freeman
3. Valdiya, K.S., (1984) Aspects of Tectonics: Focus on Southcentral Asia, Tata-McGraw Hill, New Delhi,
4. Beloussov, V.V. (1980) Geotectonics, Springer-Verlag Berlin Heidelberg
5. Condie, K.C. (1989) Plate Tectonics &Crustal Evolution, Butterworth-Heinemann
6. Billings, M.P. (1942) Structural Geology, Prentice Hall,
7. Badgley, P. C. (1965) Structural & Tectonic Principles, Harper & Row
8. Valdiya K.S. (2014) Making of India, Springer.
9. Valdiya K.S. (1984) Aspects of tectonics, Tata McGrath Hill.

GL 253 -P- Practicals related to GL 251 T & GL 252 T

Title of the Course and Course Code	**Practicals related to GL 251 T & GL 252 T GL 253 -P**	**Credits:02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CLO 1	Identify different textures and structures in rocks.	
CLO 2	Classify various rocks using megascopic and microscopic properties.	
CLO 3	Examine different rocks in hand specimens.	
CLO 4	Distinguish different optical properties in minerals under microscope.	
CLO 5	Determine different minerals in micro-sections.	

Topics	No. of Practicals
Igneous Petrology: Identification of the following **megascopic** rocks with respect to their texture/structure, mineral composition, and classification a) Igneous: Varieties of gabbro (anorthosite, troctolite, norite), felsites, peridotite, lamprophyre, serpentinite, varieties of basalt, carbonatite, granite, rhyolite.	2
Description, genesis and significance of the following microscopic textures and structures Granitic, porphyritic, intergranular/ intersertal, poikilitic, ophitic and sub-ophitic, graphic, glassy, flow, vitrophyric, microlitic, spherulitic, orbicular, reaction rims, expansion cracks, perlitic cracks, myrmekitic (any 5)	1
c) study of Microscopic of Igneous rocks with regard to their texture, mineral composition, identification and classification: Norite, troctolite, anorthosite, peridotite lamprophyre, olivine basalt, granite, carbonatite, rhyolite, andesite (Any 5)	1
d)Problems related to **CIPW** Norm calculation for silica saturated igneous rocks	1
Sedimentary Petrology: a) Study of Megascopic sedimentary rocks with regard to their texture / structure, mineral composition, identification, classification and sedimentological significance : Laterite, bauxite, Conglomerate, breccias, grit, arkose, speckled sandstone, sandstone with dendritic markings, ferruginous and carbonaceous shale, limestone (Chemical and Organic), calc-tuffa.	1
b) Thin section study of the following sedimentary rocks: Sandstone, arkose, greywacke, nummulitic and oolitic limestones.	1
c)Interpretation of the sedimentary structures giving their geological significance: Sandstone showing tracks and trails, Ball & Pillow, Flame, Load cast, Flute marks	1
Metamorphic Petrology: a) Study of the following metamorphic megascopic rocks with regard to their texture / structure, mineral composition, colour, type of metamorphism, grade facies and the original rocks: Slate, phyllite, chlorite schist, mica (Biotite) schist, hornblende schist, staurolite schist, Kyanite schist, talc – tremolite schists, mica gneiss, hornblende gneiss, sillimanite gneiss, augen gneiss, eclogite, charnockite, fuschite quartzite, banded haematite quartzite, marbles **(any 8)**	2
b) Study of the thin sections of the following metamorphic rocks about their / structure, mineral composition, colour, type of metamorphism, grade, facies and the original rock: Chlorite schist, staurolite schist, kyanite schist, mica gneiss, sillimanite gneiss, augen gneiss, eclogite, charnockite, khondalite, banded haematite quartzite. (any 5)	1
c)Plotting of Chemical Composition of Metamorphic rocks on **ACF** diagrams.	1
Geodynamics of Lithosphere: a) Marking of Mid Oceanic Ridges and Tectonic Plate Boundaries b) Problems related to P & S waves – Interior of the Earth c) Mathematical problems related to Geotherm/ Isostacy	1
Total No. of Practicals	13

VSC 251 GL-T - Optical Mineralogy

Title of the Course and Course Code	**Optical Mineralogy VSC 251 GL-T**	**Credits:02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CLO 1	Describe various properties and laws of light.	
CLO 2	Compare optical properties of minerals in Plane Polarised Light and in Between Crossed Nicols.	
CLO 3	Determine the refractive indices and optical sign of minerals.	
CLO 4	Explain interference figures.	
CLO 5	Compare uniaxial and biaxial minerals.	

Unit/ Hour	**Contents**	**No of Lectures**
I/15	**Introduction:** Light and the properties of light, Interference of light, Velocity of light in crystals and refractive index, Snell's Law and refraction of light, Polarized light and Crossed polars Petrological microscope Introduction to optical properties: Opaque and Non opaque Minerals **Properties in plane polarized light:** Color, form, cleavage, cracks, relief, twinkling, pleochroism and scheme of pleochroism Refractive indices and their comparison with Becke line	**15**
II/15	**Properties in between crossed nicols:** Isotropism and anisotropism, extinction positions and determination of extinction angle, twinning, zoning, and undulatory extinction,interference colors and Michel-Lévy color chart Introduction to Uniaxial and biaxial minerals Introduction to Interference figures of Uniaxial MInerals Accessory plates: mica plate, gypsum plate and quartz wedge **Preparation of Geological Thin Section**	**15**

Suggested Readings:
Books Recommended:

1. Dexter Perkins, 1998, Mineralogy, 3rd Edition, Pearson Education
2. Kevin Hefferan and John O'Brien, 2010 Earth Materials, A John Wiley & Sons, Ltd., Publication
3. Gribble, C. D., 1988, Rutley's Elements of Mineralogy, 27th Edition, Unwin Hyman, London
4. Deer, W. A., Howie, R. A. and Zussman, J., 2013, An Introduction to Rock Forming Minerals, Essex: Longman Scientific and Technical; New York
5. Berry, L. G., Dietrich, R. V., and Mason, B., 1985, Mineralogy, CBS Publishers & Distributors, India,
6. Kerr, P.F, Rogers, A.F.,1959, Optical Mineralogy, McGraw-Hill Inc.

MN 251 GL-T - Dynamics of Earth

Title of the Course and Course Code	**Dynamics of Earth** **MN 251 GL-T**	**Credits:02**
Course Learning Outcomes (CLOs) On completion of the course, the students will be able to:		
CLO 1	To learn different branches of Geology and its Scope.	
CLO 2	To learn Solar system in relation to the evolution of the earth, and an overall idea about cosmology in context to the evolution of planetary system	
CLO 3	Student will know the applications of the physical and chemical properties in understanding the evolution of the earth with the interior.	
CLO 4	Student will learn about the magnetic field of the earth.	
CLO 5	origin, history and evolution of the Earth	
CLO 6	Familiarize with the structure, composition and general characteristics of the lithosphere, hydrosphere, atmosphere and biosphere.	
CLO 7	Students will learn the interior structure of the earth and plate movements.	
Unit/ Hour	**Contents**	**No of Lectures**
I/15	**Introduction to Geology:** Definition of Geology, its divisions, sub-divisions and scope **Planet Earth** Origin of the Universe (Big Bang Theory), Origin of the Solar System (Nebular, Encounter and Tidal Hypothesis) a. Earth: Its size, shape and density. Temperature, pressure and magnetism within the Earth, Present day Hypsographic curve b. Age of the Earth: A brief account of the historical methods. Determination of age by U/Pb, Th/Pb, K/Ar and Carbon method of Dating. c. Meteorites (Definition, types and origin) **Geological time scale:** Concept and Criteria **Earth's Atmosphere:** (Introduction, Classification of Atmosphere, Introduction to Atmospheric circulation, land-air-sea interactions), Hydrosphere (Introduction to ocean currents, types, causes and significance), Lithosphere (Structure and composition) and Biosphere (Ecology and food chain)	**15**
II/15	**Dynamics of earth:** **Interior of Earth**: Earth's Crust, Mantle and Core **Plate Tectonics-** Historical Overview, Different types of plate movements with their salient characters, Various plates of the world and their movements Concept of Isostacy **Volcanoes**: Genesis of volcanoes, Central and fissure type of eruptions. Products of volcanoes, effects of volcanoes, earth's volcanic belts. **Earthquakes**: Definition, terminology, causes, intensity and magnitude. Recording of earthquakes (Modern recording method). Use of seismic waves and their importance in interpreting the earth's internal structure. Seismic zones. History and susceptibility of the Indian subcontinent to earthquakes.	**15**

	Types of Mountains: Fold, fault block, volcanic and residual. **Geomorphic processes and landforms-** Weathering, erosion and denudation **Types of weathering:** Mechanical and Chemical Study of various erosional and depositional landforms resulting from the action of: River, Wind, Sea and Glaciers	

Suggested Readings:
Books Recommended:

1. Holmes'Principles of Physical Geology: Edited by P. McL. D. Duff
2. Plate tectonics and Crustal evolution: Condie
3. Our evolving planet: Bergen, Alma Mater Fortag
4. Geomorphology and Global Tectonics: Summerfield M. A.
5. Geomorphology: Thornburry
6. Concepts of Geomorphology: Gupta and Kale

MN 252 GL-P- Practicals related to MN 251 GL-T

Title of the Course and Course Code	**Practicals related to MN 251 GL-T MN 252 GL-P**	**Credits:02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CLO 1	Identify different textures and structures in rocks.	
CLO 2	Classify various rocks using megascopic and microscopic properties.	
CLO 3	Examine different rocks in hand specimens.	
CLO 4	Distinguish different optical properties in minerals under microscope.	
CLO 5	Determine different minerals in micro-sections.	

Topics	No. of Practicals
Study of the Interior of the Earth with respect to its Chemical and Rheological Classification	1
Sketch and label the Global circulation patterns Polar cell, Ferrel cell, Hadley cell	1
Sketch and label the warm and cold Ocean Currents	1
Preparation of Hazard zonation maps for India and World: Earthquake	1
Marking of Mid Oceanic Ridges and Tectonic Plate Boundaries	1
Tracing of Drainage from Satellite Imageries/Aerial Photos	1
Study of Landform Models Any 2 from each environment: Fluvial ,Dessert, Coastal, Glacial	3
Problems related to Isostay	1
Total No. of Practicals	10

SEC 251 GL- Geophysical Prospecting

Title of the Course and Course Code	**Geophysical Prospecting SEC 251 GL**	**Credits:02**
Course Outcomes (COs) On completion of the course, the students will be able to:		

CLO 1	To understand the methodologies for extracting geological information out of geophysical datasets generated from different petrophysical properties
CLO 2	the student will gain first-hand knowledge dealing with the principles and their significance
CLO 3	To understand geophysical techniques for geophysical prospecting
CLO 4	To understand gravity methods and its applications
CLO 5	To understand magnetic methods and its applications
CLO 6	To understand seismic methods and its applications

Unit/ Hour	Contents	No of Lectures
I/15	**A) Objectives, stages & types of prospecting** **B) Geological Prospecting:** a) Geological Criteria: Climatic, Stratigraphic, Lithological, Structural, Geochemical, - Magmagene and - Geomorphological. b) Physiographic Guides: Topographic expressions, Physiographic environment of the ore deposits, physiography in relation to oxidation & environment c) Mineralogical Guides: Rock alteration, Target rings of mineral distribution, Significance of accessory & gangue minerals. Stratigraphic & lithologic guides for Syngenetic & Epigenetic deposits, Fracture pattern as guides, Contacts & folds as guides	**15**
II/15	**A) Gravity Method:** a. Introduction, Principles, Types of Gravimeters, Concept of Free Air & Bouguer Anomaly b. Airborne surveys in Gravity methods b. Applications & Generalized interpretation of Gravity data- Case Study. **B) Magnetic Method:** a. Introduction, Principles, Types of magnetometers- Magnetic anomalies and their interpretation. b. Air borne surveys in Magnetic Methods c. Gravity and magnetics for the exploration of the minerals, oil /gas and groundwater d. Processing, interpretation & applications. **C) Seismic Method:** a. Introduction and Principles b. Seismic Reflection Method and Seismic Refraction Method c. Seismic instruments and Field procedures d. Processing of Seismic data, applications and Case Study	**15**

Suggested Readings:
Books Recommended:

1. Dobrin, M B and Savit C H. (1988) Introduction to Geophysical Prospecting, McGraw Hill Inc.
2. Ramachandra Rao and Prasaranga, M B. (1975) Outlines of Geophysical Prospecting - A Manual for Geologists by University of Mysore, Mysore.

3. Bhimasarikaram V.L.S., (1990) Exploration Geophysics - An Outline by Association of Exploration Geophysicists, Osmania University, Hyderabad.
4. Telford, W. M., Geldart, L. P., and Sheriff, R. E., (1990) Applied geophysics (vol. 1). Cambridge University Press.
5. Lowrie, W., (2007) Fundamentals of Geophysics. Cambridge University Press

OE 251 GL P - GIS

Title of the Course and Course Code	**GIS OEP 251 GL**	**Credits:02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CLO 1	Understand the fundamentals of geospatial data	
CLO 2	To study Open-source Software and installation	
CLO 3	To study Vetor Data	
CLO 4	To Study Raster data	

Topics	**No. of Practicals**
Introduction to GIS: Definitions, Evolution, Components and Objectives Overview of GIS Software Packages	2
Open-Source GIS: Basic Concepts, Introduction to Open-Source Software	1
Introduction to QGIS, Interface of the software	1
Plugins - Installing and Managing Plugins, Useful QGIS Plugins	1
Data visualization: Import data layers, add labels, and design layouts for maps	1
Georeferencing of map in QGIS	1
Working with Vector data - Generation of Vector Layers, Vector Analysis, Spatial and Attribute Queries	2
Working with Raster data - Symbology, Terrain analysis, Raster Analysis	2
Editing Data: Selecting Features, Simple Editing Functions, Creating New Features, Modifying, Schema Changes	2
Total No. of Practicals	13

OE 252 GL T- Water Resource Management

Title of the Course and Course Code	**Water Resource Management OE 252 GL T**	**Credits:02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CLO 1	Understanding the distribution of Water on Earth	
CLO 2	Study availability and Consumption of water	
CLO 3	Study concept of WRM	
CLO 4	Understanding Sustainable Development Goal 6 (SDG)	
CLO 5	Study of Best community water management practice	

Unit/ Hour	**Contents**	**No of Lectures**
I/15	Water as a resource, Concept of valuing water, Types of water resources Hydrological Cycle Surface water distribution and importance Ground water distribution and importance. Cryosphere: Distribution and importance Marine waters: Distribution and importance Distribution of water, Availability and consumption patterns in domestic, industrial, and agricultural sectors Concept of water stress and scarcity, Domestic water demand and consumption in urban and rural India	15
II/15	Nature and scope of Water Resource Management Global Water resource Concept of sustainable water resource development Need of water resource development in India Sustainable Development Goal 6 (SDG) Best community water management practice in India Water Resource Management: Case study of Maharashtra	15

Suggested Readings:

Books Recommended:

1. Raghunath H.M. (2003) Groundwater, New age education.
2. Karanth K.R. (1987) Groundwater assessment development and management, Tata Mcgrath Hill education.
3. Todd, D. K. and Mayo, L. W. (2004) Groundwater hydrology, Wiley.
4. Belsare and Kolhe, (2019) Water Resource Development and Management in Maharashtra: Issues, inetiatives and way forward, Water Resource Department, Government of Maharashtra.