B.Sc., Geology (Hons. - 4 Years)

SYLLABUS

(With effect from June 2024 Onwards)

Centre for Applied Geology
Gandhigram Rural Institute (Deemed to be University)
Gandhigram – 624 302 Tamilnadu

B.Sc., Geology – (Hons. - 4 Years)

Syllabus w.e.f. 2024 Onwards

(Students will have the option to exit from the UG Programme after one year with a certificate, two years with the award of the diploma, three years with the award of the bachelor degree, and after 4 years with the award of the bachelor degree with honours).

Centre for Applied Geology

Gandhigram Rural Institute (Deemed to be University)

B.Sc., Geology (Hons) - 4 Years Programme

Geology is the study of the earth and its physical structure, properties, and phenomena. It is a branch of science dealing with rocks, minerals, sediments, and processes that enhance the earth's internal and external landscapes. The sub-disciplines in geology are numerous and exciting, including Physical Geology, Geomorphology, Structural Geology, Mineralogy, Crystallography, Palaeontology, Stratigraphy, Petrology, Hydrogeology, Geophysics, Geochemistry, Mining Geology, Environmental Geology, Natural resources, Disaster Management, Climatology, Remote Sensing and Geographical Information System. Studying geology as a unique course equips students to secure jobs in many government firms and the private sector. Mining, the petroleum industry, mineral prospecting, and hydrogeology are some industries that employ geologists. The Ministry of Earth Sciences sponsors multiple research schemes with a geological focus. The fascinating Geological research activities have gained worldwide attention, and geology students are well dignified to take advantage of the research opportunities. Allied studies in Geology involve other basic sciences like Physics, Chemistry, Mathematics and Biology. Therefore, the students get a well-grounded scientific approach to contemporary problem-solving. The course offered by Gandhigram Rural Institute has a comprehensive syllabus, technical laboratory work and extensive field surveys as part of the course. The scope of the course is modern and has the potential to offer rewarding research that enhances the student’s careers. The syllabus for the geology program offered at the Undergraduate (UG) level using the Choice-Based Credit System (CBCS) has been framed in compliance with the model syllabus given by UGC. The main objective of framing this syllabus is to provide the students with an inclusive understanding of the subject, giving substantial weight to both the core content and advanced techniques used in geology. The ultimate goal of the syllabus is for the students to understand the subject and secure a job. Also, the syllabus has been framed so that the basic skills of the subject are taught to the students at the UG level so that everyone might not need to go for higher studies, and the scope of securing a job after graduation will increase. While the syllabus complies with the UGC model curriculum, some changes have been made to ensure all topics are covered, and any subjects aren’t challenging to complete in one semester.

CENTRE FOR APPLIED GEOLOGY

VISION: To create space, Spatial and Geosciences-based Rural Development Models and Plans. The branch of Geology is one of the vital disciplines for comprehensive, holistic and Sustainable Rural Development. The Centre for Applied Geology has been created to achieve this ambition/goal.

MISSIONS:

Using geological technologies in earth and space system studies, the following academic programmes for a B.Sc. Geology (Hons) and M.Sc. Applied Geology and Geomatics, as well as Research and Extension programs, are envisaged independently and interdependently with various departments of GRI-DU.

MISSION:1 Rural Natural Resources Inventory and Management: Mineral, Water, Hydrocarbon and Geothermal Resources inventory and creation of natural resources based rural development plans.

MISSION:2 Rural Water Management: Specific Studies to bring out village-wise / taluk-wise water management plans, including surface water potential, water quality pollution due to rock-water interaction and anthropogenic activities with the rejuvenation of defunct water bodies inventory, modelling of Groundwater, Artificial recharge techniques, etc.

MISSION:3 Rural Geo-Energy Management: Geo-Energy Resources inventory & Planning like Oil and Gas, Coal, radioactive and geothermal energy.

MISSION:4 Geological Eco system-based development plans: Creation of Rural development plans based on geomorphic provinces like river systems, coastal systems, arid systems, etc.

MISSION:5 Natural Disaster Vulnerability Mapping and Management Models: Earthquakes, Landslides, Floods, Tsunamis and other disaster prediction and prevention plans for rural areas.

MISSION:6 Creation of Spatial Decision Support Systems for the development of rural areas.

ELIGIBILITY: A pass in Higher Secondary examination with Physics, Chemistry and Geology/ Mathematics/ Botany /Zoology / Biology / Computer Science/ Geography / or any other subject.

THE GANDHIGRAM RURAL INSTITUTE - DEEMED TO BE UNIVERSITY, GANDHIGRAM - 624302

OBE ELEMENTS

Name :

Designation & Department/ Centre : Centre for Applied Geology

Academic Programme offered : B. Sc. Geology (Hons)

OBE Elements for B. Sc., Geology

Programme Educational Objectives (PEO)

The students pursuing the undergraduate course in Geology programme will subsequently learn the basics and outline emerging geological techniques.

PEO1: To make the students understand the fundamentals of Geology and its branches

PEO2: To articulate the students in developing the geological field knowledge and laboratory studies, thereby increasing their problem- solving potential

PEO3: Exposing updated practical technologies to enhance their capability in job competency

PEO4: To enable them to work with integrated team effort to understand the Earth System process

PEO5: To increase the potentiality of the candidate towards updated application - oriented studies.

Programme Outcome (PO)

The graduates will be capable of sharing their knowledge in Geology to a higher level of research and improved professional skills.

PO1: To become familiar with Geology and apply the doctrine to the needs of the Geological Society.

PO2: Gain diagnostic skills in the field/area of Geology

PO3: Understand and appreciate professional ethics and Nation Building initiatives

PO4: Able to identify, analyze, and interpret geological data from multiple perspectives

PO5: Able to identify and utilize recently updated skills in the field of Geology

PO6: Able to work as an individual and in a team with a cross-cultural perspective with the potential to become a leader with effective communication skills.

PO7: Identify, formulate and analyze complex problems for substantiated conclusions

PROGRAMME SPECIFIC OUTCOME (PSO)

The graduates will be able to ensure that they are in a position to enhance their skills in the field of geology with precise qualifications.

PSO1: Apply the knowledge of geology to explore natural resources and assess natural disasters and ecosystem studies.

PSO2: Solve the complex problems in the field of Geology with an understanding of the interior features of the Earth and its impacts upon the surface layers

PSO3: Use accurate, practical techniques to interpret the estimation of the resources in the field with appropriate results

PSO4: Ensure the Environmental safety extraction of the resources and enhance sustainable development

PSO5: Assures the candidate has precise professional qualities for the fundamental positions in the field of geology with adequate efficiency.

BSc. Geology (Hons)

SCHEME OF EXAMINATIONS

Category	Course Code	Course Title	Number of Credits	Lecture Hours per week	Exam Duration (Hrs.)	Marks		
						C.F.A	E.S.E	Total
Semester-I								
Core Major-1	24GEUC1101	Physical Geology	3	3	3	40	60	100
Core Major-2	24GEUC1102	Surveying - Practical	1	3	3	60	40	100
Core Minor-1	24MAUB1105	Mathematics - I	4	4	3	40	60	100
	(Or)							
	24PHUB0001	Physics - I	3	3	3	40	60	100
Core Minor-1 Lab	24PHUB0002	Physics Practical –I	1	3	3	60	40	100
Multi disciplinary	--	Multidisciplinary-I	3	3	3	40	60	100
Ability Enhancement course (AEC)	24ENUA1101	Essential English: Basic	3	3	3	40	60	100
Skill Enhancement Course	24TAUS1101/ 24MLUS1101/ 24HIUS1101	Indian Language (Tamil/Malayalam/Hindi)-I	3	3	3	40	60	100
Value Added Course	24FSUV1001	Environmental Science/Education	2	2	2	50	-	50
Value Added Course	24FAUV1001/ 24GTUV1002	Heritage & Cultural History of India / Shanthi Sena	2	2	2	50	-	50
Total			21					
Semester-II								
Core Major-3	24GEUC1203	Structural Geology	3	3	3	40	60	100
Core Major-4	24GEUC1204	Structural Geology – Practical	1	3	3	60	40	100
Core Minor-2	24MAUB1210	Mathematics – II	4	4	3	40	60	100
	(Or)							
	24PHUB0003	Physics – II	3	3	3	40	60	100
Core Minor-2 Lab	24PHUB0004	Physics Practical -II	1	3	3	60	40	100
Multi disciplinary	--	Multidisciplinary-II	3	3	3	40	60	100
Ability Enhancement course (AEC)	24ENUA1202	Essential English: Intermediate	3	3	3	40	60	100
Skill Enhancement Course	24TAUS1202/ 24MLUS1202/ 24HIUS1202	Indian Language (Tamil/Malayalam/Hindi)-II	3	3	3	40	60	100

Value Added Course	24PEUV1001	Yoga & Fitness	2	2	2	50	-	50
Value Added Course	24GTUV1001	Let us Know Gandhi	2	2	2	50	-	50
Skill Enhancement Course	24TAUS0004/ 24MLUS0004/ 24HIUS0004	Functional Tamil/ Malayalam/Hindi	2	2	2	50	-	50
Total			23					
Semester-III								
Core Major-5	24GEUC2105	Geomorphology	4	4	3	40	60	100
Core Major-6	24GEUC2106	Paleontology	3	3	3	40	60	100
Core Major-7	24GEUC2107	Paleontology- Practical	1	3	3	60	40	100
Core Minor-3	24CHUB2101	Chemistry – I	3	3	3	40	60	100
Core Minor-3 Lab	24CHUB2102	Chemistry Practical - I	1	3	3	60	40	100
Multi disciplinary	--	Multidisciplinary-III (Online Course)	3	3	3	40	60	100
Ability Enhancement course (AEC)	24ENUA2103	Essential English: Advanced	3	3	3	40	60	100
Skill Enhancement Course	24TAUS2103/ 24MLUS2103/ 24HIUS2103	Indian Language (Tamil/Malayalam/Hindi)-III	3	3	3	40	60	100
Extension	24EXUE2101	Village Placement Programme	2	2	2	50	-	50
Total			23					
Semester-IV								
Core Major-8	24GEUC2208	Mineralogy	3	3	3	40	60	100
Core Major-9	24GEUC2209	Mineralogy - Practical	1	3	3	60	40	100
Core Major-10	24GEUC22010	Crystallography	3	3	3	40	60	100
Core Major-11	24GEUC2211	Crystallography - Practical	1	3	3	60	40	100
Core Major-12	24GEUC2212	Stratigraphy	4	4	3	40	60	100
Core Minor-4	24CHUB2201	Chemistry - II	3	3	3	40	60	100
Core Minor-4 Lab	24CHUB2202	Chemistry Practical - II	1	3	3	60	40	100
Ability Enhancement course (AEC)	24MAUA220X	AEC	3	3	3	40	60	100
Extension	24EXUE2202	Community Engagement	2	2	2	50	-	50
Total			21					

Semester-V								
Core Major – 13	24GEUC3113	Igneous Petrology	3	3	3	40	60	100
Core Major – 14	24GEUC3114	Igneous Petrology - Practical	1	3	3	60	40	100
Core Major – 15	24GEUC3115	Metamorphic Petrology	3	3	3	40	60	100
Core Major – 16	24GEUC3116	Metamorphic Petrology- Practical	1	3	3	60	40	100
Core Major –17	24GEUC3117	Sedimentary Petrology	3	3	3	40	60	100
Core Major – 18	24GEUC3118	Sedimentary Petrology- Practical	1	3	3	60	40	100
Core Minor – 5	24GEUB3101	Meteorology and Climatology	4	4	3	40	60	100
Core Major – 19	24GEUC3119	Internship	2	2	2	50	-	50
	24GEUE3101	Field Study	2	2	2	50	-	50
Total			20					
Semester-VI								
Core Major – 19	24GEUC3219	Hydrogeology	3	3	3	40	60	100
Core Major – 20	24GEUC3220	Hydrogeology - Practical	1	3	3	60	40	100
Core Major – 21	24GEUC3221	Economic Geology	3	3	3	40	60	100
Core Major – 22	24GEUC3222	Economic Geology- Practical	1	3	3	60	40	100
Core Major – 23	24GEUC3223	Mining and Engineering Geology	4	4	3	40	60	100
Core Major – 24	24GEUC3224	Remote sensing and GPS	3	3	3	40	60	100
Core Major – 25	24GEUC3225	Remote Sensing - Practical	1	3	3	60	40	100
Core Minor – 6	24GEUB3202	Geostatistics	4	4	3	40	60	100
Core Major – 26	24GEUC3226	*Project	4	4	3	40	60	100
		(Or)	***Project: Internal 75 + Viva 25 = 100 Marks**					
		Field Geology	4	4	3	40	60	100
Total			24					

Semester-VII								
Core Major – 27	24GEUC4127	Geophysics	3	3	3	40	60	100
Core Major – 28	24GEUC4128	Geophysics - Practical	1	3	3	60	40	100
Core Major – 29	24GEUC4129	Coal and Petroleum Geology	4	4	3	40	60	100
Core Major – 30	24GEUC4130	Digital Image Processing	3	3	3	40	60	100
Core Major – 31	24GEUC4131	Digital Image Processing – Practical	1	3	3	60	40	100
Core Minor – 7	24GEUB4103	Environmental Geology and Disaster management	4	4	3	40	60	100
Core Minor – 8	24GEUB4104	Geoscientific Instrumentation and Analytical Techniques	4	4	3	40	60	100
Total			20					
Semester-VIII								
Core Major – 32	24GEUC4232	Geochemistry	**3**	3	3	40	60	100
Core Major – 33	24GEUC4233	Geochemistry - Practical	**1**	3	3	60	40	100
Core Major – 34	24GEUC4234	Geographic Information System	**3**	3	3	40	60	100
Core Major – 35	24GEUC4235	Geographic Information System and GPS - Practical	**1**	3	3	60	40	100
Core Major – 36	24GEUC4236	*Project	**12**	12				300
			***Project: Internal – 100 + Evaluation – 100 + Viva – 100 = 300 Marks**					
Total			20					

ABSTRACT - CREDITS

Course	Semester															
	I		II		III		IV		V		VI		VII		VIII	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Core (Major+ Minor) Papers	7	1	7	1	11	1	14	2	13	3	21	3	18	2	18	2
Multi-disciplinary	3		3		3		-		-		-		-		-	
Ability Enhancement Course	3		3		3		3		-		-		-		-	
Skill Enhancement Course	3		3		3		-		-		-		-		-	
Value Added Course/Internship	4		4		-		-		2		-		-		-	
Village Placement Programme/Field Study/Functional Languages/Community Engagement			2		2		2		2		-		-		-	
Total	**21**		**23**		**23**		**21**		**20**		**24**		**20**		**20**	
Total	**172**															

Course Code &Title	**24GEUC1101** **PHYSICAL GEOLOGY**		
Class	B. Sc., Geology (Hons.)	Semester	I
Cognitive Level	K-1 K-2 K-3		

Course Objectives

The Course aims

- To understand the Origin and Evolution of Earth
- To Describe the Age and Interior of the Earth
- To Exemplify the Earth's atmosphere and Geological Time Scale.
- To Describe the geological processes of weathering and its products.
- To Summarize the concept of Plate tectonics

Unit	Content	Lectures
I	**Geology:** Earth Sciences, Branches of Geology, Scope of Geology. **The Stellar System – The Solar System –** The terrestrial (Mercury, Venus, Earth and Mars) and extra- terrestrial Planets (Jupiter, Saturn, Uranus, Neptune and Pluto). **Outline of Meteorites**. **Theories of Origin of the Earth:** The Nebular hypothesis – The Tidal Hypothesis – The Gas-Dust cloud hypothesis – Weizascker's Hypothesis – Schmidit's Hypothesis – Hoyle's Magnetic Theory, Modern Theories.	9
II	**Age of Earth: Indirect Methods -** Varve clock, Sedimentation clock, Salinity Clock, Rate of Cooling of the Earth, Evolutionary Changes of Animals; **Direct Methods** – Uranium-Lead Method, Thorium – Lead Method, Rubidium-Strontium Method, Lead-Lead Method, Meteoric Lead Method. **Interior Structure of Earth:** Description, Seismology and Interpretation. **The Crust:** Mountainous, Continental and Oceanic Areas, Continental Crustal Layers, Oceanic Crust. **The Mantle:** Upper and Lower Mantle, **The Core:** Inner and Outer Core. **Rock Cycle**	9
III	**Earth's Atmosphere:** Troposphere, Stratosphere, Mesosphere, Thermosphere, **Lithosphere and Hydrosphere**. Concept of Geoid and spheroid. **Isostasy** – Airy's, Pratt's and Heiskanen's Hypothesis, Evidence of Isostasy. **Geological Time Scale** – Outline of the geological history of the Earth.	9
IV	**Rock Weathering:** Introduction, weathering, erosion, Denudation. **Physical Weathering***:* Frost Action, Salt Action, Sheeting. **Chemical Weathering**: Oxidation, Carbonation, Hydration, Hydrolysis, Chelation, **Biological Weathering -** Role of Plants and Organisms, **Miscellaneous Weathering:** Spheroidal weathering and Exfoliation. **Agents of Weathering. Products of Weathering:** Regolith, Soil Profile, Climate and Soil formation. **Landforms formed by Weathering.**	9
V	**Continental Drift –** Evidence, Theories and Paleomagnetism. **Sea Floor Spreading and its supporting evidence. Theory of Plate Tectonics -** Convergent, Divergent and Transform Boundaries, Causes and Importance. **Earthquakes:** Causes, Effects, Classification, Seismology. **Earthquake Detection and Measurement:** Seismographs, Earthquake Scales – Intensity Scale and Magnitude Scale, Prediction and Control. **Volcano:** Causes of Volcanism.	9

Text Books:

1. Radhakrishnan, V., (1987) General Geology, V.V.P. Publishers, Tuticorin.
2. Mahapatra, G.P., (2022) A Textbook of Geology, CBS Publishers, New Delhi.

Reference Books:

1. Sunil Kumar., (2016) Textbook of Geology, Sonali Publications, New Delhi.
2. Mukherjee, P.K., (2010) A Textbook of Geology, The World Press, Kolkata.

3. Kathuria, C.D., (2011) Textbook of Earth Science, Centrum Press, Bengaluru.
4. Coulter, J.H., (2020) Basics of Earth Science, Agrotech Press, Jaipur.
5. Garg, S.K., (2009) Physical and Engineering Geology, Khanna Publishers, Delhi.

Web Resources:

1. *https://opentextbc.ca/geology/chapter/1-1-what-is-geology/*
2. *https://www.nap.edu/read/6024/chapter/3*
3. *https://simple.wikipedia.org/wiki/Structure_of_the_Earth*
4. *https://www.clearias.com/interior-of-the-earth/*
5. *https://www.nationalgeographic.org/encyclopedia/weathering/*
6. *https://www.livescience.com/37706-what-is-plate-tectonics.html*
7. *https://www.britannica.com/science/plate-tectonics*
8. *https://www.nationalgeographic.com/environment/naturaldisasters/volcanoes/*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Discuss the Basics of Geology, the Solar system and the Theories of the Origin of Earth

CO2: Evaluate the Age of Earth and its Interior Structure

CO3: Describe the Earth's Atmosphere, the Geological time scale, and the concept of Isostasy.

CO4: Explain the types of Weathering, its Products and the Agents of weathering with soil formation.

CO5: Discuss continental drift, the theory of plate tectonics, Earthquakes, and volcanism.

24GEUC1101 PHYSICAL GEOLOGY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S	L					S	S	M	S	S
CO2	S	S	L					S	S	L	S	S
CO3	S	S	L	L	L			S	M	L	S	S
CO4	S	S	M	L	M		L	S	M	L	S	S
CO5	S	S	M	L	L		L	S	S	M	S	S

Course Code &Title	**24GEUC1102** **SURVEYING PRACTICAL**
Class	B. Sc., Geology (Hons.) Semester I
Cognitive Level	K-1 K-2 K-3

The Course aims

Course Objectives

- To introduce the basic surveying techniques relevant to geological mapping and mining geology.
- To know the operational process of the survey equipment.
- To understand and conduct a geological survey investigation using the equipment's

Contents

SURVEYING

1. Definition – Primary divisions – classification
2. Chain survey – description of instruments employed – chain traverse - Open traverse and closed traverse
3. Compass survey – description of prismatic compass – whole circle bearings – reduced bearings – quadrant bearings
4. Plain table surveying: Finding distance between inaccessible stations
5. Locating the instrument station – Clinometer compass.
6. Levelling: Rise and Fall method
7. Finding dip and strike of beds
8. Bearing mapping methods using toposheet
9. Modern Surveying techniques.
10. GPS: Fundamentals and applications.
11. Mapping using GPS.
12. Theodolite: The essentials of transit theodolite; definition and terms.
13. Measurement of horizontal and vertical angles using Theodolite
14. An introduction to Total Station
15. Angle measurement using Total Station
16. Distance Measurement using Total Station
17. Calculation of Surface Area using Total Station.

Course Outcomes

On completion of the Course, the students should be able to

CO1: Discuss the Basics of Surveying
CO2: Evaluate types of Surveying
CO3: Describe the fundamentals and applications of GPS.
CO4: Explain the definition and terms of Theodolite
CO5: Discuss the principles and applications of Total Station

24GEUC1102 SURVEYING - PRACTICAL												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S	S	M	S	L	M	S	M	S		S
CO2	S	S	S	M	S	M	M	S	M	S		S
CO3	S	S	S	M	S	L	L	S	M	S		S
CO4	S	S	S	M	S	M	L	S	M	S		S
CO5	S	S	S	M	S	M	L	S	M	S		S

Course Code &Title	**24GEUC1201 STRUCTURAL GEOLOGY**		
Class	B. Sc., Geology (Hons.)	Semester	II
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To understand the different structures in crustal rocks derived from various forces active on and within the Earth's crust. • To Describe the mechanism and classification of Folds • To Describe the mechanism and classification of Faults and joints • To Describe the mechanics of Unconformities, Foliation and Lineation • To Describe shear zone, Boudinage and structural analysis.		

Unit	Content	Lectures
I	Objectives of Structural Geology: Relation to Geology, Primary and Secondary Structures - Structural Elements- *Dip and Strike - Apparent and true dip* - **Types of Dips**: Primary dip - Secondary dip - Regional dip. **Outcrop**: Outcrop pattern of strata; Outliers, Inliers- Outcrop Dimensions: Intrusions, Flows and Masses; Rule of V of outcrops. - Stereographic projections, Introduction to deformation mechanisms. Mechanical Properties of rocks - Theory of stress and strain. Behaviour of rocks under stress - Diagram. Strain Rate, Elastic (Hookean) Geometry and analyses of brittle-ductile and ductile shear zones. Behaviour of minerals and rocks under deformation conditions; Rheology, Viscous Behavior, Plastic (Saint-Venant) Behavior, Elastic, viscous (Maxwell) behaviour - **Controlling Factors**, finite strain: Strain ellipsoid; Flinn diagram, **Mohr's circle - types of stress ellipsoid and their geological significance - strain analyses of naturally deformed rocks.**– **Bedding - types of Stereonet** -Wulff net and Schmidt net.	9
II	**Folds**: Meaning and significance of folds- ***Geometry and Mechanism of Folding*:** -Fold orientation - Parts of a fold – **plunge of fold – Geometric and genetic Classification of folds**: Anticlines - Synclines - Symmetrical and Asymmetrical fold - Isoclinal fold - Recumbent fold - Conjugate fold - Box fold –Open and closed fold - Concentric fold - Similar fold - Supratenuous fold - Plunging fold - Chevron fold - Cuspate fold - Domes and basins - Monoclinic fold - Homocline fold - Drag fold. Ramsay's fold classification based on dip isogons, cylindrical, non-cylindrical and conical folds - Canoe fold and inverted canoe fold. Causes of folding**:** Minor folds and their uses in determining the major fold structure; Fault-related fold. **Tectonic process - non-tectonic process.** Depressions and Culminations - Domes and Saddles -	9

III	**Fault: *Mechanism of faults*:** Fault geometry and nomenclature - Fault plane - Dip and Hade - The walls - Fault zone - Shear zone - Slip and separation - The Slickenside's - Gouge - Fault breccia -Classification of faulting - Criteria for faulting. **Normal faults** - representation of normal faults on the block diagrams - **reverse faults and thrust faults** – Tectonic features of extensional, compressional, and strike-slip terrains and relevance to plate boundaries - Stratigraphic differences between normal and reverse faults - Nappe, klippe and tectonic window - flat, and steeps of the reverse faults - **autochthonous and allochthonous units** - imbricate and duplex structures - horst and graben - Strike-slip faults and minor structures associated with such faults - cataclastics and mylonites - **Transform Faults- Characteristics of faults and fault zones.** ***Joints**: Introduction - Classification:* Systematic joints - non-Systematic joints. Geometry - Origin of joints: Tension joints - Shear joints - Compression joints - Occurrence of Joints: Igneous rocks: Sheet joints - Mural joints - Columnar joints - Sedimentary rocks - Metamorphic rocks. Geometrical classification and genetic classification of joints. Relation of rupture to stress and strain - Joint formation in response to loading and stress; Fracture development and propagation; Classification of joints and extension fractures.	9
IV	**Unconformity**: Origin and Kinds of Unconformities - Recognition of Unconformities. Significance in stratigraphy - Distinguishing Faults from Unconformities - Radiogenic dating - Tectonism and sedimentation. Diapirs and Salt Domes.- Types: Angular Unconformity - Disconformity - Nonconformity - Local Unconformity - Regional Unconformity - Recognition of Unconformity. **Foliation**: Introduction - Geometry and mechanics of development of Foliation and its types - Metamorphic foliation: Gneissic structure - Schistocity and phyletic structure - Crenulation cleavage - Flattened pebble conglomerate - Foliations in Sedimentary rocks: Spaced cleavage. Foliation in Igneous rocks: Flow foliation - Migmatite. **Lineation**- Introduction - Geometry and mechanics of development of Lineation and its types: Intersection lineation - Crenulation lineation - Mineral lineation - Stretching lineation. **Cleavage**: Spaced cleavage, continuous cleavage, fracture cleavage.	9
V	**Shear Zone**: Pure shear zone, sub-simple shear zone, simple shear zone, ductile shear zone. Kinematic classification of shear zones. **Boudinage and pinch and swell structure**: Geometry, viscosity and strain: Asymmetric Boudinage; Foliation Boudinage. Boudinage with strain ellipse; Large scale boudinage. **Lineament:** Mapping and Analysis - Basin Tectonics - Microstructures and Structures of Sedimentation and Intrusion- Structural analyses: - kinematic and dynamic analysis of deformation. **Structural Identification**: Field observations, Remote sensing and geodesy, DEM, GIS and Google Earth, Seismic data, Experiments, Numerical models and other data sources: Gravimetric and magnetic data. **Structural analysis**: Geometric analysis, Strain and kinematic analysis, Dynamic analysis, Tectonic analysis	9

Text Books:

1. Billings, M. P., (2016) Structural Geology. Prentice Hall of India Ltd. New Delhi.
2. Gokhale, N.W., (2019) Theory of Structural Geology, CBS publications, Delhi.

3. Parbin Singh, B., (2013) A Textbook of Engineering and General Geology, K.Kataria& Sons. Delhi.
4. Stephen Marsha and Gautum Mitra., (2017) Basic Methods of Structural Geology. Pearson Education, India.

Reference Books:

1. Sathya Narayanaswami, B. S., (1994) Structural Geology. Dhanpat Rai & Sons, New Delhi.
2. Davis, G.H., and Reynolds, S.J., (1996) Structural Geology of Rocks and Regions, 2nd ed., Wiley, New York.
3. Gokhale, N. W., (2009) Theory of Structural Geology., CBS Publications.
4. Hobbs, B. E., Means, W. D., & Williams, P. E., (1996) An Outline of Structural Geology, John Wiley & Sons, Inc, Australia.
5. Park, R. G., (2004) Foundations of Structural Geology. Chapman & Hall.
6. Pollard, D. D., (2005) Fundamental of Structural Geology. Cambridge University Press.
7. Fossen Haakon., (2016) Structural Geology, Second Edition Cambridge University Press.

Web Resources:

1. *http://www.geosci.usyd.edu.au/users/prey/Patrice_Intro_to_SG.pdf*
2. *https://www.geoexpro.com/articles/2013/07/folds-and-folding-Part – i*
3. *https://www.civil.org/faults-geological-faults-in-earth.html*
4. *http://www.yourarticlelibrary.com/geology/faults-meaning-classification-and-importance-geology/91572*
5. *http://www.geographynotes.com/geology-2/structural-geology/joints-definition-classification-and-consideration-geology/1375*
6. *http://www.indiana.edu/~geol105b/images/gaia_chapter_6/unconformities.html/*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Understand the concepts of deformation and primary and secondary structures

CO2: Explain the mechanism and types of fold

CO3: Describe and classify the faults and Joints in the field

CO4: Discuss types of Unconformities and Foliation and Lineation

CO5: Describe the Shear zone, Boudinage and Structural analysis

24GEUC1201 STRUCTURAL GEOLOGY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	M		M			L	S		L		S
CO2	S	M		M	L		L	S	L	L		S
CO3	S	M		M	L		L	S	L	M	M	S
CO4	S	M		M	L		M	S	L	M	L	S
CO5	S	M	L	M	L		S	S	L	M	S	S

Course Code &Title	**24GEUC1202** **STRUCTURAL GEOLOGY PRACTICAL**		
Class	B. Sc., Geology (Hons.)	Semester	II
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Complete the Structural Geology Maps, Strike and Dip of the Beds • To understand the Structural and Lithological maps and Write their Geological history • To determine the geological structures through cross-sections. • To identify the True dip, apparent dip, and thickness of Beds		

Contents

1. The basic idea of topographic contours
2. Topographic sheets of various scales.
3. Drawing profile sections and interpretation of geological maps
4. Reading of solid, conformable maps
5. Deciphering dip and strike of outcrops
6. Completion of a map when three points over a bedding plane are given
7. Determination of vertical thickness of formations.
8. Reading of solid fold and fault maps –Determination of throw of faults – Construction of vertical sections
9. Introduction to Geological maps: Lithological and Structural maps
10. Reading solid maps of areas with more than one structure and intrusion – Writing of geological history.
11. Solving dip and strike problems by trigonometrical method
12. Determination of true dip &apparent dip and thickness by calculation and graphical method.
13. Three-point problems for Fold maps, Fault maps, and Unconformity maps, as well as Preparation of cross-sections across the geological maps to bring out the structure and order of superposition of the beds.
14. Structural geology problems/Graphical determination of Dip in gradient.
15. Determination of True dip by a simple calculation.
16. Determination of Apparent dips by Graphical method.
17. Determination of Thickness of bed by calculation on level ground.
18. Geometric analyses of linear and planar features using Stereographic projection
19. Stereographic projection by using Stereonet windows software

Course Outcomes

On completion of the Course, the students should be able to

CO1: Assess the true dip and strike of the geological formations

CO2: Assess the contour and topographic maps and the strike and dip of the maps and Compute the thickness of the outcrops

24GEUC1202 STRUCTURAL GEOLOGY - PRACTICAL												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S	L	M	M	L	S	S	M	S	L	S
CO2	S	S	L	M	M	L	M	S	M	S	L	S
CO3												
CO4												
CO5												

Course Code &Title	**24GEUC2301 GEOMORPHOLOGY**		
Class	B. Sc., Geology (Hons.)	Semester	III
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To understand the general concepts of geomorphology, geomorphic processes, weathering processes, soil processes, mass wasting concepts, and Karst topography. • To Describe the Geological work of Wind, River and associated landforms • To Describe the Geological work of Groundwater and associated landforms • To Describe the Geological work of Sea and coral reef landforms • To Describe the volcanic, Glacial Geomorphology and environmental changes in landforms.		

Unit	Content	Lectures
I	**Geomorphology**: **Definition and concepts of geomorphology- Geomorphic Processes;** Exogenetic and Endogenic processes **Weathering:** physical weathering, chemical weathering, and biological weathering**. Soil Processes**: soil profile, climate and soil formation, soil types. **Mass Wasting Process:** gravity, slope angle, material properties, water content, and vegetation. **Types of mass wasting: r**ock falls, slides and flows**; Triggers of Mass Wasting:** heavy rainfall, earthquakes, volcanic activity and human activities. **Karst Topography**: Landform features	12
II	**Geological work of Wind:** wind erosion and its landforms; undercut hills, cave rocks, toad rocks (frog rock), mushroom, table and pedestal or pinnacled rocks, natural bridges, yardang, ventifacts, desert varnish, forms bowels and caves, deflation basin, desert lakes and desert pavements. Sediment transport by wind, and its landforms, deposition by wind and its landforms - **Sand dunes** – **Dynamics;** Ripples, loess, dunes - Longitudinal dunes, Transverse dunes, Barchan dunes, Parabolic dunes and Playa Lake. **Geological work of River:** Sources of stream water – river profile – geological work – methods of river erosion: hydraulic action, abrasion, attrition, solution, corrosion or chemical erosion, traction and saltation. **Rate of river erosion**: river discharge, sediment load, geology, vegetation, human activities and climate. Features of stream erosion: V-shaped valleys, meanders, oxbow lakes, river cliffs, alluvial terraces, waterfalls and rapids, gorges and canyons. **Sediment transport by river**; Erosion, Transportation - bedload, suspended load and dissolved load- deposition by river. **Drainage patterns and its types, Major rivers in India. Lakes**: Geological function, classification, origin, size, distribution and Indian lakes	12

III	**<u>Geological work of Groundwater</u>:** Description, **Sediment motion by groundwater. Chemical work of groundwater**: dissolution, chemical weathering, mineral precipitation, Ion exchange and redox reactions**. Deposition by groundwater:** saturation and precipitation, changes in environment, formation of mineral deposits, speleothem formation, and contribution to sedimentary processes. **Mechanical work of groundwater**: pressure release and joint expansion, subsidence and land movement, erosion of sediment particles and cavern formation in Karst landscapes. **Landforms formed by groundwater process:** caves, sinkholes, karst valleys, karst towers and pavements, karst springs and cave deposits (speleothems): **Drainage patterns** and its types**. Major rivers in India.**	12
IV	**<u>Geological work of Sea:</u> Geological parameters of the ocean,** Definition of the continental shelf, continental slope, abyssal plain, continental rise and submarine canyons. Marine erosion and features of marine erosion – Coastal erosional landform: sea cliffs, wave cut, terraces, sea caves, sea arches, headlands, stacks and stumps. Coastal depositional landforms: beach ridges, stand plain complex, swales, mudflats, creeks, backwaters, salt flats, beaches, bay mouth bars, protruding deltas, submarine deltas, offshore islands, coastal dunes and coastal sand sheets. Classification of coast: emerging coast, subsiding coast, couponed coast and neutral coast. **Coral reefs – Types & uses. Indian occurrence of coral reefs.**	12
V	**Volcanic Geomorphology**: Volcanic process; Types of volcanoes, Landforms created by volcanic eruptions, Volcanic Plateaus and Plains. Active volcanoes of the world. **Glacial Geomorphology**: Process of glaciation; Movement of Glaciers, Glacial Erosion landforms– Cirque, Tarn, Horn, Arete, Glacial Valley and Hanging Valley - Deposition landforms; Moraines, Kames, Esker, Kettles/Kettle Ponds and Braided Outwash Streams. Types of Glaciers - Geomorphology and topographic analysis including DEM, **Environmental change** – causes, effects on processes and landforms. Extra-terrestrial geomorphology	12

Text Books:

1. Thornbury, W.D. (2002) Principles of Geomorphology, John Wiley and Sons, 2nd Edition, New Tork
2. Radhakrishnan, V., (1996) General Geology, V.V.P. Publishers, Tuticorin.
3. Mahapatra, G.P., (1992) Textbook of Geology, CBS Publishers, New Delhi.
4. Dayal, P., (2019) A Text Book of Geomorphology, Rajesh publications.
5. Richard John Huggett, (2011) Fundamentals of Geomorphology, Taylor& Francis.
6. Gautam, A ., (2009) Geomorphology, First Edition: Sharada Pustak Bhawan
7. Savindra Singh, (2012) Geomorphology, Fifth Edition: Prayag Pustak Bhawan.

Reference Books:

1. Worcester, P. G., (1960) A Text Book of Geomorphology, East West Press Ltd. Delhi.
2. Singh, S., (2007) Geomorphology. S. Chand &Co. Delhi.
3. Park, R. G, (1989) Foundation of Structural Geology, Blackie and Sons Ltd., Glasgow, New Zealand, Second edition.
4. Davis, G. H., (1985) Structural Geology of Rocks and Regions. Elements of Structural Geology, Wiley.
5. Siddhartha, K., (2021) The Earth's Dynamic Surface, Kitab Mahal publishers.

Web Resources:

1.
2. *http://geomorphology.org.uk/what-geomorphology-0*
3. *http://geographymat.blogspot.com/2011/02/fundamental-conecpts.html*
4. *http://www.preservearticles.com/2011110116387/what-is-the-gological-action-of-river.html*

5. *http://www.alevelgeography.com/the-long-profile-changing-processes-types-of-erosion-transportation-and-deposition/*
6. *http://www.preservearticles.com/2011110116404/what-is-the-geological-action-of-the-underground-water.html*
7. *http://www.preservearticles.com/2011110116411/what-are-the-geological-action-of-glaciers.html*
8. *http://www.preservearticles.com/2011110116424/what-are-the-geological-activities-of-the-sea-a-oceans.html*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Outline the concept of Geomorphology and Weathering, Soil processes, and Karst Topography

CO2: Describe the Landforms created by Wind, River and Drainage systems.

CO3: Evaluate the Landforms created by Groundwater and describe the drainage pattern

CO4: Explain the Landforms developed by Sea and Coral reefs

CO5: Describe the Geomorphology of Volcanic, Glacial and Environmental changes of landforms

24GEUC2301 GEOMORPHOLOGY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	M	M	L				S	L		L	S
CO2	S	M	M	L				S	L		L	S
CO3	S	M	M	M				S	L		L	S
CO4	S	M	M	L				S	L		L	S
CO5	S	M	M	L				S	L		L	S

Course Code &Title	**24GEUC2302** **PALAEONTOLOGY**			
Class	B. Sc., Geology (Hons.)		Semester	III
Cognitive Level	K-1 K-2 K-3			

The Course aims

Course Objectives

- To Explore the fundamentals of Palaeontology and its divisions
- To Understand the phylum vs time of various fossils explored.
- To Describe the different phylum and the fossil details associated with it.
- To Illustrate the mega-fossils and microfossils and their economic importance.
- To Define and explain the vertebrate and invertebrate fossils and micropaleontology.

Unit	Content	Lectures
I	**Introduction** and history of Palaeontology. Detailed account of Geological time scale with fossil evidence through ages**. Fossils and fossilization:** Definition – Evolution and Mass Extinction concept and their causes, Modes of preservation of fossils – Conditions for fossilization – Types of fossils – Significance of fossils. Collection, preparation and nomenclature of fossils: Index fossils and zone fossils – general study of ***Palaeogeography***, ***Palaeoclimate***, ***Palaeoecology***, organic evolution, ***Palaeobotany***-Detailed study of Vascular and Non-vascular plant fossils. General outline of the classification of organisms and plants.	9
II	**Invertebrate Paleontology:** ***Phylum Mollusca****:* General morphology in detail, classification, evolutionary trends, and geological distribution with important fossils of the classes Lamellibranchia, Gasteropoda and Cephalopoda. ***Phylum Arthropoda***: General morphology in detail, classification, evolutionary trends, and geological distribution with important fossils of the class Trilobita. ***Phylum Brachiopoda:*** General morphology in detail, classification, evolutionary trends, and geological distribution with important fossils of Brachiopods.	9
III	***Phylum Coelenterata:*** General morphology in detail, classification, evolutionary trends, and geological distribution with important fossils of the class Anthozoa. ***Phylum Echinodermata***: General morphology in detail, classification, evolutionary trends, and geological distribution with important fossils of class Echinoidea and Crinoidea. ***Phylum Hemichordata:*** General morphology in detail, classification, evolutionary trends, and geological distribution with important fossils of class Graptozoa. ***Phylum Annelida***: General morphology in detail, classification, evolutionary trends, and geological distribution with important fossils of class Chaetopoda.	9
IV	**Vertebrate Palaeontology: *Pisces***: General features and classification - ***Amphibians*****:** Origin, general features and classification - ***Reptiles***: Origin, general features and classification. A detailed study on Dinosaurs-classification and causes for extinction. ***Aves*****:** Origin, general features and classification. ***Mammals***: Origin, general features and evolutionary trends of Whales, Horses, Camel, Elephants and Homosapiens. Records of Mega Fossils of Indian sub-continent.	9
	Micropalaeontology: Introduction to microfossils-Field and laboratory techniques of micropalaeontology- Cyanobacteria, Bacteria, Diatoms,	9

V Coccoliths, Silicoflagellates and Dinoflagellates. ***Phylum Protozoa***: General morphology in detail, classification, evolutionary trends, and geological distribution with important fossils of order ***Foraminifera*** and ***Radiolaria***. ***Phylum Porifera:*** General morphology in detail, classification, evolutionary trends, and geological distribution with important fossils of ***Sponges***. Uses of microfossils. Significance and Scenario of microfossils in Asian continent.

Text Books:

1. Jain, M. L. & Anantharaman P. C., (2013) An Introduction to Palaeontology. Vishal Publications. Delhi.
2. Henry Woods., (2005) Palaeontology Invertebrate, The University Press.

Reference Books:

1. Moore, R.C, Lalicker, C.G & Fisher, A.G., (1997) Invertebrate fossils. (1st Indian edition), CBS Publishers &Distributors, New Delhi.
2. Black, R.M., (1972) Elements of Palaeontology, Oxford University Press, UK.
3. Clarkson, E.N.K., (2012) Invertebrate Palaeontology and Evolution-IVth edition, Wiley, New Delhi.
4. Shrock&Twenhofel., (2005) Principles of invertebrate Palaeontology, 2nd edition, New Delhi.
5. Easton, W. H., (1960) Invertebrate Palaeontology. Harper & Brothers. New York.
6. Raup D.M., (2004) Principles of Palaeontology 2Ed, CBS Publishers.

Web Resources:

1. *http://www.biologydiscussion.com/articles/geological-time-scale-meaning-divisions-and-events/22622*
2. *http://www.uno.edu/cos/earth-environmental-sciences/ees-docs/ClassResources/Lab6_Fossilization.pdf*
3. *https://sites.google.com/site/paleoplant/home/what-is-paleobotany*
4. *http://www.ucmp.berkeley.edu/mollusca/mollusca/gastropoda/gastropodafr.html*
5. *https://theodora.com/encyclopedia/l/lamellibranchia.html*
6. *http://www.ordovicianatlas.org/atlas/brachiopoda/brachiopod-general-morphology/*
7. *http://www.ucmp.berkeley.edu/echinodermata/echinomm.html*
8. *http://www.ucmp.berkeley.edu/foram/forammm.html*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Explain the modes of preservation of fossils

CO2: Evaluate the morphology of the Mollusca fossils, Trilobites and Brachopida

CO3: Describe the morphology of the Coelenterata and Hemichordata.

CO4: Outline the origin of vertebrates

CO5: Explain the morphology of Echinodermata, Foraminifers and Porifera

24GEUC2302 PALAEONTOLOGY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S	M			L		M				S
CO2	S	S	M			L		M				S
CO3	S	S	M			L		M				S
CO4	S	S	M			L		M				S
CO5	S	S	M			L		M				S

Course Code &Title	**24GEUC2303 PALAEONTOLOGY – PRACTICAL**		
Class	B. Sc., Geology (Hons.)	Semester	III
Cognitive Level	K-1 K-2 K-3		

The Course aims

Course Objectives

- To Know various types of fossils
- To Examine the morphological characteristics of the fossils
- To Describe the age with respect to the fossils
- To Understand the characteristics of microfossils
- To Explain the uses of fossils

Contents

Identification, Diagram with parts and description of the following fossils:

a) **Lamellibranchs:** Arca, Meretrix, Pecten, Cardita, Lima, Alectryonia, Inoceramus, Gryphaea, Exogyra, Radiolites, Ostrea, Unio, Trigonia.
b) **Gastropods**: Turritella, Turbo, Cerithium, Trochus, Physa, Murex, Voluta, Helix, Euomphalus, Cyprea.
c) **Cephalopods**: Nautilus, Orthoceras, Ceratite, Goniatite, Belemnites, Baculites, and Perisphinctes.
d) **Echinodermata**: Cidaris, Holaster, Hemiaster, Stigmatophygus, Apiocrinus.
e) **Trilobites**: Paradoxides, Olenus, Olenellus, Phacops, Calymene.
f) **Corals**: Calceola, Zaphrentis, Lithostrotion, Omphyma, Thecosmelia, Montlivaltia.
g) **Brachiopoda**: Terebratula, Spirifer, Productus, Monograptus, Tetragraptus, Diplograptus, Atrypa, Lingula.
h) **Plant fossils**: Ptilophyllum, Glossopteris, Lepidodendron and Petrified wood.
i) **Microfossils**: Globigerina, Textularia,Lenticulina, Cibicides, Lagena, Nodosaria, Quinqueloculina, Rhabdammia, Orbulina, Siderolites.

Course Outcomes

On completion of the Course, the students should be able to

CO1: Explain the morphology of Lamellibranchs and Gastropods.

CO2: Evaluate the morphology of the Cephalopods and Echinodermata

CO3: Describe the morphology of the Trilobites, Corals and Brachiopoda.

CO4: Outline of the Plant fossils.

CO5*:* Details of the Microfossils.

24GEUC2303 PALAEONTOLOGY - PRACTICAL												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S			M			L	S		M		S
CO2	S			M			L	S		L		S
CO3	S			M			L	S		M		S
CO4	S			M			M	S		S		S
CO5	S			M			M	S	M	S		S

Course Code &Title	**24GEUC2401 MINERALOGY**		
Class	B. Sc., Geology (Hons.)	Semester	**IV**
Cognitive Level	K-1 K-2 K-3		

Course Objectives

The Course aims

- To Learn the physical and chemical properties of minerals
- To Explain the Quartz and Feldspar Groups of Minerals and its verities
- To Classify the Feldspathoid and Pyroxene Group of essential minerals.
- To categorize minerals in Amphibole, Olivine, Mica, Garnet, and Zeolite groups of minerals, as well as accessory minerals.

Unit	Content	Lectures
I	**Mineralogy:** An Introduction of mineral and mineraloid. **Properties of minerals** – **Physical characteristics depend upon cohesion, light, specific gravity, heat, electricity, m**agnetism, and senses. **Chemistry of minerals:** Crystal chemistry- bonding – chemical classification of Minerals - structures of silicates – Atomic Substitution and Solid solution in Minerals – iso structuralism – isotypism and Isomorphism - Polymorphism and Polytypism – Pseudomorphism - Non-Crystalline minerals	9
II	**Rock Forming Minerals – I: Quartz Group:** Description, General Characteristics, Crystalline Verities, Cryptocrystalline Verities, Amorphous Verities. **Feldspar Group:** Crystal System Details, Introduction, **Alkali Feldspar:** Orthoclase, Sanidine, Microcline, Celsian, Perthite. **Plagioclase Feldspar:** Plagioclase Series - Albite, Labradorite, Oligoclase, Bytwonite, Andesite and Anorthite. Phenomena of Solid Solution. Solid Solution, Solid Solution in Plagioclase Feldspars. **Feldspathoid Group:** Introduction, Chemistry, Leucite, Nepheline, Cancrinite, Sodalite, Hauynite, Noselite, Lazurite	9
III	**Rock Forming Minerals – II: Pyroxene Group:** General Characteristics, Orthopyroxene, Clinopyroxene, Clinoenstatites, Pigeonite, Diopside-Hedenbergite, Augite, Wollastonite, Agerite, Jadeite, Spodumene, Rhodonite. **Amphibole Group:** General Characteristics, Anthophyllite, Cummingtonite, Tremolite - Actinolite, Hornblende, Glaucophane – Arfvedsonite. General description and Mineral characteristics: **Olivine**, **Mica, Garnet**, **Zeolite** Group of Minerals. **Accessory Minerals:** Epidote, Scapolite, Beryl, Apatite, Fluorite, Kyanite, Sillimanite, Andalusite, Topaz, Tourmaline, Cordierite, Calcite, Dolomite, Staurolite, Talc, Kaoline, Serpentine, Steatite, Zircon, Sphene, Rutile, Magnetite, Ilmenite.	9
IV	**Optical Mineralogy:** Mineral Preparation for Microscopic study - Types of Preparation, Materials for Thin Section, The Mineral Slice and Cutting. Polishing hardness – Microhardness **Transmitted light microscope:** Polarizing Microscope; General Features, Parts of Microscope, Phase Microscopy and its Examination. Adjustment of Polarizing Microscope. **Elementary concept of Light**: Polarization and Nicol Prism - Snell's law -	9

	Refractive Index – Dispersion – Total Reflection – Double Refraction - **Behavior of the light through the Microscope:** Properties in plane-polarized light – Properties under crossed polars	
V	**Transmitted Light Crystallography:** Polarised light – Refractive index – isotropy – biaxial indicatrix triaxial ellipsoid – uniaxial indicatrix – interference colours and Newton's scale - fast and slow components, and order determination – Interference figures – Pleochroic scheme – extinction angle.	9

Text Books:

1. Berry Mason, L.G., (1985) Mineralogy, W.H. Freeman &Co.
2. Gribble, C. D., Rutley's., (1988) Elements of Mineralogy. CBS, New Delhi.
3. Gribble, C.D., Hall, A.J., (1985) Optical Mineralogy Principles & Practice. George Allen and Unwin, London

Reference Books:

1. Parbin Singh, B., (2005) A Textbook of Engineering and General Geology, S. K. Kataria & Sons, Delhi.
2. Perkins & Dexter., (2010) Mineralogy (3rd Edition) Prentice Hall.
3. Kerr B.F, (1995) Optical Mineralogy. McGraw Hill, 5th Edition, New York.
4. Deer, W. A., Howie, R. A & Zussman., (2013) An Introduction to Rock Forming Minerals, Third Edition, ELBS, Ed.
5. Revelli Phillips, W.M. & Dana. T. Griffen., (2004) Optical Mineralogy-The Non- Opaque Minerals, CBS publishers & Distributors, New Delhi.

Web Resources:

1. *http://www.tulane.edu/~sanelson/eens211/#Lecture%20Notes*
2. *http://jaeger.earthsci.unimelb.edu.au/msandifo/Teaching/Mineralogy2/mineralogy.pdf*
3. *http://epgp.inflibnet.ac.in/ahl.php?csrno=448*
4. *https://www.researchgate.net/publication/221923612_An_Introduction_to_Mineralogy*
5. *http://www.minsocam.org/msa/openaccess_publications/McNamee_Gunter_Lab_Manual.pdf*
6. *https://www.tulane.edu/~sanelson/eens211/silicate_structures08.htm*
7. *https://www.britannica.com/science/mineral-chemical-compound/Nesosilicates*
8. *http://bsrithai.geol.science.cmu.ac.th/pdf/205234/Sorosilicate.pdf*
9. *http://bsrithai.geol.science.cmu.ac.th/pdf/205234/Cyclosilicate.pdf*
10. *https://www.tulane.edu/~sanelson/eens211/inosilicates.pdf*
11. *http://www.geo.umass.edu/courses/geo311/phyllosilicates.pdf*
12. *http://www.geo.umass.edu/courses/geo311/lecture%2012%20Tectosilicates.pdf.*
13. *http://www.geo.umass.edu/courses/geo311/pyroxenes.pdf*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Identify the physical and chemical properties of the minerals
CO2: Explain verities of minerals in Quartz and Feldspar Groups
CO3: Describe minerals in Feldspathoid and Pyroxene Groups.
CO4: Outline the minerals in Amphibole, Olivine, Mica, Garnet, Zeolite groups of minerals, and accessory minerals**.**
CO5: Identify the Optical Characteristics of various Minerals.

24GEUC2401 MINERALOGY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	M	L	M	L	L	L	M				M
CO2	S	M	L	M				M				M
CO3	S	M	L	M				M				M
CO4	S	M	L	M				M				M
CO5	S	M	L	L				M				M

Course Code &Title	**24GEUC2402 MINERALOGY PRACTICAL**		
Class	B. Sc., Geology (Hons.)	Semester	IV
Cognitive Level	K-1 K-2 K-3		

Course Objectives

The Course aims

- To Study the megascopic properties of rock-forming minerals
- To Understand the Origin and Occurrences of the minerals
- To discriminate the structural formulae for various mineral groups.
- To Examine the optical properties of rock-forming minerals

Content

1. **Megascopic identification and description of Following Rock-Forming and accessory Minerals**
   - **Quartz group:** Quartz, chalcedony, opal, agate, flint, jasper, amethyst, rose quartz.
   - **Feldspar group:** Orthoclase, microcline, albite, Anorthite, oligoclase, labradorite
   - **Feldspathoid group:** Adularia, sanidine, nepheline, sodalite, lapislazuli
   - **Pyroxene group:** Enstatite, bronzite, hypersthene, augite, Diopside
   - **Amphibole group:** Anthophyllite, Hornblende, Actinolite, Tremolite
   - **Olivine group:** Olivine, serpentine
   - **Mica group:** Muscovite, biotite, phlogopite, lepidolite, vermiculite
   - **Accessory minerals:** Chlorite, epidote, garnet, apophyllite, stilbite, heulandite, talc, steatite, beryl, kaolin, cordierite, apatite, andalusite, staurolite, sillimanite, kyanite, tourmaline, topaz, calcite, dolomite and fluorspar
2. **Determination of structural formula of the following mineral groups**: Garnet, Olivine, Pyroxene, Feldspar, Mica and Amphibole.
3. **Optical Mineralogy:**
   - Determination of Optical Properties of Rock-forming and accessory Minerals using Petrological Microscope.

Determination of Relative Birefringence, order of interference color, sign of elongation, birefringence, scheme of pleochroism and pleochroic formula.

Course Outcomes

On completion of the Course, the students should be able to

CO1: Identify the megascopic properties of the Quartz and Feldspar group of minerals
CO2: Outline the megascopic properties of the Feldspathoid and Pyroxene group of minerals
CO3: Describe the megascopic properties of the Amphibole group of minerals
CO4: Identify, Discriminate and describe the megascopic properties of the Olivine and Mica group of Minerals.
CO5: Describe Microscopic properties of minerals.

24GEUC2402
MINERALOGY - PRACTICAL

CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	L		M	L		M	M		M		S
CO2	S	L		M	L		M	M		M		S
CO3	S	L		M	L		M	M		M		S
CO4	S	L		M	L		M	M		M		S
CO5	S	L		L	L		M	M				S

Course Code &Title	**24GEUC2403 CRYSTALLOGRAPHY**		
Class	B. Sc., Geology (Hons.)	Semester	IV
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To identify the crystal forms in minerals • To Know the Internal and External structures of crystals and their characteristics. • To describe the Isometric and Tetragonal system • To Classify the Hexagonal system and Rhombohedral divisions. • To Learn the Orthorhombic, Monoclinic and Triclinic crystal forms. • To Explain the characters of twinning in crystals		

Unit	Content	Lectures
I	***Crystallography:*** Definition of a crystal - Molecular structure in general - Crystalline and amorphous - External form - Variation of form and surface - Constancy of the Interfacial angles in the same species - Diversity of Form or habit - Diversity of Size – **Basic crystal symmetry** - Planes of symmetry - Axes of symmetry - Centre of symmetry - Relation of Geometrical to Crystallographic symmetry - Pseudo symmetry - Crystallographic axes - *Systems of crystallization*. **Concept of point groups.**	9
II	**Isometric system**: Normal class - Pyritohedral class - Tetrahedral class - Plagiohedral class - Tetratohedral class. **Tetragonal system**: Normal class - Hemimorphic class - Tripyramidal class - Pyramidal - Hemimorphic class - Sphenoidal class - Trapezohedral class - Tetratohedral class.	9
III	**Hexagonal system**: Normal class - Hemimorphic class - Tripyramidal class - Pyramidal - Hemimorphic class - Trapezohedral class - **Rhombohedral division**: Trigonal class - Rhombohedral class - Rhombohedral hemimorphic class - Tri-Rhombohedral class - Trapezohedral class.	9
IV	**Orthorhombic system**: Normal class - Hemimorphic class - Sphenoidal class. **Monoclinic system**: Normal class - Hemimorphic class - Clinohedral class -**Triclinic system**: Normal class - Asymmetric class. Crystallographicnotation – parameter system of Weiss, index system of Miller. **Crystal chemistry:** Dimorphism, polymorphism, pseudomorphism, isomorphism and solid solution.	9
V	**Compound or Twin crystals**: Definition - Distinction between Twinning and Parallel grouping - Twinning Axis - Twinning Plane - Composition plane - Contact and Penetration twins - Paragenic and Metagenic twins - Repeated twinning, polysynthetic and symmetrical - Secondary twinning - **Twinning**: Isometric system - Tetragonal system - Hexagonal system -	9

Orthorhombic system - Monoclinic system - Triclinic system. **Uses of crystals in different fields.**

Text Books:

1. Ford, W.E., (1988) Dana's Textbook of Mineralogy. Wiley. New Delhi. (Reprint).
2. Wade, F.A. & Mattox. R.B., (1960) Elements of Crystallography and Mineralogy. Harper & Brothers—Harper's Geoscience Series, New York.

Reference Books:

1. Perkins, D. & Henke. K. R., (2003) Minerals in Thin Section, Prentice Hall, New Delhi.
2. Kerr, P. F., (1977) Optical Mineralogy, 4th ed. McGraw Hill, New York.
3. Berry Mason, L.G, (1977) Mineralogy, W.H. Freeman &Co.
4. Deer, W. A., Howie, R. A & Zussman., (2013) An Introduction to Rock Forming Minerals, Third Edition, ELBS, Ed.
5. Ravell Phillips, W. M. & Dana. T. Griffen., (2004) Optical Mineralogy-The Non-Opaque Minerals, CBS publishers & Distributors.
6. Phillips, R.C., (2011) An introduction to Crystallography, Read Books.

Web Resources:

1. *https://www.britannica.com/science/isometric-system*
2. *http://www.mineralogy4kids.org/all--crystals/crystal-systems/tetragonal-system*
3. *https://uwaterloo.ca/earth-sciences-museum/resources/crystal-shapes/hexagonal-crystal-system*
4. *https://www.britannica.com/science/orthorhombic-system*
5. *https://uwaterloo.ca/earth-sciences-museum/resources/crystal-shapes/monoclinic-crystal-system*
6. *http://www.chem.wisc.edu/~danny/interactive/triclinic/*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Explain the basics of crystallography, various crystal forms, Crystallographic Axis and symmetry

CO2: Describe Isometric and tetragonal crystal forms.

CO3: Identify and describe the Hexagonal, rhombohedral and mineral forms

CO4: Identify the Orthorhombic, Monoclinic and triclinic crystal forms.

CO5: Describe Twinning crystals.

24GEUC2403 CRYSTALLOGRAPHY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	M		L				M			M	S
CO2	S	M		L				M			M	S
CO3	S	M		L				M			M	S
CO4	S	M		L				M			M	S
CO5	S	M		L				M			M	S

Course Code &Title	**24GEUC2404 CRYSTALLOGRAPHY – PRACTICAL**		
Class	B. Sc., Geology (Hons.)	Semester	IV
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Do Exercises on Crystal Models • To Identify the Crystal Axis and Symmetries • To Identify the Twinning Crystals. • To Explain the general characteristics and the uses of crystals		

Contents

Description of forms present with diagram and determination of Miller indices of the following crystal models:

I. **Isometric System:** Normal Class – Galena, Fluorite, Magnetite, Garnet, Leucite, Copper- Pyritohedral class – Pyrite, Tetrahedral Class – Tetrahedrite.

II. **Tetragonal System**: Normal Class – Zircon, Vesuvianite, Cassiterite, and Rutile. Tripyramidal – Scheelite, Meionite Sphenoidal Class – Chalcopyrite.

III. **Hexagonal System**: Normal Class – Beryl, Tripyramidal – Apatite, Hemimorphic – Zincite, Rhombohedral Normal – Calcite, Trapezohedral Class – Quartz.

IV. **Orthorhombic System**: Normal – Barite, Sulphur, Stibnite, Topaz, Staurolite, and Aragonite. Hemimorphic – Calymene, Sphenoidal Class – Epsomite.

V. **Monoclinic System**: Normal – Gypsum, Pyroxenes and Amphiboles.

VI. **Triclinic System**: Normal – Axinite, Albite, and Rhodonite.

VII. **Twin Crystals**: Contact and Penetration twins of Fluorite, Iron Cross Twin of Pyrite, Knee type twin of Cassiterite, Polysynthetic twin of Aragonite, Cyclic twin of Cerussite, Swallow Tail of Gypsum, Twins of Carlsbad, Baveno, Manebach, Albite law of Albite

VIII. Crystal Projections, Stereographic projections and calculation of crystal elements.

Course Outcomes

On completion of the Course, the students should be able to

CO1: Identify the various crystal Systems and Symmetry through crystal models

CO2: Assess the miller Indices of the crystal models

CO3: Identify of Twining crystals

24GEUC2404 CRYSTALLOGRAPHY - PRACTICAL												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S			L			L	S		M	M	S
CO2	S			L	L			L				S
CO3	S			L			L	S		M	M	S
CO4												
CO5												

Course Code &Title	**24GEUC2405 STRATIGRAPHY**		
Class	B. Sc., Geology (Hons.)	Semester	IV
Cognitive Level	K-1 K-2 K-3		

Course Objectives

The Course aims

- To learn the geological time scale, physiographic and geological divisions of India
- To Describe Proterozoic stratigraphy of the Indian sub-continent
- To Explain Paleozoic Group of Indian stratigraphy.
- To Discuss Mesozoic age group of Indian Strata.
- To Summarize the Origin of Deccan traps, the Gondwana system, Boundary and age problems and World Stratigraphy

Unit	Content	Lectures
I	Stratigraphy – Definition, Laws of stratigraphy. ***Principles of correlation*** – Objectives – Elements of correlation – Standard stratigraphic scale – Order of superposition, Geological Timescale. Physiographic Divisions of India. Elements of lithostratigraphic, chronostratigraphic and biostratigraphic classification. Introduction, Distribution, Lithology, Economic importance of **The Archean Group - Dharwar System. Sequence stratigraphy** and Quaternary Stratigraphy.	12
II	**Proterozoic group: The Cuddapah System**: Definition and distribution – **Cuddapah Basin of Andhra**: Kistna series – Nallamalai series – Cheyair series – Papaghani series. Cuddapah rocks of Madhya Pradesh –The Delhi System - Economic minerals of the Cuddapah system. **The Vindhyan System**: Definition and distribution – Lithology – Life – **Stratigraphic classification of Vindhyan System**: Upper Vindhyan – Lower Vindhyan – Kurnool system- Economic minerals of Vindhyan system.	12
III	**Palaeozoic Group**: Introduction – **The Cambrian system**: Definition and Distribution – Cambrian of Spiti (Haimanta system) – Lithology- Classification: Upper Haimanta, Middle Haimanta and Lower Haimanta– Life – The Cambrian of Kashmir – Cambrian of Salt range. **The Ordovician system**, **The Silurian System and the Devonian System. The carboniferous system:** Carboniferous of Spiti – Carboniferous of Kashmir**. The Permian System:** Kashmir – Salt range**.**	12
IV	**Mesozoic Group:** Introduction – The Mesozoic of Tethys Himalaya. **The Triassic System**: Spiti- Definition – Lithology – Classification: Keuper – Muschelkalk - Bunter – Life. Kashmir: Lithology – **Classification:** Upper Triassic- Middle Triassic – Lower Triassic – Life. Salt range. **The Jurassic System**: Spiti – Kashmir – Salt range- The Jurassic of Kutch: Patcham series – Chari series – Katrol series – Umia series. **The Cretaceous system:** Definition and distribution – The marine facies of cretaceous system – The Coromandel coast – Cretaceous of Narmada valley – Marine cretaceous of Extra- Peninsula – Origin of Marine cretaceous – The Fluviatile Cretaceous (Lameta series). Methods for paleogeographic reconstruction. Earth's Climatic History. Phanerozoic stratigraphy of India with reference to the type areas– their correlation with equivalent formations in other regions.	12
V	**Deccan Traps:** Distribution - Classification - Structure - Geological Succession – Inter-Trappean and Intra-Trappean beds- Bagh Beds – Origin- Economic importance - Lameta beds - Age and Economic importance. **The Gondwana group**: Introduction – Distribution – Classification –Upper Gondwana – Middle Gondwana – Lower Gondwana – Lithology – Life – Economic importance. **Cenozoic Group: The Tertiary group;** Introduction –	12

Distribution – Tertiary group of extra peninsulas–Cuddalore sandstone. **The Eocene system**; Definition and distribution – lithology – Life. **The Oligocene-Lower Miocene systems** – **The Siwalik system**: Definition and distribution – Lithology – classification – Life – structure – Origin – **The Pleistocene system**: Definition and distribution – Indo-Gangetic alluvium – lithological characters – Origin. **Boundary and Age Problems**- K-T boundary problem, Precambrian – Cambrian boundary problem, Permian - Triassic boundary problem. Global Boundary Stratotype Sections and Points (GSSP) - **World stratigraphy**: Brief description of the principle and stratigraphic units of the world in the type area.

Text Books:

1. Krishnan, M. S., (1986) Geology of India, Burma and Pakistan, CBS. New Delhi.
2. Mehdiratta, R. C., (1974) Geology of India, Pakistan, Bangladesh and Burma. Atma Ram & Sons. Delhi.
3. Kumar, R., (1988) Fundamentals of Historical Geology and Stratigraphy of India, Wiley, New Delhi.
4. Wadia, (1893) Geology of India, McGraw Hill Book Co.
5. Sharma., R., (2010) Cratons and Fold Belts of India, Springer
6. Valdiya, K.S., (2016) The Making of India: Geodynamic Evolution, Springer
7.

Reference Books:

1. Wadia, D.N., (1953) Geology of India. McMillan India, Delhi.
2. Boggs, S., (1987) Principles of Sediment logy and Stratigraphy, Merrill Publishing Co. New York.
3. Weller, J.M., (1960) Stratigraphic Principles and Practice, Asia Publishing House. Delhi.
4. Gignoux, M., (1960) Stratigraphical Geology, Mc Graw hill publications.
5. Ravindra Kumar, (2010) Fundamentals of Historical Geology and Stratigraphy of India, New Age International (p) Ltd.

Web Resources:

1. *http://eps.mcgill.ca/~courses/c240/W3_L1.pdf*
2. *https://www.gktoday.in/academy/article/indias-rock-formation-archean-dharwar-cudappah-vindhyan-gondwana-and-tertiary-rocks/*
3. *https://www.pmfias.com/indian-rock-system-archaean-purana-dravidian-aryan-rock-system/*
4. *https://digital.library.adelaide.edu.au/dspace/bitstream/2440/103376/2/02wholeGeoHon.pdf*
5. *https://theodora.com/encyclopedia/c/cambrian_system.html*
6. *https://www.britannica.com/science/Permian-Period*
7. *https://massextinction.princeton.edu/deccan-volcanism/01-deccan-volcanism-adventure-science*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Explain the fundamental principles of Stratigraphy and physiographic divisions of India.

CO2: Identify rocks and fossils of the Proterozoic period.

CO3: Evaluate the sub-divisions of the Paleozoic period.

CO4: Describe the Mesozoic systems.

CO5: Outline the age of Deccan traps, Gondwana, Tertiary group of series, Boundary and Age Problems and World Stratigraphy.

24GEUC2405 STRATIGRAPHY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S	L	S		L	M	L	M		M	L
CO2	S	S	L	M			S			M	M	L
CO3	S	S	L	M			M		S	S	M	L
CO4	S	S	L	M			M			M	M	L
CO5	S	S		M	L		L	L			M	L

Course Code &Title	**24GEUC3501** **IGNEOUS PETROLOGY**		
Class	B. Sc., Geology (Hons.)	Semester	V
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Describe the Composition of Magma and its crystallization process • To Discriminate the various forms of Igneous rocks • To Describe the structure and texture of Igneous rocks • To Classify various Igneous rocks • To define the petrography of various igneous rocks.		

Unit	Content	Lectures
I	**Igneous Petrology:** Magma - Composition and Constitution, The Pyrogenetic Minerals, Physio-chemical composition, Primary Magmas, Rock Forming Minerals. **Types of Igneous Rocks -** Volcanic rocks, Plutonic rocks, Hypabyssal rocks. **Bowen's Reaction Series -** Continuous and Discontinuous series. **Crystallization of Binary Magma:** Diopside - Anorthite System - Albite – Anorthite system. **Ternary systems:** Albite – Anorthite - Diopside system, Anorthite - Forsterite - Silica system. **Diversity of Igneous rocks** – Partial Fusion, Differentiation and Assimilation.	9
II	**Forms of Igneous Rocks**: Concordant bodies - sill, laccolith, lopolith and phaccolith, Discordant Bodies dykes, cone sheets, volcanic neck, ring dyke, batholiths, stocks, bosses and bysmaliths, Igneous extrusions – lava flows, pyroclastic deposits - agglomerate, lapilli, volcanic ash and pumice.	9
III	**Structures of Igneous Rocks**: Definition – Types: Flow – Pillow – Ropy and Block – Spherulitic and orbicular- Vesicular structure – Miscellaneous structure **Textures of igneous rocks**: Factors explaining textures: Degree of crystallization – Granularity – Fabric. **Types of Textures**: Equigranular and Inequigranular texture – Porphyritic texture – Poikilitic texture – Directive texture – Inter growth texture -Intergranular texture.	9
IV	**Classification of Igneous Rocks:** Chemical Classification – Silica and Aluminum Saturation, Mineralogical Classification, Textural Classification, Normative Classification – CIPW, Streckeisen's classification (IUGS or QAP), Tyrrells Tabular Classification.	9
V	**Distinguished Petrographic Characteristics (Texture, mineralogy, classification, occurrence and origin) of** Granite, Granodiorite, Diorite, Syenite, Nepheline Syenite, Gabbro, Anorthosite, Peridotite, Dolerite, Lamprophyre, Rhyolite, Dacite, Trachyte, Phonolite, Andesite, Basalt, Ophiolites, Kimberlites and Carbonatites.	9

Text Books:

1. Tyrrell G.W., (2008) The Principles of Petrology, Surjeet Publications, Delhi.
2. Walter T. Huang., (2012) Petrology, Surjeet Publications, Delhi.

Reference Books:

3. John D. Winter., (2018) Principles of Igneous and Metamorphic Petrology (2nd Edition), Pearson, Uttar Pradesh.
4. Ernest G. Ehlers, & Harvey Blatt., (1999) Petrology Igneous Sedimentary and Metamorphic, CBS Publishers and Distributors, New Delhi.
5. Myron G. Best., (1986) Igneous and Metamorphic Petrology. CBS Publishers and Distributors, New Delhi.

6. Turner, F.J., and Verhoogen, J., (2004) Igneous and Metamorphic petrology, C.B.S. Publishers and Distributors, Delhi.

Web Resources:

7. *https://flexiblelearning.auckland.ac.nz/rocks_minerals/rocks/*
8. *http://www.indiana.edu/~geol105/images/gaia_chapter_5/igneous_rock_textures.htm*
9. *https://www.tulane.edu/~sanelson/eens212/intro&textures.html*
10. *https://www.eartheclipse.com/geology/formation-types-and-examples-of-igneous-rocks.html*
11. *http://pages.geo.wvu.edu/~lang/Geol285/Pet5PhaseD-outline.pdf*
12. *https://opentextbc.ca/geology/chapter/3-3-crystallization-of-magma/*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Discuss the origin of Igneous rocks based on magmatic crystallization process

CO2: Explain forms of igneous rocks

CO3: Describe the structure and texture of igneous rocks

CO4: Explain the classification of igneous rocks

CO5: Describe the petrographic characteristics like Texture, mineralogy, classification, occurrence and origin of various igneous rocks.

24GEUC3501 IGNEOUS PETROLOGY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	M					M	L				S
CO2	S	M		M			M	M	L			S
CO3	S	M		M			M	M	L			S
CO4	S	M		L			M	M	L			S
CO5	S	M	L	L			M	M	L		L	S

Course Code &Title	**24GEUC3502** **IGNEOUS PETROLOGY – PRACTICAL**		
Class	B. Sc., Geology (Hons.)	Semester	V
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Differentiate the megascopic properties of igneous rocks • To discriminate the microscopic petrography of igneous rocks • To calculate the normative composition of Igneous rocks. • To construct the Niggli and Harker variation diagram		

Contents

a) **Megascopic** identification of Igneous rocks.
b) **Microscopic** identification of igneous rocks.
c) Calculation of **CIPW** norm
d) Calculation of **Niggli** Values
e) Construction of **Harker Variation diagram**
f) Construction of **Niggli Variation diagram**

Course Outcomes

On completion of the Course, the students should be able to

CO1: Identify and discuss the megascopic properties of igneous rocks.

CO2: Identify and discuss the microscopic properties of primary rocks

CO3: Determine the rock types based on the mineralogical chemical composition of magma.

CO4: Determine the type of igneous rocks based on the variation diagrams.

24GEUC3502 IGNEOUS PETROLOGY - PRACTICAL												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	M				M	M	S	M	L		S
CO2	S	M				M	M	S	M	L		S
CO3	S			L					L	L		L
CO4	S			L					L	L		L
CO5												

Course Code &Title	24GEUC3503 METAMORPHIC PETROLOGY		
Class	B. Sc., Geology (Hons.)	Semester	V
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Discriminate the metamorphic rocks and their types • To Classify the different metamorphic zones and facies • To Describe the structure and texture of metamorphic rocks • To Define the metamorphic compositional diagrams • To Describe the petrography of various Metamorphic rocks.		

Unit	Content	Lectures
I	**Metamorphic Petrology:** Description, Factors (Agents) of Metamorphism: Temperature, Pressure, chemically active fluids, Time and Parent rock chemistry. **Types of Metamorphism:** Contact metamorphism, Regional metamorphism – Orogenic and Ocean floor, Burial metamorphism, Cataclastic metamorphism, Hydrothermal metamorphism, Impact/shock metamorphism, Plutonic metamorphism, Progressive and retrogressive metamorphism. **Metasomatism.**	9
II	**Metamorphic grade concept:** Grades of Metamorphism. Stability of minerals in P-T field. **Metamorphic Zones**. Geothermobarometry. **Classification of Metamorphic Rocks:** Foliated Rocks, Non-Foliated Rocks**. Concept of Metamorphic Facies:** Zeolite facies, Green schist facies, Amphibolite facies, Granulite facies, Blue schist facies, Eclogite facies and Contact facies.	9
III	**Metamorphic Textures:** Crystalloblastic Textures, Palimpsest (Relict) Textures. **Metamorphic Structures:** Cataclastic Structure, Schistose Structure, Gneissose Structure, Maculose Structure, Augen Structure, Granulose Structure.	9
IV	**Stable Mineral Assemblages in Metamorphic rocks:** Equilibrium Mineral Assemblages, The Phase Rule and **Chemographic Diagrams -** Concepts – AFM Diagrams for Pelitic rocks, ACF Diagrams for Mafic rocks and AKF Diagram. Isograds	9
V	**Petrography and origin of the metamorphic rocks:** Slate, Schist, Gneiss, Quartzite, Marble, Phyllite, Hornfels. Migmatite, Eclogites**,** Mylonites, Granulites, Amphibolites, Migmatites and Charnockites.	9

Text Books:

1. John D. Winter., (2018) Principles of Igneous and Metamorphic Petrology (2nd Edition), Pearson, Uttar Pradesh.
2. Myron G. Best., (1986) Igneous and Metamorphic Petrology. CBS Publishers and Distributors, New Delhi.

Reference Books:

1. Tyrrell G.W., (2008) The Principles of Petrology, Surjeet Publications, Delhi.
2. Walter T. Huang., (2012) Petrology, Surjeet Publications, Delhi.
3. Ernest G. Ehlers, & Harvey Blatt., (1999) Petrology Igneous Sedimentary and Metamorphic, CBS Publishers and Distributors, New Delhi.
4. Turner, F.J., and Verhoogen, J., (2004) Igneous and Metamorphic petrology, C.B.S. Publishers and Distributors, Delhi.

Web Resources:

1. *https://flexiblelearning.auckland.ac.nz/rocks_minerals/rocks/*
2. *https://www.tulane.edu/~sanelson/eens212/typesmetamorph.html*

3. *http://csmgeo.csm.jmu.edu/geollab/Fichter/MetaRx/Textclass.html*
4. *http://www.appstate.edu/~abbottrn/rck-id/mtmchrt.html*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Discuss the process of metamorphism and its types

CO2: Explain the concept of metamorphic zones and facies

CO3: Describe types of structure and texture of metamorphic rocks

CO4: Explain the compositional diagrams in metamorphism

CO5: Evaluate the origin, occurrence and characteristics of different metamorphic rocks.

24GEUC3503 METAMORPHIC PETROLOGY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S				L		M	L	M		S
CO2	S	S						M				S
CO3	S	S				L		M	L	M		S
CO4	S	M		L								S
CO5	S	S				M		S	L	M		S

Course Code &Title	**24GEUC3504** **METAMORPHIC PETROLOGY – PRACTICAL**			
Class	B. Sc., Geology (Hons.)		Semester	V
Cognitive Level	K-1 K-2 K-3			
Course Objectives	**The Course aims** • To Differentiate the megascopic properties of Metamorphic rocks • To discriminate the microscopic petrography of Metamorphic rocks • To construct the Chemographic diagram based on the formation			

Contents

g) **Megascopic** identification of Metamorphic rocks.
h) **Microscopic** identification of Metamorphic rocks.
i) Construction of **ACF diagram (Eskola)**
j) Construction of **AKF diagram (Eskola)**
k) Construction of **AFM diagram (Thompson)**

Course Outcomes

On completion of the Course, the students should be able to

CO1: Identify and discuss the megascopic properties of Metamorphic rocks.

CO2: Identify and discuss the microscopic properties of Metamorphic rocks

CO3: Determine the mineral assemblages of metamorphic facies.

24GEUC3504 METAMORPHIC PETROLOGY - PRACTICAL												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S		L			S	S		S	S	S
CO2	S	S		L							S	S
CO3	S	S								M		S
CO4												
CO5												

Course Code &Title	24GEUC3505 SEDIMENTARY PETROLOGY		
Class	B. Sc., Geology (Hons.)	Semester	V
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Understand the Origin and Composition of Sedimentary rocks • To Recognize the Texture and Structure of the Sedimentary rocks • To understand the geometry and the concept of Diagenesis in Sedimentary rocks • To study the different classifications of sedimentary rocks along with Paleocurrent Analysis. • To Evaluate the petrography of different sedimentary rocks.		

Unit	Content	Lectures
I	***Sedimentary Petrology*:** Nature and Origin of sedimentary rocks: Clastic Rocks, Chemically and organically formed rocks. **Depositional Basins, Geosynclines and Plate Tectonics:** Ocean Basins, Rifted Continental Margins, Arc- Trench Systems, Suture Belts and Intracontinental Basins. **Composition of Sedimentary Rocks**: Chemical and Mineralogical Composition.	9
II	**Textures of Sedimentary rocks:** Particle Size, Shape and Roundness, Surface textures, Fabric and Framework Geometry, Crystalline and Other Endogenetic Fabric, Biogenic Fabrics. **Structure of Sedimentary rocks**: Classification - Bedding, Internal Organization and Structure of Beds, Bedding Plane Marking and Structures, Deformed and Disturbed Bedding, Stromatolites and Other Biogenic Structures, Diagenetic Structures.	9
III	**Geometry of Sedimentary Bodies:** Sandstone Bodies, Sandstone Dikes, Sills and Auto intrusions, Carbonate rock Geometry, Salt Domes, Stocks and Anticlines, Filled Cavities and Sinks, Miscellaneous Sedimentary Bodies. **Diagenesis**: Concepts of Diagenesis, Stages of Diagenesis, Compaction and cementation**.**	9
IV	**Classification of sedimentary rocks**: **Clastic rocks –** Gravels, Sand, Silt and Clay; **Non- clastic rocks -** Chemically Formed Rocks, Organic Deposits; Miscellaneous Deposits. **Provenance of Sediments and Sedimentary Rocks. Paleocurrent Analysis:** Paleocurrents for different sedimentary environments (Directional, Scalar and Compositional Properties).	9
V	**Descriptive petrography and Uses of sedimentary rocks**: Breccia, Conglomerate, Sandstone, Shale, Limestone, Dolomite, Coal, Iron Ores of Sedimentary Origin, Gypsum, Rock salt, Flint, Chert, Tillite, Volcanoclastic Sediments, Concretions, Nodules and Other Diagenetic Segregations.	9

Text Books:

1. Pettijohn, F.J., (2004) Sedimentary Rocks (3rd Edition), CBS Publishers and Distributors, New Delhi.
2. Ernest G. Ehlers, & Harvey Blatt., (1999) Petrology Igneous Sedimentary and Metamorphic, CBS Publishers and Distributors, New Delhi.

Reference Books:

1. Walter T. Huang., (2012) Petrology, Surjeet Publications, Delhi.
2. Sengupta, S.M., (2012) Introduction to Sedimentology (2nd Edition), CBS Publishers and Distributors, New Delhi.
3. Tyrrell G.W., (2008) The Principles of Petrology, Surjeet Publications, Delhi.
4. Maurice E. Tucker., (2011) Sedimentary Petrology (3rd Edition), Wiley.

Web Resources:

1. *https://www.eartheclipse.com/geology/formation-types-and-examples-of-sedimentary-rocks.html*
2. *http://www.geologyin.com/2014/12/sedimentary-textures-and-classification.html*
3. *http://www.rocksandminerals4u.com/sedimentary_rock.html*
4. *http://csmgeo.csm.jmu.edu/geollab/fichter/SedRx/sedclass.html*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Explain the sedimentary rocks and their genesis of the formation

CO2: Outline the various structure and texture of sedimentary rocks

CO3: Explain the Geometry and Diagenetic properties of sedimentary rocks

CO4: Discuss the Classification of Sedimentary rocks

CO5: Evaluate the petrographic properties of Sedimentary rocks.

24GEUC3505 SEDIMENTARY PETROLOGY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S	S	S		S	S	S	S	S	S	S
CO2	M	M	S	S	M		S			S	S	S
CO3	S	M	S	M	M	S	S	M	S	M	M	M
CO4	S	M	S	S	S	M	M	S		M	S	S
CO5	S	S	S		S	M	M	S	S	S	S	M

Course Code &Title	**24GEUC3506** **SEDIMENTARY PETROLOGY – PRACTICAL**		
Class	B. Sc., Geology (Hons.)	Semester	V
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Differentiate the megascopic properties of Sedimentary rocks • To discriminate the microscopic petrography of Sedimentary rocks • To analyze the sedimentary grain size		

Contents

a) ***Megascopic identification and description of the following***: conglomerate, breccia, laterite, sandstone, arkose, greywacke, grit, shales, limestones, chert, flint, peat, bituminous coal, anthracite, lignite, chalk.
b) ***Microscopic identification and description of the following***: sandstone, arkose, breccias; conglomerate shale, greywackes, limestone, flint and chert.
c) Analysis and Interpretation of data on size, sorting, roundness and sphericity

Course Outcomes

On completion of the Course, the students should be able to

CO1: Identify and discuss the megascopic properties of Sedimentary rocks.

CO2: Identify and discuss the microscopic properties of Sedimentary rocks

CO3: Determine the grain size assemblages of sedimentary rocks.

24GEUC3506 SEDIMENTARY PETROLOGY- PRACTICAL												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S		L			L	S		S	S	S
CO2	S	L		L							S	S
CO3	S	S								M		S
CO4												
CO5												

Course Code &Title	24GEUB3501 METEOROLOGY AND CLIMATOLOGY		
Class	B. Sc., Geology (Hons.)	Semester	V
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Understand the atmospheric composition and its layer details • To understand the General circulation and climate Models. • To learn about local winds and clouds and precipitation formation. • To understand the Atmospheric stability, instability and thunderstorms. • To Learn the air masses and fronts and climate classifications. • To Acquire knowledge of satellite meteorology.		

Unit	Content	Lectures
I	**Meteorology** and **Climatology** – Scales in climatology - Thermal structure of the atmosphere and its composition – Insolation and Heat Budget - Temperature of the Atmosphere, Temperature distribution - Air pressure and measurement – Pressure gradient and pressure variations, Atmospheric pressure patterns and Vertical structure of Cyclones and Anticyclones. Wind - Fundamental forces affecting wind, Surface wind systems, Atmospheric circulation patterns and wind Belts	12
II	**General Circulation and Climate Modelling:** Zonally symmetric circulations, meridional circulation models, mean meridional and eddy transport of momentum and energy, angular momentum and energy budgets; zonally asymmetric features of general circulation; standing eddies; **Ocean Circulation** – El Nino – Southern Oscillation Events, **East-West circulations in tropics**: MJO (Madden-Julian oscillation), ENSO, QBO (quasi-biennial oscillation) and sunspot cycles - concepts of ocean-atmosphere coupled models.	12
III	**Local Winds:** Land Breeze and Sea Breeze, Mountain Breeze and Valley Breeze – Humidity - **Fog and Clouds:** fog classifications – form of clouds and classification of clouds**. Precipitation**: precipitation process - Bergeron, collision-coalescence theory – Forms of Precipitation and types of precipitation – Intensity of precipitation and artificial precipitation. Monsoon – Concepts of the origin of monsoon, Asian monsoon and Indian monsoon, climatic significance of monsoon, Economic importance of monsoon.	12
IV	**Atmospheric Stability and Instability:** Concept of equilibrium – geopotential - adiabatic process of temperature changes – adiabatic Lapse rates – Atmospheric Stability and lapse rate – Atmospheric equilibrium in saturated air – stability and daily weather – changes in stability. Hydrostatic equilibrium - variation of pressure with height. **Thunderstorms:** origin and structure – stage of development – factors favouring thunderstorm development – Thunderstorm electricity – classification of thunderstorms.	12
V	**Air masses:** sources, origin and classification of air masses. **Fronts:** General frontal characteristics - frontogenesis and frontolysis – Classification of fronts – principal zones of frontogenesis. **Extra-tropical synoptic scale features:** jet streams, extratropical cyclones and anticyclones. **Classification of climates** – Koppen's and Thornthwaite's scheme of classification. Climate change. **Satellite Meteorology:** Meteorological satellites – Polar orbiting and geostationary satellites, visible and infrared radiometers, multi-scanner radiometers.	12

Text Books:

1. Lal, D.S., (2003) Climatology, Sharda Pusthak Bhavan, Allahabad.
2. Robert V.R., Anthony J.V., Climatology fourth edition, united states of America.
3. Kelkar, R.R., (2007) Satellite Meteorology, BS Publications.

Reference Books:

1. Ahrens, C.D., and Henson, R., (2016) Meteorology Today: An Introduction to Weather, Climate, and the Environment, Eleventh Edition Cengage Learning Barry, R.G., and Chorley, R.J., (2003) Atmosphere, Weather and Climate, Taylor & Francis Group.
2. Lutgens, F. K., and Tarbuck, E.J., (2010) The atmosphere: An Introduction to meteorology 11th edition, Pearson.
3. Moran, J.M., Morgan, M.D., and Pauley, P.M., (1997) Meteorology: The Atmosphere and the Science of Weather, Prentice-Hall, New York.
4. Murthy, P., (2004) Environmental Meteorology, I K International, New Delhi.
5. Siddhartha, K. (2002), Atmosphere, Weather and Climate, Kisalaya Publications Pvt. Ltd.

Web Resources:

1. *https://www.topfreebooks.org/meteorology/*
2. *https://www.nap.edu/search/?rpp=20&ft=1&term=METEOROLOGY*
3. *https://www.geos.ed.ac.uk/~dstevens/teaching/MetAE_labbook_2013-14_FINAL.pdf*
4. *https://imdpune.gov.in/training/training%20notes/Climatology-IMTC.pdf*
5. *https://digitalcommons.usu.edu/modern_climatology/15/*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Explain the Meteorology and Climatology

CO2: Outline the General Circulation and Climate Modelling and East-West circulations in the tropics

CO3: Explain the Local Winds, Fog Clouds and Precipitation

CO4: Discuss the atmospheric stability and instability

CO5: Explains the concept of Air masses, Fronts and Classification of climates

.

24GEUB3501 METEOROLOGY AND CLIMATOLOGY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	L					L	M			M	S
CO2	S	M					M	M		M	S	S
CO3	S	S		L			M	M	L		S	S
CO4	S	S	M				M	M		M	S	S
CO5	S	S	M				M	M	L	M	S	S

Course Code & Title	**24GEUC3601** **HYDROGEOLOGY**

Class	B. Sc., Geology (Hons.)	Semester	VI

Cognitive Level: K-1, K-2, K-3

Course Objectives:

The Course aims

- To Describe the hydrological properties of rocks
- To Illustrate the groundwater exploration methods
- To Understand the groundwater quality
- To Know methods of Interpretation of Water Quality and Pollution
- To Learn the geological considerations for constructing dams, reservoirs, tunnels

Unit	Content	Lectures
I	**Hydrological Properties of Rocks:** Porosity, Permeability, Specific Yield and Specific Retention, **Darcy's Law** – Permeability Determination – Laboratory methods – Constant head method – Falling head method – Non-discharge method – Field Methods – By using tracers.	9
II	**Groundwater Exploration** - Surface Methods – Geological methods – Lithological control – Structural control – Stratigraphic control – Geobotanical Indicators – **Geophysical method of exploration** – Electrical resistivity survey – Seismic survey – Sub-surface methods – Drilling – Well logging – Sampling - Geophysical logging.	9
III	**Sources of elevated concentration of salts** – Calcium and Magnesium, Sodium, Potassium, Iron, Silica, Acids, Nitrates. Minor and Trace elements. **Chemical Analysis of Water** – Estimating PH, Ec, TDS, Carbonate, bicarbonate, chloride, sulphate, calcium, magnesium, sodium and potassium. **Water Quality** – Standards of water for different uses – Drinking purposes – Irrigation purposes – Industrial purposes (WHO, BIS and ICAR) - Water Quality Parameters for Drinking, Agriculture, and Industrial Uses.	9
IV	**Graphical Representation and Interpretation of Water Quality Data:** WILCOX, USSL, GIBBS plot, Piper, Doneen and Durov diagrams, Water Pollution – Introduction – Types of Pollution - Controlling methods. **Seawater Intrusion** – Ghyben-Herzberg relation – Freshwater – saltwater relation in Oceanic Island – Control of seawater Intrusion – Groundwater recharge.	9
V	**Pumping Tests**: Dupuit's equilibrium formula for unconfined and confined aquifers – Thiem's equilibrium formula for unconfined and confined aquifers. **Natural and artificial recharge** – Quality of recharging water – Recharge rate – Artificial recharge methods. Water Purification – Settings – Coagulation – Fluorination – Defluorination – Disinfection – Deuteration – Groundwater basins of Tamil Nadu.	9

Text Books:

1. David Keith Todd, Larry W. Mays, (2013) Groundwater Hydrology, Wiley publications.

2. Raghunath, H.M., (2003) Groundwater, New Age international publications.

Reference Books:

1. Ramakrishnan. S. (1998) Groundwater, CBS Publishers & Distributors.

2. Fetter, C. W, (2007) Applied Hydrology, CBS Publications.

3. Herman Bouwer, (2014) Groundwater Hydrology, McGraw Hill Education Private Limited.

Web sources:

1.file:///C:/Users/Geology/Downloads/Hydrogeology--TDM.pdf

2.http://water.lecture.ub.ac.id/files/2012/03/Book_Hydrogeology Field Manual - 2nd Edition.pdf

3.http://www.hawaiidoh.org/references/Domenico%201990.pdf

Course Outcomes

On completion of the course, the students will be able to

CO1: Predict the origin and occurrence of groundwater
CO2: Assess the groundwater exploration phenomena
CO3: Describe the characteristics of groundwater quality and analytical methods
CO4: Assess the interpretation of water quality parameters using graphical methods.
CO5: Discuss the recharge methods, pump test principles and water purification methods

24GEUC3601 HYDROGEOLOGY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S	M	M			M	M	S	L		M
CO2	S	M	M	M	M		M	M	S	L		M
CO3	S	M	M	L	M		M	M	S	M	L	M
CO4	S	M	M	L	M		M	S	S	L	L	
CO5	S	M	M	L	M		M	S	S	M	L	M

Course Code & Title	**24GEUC3602** **HYDROGEOLOGY - PRACTICAL**		
Class	B. Sc., Geology (Hons.)	Semester	**VI**
Cognitive Level	K-1 K-2 K-3		
Course Objectives	The Course aims • To Analyze and interpret the resistivity data using the Wenner method and Schlumberger method • To Interpret the hydrological properties of rocks • To Process, analyze and rainfall data • To explore the water quality • To Know the applications of software in hydrogeology		

Contents

1. Resistivity survey and the interpretation for lithology and water resources
   (i) Schlumberger method
   (ii) Wenner method
2. Problems with hydrological properties of rocks
   (i) Porosity
   (ii) Specific yield
   (iii) Specific retention.
3. Methods of rainfall assessment-
   (i) Arithmetic mean method
   (ii) Thiessen polygon method
   (iii) Isohyetal method
4. Geochemical anomaly map preparation and interpretation
5. Water quality analysis
   (i) Physical parameters
      (a) Estimation of pH
      (b) Estimation of EC
      (c) Estimation of TDS
      (d) Estimation of TH
   (ii) Chemical parameters
      (a) major cations
      (b) major anions
6. Graphical interpretation of water quality data.
   (i) Collins bar diagram
   (ii) Stiff diagram
   (iii) Piper Diagram Interpretation
7. Pumping test data interpretation.
8. Isohyetal map generation through surfer software
9. Rockworks software and its application

Course Outcomes

On completion of the course, the students will be able to

CO1: Predict the subsurface groundwater conditions through electrical methods
CO2: Use of hydrogeological properties of rocks in Groundwater exploration
CO3: Analyze the rainfall data
CO4: Interpret the hydrogeochemical properties of surface and sub-surface

24GEUC3602 HYDROGEOLOGY - PRACTICAL												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S	S	M	S	M	M	S	M	M	M	L
CO2	S	S	S	M	S	M	L	S	M	M	M	M
CO3	S	S	S	M	S	M	L	S	M	M	M	L
CO4	S	S	S	M	S	M	M	S	M	M	M	S
CO5												

Course Code &Title	**24GEUC3603 ECONOMIC GEOLOGY**		
Class	B. Sc., Geology (Hons.)	Semester	VI
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Understand basic terminologies and ore deposit environments • To Describe the mineral resources of India • To Summarize the role of economic minerals in industries • To Evaluate the mineral economics and ore textures • To Describe ore dressing methods.		

Unit	Content	Lectures
I	Basic Terminologies of Economic Geology: Ore minerals, Gangue, Grade, Tenor and Tonnage. Resources and reserves - **Process of formation of Mineral Deposits:** Endogenous and Exogenous process: Ore deposit environments **-**Magmatic concentration - Sublimation - Contact metasomatism - Bacteriogenic - Submarine exhalative and Volcanogenic - Evaporation - Residual and Mechanical concentration - Oxidation and Supergene enrichment - Metamorphism – Syngeneic and epigenetic deposits, forms of ore bodies, stratiform and strata-bound deposits **Classification of mineral deposits** - **Controls and Localization of Mineral Deposits** – Characteristics of mineral deposits spatial and temporal distribution Metallogenic Epochs its relation to crustal evolution, Metallogenic Provinces - Geological Thermometry and barometry for Ore minerals.	9
II	**Geological setting, characteristics, and genesis of Magmatic and pegmatitic deposits:** Chromite, Titanium, Diamond, Cu-Ni sulphide, PGE, REE, muscovite. **Hydrothermal deposits:** Porphyry Cu-Mo, Greisen Sn-W, Sulphide deposits, Orogenic gold. **Sedimentary deposits**: Fe, Mn, Phosphorite, Placer deposits, Supergene deposits: Cu, Al, Ni and Fe. **Metamorphic and metamorphosed deposits:** Mn, Graphite **Geological setting, characteristics, and genesis of ferrous, base and noble metals. Base Metals:** Iron, Copper, Nickel, Zinc, Lead, Aluminium, Tin, Tungsten, Molybdenum, Tantalum, Cobalt, Chromium, Cadmium, Titanium	9
III	**Minerals used in Refractory-**Fire clay, graphite, dolomite, sillimanite group of minerals**, Fertilizer-** phosphate, potash, nitrates, lime, gypsum**, ceramic-**clay, felspar, wollastonite**, cement, glass, paint industries**; minerals used as abrasive, filler; building stones - **Ore grade and Reserve**, assessment of grade, reserve estimation	9
IV	**Mineral Economics:** Significance of Minerals in National Economy - Demands and Supplies - Substitutes - Market Economy - Essential, Critical and Strategic Minerals - **Mineral Conservation Policy**- India's Status in Mineral Production. **Ore Mineral Textures-** Single Grain, Aggregates, Growth fabric, Colloidal, Sedimentary, Paramorphic replacement, Exsolution- Simple and Complex, Replacement, Relict, Decomposition, Oxidation (Weathering), Cementation, Curvature of linear features, Schlieren, Brecciation or Cataclasis, recrystallization, Re-equilibrium, Dynamic Metamorphic effect, Thermal Metamorphic effects, Skarns, Framboids or Framboidal**. Paragenesis: Shape, Relict, Colloform Banding, Growth zoning, Cross-Cutting relationship, Twinning, Exsolution, Replacement, Fluorescence**	9
V	**Mineral Dressing** - Definition and Scope of Mineral dressing (ore dressing) Physical and Chemical Properties of minerals used in Mineral dressing. **Comminution:** Principles, theories of Comminution, ore grindability.	9

Crushers: Primary and Secondary Crushers. **Grinding Mills (Tumbling Mills):** types of Mills: Rod, Ball and Autogenous Mills. Industrial Screening: Screens and their types.

Text Books:

1. Prasad, U., (2003) Economic Mineral Deposits. CBS Publishers, Delhi.
2. Parbin Singh, B., (2005) A Textbook of Engineering and General Geology. S. K. Kataria & Sons. Delhi.

Reference Books:

1. Bateman, A.M. & M. L. Jensen., (1981) Economic Mineral Deposits. 3rd ed. Wiley. New York.
2. Lindgren, (1933) Mineral deposits, McGraw Hill.
3. Krishnasamy, S., (1988) India's Mineral Resources. Oxford & IBH. Delhi.
4. Sharma, N. L & Sinha, R. K., (1985) Mineral Economics. Oxford & IBH. Delhi.
5. Gokhale & Rao, (2010) Ore Deposits of India, Thomson Press.
6. Iyengar, N. K. N., (1978) Mineral wealth of Tamilnadu, Madras Govt.

Web Resources:

1. *https://www.preservearticles.com/education/important terminologies-in-economic-geology/17739*
2. *https://www.lifepersona.com/what-are-the-endogenous-and-exogenous-processes-of-the-earth*
3. *http://crcleme.org.au/RegExpOre/1-oredeposits.pdf*
4. *https://iasmania.com/mineral-resources-india-iron-coal-aluminium-copper-lead-zinc/*
5. *http://www.aadnc-aandc.gc.ca/eng/1100100028056/1100100028058*
6. *https://everydayoil.wordpress.com/2012/11/16/different-types-of-drilling-and-its-breif-description/*
7. *http://www.cienciaviva.pt/img/upload/Introduction%20to%20mining.pdf.*
8. *https://www.americangeosciences.org/critical-issues/faq/what-are-main-mining-methods*
9. *http://emfi.mines.edu/emfi2011/Coal%20Mining%20Methods%20-%20EMFI%20Summary.pdf*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Explain the formation of mineral deposits

CO2: Describe the geological setting of mineral resources.

CO3: Discuss the Classification of economic minerals in industries

CO4: Outline the mineral conservation policy

CO5: Explain the ore dressing methods.

24GEUC3603 ECONOMIC GEOLOGY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S											S
CO2	S			L								S
CO3	S	M		L		L		M		L	L	S
CO4	S	M	L				M	M			L	S
CO5	S	M			L	M		M			L	S

Course Code &Title	**24GEUC3604** **ECONOMIC GEOLOGY - PRACTICAL**		
Class	B. Sc., Geology (Hons.)	Semester	VI
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Examine the Physical properties of the economically important minerals. • To classify the Economic minerals based on chemical composition • To Evaluate the Origin and Occurrences and distribution of the Economic Minerals • To study the optical properties of ore minerals • To Learn the ore reserve Estimation		

Contents

Economic Geology:

Megascopic identification, description of visible characteristics, mode of occurrence and uses of the following

a) **Industrial Minerals**: magnesite, gypsum, asbestos, fluorite, calcite, graphite, barite, talc, witherite, strontianite, anhydrite, halite, dolomite, aragonite, kaolin, garnet, corundum, phosphate nodule.
b) Megascopic identification, description of visible characteristics, mode of occurrence and uses of the following **Fe ores**: magnetite, hematite, limonite, pyrite, marcasite and siderite.
c) Megascopic identification, description of visible characteristics, mode of occurrence and uses of the following **Cu ores**: chalcopyrite, cuprite, bornite, malachite, azurite and native copper.
d) Megascopic identification, description of visible characteristics, mode of occurrence and uses of the following **Mn ores**: pyrolusite, psilomelane, rhodochrosite, and rhodonite.
e) Megascopic identification, description of visible characteristics, mode of occurrence and uses of the following **Pb ores:** galena, cerussite, anglesite.
f) Megascopic identification, description of visible characteristics, mode of occurrence and uses of the following **Zn ores**: smithsonite, sphalerite.
g) Megascopic identification, description of visible characteristics, mode of occurrence and uses of the following **Sn ore:** cassiterite
h) Megascopic identification, description of visible characteristics, mode of occurrence and uses of the following **As and Sb ores**: realgar, orpiment, stibnite
i) Megascopic identification, description of visible characteristics, mode of occurrence and uses of the following **Miscellaneous ores**: wolframite, molybdenite, bauxite, chromite, ilmenite, rutile, cinnabar.
j) Megascopic identification, description of visible characteristics, mode of occurrence and uses of the following **Radioactive Ores**: monazite, zircon, pitchblende, and pyrochlore.
k) Study of ore textures and interpretation of paragenesis.

Ore Reserve Estimation

1. Theory of sampling
2. Included area and valance weight method
3. Triangular grouping method
   Area of Influencing method

Course Outcomes

On completion of the Course, the students should be able to

CO1: Identify the physical properties of industrial minerals and Fe ores

CO2: Explain the physical properties of Cu and Mn ores.

CO3: Discuss the physical properties of Pb and Zn ores

CO4: Identify physical properties of Sn, As, Sb ores and radioactive ores

CO5: Analyze the Ore minerals quantitatively.

24GEUC3604 ECONOMIC GEOLOGY - PRACTICAL												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	M					M	S		M		S
CO2	S	M					M	S		M		S
CO3	S	M					M	S		M		S
CO4	S	M					M	S		M		S
CO5	S				M		S	S		L	M	S

Course Code &Title	**24GEUC3605** **MINING AND ENGINEERING GEOLOGY**		
Class	B. Sc., Geology (Hons.)	Semester	VI
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Introduce the fundamental concepts of mining • To Study the different mining techniques • To Evaluate the Ore dressing process and role of Geologists in the mining industry • To Describe the Engineering Properties of Rocks • To Explain the types of reservoirs and Tunnels.		

Unit	Content	Lectures
I	**Mining Geology:** Introduction to Mining **-** Prospecting and Sampling, Trenching, Pitting. **Classification of Mining methods -** Alluvial Mining, Opencast Mining or Quarrying, Underground Mining. **Mining terminologies**: Exploitation, Shaft, Hanging wall, Adit, Drive, Level, Crosscut, Tunnel, Raise, Winze, Ore bin, Chute, Stope. **Excavations and its types**. **Drilling:** Percussion drills, Rotary drills and Miscellaneous drilling methods. **Explosives**: Low explosives, High explosives, sheathed explosives, permitted explosives, Liquid oxygen, AN/FO and Slurry types.	12
II	**Alluvial mining:** Pan and batea, Rocker, Longtom, Sluicing, Derrick and cableway, Hydraulicking, Drift mining, Dredging. **Opencast mining:** Loading by hand, Loading by machines, Glory hole, Kaolin mining. **Underground mining:** Open stopes, Overhand stopping, Caving methods. **Coal mining methods:** Board & Pillar method, Longwall Advancing, Longwall Retreating, Horizon Mining, Underground Hydraulic Mining, Strip Mining. **Sampling and its types**.	12
III	**Ore dressing**: Crushing, Grinding, Sizing, Classification, Air sizing, Electrical Precipitation of dust, **Concentration -** Washing and scrubbing, Gigging, Tabling, Vanners, Floatation, Magnetic separation, Electrostatic separation. **Role of geologist in the mining industry, Environmental impacts by mining industries and reclamation techniques, Mine Accidents, Miner's Diseases.**	12
IV	**Engineering properties of rocks:** Rock measurements: Laboratory measures, Field-scale measure. Factors affecting rock properties – Index properties of rocks - Strength of rocks, compressive strength, tensile strength. Poisson's ratio and their measurement Rocks as materials for construction – Rocks as sites for construction – Specific Gravity, Porosity, Absorption - Soil profile, soil particles, soil structure, plasticity & swelling - Decorative stones & Building Stones.	12
V	**Dams:** Objective of the dams, **Types of Dams:** Gravity dams, Buttress dams, Arch dams, Embankment dams, Geotechnical considerations, Selection of dam sites, Geological characters for dam sites, Brief account of Major Indian Dams. **Reservoirs:** Types of Reservoirs, Important terms related to Reservoirs, Geological investigations, **Tunnels:** Types of tunnels, Geological Investigations and Considerations, Road network & related problems & preventive measures, Ghats Road alignment.	12

Text Books:

1. Arogyaswamy., R.N.P., (2017) Courses in Mining Geology, CBS Publishers, New Delhi.
2. Parbin Singh., (2013) Engineering and General Geology, S. K. Kataria & Sons, New Delhi.

Reference Books:

1. Thomas, R. T., (1986) Introduction to mining Methods, McGraw Hill, New York.
2. Peters, W. C., (1978) Exploration and mining Geology, Wiley, New York.
3. McKinstry, H. E., (1948) Mining Geology, Asia Publishing House, Delhi.
4. Gaudin, A. M., (1939) Principles of Mineral Dressing, TMH, Delhi.
5. Taggart, A. F., (1945) Handbook of Mineral Dressing, Chapman and Hall, Delhi.

Web Resources:

1. *http://www.aadnc-aandc.gc.ca/eng/1100100028056/1100100028058*
2. *https://everydayoil.wordpress.com/2012/11/16/different-types-of-drilling-and-its-breif-description/*
3. *http://www.cienciaviva.pt/img/upload/Introduction%20to%20mining.pdf.*
4. *https://www.americangeosciences.org/critical-issues/faq/what-are-main-mining-methods*
5. *http://emfi.mines.edu/emfi2011/Coal%20Mining%20Methods%20-%20EMFI%20Summary.pdf*
6. *https://www.kau.edu.sa/Files/0052737/Subjects/(8)%20Ore%20processing%20(beneficiation).pdf*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Explain the basics of mining Geology

CO2: Discuss the Various mining methods

CO3: Describe the Ore dressing processes

CO4: Discuss the engineering properties of rocks

CO5: Outline the Dams and tunnels along with their types.

24GEUC3605 MINING AND ENGINEERING GEOLOGY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S	L	M	L	M		S		M	S	S
CO2	S	S		M	S	L	L	S	M	L	M	S
CO3	S	S		M	S	M	M	S	M	M		S
CO4	S	S	M	S	S	S	S	S	S	M	M	S
CO5	M				S			M				S

Course Code & Title	**24GEUC3606** **REMOTE SENSING AND GPS**
Class	B. Sc., Geology (Hons.)
Semester	VI
Cognitive Level	K-1 K-2 K-3
Course Objectives	**The Course aims** • To understand the basic principles and types of Remote sensing and visual interpretation of key elements. • To recognize in detail how the Electromagnetic Spectrum is related to the field of Remote sensing • To learn about the instrumental and viewing parameters of the satellites and the sensors • To elucidate the types of remote sensing and data interpretation • To illustrate the principles, components, advantages and limitations of GPS and the mapping application.

Unit	Content	Lectures
I	**Remote Sensing** – An Introduction: History and Development of Remote Sensing, Fundamentals **of Remote Sensing- Stages** in Remote Sensing Process. **Types of Remote Sensing-** Based on Platforms, energy source, Imaging media, Regions of the EM spectrum & number of Bands, Advantages & Applications of Remote sensing, **Aerial Photographs**-, Basics, Types, Stereo models, Photo Mosaics and Photo scale. **Photo Interpretation Elements** - Tone, Texture, Shadow, Size, Shape, Pattern and Association. **Geotechnical / Geomorphic Elements** - Landforms, Drainage, Erosional Pattern, Vegetative Cover	9
II	**The Characteristics of Electromagnetic Radiation (EMR)-** Wave theory, Particle theory and other properties of EMR. Electromagnetic spectrum with their wavelength's frequencies and their uses. Blackbody radiation and its related laws: Stefan-Boltzmann Law, Wien's Law, Planck's Law and Kirchhoff's Law. Energy interactions in the atmosphere: Absorption, Reflection, Scattering and its types & Transmission, & Atmospheric windows. Interaction of energy with terrain features: Energy balance equation, Absorption, Transmission, Reflection and its types. Spectral reflection & Reflectance curves.	9
III	**Satellites and Sensors- Platforms:** Types and their advantages and limitations**- Satellite Orbits:** Geostationary, Sun-synchronous, LEO, MEO, GTO and Lagrange points. **Sensors- Resolution:** Spatial Resolution, Spectral Resolution, Radiometric Resolution, Temporal Resolution, and Multispectral Resolution. **Scanning Mechanisms:** Across Track Scanning**,** Along Track Scanners. **Satellite Meteorology**: Meteorological satellites – Polar-orbiting and geostationary satellites, visible and infrared radiometers, multi scanner radiometers; identification of synoptic systems, fog and sandstorms, detection of cyclones, estimation of SST, cloud top temperatures, winds and rainfall: temperature and humidity soundings.	9
IV	**Thermal Remote Sensing:** Laws defining Thermal Remote sensing, Emissivity, Thermal properties of objects, Thermal scanning and Data Interpretation. Thermal sensors- ASTER, MODIS- **Microwave Remote Sensing**: Basic concepts, Active and Passive Microwave System and Data Interpretation.MW sensor ASTER – **Hyperspectral Remote Sensing:** *Basic concepts, Data Interpretation and Applications of Hyperspectral Remote Sensing*. **AVIRIS- LIDAR** sensing	9
	GPS Basics: Introduction, GLONASS, GALILEO, BEIDOU, QUASI ZENITH,	9

V IRNSS – Satellite, Control and User Segments, Advantages and Limitations, Applications of GPS. Errors in GPS observations, Differential GPS. GPS Code and Carrier measurements, GPS positioning, **GPS Mapping**: Conventional Static, Kinematic GPS Semi kinematic (Stop & Go) – Rapid static Mobile mapping.

Text Books:

1. Anji Reddy, M., (2012) Textbook of Remote Sensing & GIS, BS Publications, Hyderabad.
2. Curran, P., (1985) Principles of Remote Sensing, Longman, London.
3. Sabins, F.F., (2007) Remote Sensing Principles and Interpretation, Freeman, San Francisco.

Reference Books:

1. John, T. Smith, Jr, (1973) Manual of Colour Aerial Photography (I Edition) American
   Society of Photogrammetry, ASP Falls Church, Virginia.
2. Lillesand, T.M., and Kiefer, P.W., (2007) Remote Sensing and Image Interpretation, Third Edition, John Wiley & Sons, New York.
3. Rampal, (1999) Handbook of Aerial Photography and Interpretation, Concept publishing.
4. Pandey, S.N., (1987) Principles and Applications of Photo geology, Wiley Eastern Limited, India.
5. Gupta, R.P., (2003) Remote Sensing Geology, Springer - Verlag - New York, London.
6. Basudeb Bhatta, (2008) Remote sensing and GIS, Oxford University Press

Web resources:

1. *http://www.gdmc.nl/oosterom/PoRSHyperlinked.pdf*
2. *http://www.geoservis.ftn.uns.ac.rs/downloads/ISP/1999-fundamentals-of-remote-sensing.pdf*
3. *https://webapps.itc.utwente.nl/librarywww/papers_2009/general/PrinciplesRemoteSensing.pdf*
4. https://researchweb.iiit.ac.in/~sai.deepak/lectures/Thermal%20infrared%20remote%20sensing.pdf
5. http://eoscience.esa.int/landtraining2017/files/materials/D2T3__P.pdf
6. https://www.tutorialspoint.com/satellite_communication/satellite_communication_global_positioning_system.html.
7. https://www.trimble.com/gps_tutorial/
8. https://www.earthdata.nasa.gov/learn/backgrounders/remote-sensing
9. https://www.esa.int/Enabling_Support/Space_Transportation/Types_of_orbits

Course Outcomes

On completion of the course, the students will be able to

CO1: Describe the basic principles of Remote Sensing and Visual interpretation key elements of Satellite imageries

CO2: Describe the Electromagnetic spectrum and EMR interactions.

CO3: Categorize insight into different kinds of sensors, systems and satellite platforms

CO4: Discuss the types of Remote sensing

CO5: Predict the basic principles of GPS and GPS mapping

24GEUC3606 REMOTE SENSING AND GPS												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S		M	S	M		M	M		S		S
CO2	S	M		M	S			M		S	M	S
CO3	M			S	M		M	L		M		S
CO4	S	M	M	S	S			M		S		S
CO5	S	M	M	M	S		M			M		S

Course Code &Title	**24GEUC3607** **REMOTE SENSING - PRACTICAL**
Class	B. Sc., Geology (Hons.) Semester VI
Cognitive Level	K-1 K-2 K-3
Course Objectives	**The Course aims** • To understand the marginal information given in aerial photographs/satellite imagery, • To learn how to establish the Scale of Photograph • To visually interpret the various morphological landforms in the satellite imageries.

Contents

Reading the marginal information of aerial photograph/satellite imagery, establishing the scale of Photographs by various methods, and visualizing satellite imagery with visual interpretation of key elements and geotechnical elements.

1. Write about the marginal information that can be found in aerial photographs / satellite imagery.
2. Find the Scale of Photograph if the Photo distance and ground distance are known. (2 Problems)
3. Find the Scale of Photograph if the Focal length and Flying height are known. (2 Problems)
4. Interpretation of Fluvial landforms in the satellite imagery. (2)
5. Interpretation of Coastal morphological features in the satellite imagery. (2)
6. Interpretation of Aeolian landforms in the Satellite imagery. (2)
7. Interpretation of Denudational landforms in the satellite imagery. (2)
8. Interpretation of Glacial morphological features in the satellite imagery

Course Outcomes

On completion of the course, the students will be able to
CO1: Able to understand the information given in the data
CO2: Compute the Scale by different methods.
CO3: Visually interpret the Fluvial, Coastal, Aeolian, Denudational and Glacial Geomorphology from the Satellite imageries

24GEUC3626 REMOTE SENSING - PRACTICAL												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S		M					S		L		S
CO2	S		M		M		L	S				S
CO3	S	M	M	L	M	L	L	S		M	S	S
CO4												
CO5												

Course Code &Title	**24GEUB3601 GEOSTATISTICS**		
Class	B. Sc., Geology (Hons.)	Semester	VI
Cognitive Level	K-1 K-2 K-3		

Course Objectives

The Course aims

- To introduce the advanced and applied aspects of Mathematical Geology.
- To understand the Concepts of Geostatic and concepts of data distribution in space
- To learn the concepts of correlation, exploratory spatial data analysis and interpolation

Unit	Content	Lectures
I	**Introduction to Geostatistics**: Scope, Definition and History of Geostatistics. Common statistical terms. Qualitative data. Quantitative data, Measures of Central Tendency – Averages, Mean, Median, Mode. Measures of Location – Percentiles, Graphic method, Arithmetical method. Uses of Geostatistics.	12
II	**Concepts of probability:** Radom variation – Sampling estimates and standard errors- Simple tests based on normal, chi-square and F Distributions. Standard deviation. **Spatial data**- Definition and Characteristics Types: Point pattern, continuous surfaces, Area with counts and aggregate rates, Terms in Spatial Analysis – Spatial dependence, Stationary and Isotropy, Anisotropy, Region of stationary, Spatial correlation, Autocorrelation, Corelogram.	12
III	**Spatial data analysis:** ESDA/EDA - Meaning of Exploratory spatial data analysis (ESDA) and Exploratory data analysis (EDA). **Concepts of data distribution in space** - Data Sampling, ii. Heterogeneity, iii. Dependency, Univariate description. Frequency tables, Histogram, Cumulative frequency table, Normal probability plots. Summary / Descriptive statistics, Bivariate description - Scatter plot, correlation, covariance, correlation coefficient, linear regression, Transgression.	12
IV	**Exploratory Geostatistics:** Introduction to applications of geostatistics in petroleum geosciences, Simulation of random functions: non-conditional and conditional simulation, sequential simulation, LU-based simulation, simulated annealing, co-simulation; truncated Gaussian and indicator simulation; introduction to object-based simulation. Application of simulation techniques in petroleum geology: simulation of facies and reservoir characteristics. Introduction to non-conditional and conditional simulation of mineral deposits. Concept of recoverable reserves, global grade-tonnage curves. Introduction to non-linear geostatistics.	12
V	**Structural analysis**: Meaning/definitions -. i. Spatial correlation, ii. Autocorrelation, and iii. Spatial Autocorrelation, Spatial autocorrelation. Concept and “Moran’s I” statistic, Correlogram - a. Concept, b. types: **Omnidirectional and directional**, Concepts of i. Autocovariance ii. Semivariances. iii. Semi variogram iv. Variogram: a. Components-Nugget variance, Sill, & Range. Variogram models.	12

Text Books:

1. Sancheti. D. C. and Kapoor, V. K. (1992) Statistics Theory, Methods and Application. Sultan Chand & Sons publishers
2. Isaaks, E. H., and Srivastava, R.M., (1989) An Introduction to Applied Geostatistics, Oxford University Press,

Reference Books:

1. Davis, J. C., (2002) Statistics and data analysis in geology, third edition, John Wiley & Sons, Singapore.
2. Using ArcGIS Geostatistical Analyst. (2001) GIS by ESRI.
3. Kitanidis P.K., (1997) Introduction to Geostatistics, Applications in Hydrogeology, Cambridge University Press.
4. Sharma, D. D., (2009), Geostatistics with applications in Earth sciences Jointly published with Capital Publishing Company.
5. Simon W., (2000) Houlding Geostatistics: Modeling and Spatial Analysis, Springer: Har/CdrEdition (8 June 2000), CD-ROM: 161 pages, 2000.
7. Cressie, N.A.C. (1993) Statistics for Spatial Data, New York: John Wiley & Sons, Inc.
8. Duetsch, C.V. and Journel, A.G. (1992) GSLIB: Geostatistical Software Library and User's Guide, New York: Oxford University Press,
9. Hohn, M.E. (1988) Geostatistics and Petroleum Geology, New York: Van Nostrand Reinhold,

Web Resources:

1. http://people.ku.edu/~gbohling/cpe940/Variograms.pdf
2. http://maps.unomaha.edu/Peterson/gisII/ESRImanuals/Ch3_Principles.pdf
3. http://geofaculty.uwyo.edu/yzhang/files/Geosta1.pdf

Course Outcomes

On completion of the Course, the students should be able to

CO1: Describe the principles of Geostatics.
CO2: Apply Geostatistics in geological data interpretation.
CO3: To understand the concepts of spatial modelling of resources using geostatistical data.
CO4: Define the concept of Exploratory studies through geostatistical interpretation.
CO5: Enhance the details of structural geostatistical analysis.

24GEUB3601 GEOSTATISTICS												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	M		M	L			S				S
CO2	S	M		M	L			S		L		S
CO3	S	M		M	M		M	S		L	L	S
CO4	S	M		M	M		M	S		L	M	S
CO5	S	M		M	M		M	S		L	M	S

Course Code & Title	**24GEUC3226** **Field Geology**
Class	B. Sc., Geology (Hons.) Semester VII
Cognitive Level	K-1 K-2 K-3
Course Objectives	The Course aims • To know the Physiography - Topographic expressions • To learn about the Geological field equipment's • To describe about the Field geological methods • To gain knowledge of the Aerial photographs and rock structures

Unit	Content	Lectures
I	Introduction - Literatures and maps - Destruction of rocks - Physiography - Topographic expressions and relief - Inliers and outliers - requirements of the field - suggestions and precautions. Equipment and Supplies: General, Geological Hammers, Pocket and Hand Lenses, Hydrochloric Acid, Streak Plate, Pocket Magnet, Pocket Knife, Measuring Tapes and Scales, Haversack or Rucksack, Mohs Scale of Hardness, Cold Chisel, Protractors, Pocket Calculator, Cameras, Care and Upkeep of Instruments. The compass and Clinometer: The compass and its uses- Dip of the compass needle - Magnetic declination - Clinometer: Bearing and Reading directions - Measuring altitudes - Handling of the compass.	9
II	Topographic maps: Base Maps, Scale of maps – Depiction of relief - Latitudes and Longitudes - Map grids - Measurement of mapped areas- Mounting and folding field maps- Marking on maps. Field documentation: Field sketches and Drawings - Field photographs. Basic field procedures: Location - Soils and vegetation- measuring distances - Compass and tape traversing - Determination of slopes and gradients- Measuring difference in elevation - Field identification of rocks - Basic field observations.	9
III	Geological Mapping: General considerations - Reconnaissance - Surface features - Cuttings - Quarries and Mines - Unconsolidated and residual deposits - soils. Systematic Mapping: Strike and dip - Contacts and boundaries - correlation - Geologic cross- sections - Marking the map	9
IV	Mapping on Aerial photographs. Specimens and Sampling: General - Trimming of Hand specimens - Fossil specimens - Mineral specimens - Samples and sampling - Numbering and labeling of specimens - packing and storage.	9
V	Study of Fossils and Biogenic structures. Field observations of Sedimentary rocks - Igneous rocks - Metamorphic rocks. Structures: General, Top and bottom Strata - Joints - Unconformities - folds - faults. Mineral Investigation and Identification: General - Geological plan - Sampling - pitting and trenching.	9

1.

Course Outcomes

On completion of the course, the students will be able to

CO1: Explain the basic principles, Field procedures of field Geological studies.
CO2: Analyze the basic principles, Field procedure and application Geological field equipment's
CO3: Evaluate the basic principles, Field procedure and systematic geological mapping
CO4: Describe the basic principles and applications of Aerial photographs
CO5: Assess the fossils and rock structures

24GEUC3226 Field Geology												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S			M	M			S		S		S
CO2	S			M	M			S		S		S
CO3	S			M	L		L	S		M		S
CO4	S			M	L		L	S		M		S
CO5	S			M	L		L	S	S	M		S

(Or)

24GEUC3608
Project

Course Code & Title	**24GEUC4701** **GEOPHYSICS**
Class	B. Sc., Geology (Hons.) Semester VII
Cognitive Level	K-1 K-2 K-3
Course Objectives	The Course aims • To know the gravity and radiometric method of exploration • To learn the magnetic and electromagnetic methods of exploration • To describe the electric method of exploration and its interpretation and analysis techniques. • To gain knowledge of the seismic method of exploration

Unit	Content	Lectures
I	**Introduction & Gravity Methods**: Scope of exploration geophysics – physical properties of the earth Objectives of Geophysics – Classification of Geophysical methods - Gravitational - Electrical - Magnetic - Thermal and Chemical – Introduction **Gravity Methods** - Gravitational field of the Earth - Densities of rocks and minerals - **Instruments**: Pendulum - Torsion Balance - Gravity meters. Field procedures - **Reduction of Gravity data**: Instrument drift - Latitude correction - Free air correction - Bouguer correction - Terrain correction and Tidal correction. Gravity anomaly maps and Interpretation methods in gravity prospecting. Advantages and Limitations of gravity method of prospecting	9
II	**Magnetic Methods**: Principle– Magnetic Susceptibility - Earth's Magnetism - Magnetism of rocks and minerals: Induced and remnant magnetism. Magnetic materials and Magnetic domains: The Neel temperature and Curie temperature – Magnetic properties of materials: Diamagnetism – Para magnetism – Ferromagnetism – Anti-ferromagnetism – Ferrimagnetism Instruments: Schmidt type Magnetometers: Vertical force magnetometer - Horizontal force magnetometer - Torsion magnetometer - Field procedures - Reduction of data: Temperature correction - Correction for diurnal variations - Normal corrections - Preparation of magnetic anomaly maps and profiles - Interpretations - Applications and limitations.	9
III	**Electrical Methods:** Principles **and types - Resistivity methods:** Principles - Instruments: D.C Potentiometer - Electric mill voltmeter. Equipotential and in equipotential method – Typical resistivity values of Important rocks - Electrode arrangements: Wenner arrangement - Schlumberger arrangement – Pole – Dipole method – Di pole – Di pole method **Field procedures**: Lateral exploration or profiling- Vertical Exploration or Depth sounding **- Interpretation - Application of resistivity methods. Self-Potential method: Principle – Background potentials – Mineralization potential – Sato and Mooney's hypothesis – Field equipment -** Non-polarizable electrodes - The potentiometer - Electric millivoltmeter. **Field procedure** - Interpretation - Applications. **Induced Polarization Methods:** Principle - Polarization types: Membrane or electrolytic polarization – Electrode polarization - Time-domain IP and Frequency Domain IP – Instruments Field procedures - Interpretation - Applications.	9

IV	**Radioactivity methods**: Fundamentals of radioactivity – principle of radioactivity methods –instruments – field methods and interpretation – Instruments: Geiger- muller counters - Scintillation counters - Gamma-ray spectrometers. Field procedures - Interpretation of radiometric data - Applications and Limitations. **Electromagnetic Methods:** General principles- Eddy currents - Instruments- Field procedures - Anomalies – Interpretation of EM data - Applications and limitations - **Telluric and Magneto Telluric Field methods: Introduction – Surveying with TC and MT– Equipment – Depth equation.**	9
V	**Seismic Methods:** Principle -Seismology and seismic prospecting - Elastic properties of rocks – Factors influencing Seismic wave velocities - Refraction and Reflection of seismic waves - Instruments: Geophones - Amplifiers and filters - Gain control systems - Time markings Magnetic recorders - Operational methods: Fan shooting, Arc shooting and Profile shooting - Reduction of data – Travel time curves for single homogenous and heterogenetic layers - Interpretation - Applications and limitations	9

Text Books:

1. Lowrie, W., (2007) Fundamentals of Geophysics. 2nd ed. Cambridge University Press, New Delhi,
2. Ramachandra Rao, M.B., (1993) Outlines of Geophysical Prospecting. EBD, Dhanbad.
3. Telford, W.M., Geldart, L.P.& Sheriff, R.E., (1990) Applied Geophysics. 2nd ed. Cambridge University Press, New Delhi.

Reference Books:

1. Arogyaswamy, R.N.P., (1980) Courses in Mining Geology. Oxford& IBH, New Delhi.
2. Banerjee, P.K. & Ghosh, S., (1997) Elements of Prospecting for Non-Fuel Mineral Deposits. Allied Publishers, Chennai.
3. Dobrin, M.B. &Savit, C.H., (1988) Introduction to Geophysical Prospecting. 4th ed. McGraw Hill. New Delhi.
4. Hartman, H.L., (1992) SME Mining Engineering Handbook. SMME Inc.Colorado.
5. Kearey, P., Brooks, M &Hill.I., (2002) An Introduction to Geophysical Exploration, 3rd ed. Blackwell Science.
6. Moon, C.J., Whateley, M.K.G. &Evans, A.M., (2006) Introduction to Mineral Exploration. Wiley Blackwell, New Delhi.
7. Mussett, A.E. & Khan, M.A., (2000) Looking into the Earth: An Introduction to Geological Geophysics. Cambridge University Press, New Delhi.
8. Parasnis, D.S, (1975) Principles of Applied Geophysics. Chapman & Hall. New York.
9. Kearey, P., Brooks, M., and Hill, A., (2002) An Introduction to Geophysical Exploration, Third Edition, Wiley Blackwell.
10. Li, M., Zhao, Y., (2014) Geophysical Exploration Technology, Elsevier Science Limited.

Web resources:

2. *https://www.school-for-champions.com/astronomy/earth.htm#.WxddcO6FO70*
3. *https://geoinfo.nmt.edu/geoscience/projects/astronauts/gravity_method.html*
4. *http://www.geol-amu.org/notes/b8-4-4.htm*
5. *https://www.michigan.gov/documents/deq/GIMDL-USGSINF672R6_302983_7.pdf*
6. *http://www.geol-amu.org/notes/b8-3-6.html*
7. *https://csegrecorder.com/articles/view/magnetic-and-gravity-methods-in-mineral-exploration*
8. *http://rallen.berkeley.edu/teaching/F04_GEO594_IntroAppGeophys/Lectures/L05.pdf*
9. *http://crack.seismo.unr.edu/ftp/pub/louie/class/492/data/2011/gph492_all_files_2011/AppliedGeophysics_Telf ord/AppliedGPH_MagneticMethods.pdf*
10. *https://sites.ualberta.ca/~unsworth/UA-classes/223/notes223/223D1-2009.pdf*
11. *http://www.engr.uconn.edu/~lanbo/G228378Lect0510EM1.pdf*
12. *https://www.kau.edu.sa/Files/0003035/Subjects/EM(1).pdf*

13. *http://shodhganga.inflibnet.ac.in/bitstream/10603/65005/8/08_chapter%201.pdf*
14. *http://www.tomoquest.com/attachments/File/EEG_Electrical_Surveying_SP.pdf*
15. *http://en.geophysik.at/index.php/methods/seismic-methods*
16. *http://www.geosearches.com/seismic.php*
17. *http://www.subsurfacesurveys.com/pdf/Methods.pdf*
18. *http://www.mdru.ubc.ca/home/resources/seg/seg_talks/Ray_Lett_Notes.pd*
19. *http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.489.6536&rep=rep1 &type=pdf*

Course Outcomes

On completion of the course, the students will be able to

CO1: Explain the basic principles, Field procedure and application of Gravity methods for Geological studies.

CO2: Analyze the basic principles, Field procedure and application of Magnetic methods for Geological studies.

CO3: Evaluate the basic principles, Field procedure and application of Electrical Methods for Geological studies.

CO4: Describe the basic principles of Radioactivity methods and Electromagnetic methods.

CO5: Assess the basic principles, Field procedure and application of the Seismic method for Geological studies

24GEUC4701 GEOPHYSICS												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S			M	L			S		M		S
CO2	S			M	L			S		M		S
CO3	S			M	L		L	S		M		S
CO4	S			M	L		L	S		M		S
CO5	S			M	L		L	S	M	M		S

Course Code & Title	**24GEUC4702** **GEOPHYSICAL PRACTICAL**		
Class	M. Sc. Applied Geology and Geomatics	Semester	VII
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Analyze and interpret the resistivity data using the Wenner method and Schlumberger method • To Interpret the structures using Gravity and seismic data • To understand the concept of radioactivity and find a half-life period		

Contents

1. Resistivity survey and the interpretation for lithology and water resources - Wenner method
2. Resistivity survey and the interpretation for lithology and water resources - Schlumberger method
3. Geological and structural interpretation using Gravity data
4. Geological and structural interpretation using seismic data.
5. Find out the half-life period of the elements by using Radiometric data.

Course Outcomes

On completion of the course, the students should be able to

CO1: Predict the subsurface lithologies through electrical methods

CO2: Use of Gravity and Seismic data for structural interpretation

CO3: Analyze the half-life period of the Elements by using radiometric data

24GEUC4702 **GEOPHYSICS - PRACTICAL**												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	M		L			L	S	M	M	M	S
CO2	S	M		L			L	S	L	M	M	S
CO3	S	M	L	L			L	S	L	M	M	S
CO4												
CO5												

Course Code & Title	**24GEUC4703** **COAL AND PETROLEUM GEOLOGY**		
Class	B. Sc., Geology (Hons.)	Semester	VII
Cognitive Level	K-1 K-2 K-3		
Course Objectives	The Course aims • To gain knowledge of coal, its formation, varieties and distribution. • To classify the various types of Coal and Petroliferous basins of India • To understand the chemical characterization and methods of exploration of petroleum. • To Evaluate the Well logging process To Summarize Origin, Occurrences and Exploration of Coal and Petroleum		

Unit	Content	Lectures
I	**Coal:** Origin of peat, lignite, bitumen and anthracite - Physical and Chemical Properties of coal - Classification of Coal: Fundamentals of Coal, **Coal quality and** Classification **of coal:** Combustion, Gasification, Carbonization and coke, Hydrogenation; Coal and Environment. Mineral content of coal: Coalification (rank): Coalification, causes of coalification, Coal Bed Methane (CBM): Global and Indian scenario Underground coal gasification Coal liquefaction. Grading of coal; coal petrography.	12
II	Diagenesis of peat and coalification process – causes, role of time, temperature; Physical changes associated with increased coal rank. **Physical description of coal:** Macroscopic description of coal: Microscopic description of coal. Chemical characterization: proximate and ultimate analysis; Trace elements in coal; Lithologic characters of Coal: Bed Structure, Coal Texture; Maceral Concept: Vitrain, Clarain, Durain and Fusain. Coke, Coal for Liquefaction - Coal Gasification- Beneficiation of Low-Grade Coal and Conservation –. Depositional models of coal-bearing sequences, facies correlation, facies map	12
III	Age and Occurrences of Coal: **Deposits of coal in India**. Distribution of Gondwana and Tertiary coal fields of India. Coal bed methane, – Lignite deposits in India - coal resources of India. Gas hydrates, Nuclear and non-conventional energy resources	12
IV	Origin – Physical and Chemical Properties of Petroleum - Environment of Oil Formation: Sedimentary Basins - Continental and Offshore; Migration of Petroleum: Porosity, Permeability mechanism, pattern and barriers; Biogenic and Thermal effect**. Occurrences of petroleum:** Surface occurrences, sub-surface occurrences. Entrapment of petroleum; Source rock, maturation, reservoir rock and petroleum traps - Classification: Fragmental reservoir rock –chemical reservoir rock – miscellaneous reservoir rock. Concepts of petrophysics, Deposits of Petroleum in India – Gas hydrates – Petroliferous basins of India. Petroliferous basins of India	12
V	Well Logging: Drillers logs, sample logs, electric logs, radiation logs, drilling time logs, core and capillary logs, temperature logs, sonic logs and nuclear magnetism logs. Mud logging method and usage in oil companies. Wireline logs, different types of wireline logs. Identification of major minerals like oil and gas (Hydrocarbons), Coal.	12
	Text Books:	

1. Prasad, U., (2000) Economic Geology- Economic Mineral Deposits, Second Edition, CBS Publishers and Distributors, Delhi
2. Levorsen, A.I., (1985) Geology of Petroleum, Second Edition, CBS Publishers and Distributors, Delhi.
3. Larry Thomas, (2012) Coal geology, Wiley India Pvt. Ltd.
4. Dickson, M.H., and Fanelli, M., (2013) Geothermal energy utilization and technology, 1st Edition, Routledge- CRC press.

Reference Books:

1. Selley, R.C., (1998) Elements of Petroleum Geology, Academic press, Delhi.
2. Gokhale, K.V.G.K., & Rao, D.M., (2010) Ore Deposits of India, Thomson press.
3. Deshpande B.G., (1993) The word of Petroleum, Wiley eastern Limited, Delhi.
4. Thomas L., (2002) Coal Geology, John Wiley and Sons Inc.
5. Brown, A. R., (1986) Interpretation of Three-Dimensional Seismic Data, American Association of Petroleum Geologists, USA.
6. Aswathanarayana, U., (1985) Principles of Nuclear Geology. NBT. Delhi.
7. Paine, D.P., (1986) Aerial photography and image interpretation for resource management, Wiley and Sons, New York.
8. Rao, D.P., (1999) Remote Sensing for Earth Resources, Second Edition, Association of Exploration Geophysicist, Hyderabad.
9. Chandra, D., and Singh, R M., (2000) Textbook of coal geology (Indian context) Tara Book Agency, Varanasi.

Course Outcomes

On completion of the course, the students will be able to

CO1: Explain the Formation, properties, Migration and accumulation of Petroleum.
CO2: Identify the Occurrences of Petroleum.
CO3: Explain the Characteristics of Coal.
CO4: Identify the Occurrences of Coal.
CO5: Predict the Geothermal Resources and uses.

24GEUC4703
COAL AND PETROLEUM GEOLOGY

CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	M		L				M		L	M	M
CO2	S	M	S	L	M		L	M	S	L	M	M
CO3	S	M		L				M	S	L	M	S
CO4	S	S	L	L	M		L	M		L	M	M
CO5	S	M	L	L	M		L	M	S	L	M	M

Course Code & Title	**24GEUC4704** **DIGITAL IMAGE PROCESSING**		
Class	B. Sc., Geology (Hons.)	Semester	VII
Cognitive Level	K-1 K-2 K-3		
Course Objectives	The Course aims • To understand the basic principles of Image Processing and image restoration techniques • To learn the image enhancement techniques • To understand the Image Transformation and Fusion techniques. • To know the types of Image classification and their differences. • To validate the accuracy of the image classification methods and to calculate Vegetation and Water indices.		

Unit	Content	Lectures
I	**Image Processing**: Digital images, Digital image processing. **Digital Image formats** – BSQ, BIL, BIP. **Image Processing systems:** Hardware Component, Software Consideration and colour composites, Image Display. **Image Restoration**: **Geometric Correction Methods**: Sources of Errors, Systematic and Nonsystematic Correction Processes. Resampling and Interpolation.	9
II	**Radiometric Correction**: Sources of errors, correction processes. **Atmospheric Correction Methods. Miscellaneous Pre-processing. Ortho Rectifications Methods. Image Enhancement: Contrast Enhancement**; Linear Contrast stretch. Non-Linear Contrast enhancement. Histogram Equalization, Gaussian Stretch, Density Slicing.	9
III	**Spatial Filtering:** Spatial convolution filtering, Low-frequency filtering in the spatial domain, High-frequency filtering in the spatial domain. **Edge enhancement in the Spatial Domain:** Linear edge enhancement, Band rationing, Color Ratio Composite Images **Image Transformation:** Image Arithmetic operations; Image addition, Image subtraction, Image multiplication, Indices/Ratioing. **Image Fusion:** Multiplicative Fusion, PCA transform fusion, HIS transform fusion.	9
IV	**Image Classification: The Classification Stage** **Supervised classification**; Minimum distance to Means Classifiers, Parallelepiped Classifiers, Gaussian Maximum Likelihood Classifier, **The Training Stage Unsupervised classification**; Cluster building, Cluster Labeling, Reclassification Processing and Feature Extraction. Sub-pixel classification	9
V	**Classification Accuracy Assessment:** Overall Classification Map Accuracy Assessment, Site-Specific Classification Map Accuracy Assessment. Classification Error Matrix method. Normalized Density Vegetation Index, Normalized Density Water Index, Pan sharpening. Drone data analysis. **Digital Online Data Sources:** Bhoonidhi, USGS, GLCF, and Google Earth.	9

Text Books:

1. Curran, P., (1985) Principles of Remote Sensing, Longman, London.
2. Nilblack, W., (1986) An Introduction to Digital Image Processing, III Edition, Prentice-Hall International.
3. Davis, B.E., (2001) GIS A visual approach, Second edition, Onword Press/ Thomson Learning

Reference Books:

1. Hord M.P., (1982) Digital Image Processing of Remotely Sensed Data, Academic Press.
2. Jenson, (2004) Introduction to Digital image processing, 3 Edition, Prentice Hall.
3. Lillesand, T.M., and Kiefer, P.W., (2003) Remote Sensing and Image Interpretation, John Wiley & Sons, New York.
4. Paul J. Gibson and Clara H. Power (2000) Introductory Remote Sensing, Digital Image Processing and Applications, Routledge.
5. Pratt, S.K., (1990) Digital Image Processing, Wiley - Inter-Science, New York. Gupta, R.P., (2003) Remote Sensing Geology, Springer - Verlag - New York, London.
6. Basudeb Bhatta., (2008) Remote sensing and GIS, Oxford University Press.

Web resources:

1. *http://148.206.53.84/tesiuami/S_pdfs/Remote%20Sensing%20Digital%20Image%20Analysis.pdf*
2. *http://www.wamis.org/agm/pubs/agm8/Paper-5.pdf*
3. *http://www.fao.org/3/a-i0304e.pdf*
4. *https://think-asia.org/bitstream/handle/11540/5035/disaster-management-handbook.pdf?sequence=1*
5. *http://www.untagsmd.ac.id/files/Perpustakaan_Digital_1/DISASTER%20MANAGEMENT%20Disaster%20Management%20Handbook.pdf*
6. *https://think-asia.org/bitstream/handle/11540/5035/disaster-management-handbook.pdf?sequence=1*
7. *http://www.untagsmd.ac.id/files/Perpustakaan_Digital_1/DISASTER%20MANAGEMENT%20Disaster%20Management%20Handbook.pdf*
8. https://www.lkouniv.ac.in/site/writereaddata/siteContent/202004021910156883ajay_misra_geo_Digital_Image_Processing.pdf
9. https://niu.edu.in/sla/online-classes/DIGITAL_IMAGE_PROCESSING.pdf

Course Outcomes

On completion of the course, the students will be able to

CO1: Describe the basic principles of DIP
CO2: Illustrate the Image restoration and enhancement techniques
CO3: Describe Image transformation and Fusion techniques and their uses
CO4: Describe the types of Image classification and their advantages
CO5: Describe the Classification accuracy assessment methods and the NDVI and NDWI calculations

24GEUC4704 DIGITAL IMAGE PROCESSING												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	L		L	M		L	S		L	M	S
CO2	S	S	L	S	S			S	S	S	M	S
CO3	S	S		S	S		L	S	S	M		S
CO4	S	S	L	S	M		L	S	M	M		S
CO5	S	S	L	S	M			S		M		S

Course Code &Title	**24GEUC4705** **DIGITAL IMAGE PROCESSING - PRACTICAL**		
Class	B. Sc., Geology (Hons.)	Semester	VII
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To learn how to download data from various online sources • To explore the Digital Image processing Software Interface tools • To work with True and False colour composite remote sensing data • To rectify the errors, enhance and classify the satellite data		

Contents

1. Data download from Bhuvan, USGS, GLCF, and Google Earth (ArcGIS Living Atlas
2. Portal and Blend, Flicker, Swipe and Geolinking.
3. Overlay of Vector Layer over Image.
4. Reading Raw Image, Reproject Raster and Geometric Correction. Mosaicing of Images
5. Spatial and Spectral Subset.
6. Image Enhancement/ Stretch, Apply Spatial Filter, Mosaic.
7. Pan sharpening.
8. Density Slicing
9. NDVI Calculation
10. NDWI Calculation
11. Principal Component Analysis (PCA).
12. Band Rationing
13. Image Fusion
14. Change Detection, Anomaly Detection.
15. Spectral Analogues Tool for Vegetation Delineation.
16. Relative Water Depth Analysis.
17. Unsupervised Classification.
18. Supervised Classification, Accuracy Assessment and Generation of Class Statistics.
19. Generation of Digital terrain model from contours and break lines
20. Generation of Contours from DEM
21. Generation of Slope and Aspect
22. Generation of Line of Sight
23. AOI based Clip/subset of imageries
24. Atmospheric Correction

Course Outcomes

On completion of the course, the students will be able to
CO1: Able to handle Digital image processing tools
CO2: Compute processes like Map registration, Reprojection
CO3: Carry out the error rectification processes.
CO4: Enhance, classify and Generate the Digital Elevation models

24GEUC4705 DIGITAL IMAGE PROCESSING – PRACTICAL												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	L		L	M		L	S			M	S
CO2	S	S	L	S	S			S	S		M	S
CO3	S	S		S	S		L	S	S	M		M
CO4	S	S	L	S	M		L	S	M	M		S
CO5												

Course Code &Title	**24GEUC4701** **ENVIRONMENTAL GEOLOGY AND NATURAL DISASTER MANAGEMENT**		
Class	B. Sc., Geology (Hons.)	Semester	VII
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Know the basic concepts, Importance of Environmental geology and various types of natural resources and problems. • To Study the Energy, Land and Air resources and their related problems • To Understand the concepts of various disasters, their classification, causes and impacts. • To Acquire knowledge about the approaches to Disaster risk reduction and various disaster management cell		

Unit	Content	Lectures
I	**Environmental Geology**: Basic concepts of environmental geology, Ecology and biodiversity; Global changes in the ecosystem and climate; global warming and its causes; anthropological impacts on the natural environment. Impact of use of energy and land on the environment. Exploitation and conservation of mineral and other natural resources. Planet Earth, environment and its types, scope and importance of environmental geology public awareness, Biogeochemical cycles; Atmospheric CO2 fluctuations throughout the geological history; impacts of circulations in atmosphere and oceans on climate. Environmental protection acts in India. Environmental impacts (EIA) due to mining and mineral processing. Applications of environmental geology in environmental protection/management; conservation and restoration of land. **Natural Resources**: types of resources (based on origin, based on continual utility). Natural Resources and Associated Problems: Water resources, Properties of water, Hydrological cycle; water resource and management degradation and contamination of surface water and groundwater quality due to industrialization and urbanization Control measures to reduce the contamination / Conservation of surface and subsurface water bodies.	12
II	**Energy Resources**: Energy resources, uses, degradation, alternatives and management; Ecology and biodiversity. Impact of the use of energy and land on the environment. Exploitation and conservation of mineral and other natural resources Land resources: Man-land relationship, Biosphere as an Ecosystem - System, the biosphere, biosphere as a system, biosphere, as an ecosystem, subsystems of the biosphere, modifiers of the biosphere, components of the biosphere – Atmosphere components **Atmospheric Disturbances**: Cyclones and Anticyclones) **Causes, Effects and Control Measures.** Pollution: Water pollution, Air pollution, mine pollution, mine waste handling, transportation and dumping.	12
III	**Introduction to Disaster**: Definitions and Concepts of Disaster, Hazard, Risk, Vulnerability, Resilience; Disaster: Classification, Causes and Impacts: Natural Disaster: Beneath the Earth Surface: Earthquake - Types and Characteristics of Seismic Waves. Distribution, magnitude and intensity of earthquakes Mitigation measures of the earthquake.	12

	Tsunami: Nature, characteristics, causes and origin of Tsunami; Arrival, adverse effects and management of Tsunami disaster	
IV	**Natural Disaster**: On the Surface: Volcanic Eruptions- Types, effects and mitigation measures of Volcanoes. Landslides- Types, Influencing factors, effects and its management strategies. Avalanche. **Meteorological /Hydrological Disasters**; Flood- Types, causes, effects and its control measures. Droughts- their types and mitigation measures. Windstorms- definition, causes, types and effects; Hailstorms- definition, formation, characters, effects and mitigations; Tornadoes- definition, formation, characters, effects and mitigations	12
V	**Approaches to Disaster Risk Reduction**: Disaster Management Cycle, Phases of Disaster Cycle. Culture of Safety, Prevention, mitigation and Preparedness. Structural measures, Components of Disaster Relief. Four phases of Disaster Management. Disaster management in India – NDMA, NIDM, SDMA. Role of Technology in Disaster Management	12

Text Books:

1. Jonathan Turk and Graham R. Thompson, Environmental Geoscience: Saunders College Division, 2000.
2. Davis, N., (1976), Environmental Geosciences, John Wiley and Sons, New York.,
3. Keith, L. H., (1996), Principles of Environmental Sampling. ACS Professional Reference book, Amer. Chem. Soc., Washington DC
4. Subramanian, V., (2002), A Textbook in Environmental Science, Narosa Publishing House, New Delhi
5. Savindra Singh, (2015) Environmental Geography, Pravalika Publications, Allahabad.
6. Keller, E.A., (2010) Environmental Geology: CBS Publisher, New Delhi
7. Valdiya, K.S., (2005) Geology Environment and Society. Universities Press,
8. Bryant, E., (2008) Natural Hazard. Camb. Univ. Press.

Reference Books:

1. Bennett, M. R. & Doyle, P., (1997), Environmental Geology: Geology and The Human Environment, Wiley India
2. Detwler, T.R., (1971), Man's Impact on Environment, McGraw Hill Environmental Geology: Ecology, Resource and Hazard Management
3. Chouhan, T.S.& Joshi, K.N., (1996) Applied Remote Sensing and Photo Interpretation, Vigyan Prakashan,
4. Savindra Singh, (2020) Oceanography, Pravalika Publications, Allahabad

Web Resources:

1. *http://www.svu.edu.eg/links/ictp/e_learning/links/courses/dr_abbas/course3/1.pdf*
2. *https://en.wikipedia.org/wiki/GIS_in_environmental_contamination*
3. *http://www.geo.unibe.ch/unibe/portal/fak_naturwis/e_geowiss/a_igeo/content/e42577/e42580/e454184/e454188/RWIforbeginnersA5-ERZ2_ger.pdf*
4. *http://wwwnaweb.iaea.org/napc/ih/documents/global_cycle/vol%20IV/IV_Ch4.pdf*
5. *https://www.conserve-energy-future.com/causes-and-effects-ofenvironmental-degradation.php*
6. *http://www.civileblog.com/types-of-soil/*
7. *http://environment.uwe.ac.uk/geocal/SoilMech/classification/default.htm*
8. *http://cbse.nic.in/natural%20hazards%20&%20disaster%20management.pdf*
9. *http://www.fao.org/3/a-i0304e.pdf*
10. *https://think-asia.org/bitstream/handle/11540/5035/disaster-managementhandbook.pdf?sequence=1*
11. *http://www.untagsmd.ac.id/files/Perpustakaan_Digital_1/DISASTER%20MANAGEMENT%20Disaster%20Management%20Handbook.pdf*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Assess the basics of Environmental Geology and Natural Disaster Management
CO2: Explain the Natural Resources and their related problems.
CO3: Analyze the risk and mitigation of hazards.
CO4: Assess the cause, effects and mitigation measures of disasters.
CO5: Discuss Natural Disaster Management through Geospatial Technology

24GEUC4701 ENVIRONMENTAL GEOLOGY AND DISASTER MANAGEMENT												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S		L		L			S				S
CO2	S		L		L			S	M			S
CO3	S		M				M	S	M			S
CO4	S		M				M	S	M			S
CO5	S		M	L			M	S	M			S

Course Code & Title	**24GEUC4702** **GEOSCIENTIFIC INSTRUMENTATION AND ANALYTICAL TECHNIQUES**
Class	B. Sc., Geology (Hons.)
Semester	VII
Cognitive Level	K-1 K-2 K-3
Course Objectives	The Course aims • This course aims to familiarize students with a range of analytical techniques. • Aims to equip students with the skills necessary to interpret and analyze data obtained from geological instruments. • To learn how to ensure the accuracy, precision, and reliability of their measurements through proper calibration, validation, and error analysis procedures

Unit	Content	Lectures
I	**Introduction to instruments & analytical:** Qualitative and quantitative analysis. Classification of methods. Types of instrumental analysis. Various instrumental techniques and laboratory safety, Laboratory operation and practices. Units of measurements. Laboratory notes. Errors and evaluation. Determination of accuracy. Statistical evaluation of data in geoscience.	12
II	**Preparation of thin section and polished section making**: cutting, grinding and polishing; powder sample preparation, crushing & pulverizing. **Petrological microscopes**: Principles, Parts, Operation and application of Petrological microscope, Ore microscope and Scanning electron microscope. Preparation of rock powder for chemical analysis. Rock digestion through acid treatment, Rock digestion through fusion with alkali salts.	12
III	**Sedimentological techniques**: Sampling methods and principles, Types of sampling, Sampling interval. Sieves & sieve shaking. Sample etching & staining, heavy minerals & clay minerals methods, size & shape of sediments studies	12
IV	**Engineering geology techniques & instrumentation**: in-situ and lab testing of strength of materials. Hydrogeological techniques & instrumentation: groundwater flow measurement, water quality measurement and water harvesting systems. Flame photometer and UV spectrometer: Basic principles, Parts and operation and mechanism.	12
V	Basic concept, and techniques of Atomic Absorption Spectrometer (AAS), Mass spectrometer Inductively Coupled Plasma – Mass Spectrometer (ICP-MS). X-Ray Diffraction (XRD). X-Ray Fluorescence (XRF) and Differential Thermal Analysis (DTA), Scanning Electron Microscope (SEM), Thermal Electron Microscope, Electron Probe Micro Analyzer (EPMA), Energy Dispersive X Ray Spectroscopy (EDAX).	12

Text Books:

1. Joe Carry, (2016) Geoscience: Instrumentation and Analytical Techniques, Syrawood Publishing House, USA.
2. Grundmann & H.Scholz (2015): Microscopic preparation for studies in mineralogy, geology,
3. George Huntington Williams (2023): Modern Petrography: An Account of the Application of the Microscope to the Study of Geology, ISBN: 978-1020025105
4. Maurice E. Tucker (1991): Techniques in Sedimentology. Publishing house Wiley-Blackwell

5. Myint Win Bo, Jeffrey Barrett (2023): Geotechnical Instrumentation and Applications. Publisher- Springer Nature

Web resources:

1. *http://www.odplegacy.org/pdf/operations/science/lab_procedures/cookbooks/thinsection_cookbook.pdf*
2. *https://www.slideshare.net/slideshow/engineering-geology-lecture-2/191022524*
3. *https://cosweb1.fau.edu/~warburton/Fall2019/GLY4200C_F19/4200L10_F19.pdf*
4. *https://www.researchgate.net/publication/285864992_Techniques_in_Sedimentology*
5. *https://www.researchgate.net/publication/285864992_Techniques_in_Sedimentology*
6. *https://pdfs.semanticscholar.org/338e/1d62b3fd6fc38ad724b22a20b7c61d595862.pdf*
7. *https://www.iitk.ac.in/che/PG_research_lab/pdf/resources/AAS-GTA-reading-material.pdf*
8. *https://www.mst.or.jp/Portals/0/en/en_icp-ms.html*
9. *https://www.slideshare.net/slideshow/inductively-coupled-plasma-mass-spectrometrypptx/251480264*
10. *https://www.slideshare.net/slideshow/x-ray-diffraction-25472126/25472126*
11. https://www.uprm.edu/geology/wp-content/uploads/sites/111/2017/03/xrf.pdf
12. *https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000831ME/P001676/M030232/ET/1525947482MODULE-3_Unit-3_COM-I.pdf*
13. *https://www.deshbandhucollege.ac.in/pdf/resources/1585214200_PHY(H)-VI-NANO_MATERIAL-1-AJAYPRATAP.pdf*
14. *https://www.deshbandhucollege.ac.in/pdf/resources/1585214315_PHY(H)-VI-NANO_MATERIAL-6-AJAYPRATAP.pdf*
15. *https://arxiv.org/pdf/0708.1522*

Course Outcomes

On completion of the Course, the students should be able to

CO1: Explain the instruments & analytical concepts

CO2: Learn the techniques of preparing thin sections.

CO3: Understanding the Sedimentological techniques

CO4: Outline of Engineering geology techniques & instrumentation

CO5: Explain the working of basic instruments and principles

24GEUC4702 GEOSCIENTIFIC INSTRUMENTATION AND ANALYTICAL TECHNIQUES												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	L									M	S
CO2	S	M		L	L						M	S
CO3	S	M		L	L						M	S
CO4	S	M		L	L						M	S
CO5	S	M		L	L						M	S

Course Code & Title	**24GEUC4801** **GEOCHEMISTRY**
Class	B. Sc., Geology (Hons.) Semester VIII
Cognitive Level	K-1 K-2 K-3
Course Objectives	The Course aims • To know the principles of geochemistry exploration & Geochemical Surveys • To learn the Geochemistry of minerals, rocks and waters • To understand the Isotope geochemistry. • To gain knowledge of Environmental geochemistry • To illustrate the principles of Exploration geochemistry & Ore Guides

Unit	Content	Lectures
I	**Principles of geochemistry:** Introduction – Periodic table - Chemical composition and properties of Earth's layers. Distribution of elements in rocks and soils. Chemical composition and characteristics of atmosphere – lithosphere - hydrosphere; geochemical cycles. Meteorites types and composition. Goldschmidt geochemical classification.	9
II	**Geochemistry of minerals, rocks and waters:** Mineral stability, compositional changes in minerals. River water, Seawater, Seafloor hydrothermal systems, Groundwater and Lakes. Characteristics of Magma, Melting of rocks, Water in magma, eutectic and melting. Distribution of trace components between rocks and melts. Fractionation of elements in minerals/rocks**.**	9
III	**Isotope geochemistry:** Radioactive Decay, Determining Isotope Decay time, Potassium-Argon Systematics, Uranium- Thorium-Lead Systematics. Types of Isotopes- Fractionation, isotope Exchange between minerals and water, Carbon, Oxygen and Sulphur isotopes, First-order decay and growth equations.	9
IV	**Environmental geochemistry;** Application of trace elements in petrogenesis-principles of equilibrium and Rayleigh fractionation- REE patterns, Eh and pH diagrams and mineral stability- Anthrosphere aquatic environment – Marine, fluvial, lacustral, aerosols-Perturbations caused by human activity. **Ore Guides**: Regional and local parameters for exploration - Regional and detailed exploration -Geochemical guides – Pathfinder elements, especially in diamond exploration – Groundwater as a guide – Geobotanical and biochemical guides.	9
V	***Exploration Geochemistry*****:** Relative abundance of elements in the whole Earth: Geochemical Anomaly and Province - Geochemical cycle - Primary and Secondary Dispersion of elements - Controls of dispersion - Mobility of elements – Oxidation Application of Utility of pathfinder elements and minerals. **Geochemical Surveys**: Definition – Types - Sampling Methodology – Application to mineral deposits.	9

Text Books:

1. "Principles and Applications of Geochemistry" by Gunter Faure and Teresa M. Mensing, Edition: 2nd, ISBN: 978-0132273908
2. "Geochemistry: Pathways and Processes" by Harry Y. McSween Jr., Steven M. Richardson, and Maria E. Uhle
3. "Earth: An Introduction to Physical Geology" by Edward J. Tarbuck, Frederick K. Lutgens, and Dennis Tasa.

Reference Books:

1. Arogyaswamy, R.N.P., (1980) Courses in Mining Geology. Oxford& IBH, New John V. Walther, Essentials of Geochemistry, Jones and Bartlett Publishers, 2005, Boston.

2. Girard, Principles of Environmental Chemistry, Jones and Bartlett Publishers, 2005, Boston.
3. Faure, G, Principles and applications of Geoche4msitry, Pearson Education, 1998, INC,Australia.
4. Arthur Brownlow, Geochemistry (Second edition), Pearson Education, INC., Australia, 1996.
5. Faure, G., Principles and applications of Geochemistry, Pearson Education, INC, Australia,1998.
6. Nelson EBY, G., Principles of Environmental Geochemistry, Thomson Brooks/Cole, UK,2004.
7. Criss, R.E. Principles of stable Isotope distributions. Oxford University Press, U.K., 1999.
8. Lajtha, J. and Michener, R. Stables isotopes in ecology and environmental Science, Blackwell, U.K., 1994.

Web resources:

1. *https://ocw.mit.edu/courses/12-479-trace-element-geochemistry-spring-2013*
2. *http://www.geol-amu.org/notes/b8-4-4.htm*
3. *https://www.soest.hawaii.edu/krubin/GG325/textbook/http://www.geolamu.org/*
4. *notes/b8-3-6.html*
5. *https://faculty.washington.edu/stn/ess_312/lecture_notes.shtml*
6. *https://www.freebookcentre.net/earth-science-books-download/GeochemistryLecture-Notes.html*
7. *http://www.geo.cornell.edu/geology/classes/Geo656/656notes09.html*
8. *https://ocw.mit.edu/courses/12-479-trace-element-geochemistry-spring 2013/resources/mit12_479s13_lec1/*
9. *http://www.engr.uconn.edu/~lanbo/G228378Lect0510EM1.pdf*
10. *https://www.internetchemistry.com/chemistry/geochemistry.php*

Course Outcomes

On completion of the course, the students will be able to

CO1: Explain the basic principles of geochemistry in Geological studies.
CO2: Analyze the basic principles and application of Geochemistry of minerals, rocks and waters
CO3: Evaluate the basic principles of the application of isotope geochemistry in geological studies.
CO4: Assess the basic principles and application of Environmental geochemistry Geological studies.
CO5: Describe the basic principles of Exploration Geochemistry

24GEUC4801 GEOCHEMISTRY												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S							S				S
CO2	S	L					M	S	M			S
CO3	S	L			M		M	S	M			S
CO4	S				M		M	S	M			S
CO5	S	L			M			S				S

Course Code & Title	**24GEUC4802** **GEOCHEMISTRY PRACTICAL**		
Class	M. Sc. Applied Geology and Geomatics	Semester	VIII
Cognitive Level	K-1 K-2 K-3		
Course Objectives	**The Course aims** • To Process, analyze and interpret the geochemical data • To Understand the exploratory techniques		

Contents

1. Geochemical Sample preparation (A solution, B solution)
2. Geochemical anomaly map preparation and interpretation
3. Statistical analysis of geochemical data.
4. Ore analysis

Course Outcomes

On completion of the course, the students should be able to

CO1: Familiarized with the chemical properties of the earth and its layers

CO2: Understand the geochemical characteristics of minerals and rocks

CO3: Collect geochemical data for exploration of earth resources

CO4: Interpret the megascopic and microscopic properties of sedimentary rocks

CO5: Analyze and Interpret geochemical data for the exploration of minerals, oil and groundwater

24GEUC4802 GEOCHEMISTRY - PRACTICAL												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S		M			M	S	S			S
CO2	S	S		M			M	S	S			S
CO3	S	S		M			M	S	S			S
CO4	S	S		L				S	S			S
CO5	S	S		M	M		M	S	S			S

Course Code & Title	**24GEUC4803** **GEOGRAPHIC INFORMATION SYSTEM**		
Class	B. Sc. Geology	Semester	VIII
Cognitive Level	K-1 K-2 K-3		
Course Objectives	The Course aims • To understand the basic principles and components of GIS and the types of Spatial data • To Learn the Raster and Vector data structure and their advantages and disadvantages. • To know the basic concepts of data quality, data problems and the acquisition and distribution of data. • To integrate and analyze the data in the GIS domain. • To Gain knowledge of the advanced processing techniques in GIS.		

Unit	Content	Lectures
I	**GIS:** Definition and History of GIS, components of GIS. GIS hardware and Software needs. GIS roles. **Geographic data and database**- Data and information definitions. Geographic data: spatial data, types of GIS database and discrete and continuous data GIS data characteristics Spatial Data Relationships, Proximity Relationships Time and GIS data, The Database and Relational Database in GIS.	9
II	**Raster and vector data:** Raster and Vector data and Models - **Raster data:** Raster Coding, Resolution, Gridding and Linear features - Raster Precision and Accuracy. Raster Data Advantages and Disadvantages. - **Vector Data.** Vector Structures - Vector Advantages and Disadvantages - **Topology,** Appling Topology - Topology Tables - Multiple Connectivity - Topology and Relational Queries - Topology contribution. **Rasterization and Vectorization**	9
III	**Data quality:** Error, Accuracy, Precision – Generational data and derived data - Scale and Precision, scale differences, scale incompatibility - Area and coverage, Incomplete Coverage, Smallest Scale Rule - Data Problems, Continuous Data Interpretation, Complete and Consistent Data - **Acquiring and Distribution of data:** Data Accessibility, Data Cost, Data Standards, Meta Data - Distributed GIS: Advantages and Disadvantages **Types Of Mapping In GIS -Interactive GIS Mapping.**	9
IV	**Inventory operations and basic Analysis**: Tools to view Spatial data in GIS, Database reading - Database Queries and Summaries - Relational Database Queries, Boolean Queries and Graphical Selection Queries - Measurement and Types, Distance applications, Reports - **Theme Modification**: Subsets and Tiles - Spatial deletes, dissolve and merge - Recoding and reclassification - **Basic Analysis:** Introduction - Overlay, its types and Principles - Database Merging and Applying Theme - Buffers and applications, Spatial analysis - Statistical Reporting and Graphing.	9
V	**Advanced Analysis:** Proximity analysis, Nearest features, Spider diagrams, Distance selection, Aggregation - Spatial operations: Centroids, Thiessen polygons - Tracking GIS - **Terrain analysis:** Elevation analysis, Terrain profiles - 3D views, Slope and Aspect, Shaded Relief views and View analysis - Overlays and Additional features, Drapping, Perspective views and Z data views - GIS output: types, Maps, Legends and Supporting elements - **Future GIS-** The Future GIS and the Future of GIS.	9

Text Books:

1. Burrough, P.A., (1986) Principles of Geographical Information Systems for Land Resources Assessment, Clarandone Press, Oxford.
2. Bernhardsen, T., (2007) Geographic Information System – An introduction, Third edition, Wiley.
3. Davis, B.E., (2001), GIS Visual Approach, Second Edition, Cengage Learning.

Reference Books:

1. Kang - Tsung Chang, (2002) Introduction to Geographic Information System, Mc Graw Hill, Boston.
2. Campbell, J., (1984) Introductory Cartography, Printers Hall Englewood Cliffs, N.J,

3. Dent B.D., (1985) Principles of Thematic Map Design, Addition - Wesley, Reading, Mass.
4. Freeman, H and Pieroni, G.G., (1980) Map Data Processing, Academic Press, New York.
5. Gurugnanam, B., (2009) Geographic Information System, New India Publishing Agency.

Web Resources:

1. https://www.saylor.org/site/textbooks/Essentials%20of%20Geographic%20Information%20Systems.pdf
2. https://webapps.itc.utwente.nl/librarywww/papers_2009/general/PrinciplesGIS.pdf
3. http://www.geografie.webzdarma.cz/GIS-skriptum.pdf
4. https://eos.com/blog/gis-mapping/
5. *https://support.esri.com/en-us/gis-dictionary*

Course Outcomes

On completion of the course, the students will be able to

CO1: Discuss the history, roles, functions and components of GIS, Geographic data and database

CO2: Explain the Raster and vector data and their advantages, disadvantages, Topology and conversion of Data from Raster to Vector and vice versa

CO3: Discuss the Data quality, Acquiring and Distribution of data and types of mapping, interactive mapping of GIS

CO4: Analyze the inventory operations, modify the theme, and perform a basic analysis.

CO5: Discuss the Advanced analysis, Terrain analysis, and the Future GIS

24GEUC4838 GEOGRAPHIC INFORMATION SYSTEM												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	L		M			M	S	L			S
CO2	S	M		M			L	S				S
CO3	S	M		M			M	S	L		M	S
CO4	S	M		M			L	S			M	S
CO5	S	M		M			L	S	L		M	S

Course Code &Title	**24GEUC4804 GEOGRAPHIC INFORMATION SYSTEM AND GPS- PRACTICAL**		
Class	B. Sc., Geology (Hons.)	Semester	VIII
Cognitive Level	K-1 K-2 K-3		

The Course aims

Course Objectives

- To learn to handle the fundamental tools of ArcGIS software
- To Gain detailed knowledge in map registration, GDB creation and Digitization
- To Compute the various Conversion and overlay techniques
- To-Do the Mosaicking, DEM generation and Classification processes.

Contents

1. Introduction to Arc GIS Features and Tools
    a. Map Registration a.Toposheet Registration b. Registration using GCPs
2. GDB Creation - Feature Data Creation
    a. Point generation and Add field b. Line feature generation and Add field c.Polygon feature generation and Add field
3. Digitization and working with Advanced Editing tools
    a. Cut polygon b. Shape editing c. Edit vertices
4. Geometric and field calculation
5. CSV to feature generation
    a. Conversion Exercise - a.Feature to line b. Feature to polygon c. kml to layer d. Layer to kml
6. Overlay analysis
    a. Union b. Split c. Merge d. Join
7. Map layout
8. Map Generalization
9. Importing Field Photo to ArcGIS
10. Query Analysis
11. Road Network Analysis
12. Subtitle - Group of features
13. Spatial Join
14. Mosaic
15. Model Builder
16. NDVI in GIS
17. NDWI in GIS
18. DEM in GIS
19. Image Classification
20. Line of Site Analysis
21. Pan Sharpening
22. Watershed Generation from SRTM & Contour.
23. Location capturing Using GPS,
24. Accuracy assessment in GPS

Course Outcomes

On completion of the course, the students will be able to

CO1: Able to handle ArcGIS tools
CO2: Compute processes like Map registration, GDB creation, Digitization and overlay analysis
CO3: Carry out Mosaicking, DEM generation, NDVI, NDWI
CO4: Generate Contour maps and classified images through image classification
CO5: Assess the location accuracy using GPS

24GEUC4839 GEOGRAPHIC INFORMATION SYSTEM AND GPS- PRACTICAL												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	S			S		L	S			M	S
CO2	S	S		M	S			S	M	M	M	S
CO3	S	S		M	S	L		S		M	M	S
CO4	M	M	L	S	S			S	M		M	S
CO5	S	S	L		S			S			M	S

24GEUC4805
Project

Course Code & Title	**VAC- II** **ENVIRONMENTAL STUDIES**
	Semester I
Cognitive Level	K-1 K-2 K-3
Course Objectives	The Course aims • To understand the basics of the Environment • To Describe the various types of Ecosystem • To Demonstrate the about the Biodiversity • To illustrate the various types of Pollution • To Summarize the Social issues and Environment

Unit	Content	
I	Multidisciplinary nature of environmental studies: Definition, scope and importance need for public awareness. Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems. a) Forest resources: b) Water resources: c) Mineral resources: d) Food resources: e) Energy resources. Ecosystems: Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem, d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) Biodiversity and its conservation: Introduction – Definition: genetic, species and ecosystem diversity. Bio geographical classification of India,	9
II	Environmental Pollution: Definition, Cause, effects and control measures of:- a. Air pollution, b. Water pollution, c. Soil pollution, d. Marine pollution, e. Noise pollution, f. Thermal pollution, g. Nuclear hazards. Disaster management: floods, earthquakes, cyclones and landslides. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in the enforcement of environmental legislation, and Public awareness. Human Population and the Environment: Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health. Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Case Studies. Field work: Visit a local area to document environmental assets, river/forest/grassland/hill/mountain. Visit a local polluted site: Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc.	9

Text Books:

1. Textbook for environmental studies, for undergraduate courses of all branches of higher studies, University Grants Commission, New Delhi and Bharathi Vidyapeeth Institute of Environment Education and Research, Pune

Reference Books:

1. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
2. Jadhav, H & Bhosale, V.M., (1995) Environmental Protection and Laws, Himalaya Pub. House, Delhi.
3. McKinneys, M.L. &School, R.M., (1996) Environmental Science Systems & Solutions, Web-enhanced edition.

Course Outcomes

On completion of the Course, the students should be able to

1. Explain about the Environment
2. Discuss the various types of ecosystem
3. Describe about the Biodiversity.
4. Evaluate the types of pollution
5. Discuss the Social issues and environment

ENVIRONMENTAL STUDIES

CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	L		M			M	S	L	L		M
CO2	S	M		M			L	S		L		M
CO3	S	M		M			M	S	L	M	M	M
CO4	S	M		M			L	S		M	M	M
CO5	S	M		M			L	S	L	M	M	M

Course Code & Title	**24GEUI1101** **APPLIED GEOLOGY ((Multi-Disciplinary)**
	Semester I
Cognitive Level	K-1 K-2 K-3
Course Objectives	The Course aims • To understand the basics of Geology • To Describe the various minerals • To Demonstrate the various rock types • To illustrate the various types of structures • To Summarize the application of Geology in Engineering Construction

Unit	Content	Lectures
I	**General Geology:** Branches of Geology – Earth Structures and Composition – Elementary Knowledge on Continental Drift and Plate Technologies. Earth Processes – Weathering – Geological Work of Rivers, Wind and Sea – Earthquake Belts in India. Groundwater – Mode of Occurrence – Prospecting.	9
II	**Mineralogy:** Elementary Knowledge on Symmetry Elements of Important Crystallographic Systems – Physical Properties of Minerals – Study of the Following Rock Forming Minerals – Quartz Group, Feldspar Group, Pyroxene Group, Amphibole Group and Mica Group. Fundamentals of Process of Formation of Ore Minerals – Identification of Minerals - Coal and Petroleum – Their Origin and Occurrence in India.	9
III	**Petrology:** Classification of Rocks – Distinction between Igneous, Sedimentary and Metamorphic Rocks. Description of Structures, Textures, Mode of Occurrence, Distribution, and Uses of the Following Rocks. Igneous Rocks – Granite, Syenite, Diorite, Gabbro, Pegmatite, and Basalt; Sedimentary Rocks - Sandstone, Limestone, Shale, Laterite, Conglomerate and Breccia; Metamorphic Rocks - Quartzite, Marble, Slate, Phyllite, Gneiss, Charnockite and Schist – Identification of Rocks.	9
IV	**Structural Geology**: Attitude of Beds – Outcrops – Introduction to Geological Maps – Study of Structures – Folds: Parts, classification of folds, Causes of folding. Faults: Parts, classification of fold, Causes of folding. Joints: Classification and Occurrence and origin of joints. **Geophysical Method:** Seismic and Electrical Methods for Geological Prospecting.	9
V	**Geological Investigations:** Geological Conditions necessary for Construction of Reservoirs and Dams, Tunnels, Buildings, Road Cuttings - Important building stones - Improvement of sites. Causes and Preventions of Land Slides –. Sea Erosion and Coastal Protection Structures.	9

Text Books:

1. Parbin Singh. “Engineering and General Geology”, S.K. Kataria & Sons, Katson Publishing House Ludhiana, 8th Edition, reprint 2011-12.
2. Venkat Reddy D. Engineering Geology, Vikas Publishers, 2010 ISBN-978-81259- 9032.

Reference Books:

1. Krynine and Judd. “Engineering Geology and Geotechniques”, CBS Publisher,2005.
2. Tyrrell “Principles of Petrology”, B.I. Publications, 1989.
3. Billings P Marland. “Structural Geology”, 3rd Edition, PHI Learning, 2008.
4. Varghese P. C “Engineering Geology for Civil Engineers”, PHI Learning Private Ltd, M-97, Connaught Circus, New Delhi -2012

Course Outcomes

Upon completion of the Course, the students should be able to

1. Explain about the internal structure of the Earth
2. Discuss the various minerals and their physical properties
3. Describe about the igneous, metamorphic and sedimentary rocks.
4. Evaluate the structural features of the Earth
5. Discuss the Geological investigations for the construction of dams and reservoirs.

24GEUI1101 APPLIED GEOLOGY ((Multi-Disciplinary)												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	M		M			M	S	L	L	L	M
CO2	S	M		M			L	S		L	L	M
CO3	S	M		M			M	S	L	M	M	M
CO4	S	M		M			L	S		M	M	M
CO5	S	M		M			L	S	L	M	M	M

Course Code & Title	**24GEUI2302** **DISASTER MANAGEMENT (Multi-Disciplinary)**
	Semester III
Cognitive Level	K-1 K-2 K-3
Course Objectives	The Course aims • To Explain the importance of Earth Science in natural disaster mapping • To Classify the various types of Natural Disasters • To Describe the Disaster Mitigation and Management

Unit	Content	Lectures
I	**Earth Sciences and Natural Disasters:** Origin of the earth, Interior of the Earth. Endogenic processes and exogenic processes of the Earth. Geological Time Scale. Definition of Disaster, Disaster, Nature and Socio-Economic Factors – Relations. Types of Disasters,	9
II	**Introduction to Natural Disasters I;** Earthquakes**:** Seismic waves, Origin, Classification and Causes of Earthquake, Earthquake Intensity Scale. Volcanoes: Structure, Classification and Products of Volcanoes. Tsunami Disaster,	9
III	**Introduction to Natural Disasters II;** Drought Disaster and its management, and climate change and its management. Other disasters and their management. Cyclone Disaster, Flood Hazard. Occurrence of Floods in India	9
IV	**Disaster Mitigation:** Mitigation strategies for earth quakes, landslides, floods, tsunami. cyclone, drought, climate change. Industrial environmental disaster: pollution. Gas leakage - chemical and fire accident. Human disaster: road and rail accidents, Biological Disasters**,**	9
V	**Disaster Management cycle:** Rescue -relief –rehabilitation. Short term and long-term rescue operations. Short term and long-term relief operations short term and long-term rehabilitation. Dams - water shed management.	9

Text Books:

1. Bangar, K.M., Principles of Engineering Geology, Nem Chand Jain Publishers, 2010.
2. Parbin Singh, A text book of Engineering and general Geology, publishers of engineering and computer books, 2009.
3. Mukerjee. P.K., A textbook of Geology, Thirteenth Edition. The world press pvt. Ltd, 1997.

Reference Books:

1. Grija Bhushan Mahapatra, A Text Book of Geology, CBS Publishers and Distributors, New Delhi, 1987.
2. Jonathan Turk and Graham R. Thompson, Environmental Geoscience, Saunders college division, 2000.
3. Pradyumna, P. Karan, Shanmugam, P. Subbiah., The Indian Ocean tsunami, Cambridge University press India Pvt. Ltd, 2012.
4. Santra S.C, Environmental Science, New central book agency, 2004.
5. Thomas D. Schneid, Disaster Management and Preparedness" Tata McGraw Hill, New Delhi, 2001.
6. Vinod K. Jain, Earth Science, CBS Publishers and Distributors, New Delhi, 2005.
7. Janet Edwards and Martin Gustafsson., Handbook for Vulnerability Mapping. Serdish Rescue Services Agency, 2007.

Course Outcomes

On completion of the course, the students will be able to

- *Understate the importance of Earth Science in Disaster studies*
- *Recognize the sources for the natural disasters*
- *Identify the mitigation measures for the natural disasters*
- *Apply Geological Knowledge in management of natural disasters*
- *Design the suitable precautionary methods.*

24GEUI2302 DISASTER MANAGEMENT (Multi-Disciplinary)												
CO/PO	PO							PSO				
	1	2	3	4	5	6	7	1	2	3	4	5
CO1	S	M		M			M	S	M	L	L	M
CO2	S	M		M			L	S		L	L	L
CO3	S	M		L			M	S	M	M	M	L
CO4	S	M		L			L	S		M	M	L
CO5	S	M		L			L	S	M	M	M	L