DEPARTMENT OF GEOLOGY

ANNA UNIVERSITY, CHENNAI

MISSION

Committed to provide quality education and research programmes that benefit the students, state and country and prepare them to understand and manage the Earth and its resources for the future.

VISION

- To lead in providing quality education and research programmes in Geology;
- To motivate our students to be productive and responsive scientists and engineers in the society

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M. Sc. APPLIED GEOLOGY (2 YEARS)

REGULATION – 2019

CHOICE BASED CREDIT SYSTEM

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO1 Imparting geological knowledge and skills to gain employment in Industry, Science and research organizations and service sectors.

PEO2 Produce quality manpower in geology that can elevate and lead the organization effectively

PEO3 Enable the students to understand and bring solutions to societal problems related to Geology.

PEO4 Motivate students to pursue higher studies and research in Geology

PEO5 Create an environment to auger entrepreneurial skills that will innovate and market geology related products.

2. PROGRAMME OUTCOMES (POs):

After going through the two years of study, our Post Graduates of Applied Geology will exhibitability to:

PO#	Graduate Attribute	Programme Outcome
PO1	Scientific knowledge	Applying the knowledge of Geology and its allied sciences to Geo-resource inventory and Natural Disaster management.
PO2	Problem analysis	Identify, formulate and solve Geological and technical problems.
PO3	Conceptualize/develop solutions	Conceive and develop solutions to societal problems related to geological processes and to understand their origin and nature.
PO4	Conduct investigations of complex problems	Conduct experiments &collect, analyze and interpret Geological data.
PO5	Modern tool usage	Apply various mapping tools and techniques, usage of geological, geophysical and geochemical equipment to improve the understanding of the earth system science.
PO6	The Geologists and society	Conduct themselves to uphold the professional and social obligations.
PO7	Environment and sustainability	Develop policies with environment consciousness that can provide sustainable development.
PO8	Ethics	Interact in industry, business and society in a professional and ethical manner.
PO9	Individual and team work	Function in a multidisciplinary team.

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PO10	Communication	Proficiency in oral and written Communication.
PO11	Project management and finance	Implement cost effective and improved geo-resource and geo hazard management system.
PO12	Life-long learning	Continue professional development and learning as a life-long activity.

3. PROGRAM SPECIFIC OUTCOMES (PSOs):

By the end of M. Sc. Applied Geology program the student will have following Program specific outcomes:

PSO1	Knowledge of Geological discipline	Demonstrate Understanding and in-depth knowledge of the geological processes, geological resources and geodynamics
PSO2	Critical analysis of Geological problems and innovation	Acquire skills to critically analyze complex Geological problems, apply independent judgment for synthesizing information and make innovative advances in a theoretical, practical and policy context
PSO3	Research methodologies and Research Ability	Ability to think, visualize and search in various domains to identify research gaps and hence to provide solution to new ideas and innovations.

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4. PEO / PO Mapping:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
I	✓	✓	✓	✓				✓				
II						✓		✓		✓	✓	
III			✓	✓	✓		✓	✓				
IV				✓	✓	✓				✓	✓	✓
V			✓			✓			✓	✓	✓	✓

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES:

			PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
YEAR 1	SEM 1	Geomorphology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Mineralogy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
		Stratigraphy and Palaeontology	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
		Structural Geology and Geotectonics	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Applied Mathematics for Gelogists	✓	✓	✓	✓	✓	✓				✓		✓
		Structural Geology lab and Geological Mapping Techniques	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		Mineralogy Lab	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓
		Survey Practicals	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
	SEM 2	Exploration Geophysics and Field Techniques	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓
		Geochemistry	✓	✓	✓	✓			✓	✓	✓	✓	✓	
		Igneous and Metamorphic Petrology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
		Program Elective I (one from list of electives)	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
		Program Elective II (one from list of electives)	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓
		Geochemistry Lab	✓		✓	✓		✓	✓	✓	✓	✓		✓
		Igneous, Metamorphic and Sedimentary Petrology Lab	✓		✓	✓	✓	✓	✓	✓		✓		✓
		Seminar	✓					✓	✓	✓	✓	✓		✓

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YEAR 2	SEM 3	Economic Geology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
		Engineering Geology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Hydrogeology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Geological Remote Sensing and GIS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
		Program Elective III (one from list of electives)	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
		Program Elective IV (one from list of electives)	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
		Hydrogeology Lab	✓	✓		✓	✓		✓	✓	✓	✓		
		Geological Field training/ Institutional/Internship training	✓	✓		✓	✓		✓	✓	✓	✓		✓
	SEM 4	Program Elective V (one from list of electives)	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
		Open Elective (one from list of courses)	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	
		Project	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ELECTIVES		Advanced Remote Sensing and GIS For Geological Applications	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
		Applied Hydro Geochemistry	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓
		Coal Geology	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓
		Earthquake Disaster and Mitigations	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
		Environmental Geochemistry	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓
		Environmental Geology	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
		Environmental Hydrogeology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
		Fuel Geology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		Geoprospecting	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
		Groundwater Contamination	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
		Industrial Geology	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
ELECTIVES		Marine Geology	✓	✓	✓		✓	✓	✓	✓	✓	✓		
		Medical Geology	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	
		Micropaleontology and Palynology	✓	✓		✓	✓	✓	✓	✓	✓	✓		
		Mineral Evaluation and Management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Mining Geology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Natural Hazards and Mitigations	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Nuclear Isotope Geology	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	
		Oil Exploration and Production	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

	Ore Geology and Mineral Technology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Petroleum Geology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Planetary Geology	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓
	Quaternary Geology	✓	✓		✓	✓	✓	✓	✓		✓		✓
	Sequence Stratigraphy	✓			✓	✓	✓	✓	✓	✓		✓	✓
	Soil Mechanics	✓	✓	✓	✓	✓		✓	✓	✓	✓		
OPEN ELECTIVES	Groundwater science	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Natural hazards and management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Ocean resources and exploration techniques	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	Planetary science and exploration	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓

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ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS

M. Sc. APPLIED GEOLOGY (2 YEARS)

REGULATION – 2019

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	AG5101	Geomorphology	PCC	3	0	0	3	3
2.	AG5102	Mineralogy	PCC	3	0	0	3	3
3.	AG5103	Stratigraphy and Palaeontology	PCC	3	0	2	5	4
4.	AG5104	Structural Geology and Geotectonics	PCC	3	0	0	3	3
5.		Program Elective I	PEC	3	0	0	3	3
6.		Audit Course – I*	AC	2	0	0	2	0
PRACTICAL								
7.	AG5111	Structural Geology Lab and Geological Mapping Techniques	PCC	0	0	4	4	2
8.	AG5112	Mineralogy Lab	PCC	0	0	2	2	1
9.	AG5113	Plane and Geodetic Surveying Laboratory	PCC	0	0	4	4	2
			TOTAL	**17**	**0**	**12**	**29**	**21**

***Audit Course is Optional**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	AG5201	Exploration Geophysics and Field Techniques	PCC	3	0	2	5	4
2.	AG5202	Geochemistry	PCC	3	0	0	3	3
3.	AG5203	Igneous and Metamorphic Petrology	PCC	3	0	0	3	3
4.	AG5204	Sedimentology and Sedimentary Petrology	PCC	3	0	0	3	3
5.		Program Elective II	PEC	3	0	0	3	3
6.		Program Elective III	PEC	3	0	0	3	3
7.		Audit Course –II	AC	2	0	0	2	0
PRACTICAL								
8.	AG5211	Geochemistry Lab	PCC	0	0	4	4	2
9.	AG5212	Igneous, Metamorphic and Sedimentary Petrology Lab	PCC	0	0	4	4	2
10.	AG5213	Seminar	EEC	0	0	2	2	1
			TOTAL	**20**	**0**	**12**	**32**	**24**

***Audit Course is Optional**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	AG5301	Economic Geology	PCC	3	0	0	3	3
2.	AG5302	Engineering Geology	PCC	3	0	0	3	3
3.	AG5303	Hydrogeology	PCC	3	0	0	3	3
4.	AG5304	Geological Remote Sensing and GIS	PCC	3	0	2	5	4
5.		Program Elective IV	PEC	3	0	0	3	3
6.		Program Elective V	PEC	3	0	0	3	3
PRACTICAL								
7.	AG5311	Hydrogeology Lab	PCC	0	0	4	4	2
8.	AG5312	Geological Field Training/ Institutional/Internship Training	EEC	0	0	2	2	1
			TOTAL	**18**	**0**	**8**	**26**	**22**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective VI	PEC	3	0	0	3	3
2.		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
3.	AG5411	Dissertation	EEC	0	0	24	24	12
			TOTAL	**6**	**0**	**24**	**30**	**18**

Total of Credits: 85

PROGRAM CORE COURSES (PCC)

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			Credits	Semester
			Lecture	Tutorial	Practical		
1.	AG5101	Geomorphology	3	0	0	3	I
2.	AG5102	Mineralogy	3	0	0	3	I
3.	AG5103	Stratigraphy and Applied Palaeontology	3	0	2	4	I
4.	AG5104	Structural Geology and Geotectonics	3	0	0	3	I

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5.	AG5111	Structural Geology Lab and Geological Mapping Techniques	0	0	4	2	I
6.	AG5112	Mineralogy Lab	0	0	2	1	I
7.	AG5113	Plane and Geodetic Surveying Laboratory	0	0	4	2	I
8.	AG5201	Exploration Geophysics and Field Techniques	3	0	2	4	II
9.	AG5202	Geochemistry	3	0	0	3	II
10.	AG5203	Igneous and Metamorphic Petrology	3	0	0	3	II
11.	AG5204	Sedimentology and Sedimentary Petrology	3	0	0	3	II
12.	AG5211	Geochemistry Lab	0	0	4	2	II
13.	AG5212	Igneous, Metamorphic and Sedimentary Petrology Lab	0	0	4	2	II
14.	AG5301	Economic Geology	3	0	0	3	III
15.	AG5302	Engineering Geology	3	0	0	3	III
16.	AG5303	Hydrogeology	3	0	0	3	III
17.	AG5304	Geological Remote Sensing and GIS	3	0	2	4	III
18.	AG5311	Hydrogeology Lab	0	0	4	2	III
					TOTAL CREDITS	**50**	

PROFESSIONAL ELECTIVE COURSES (PEC)

Sl.No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	AG5001	Advanced Remote Sensing and GIS For Geological Applications	3	0	0	3
2.	AG5002	Applied Mathematics For Geologists	3	0	0	3
3.	AG5003	Applied Hydro Geochemistry	3	0	0	3
4.	AG5004	Coal Geology	3	0	0	3
5.	AG5005	Earthquake Disaster and Mitigations	3	0	0	3
6.	AG5006	Environmental Geochemistry	3	0	0	3
7.	AG5007	Environmental Geology	3	0	0	3
8.	AG5008	Environmental Hydrogeology	3	0	0	3
9.	AG5009	Fuel Geology	3	0	0	3
10.	AG5010	Geoprospecting	3	0	0	3

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11.	AG5011	Geosciences in Natural Hazards Management	3	0	0	3
12.	AG5012	Groundwater Contamination	3	0	0	3
13.	AG5013	Industrial Geology	3	0	0	3
14.	AG5014	Marine Geology	3	0	0	3
15.	AG5015	Medical Geology	3	0	0	3
16.	AG5016	Micropaleontology and Palynology	3	0	0	3
17.	AG5017	Mineral Evaluation and Management	3	0	0	3
18.	AG5018	Mining Geology	3	0	0	3
19.	AG5019	Nuclear Isotope Geology	3	0	0	3
20.	AG5020	Oil Exploration and Production	3	0	0	3
21.	AG5021	Ore Geology and Mineral Technology	3	0	0	3
22.	AG5022	Petroleum Geology	3	0	0	3
23.	AG5023	Planetary Geology	3	0	0	3
24.	AG5024	Quaternary Geology	3	0	0	3
25.	AG5025	Sequence Stratigraphy	3	0	0	3
26.	AG5026	Soil Mechanics	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl.No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AG5213	Seminar	0	0	2	1	II
2.	AG5312	Geological Field Training/ Institutional/Internship Training	0	0	2	1	III
3.	AG5411	Dissertation	0	0	24	12	IV
					Total Credits	**14**	

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OPEN ELECTIVE COURSES (OEC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MP5491	Nuclear Energy in Health Care and Industry	OEC	3	0	0	3	3
2.	MP5492	Smart Materials for Energy and Environment Applications	OEC	3	0	0	3	3
3.	EA5491	Climate Journalism	OEC	3	0	0	3	3
4.	EA5492	Digital Photography	OEC	3	0	0	3	3
5.	AC5491	Green Chemistry	OEC	3	0	0	3	3
6.	AC5492	Food Chemistry	OEC	3	0	0	3	3
7.	AG5491	Natural Hazards and Management	OEC	3	0	0	3	3
8.	AG5492	Ocean Resources and Exploration Techniques	OEC	3	0	0	3	3
9.	MC5491	Basic Crystallography and Crystal Growth	OEC	3	0	0	3	3
10.	MC5492	Nonlinear Science	OEC	3	0	0	3	3
11.	MT5491	Statistical Methods	OEC	3	0	0	3	3
12.	HS5491	Professional Email Communication	OEC	3	0	0	3	3
13.	HS5492	Project Report Writing	OEC	3	0	0	3	3
14.	HS5493	Basic Presentation Skills	OEC	3	0	0	3	3

AUDIT COURSES (AC)
Registration for any of these courses is optional to students

SL.NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AX5091	English for Research Paper Writing	2	0	0	0	1/2
2.	AX5092	Disaster Management	2	0	0	0	
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0	
4.	AX5094	Value Education	2	0	0	0	
5.	AX5095	Constitution of India	2	0	0	0	
6.	AX5096	Pedagogy Studies	2	0	0	0	
7.	AX5097	Stress Management by Yoga	2	0	0	0	
8.	AX5098	Personality Development through Life Enlightenment Skills.	2	0	0	0	
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0	
					Total Credits:	0	

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SUMMARY

M. Sc. APPLIED GEOLOGY (2 YEARS)						
	Subject Area	Credit per semesters				Credits Total
		I	**II**	**III**	**IV**	
1	PCC	18	17	15	0	**50**
2	PEC	3	6	6	3	**18**
3	OEC	0	0	0	3	**3**
4	EEC	0	1	1	12	**14**
	Non Credit / Audit courses	✓	✓			
	Total	**21**	**24**	**22**	**18**	**85**

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AG5101 **GEOMORPHOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To impart knowledge on the origin, types and characteristics of landforms and processes.
- Give better understanding on the applications of geomorphology in geological and engineering fields,
- Providing adequate knowledge on groundwater and natural hazards Management.

UNIT I INTRODUCTION TO GEOMORPHOLOGY 7

Basic concepts, endogenous and exogenous processes, Davisian/Geomorphic cycle, Planation surfaces, Processes of weathering, Weathering Indices and their significance.

UNIT II FLUVIAL AND COASTAL PROCESSES AND LAND FORMS 12

Classification of rivers and river valleys; Drainage basin - drainage morphometric parameters, work of river, river capture. Classification of coasts, coastal processes and landforms, coastal geomorphology of India, Coral reefs – types and significance.

UNIT III AEOLIAN AND GLACIAL PROCESSES AND LANDFORMS 9

Origin of deserts; causes of aridity and desertification; types and ages of deserts, Aeolian landforms. Process of glaciation, classification of glaciers; Glacial landforms; glacial erosion and deposition processes. Glaciation in the Himalayas.

UNIT IV APPLIED GEOMORPHOLOGY 9

Geomorphology in resources exploration; Hydro-geomorphology : Role of geomorphic processes and land forms in localization of ores and minerals - Coastal, alluvial and eluvial placers - Residual deposits; Engineering geomorphology – concept and applications.
Geomorphology in natural hazard management – floods, landslides, coastal erosion, tsunami and other natural disaster.

UNIT V PLANETARY GEOMORPHOLOGY 8

Need for the study. Comparison of terrestrial and planetary landforms. Description and origin of Lunar, Martian and other planetary landforms and processes, methods of mapping planetary landforms.

TOTAL: 45 PERIODS

OUTCOMES

On completion of this course, the students expected to be able to:

- Understand the endogenetic and exogenetic processes of the Earth.
- Have better understanding of geological actions of wind, river,sea and glaciers and their related landforms .
- Appreciate and comprehend the advanced concepts of geomorphology and its applications in Geology and engineering.
- Gain knowledge on role of geomorphology in geological hazards and its mitigation
- Understand the planetary geomorphology

REFERENCES

1. W.D. Thornbury (2004) Principles of Geomorphology (Second Edition). CBS publishers, New Delhi.
2. Pelletier J D. Quantitative Modelling of Earth Surface Processes, Cambridge University Press, Cambridge, 2008.
3. Schumm S A. River Variability and Complexity, Cambridge University Press, Cambridge, 2007.
4. Holmes A. Principles of physical geology, Thomas Nelson and Sons, USA, 1964.
5. Goudie A.S. Geomorphology, Springer, UK, 1998.

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CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√	√	√	√	√	√	√	√	√	√	√	
CO3	√	√	√	√	√	√	√	√		√	√	
CO4	√	√	√	√	√		√	√	√	√	√	
CO5	√	√	√	√	√	√		√	√	√	√	√

AG5102 **MINERALOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To impart fundamentals of crystals and crystallization processes.
- Teach students on formation of minerals and their physical and chemical characteristics
- Enabling them to understand the potentiality of economic resources for exploration.

UNIT I CRYSTALLOGRAPHY **9**

Classification of crystals-systems and classes of symmetry- International system of crystallographic notation- Use of projection diagrams to represent crystal symmetry-Unit Cells, Motifs and Lattices-Bravais Lattices-Miller indices-Point groups and space groups.

UNIT II ELEMENTS AND MINERALS **9**

Stoichiometry, atomic substitution-polymorphism, isomorphism and solid solution series – exsolution-Chemical bonding types and mineral properties-chemical classification of minerals-Rules governing atomic close-packing in crystalline solids and co-ordination number. Pauling's rules and coordination polyhedral-Crystal imperfections-defects, twinning and zoning Positioning of trace elements in minerals

UNIT III DESCRIPTIVE MINERALOGY **9**

Physical, chemical and crystallographic characteristics of common rock forming silicate mineral groups. Structural classification of silicates. Common minerals of igneous and metamorphic rocks. Minerals of the carbonate, phosphate, sulphide, halide and spinel groups. Clay minerals.

UNIT IV OPTICAL MINERALOGY **9**

Polarizing microscope and accessory plate-Optical properties of common rock forming silicate minerals, uniaxial and biaxial minerals. Extinction angles, pleochroism, birefringence of minerals and their relation with mineral composition. Twinned crystals. Dispersion. U-stage and its applications.

UNIT V X-RAY CRYSTALLOGRAPHY **9**

Principle of X-ray powder diffraction, Measurement of X-ray powder diffraction patterns, Powder diffractometers, Goniometer design in powder diffractometry, Monochromatic radiation, Bragg-Brentano geometry, Debye-Scherrer geometry.

Attested

TOTAL: 45 PERIODS

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OUTCOMES:
On completion of this course, the students expected to be able to:

- Understand the crystallography and crystal symmetry
- In-depth knowledge on the elementary properties of minerals.
- Better understanding on the physical and chemical properties of various rock forming minerals and their identification.
- Gain knowledge on identification of minerals through their optical properties.
- Understand various x-ray techniques for and their applications in mineralogy.

REFERENCES

1. Ford, W.E., Dana's Text book of mineralogy (Fourth Edition), Wiley Eastern Limited., New Delhi, 1989.
2. Putnis, A Introduction to mineral sciences, Cambridge University Press, New Delhi, 1992.
3. Deer, Howie and Zusmann, Introduction to Rock forming minerals, IBH Publishers, New Delhi, 1998.
4. Rogers and Kerr Optical Mineralogy, McGraw Hill Book Company, New Delhi, 1986.
5. Winchel and Winchel, Elements of Optical Mineralogy, John Wiley & Sons, INC. USA., 1989.
6. Dexter Perkins, Mineralogy, Prentice Hall, USA, 2002
7. Hans Rudolf Wenk and Andrei Bulakh, Minerals their constitution and origin, Cambridge University Press, UK, 2004

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√	√	√	√	√	√	√	√	√	√		√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√		√	√	√	√		√	√	√
CO5	√	√	√	√	√	√	√	√	√	√	√	√

AG5103 STRATIGRAPHY AND PALAEONTOLOGY L T P C
3 0 2 4

OBJECTIVES:

- To understand the geological setting of Indian continent to its mineral deposits
- To understand the geological past events and paleoclimate.
- To understand the evolution of life and Paleoenvironment

UNIT I PRINCIPLES OFSTRATIGRAPHY 9+6

Introduction and scope of stratigraphy, Principles of stratigraphy; code of nomenclature of India, litho, bio Chrono and magnetostratigraphic units, principles of stratigraphic correlation, Walther's law. Geological time scale. Geological, physical and biological events through geological time.

Practical component: Geological events, evolution of life and mass extinctions in Indian stratigraphic scale, Order of superposition studies. Description of a litho profile.

UNIT II PRECAMBRIAN STRATIGRAPHYOF INDIA 9+6

Archean Granite-Greenstone belts, evolution of Archean cratons of India, Proterozoic mobile belts-Eastern Ghats Mobile belt, Southern Granulite terrain, Central Indian Tectonic zone, Aravalli-Delhi belt, North Singhbhum Mobile belt. Mineral deposits of Precambrian rocks.

Practical component: Locating the Archean cratons, mobile belts, CTZ, Precambrian terrain on India map. Spotting the Precambrian mineralized zones on the map

UNIT III PHANEROZOIC STRATIGRAPHY OF INDIA 9+6

Paleozoic; Spiti, Kashmir and Kumaon. Mesozoic; Spiti, Kutch, Narmada valley and Trichinopoly. Gondwana Super group. Cenozoic; Assam, Bengal basin, Garhwal-Shimla Himalayas. Siwaliks; Stratigraphic boundary problems in Indian stratigraphy.

Practical component: Demarcation of stratigraphic boundary based on fossil assemblages.

UNIT IV INVERTEBRATE AND VERTEBRATE PALEONTOLOGY 9+6

Fossil record through geological time scale. Mode of preservation of fossils and concepts of taphonomy. Body and ichnofossils, species concept, organic evolution. Ediacara fauna; morphology and time range of Graptolites, Trilobites, Brachiopods, and Molluscans. Vertebrate life through ages. Evolution in Proscidea, Equidae and Hominidae. Mass extinctions.

Practical component: Description and Identification of invertebrates. Age assessment, Index fossil and stratigraphic boundary, Paleogeography of Gondwana continents with fossil proxy. Tethyan fossils. Identification of Siwalik Vertebrates and paleoenvironment.

UNIT V MICROPALEONTOLOGY AND PALYNOLOGY 9+6

Organic and mineral walled microfossils. Methods of separation of microfossilsfrom sedimentary matrix. Morphology of Foraminifera, Ostracod.Fossil spores, pollens and dinoflagellates. Gondwana plant fossils and their significance. Applications of paleontological data in stratigraphy, paleoecology and paleoclimatology.

Practical component: Foraminifera and palynofossil separation technique, Methods of Ident cation of microfossils; foraminifera and ostracod. M-T-R Trilinear diagram analysis for identification of environment of deposition. Biozones analysis- Bio facies diagrams, biostratigraphy problems. Factor and cluster analysis and interpretation of ecology of recent foraminifera. Deformed foraminifer's shells and its relation to pollution.

TOTAL: 75 PERIODS

OUTCOMES:

On completion of this course, expected outcomes are:

- A comprehensive knowledge of mineral wealth of India; a guide for exploration and exploitation of mineral deposits.
- Education to "past is key to the present" concept for correlation and enhancement the mineral and fossil fuel mineral exploration
- Indexing the fossil system for paleoenvironment, paleotemperature, paleoecology, paleobathymetry in taking the stock of past sea level changes and global warming.
- Bio-indicator clue in pollution and bio-mineralization.
- A guide to the environment analysis by microfossil assemblages.

REFERENCES

1. Ramakrishnan, M and Vaidhyanathan Indian Geology Geological Society of India, Publication, Bangalore, 2007
2. Krishnan, M.S., Geology of India and Burma III Ed. IBH Publishers, New Delhi, 1984
3. Wadia
4. Ravindra Kumar, Fundamentals of historical Geology and stratigraphy of India, Wiley Eastern Ltd. New Delhi, 1985
5. Shorock and Twenhofel Principles of Invertebrate Paleontology, IBH New Delhi, 1983
6. Moore, Lalikar and Fisher
7. Pratul Sarwati and Srinivasan, M.S, Micropaleontology-Principles and applications. Springer International Switzerland, 2016

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CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√	√	√	√	√	√	√	√	√	√	√	
CO3	√	√	√	√	√		√	√	√	√	√	√
CO4	√	√	√	√	√	√	√	√		√		√
CO5	√	√	√	√		√	√	√	√	√	√	√

AG5104 STRUCTURAL GEOLOGY AND GEOTECTONICS L T P C
3 0 0 3

OBJECTIVES:

- To teach fundamentals of rock deformation and geotectonics.
- To provide description on various geological structures and their field identification
- To impart knowledge their significance in geological setup and exploration of geological resources.

UNIT I INTRODUCTION 9

Concept, approach and scope of structural geology-primary and secondary structures-Principles of geological mapping and map reading-V-rules and outcrop patterns-projection diagrams. Stress, Strain and rheological properties of rocks-Behaviour of minerals, sediments and rocks under deformation conditions.

UNIT II DEFORMATION MECHANISMS & MICROSTRUCTURES 9

planar and linear structures- cleavage, foliation, lineation and unconformities-Structural behaviour of igneous intrusions-Introduction to petro fabrics, Kinematic analysis and Dynamic analysis - deformation at microscaledynamic and static recrystallization-controls of strain rate and temperature on development of microfabrics.

UNIT III JOINTS AND FAULTS 9

Joints and shear fractures - brittle and ductile shear zones - Mohr's circle and criteria for failure of rocks- Fault in rocks-recognition in field -classification of faults and fault surfaces on the basis of slip sense and surface effects- Dynamic analysis of faults- measurement of strain in deformed rocks- time relationship between crystallisation and deformation - Normal faults, strike-slip faults and thrust faults terminology-role of fluid pressure- calculation of paleostress.

UNIT IV FOLDS 9

Elements of fold geometry-classificationof folds. Folding mechanisms- Regional fold styles-structural analysis of folds -Study of Superimposed folding-Type 1, 2 and 3 interference pattern. S and Z patterns-Stereoplot for different interference pattern-Distnction between F1 and F2 folds.

UNIT V GEOTECTONICS 9

Heterogeneity of the earth's crust-Major tectonic features of the Oceanic and Continental crust-Continental drift-Seafloor spreading and Plate Tectonics-Rock magnetism and its origin;-polarity reversals-polar wandering-Island arcs, Oceanic islands and volcanic arcs-Isostasy-orogeny and epi-orogeny-Seismic belts of the earth-Seismicity and plate movements-Geodynamics of the Indian plate.

TOTAL: 45 PERIODS

OUTCOMES:
On completion of this course, the students expected to be able to:

- Identify primary and secondary structures
- Have knowledge on behaviour of minerals and rocks during stress
- Acquire skills on field recognition of faults, folds and their types
- Understanding of plate tectonics and its role in geological processes such as seismicity and volcanism.
- Have knowledge on geological and structural mapping and its application in geo resource exploration.

REFERENCES

1. George H. Davis, Stephen J. Reynolds and Charles F. Kluth, Structural Geology of Rocks and Regions. John Wiley and Sons, Inc., 2012
2. Donal M. Ragan, Structural Geology: An introduction to Geometrical Techniques, Fourth Edition, 2009.
3. Robert J. Twiss and Eldridge M. Moores, Structural Geology, W. H. Freeman and Company, New York, 2007.
4. Billings, M.P. Structural Geology, Third Edition, Pearson Education Limited, 2016.
5. R. G. Park, Foundations of Structural Geology, Third Edition, Reprinted by Routlege, Abingdon, 2005.
6. Kearly, Klepies and Vine, Global Tectonics, Third Edition, Wiley, India, 2009.
7. Ramsay, J.G. & Huber, M.I. The Techniques of modern structural geology. V.1. Strain Analysis, 1983.
8. Ramsay, J.G. & Huber, M.I. The Techniques of modern structural geology. V.2. Folds and Fractures, 1987.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√	√	√		√	√	√	√	√	√	√	
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√	√	√	√	√	√	√	√	√
CO5	√	√	√	√	√	√	√	√	√	√	√	√

AG5111 STRUCTURAL GEOLOGY LAB AND GEOLOGICAL MAPPING TECHNIQUES **L T P C 0 0 4 2**

OBJECTIVES:

- To teach field measurements of attitude of rocks
- To impart geological mapping techniques.
- Provide skills to determine bed thickness and depth

UNIT I STRIKE, DIP AND THICKNESS PROBLEMS **12**

Studies of contours and different land forms – Strike, true dip and apparent dip problems - Measurement of thickness and width of the outcrops.

UNIT II STRUCTURAL MAPS AND STEREOGRAPHIC PROJECTIONS **12**

Completion of outcrops in geological maps - Three point problems - Drawing of profiles and studies of geological maps - Determination of true and apparent dip, plunge and pitch of linear structures. Computer aids to analysis of structural data.

UNIT III GEOLOGICAL MAPPING TECHNIQUES 12

Map-toposheet-study of topographic features-map scale-mapping instruments – Clinometer, brunton compass, odometer, altimeter, GPS, Map measurer, and Geologist's kit.-Procedures for geological mapping at Igneous, Sedimentary and Metamorphic terrains- Outcrop study and method of traverses-

UNIT IV LITHOLOG AND GEOLOGICAL MAP 12

lithological descriptions and litho-logging-Structural mapping, joints pattern measurements, faults identification, fold analysis and sample collection-Preparation of geological map.

UNIT V GEOLOGICAL FIELD WORK 12

Preparation of field area base map-Contour and drainage map-traversing methods-Methods of rock samples and fossil collection-Field work dairy writing-Field kits-Preparation of lithological cross sections, colour and symbol used in geological mapping-Visit to igneous, metamorphic and sedimentary fields.

TOTAL: 60 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Measure attitude of rocks
- Prepare geological profile
- Prepare structural map and analyze data using computing methods
- Prepare lithology and carryout geological mapping.
- Carryout geological field work individually and as a team

REFERENCES

1. Lahee, F.H., Field Geology, CBS publishers, N. Delhi, 2002.
2. John W. Barnes, Richard J. Lisle, Basic Geological Mapping, John Wiley & Sons Ltd, UK, 2004.
3. N. W. Gokhale, a Manual of Geological Maps, Reprinted by CBS Publishers & Distributiors Pvt. Ltd, India, 2008.
4. N. W. Gokhale, a Manual of Problems in Structural Geology, Reprinted by CBS Publishers & Distributiors Pvt. Ltd, India, 2009.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√		√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√		√	√	√	√	√			√	√	√

AG5112 MINERALOGY LAB L T P C
0 0 2 1

OBJECTIVES:

- To give hands-on exercise on identification of crystals and minerals
- To impart practical training on optical mineralogical techniques
- To provide skills in economic minerals identification

UNIT I CRYSTALLOGRAPHY AND MEGASCOPY 10

Stereographic projections – axial ratios – Napier's theorem and problems –Megascopic studies-Habit – cleavage – hardness – specific gravity – colour – luster – streak – fusibility – fluorescence – magnetic property.

UNIT II OPTICALPROPERTIES OF MINERALS 10

Systematic microscopic study of common rock forming minerals – RI – Birefringence – extinction angles – optic sign etc.

UNIT III MINERAL CALCULATION AND 4- AXES UNIVERSAL STAGE 10

Calculation of structural formula for important rock forming mineral groups. Determination of anorthite content and twin law in plagioclase feldspars.

TOTAL: 30 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Identify and name various minerals
- Have knowledge on their physical and chemical properties
- Acquire skills on recognition of minerals using their optical properties
- Understanding on various techniques to recognize rock forming minerals.
- Have knowledge on mineralogy and its practical applications for geology

REFERENCES

1. John W. Barnes, Richard J. Lisle, Basic Geological Mapping, John Wiley & Sons Ltd, UK, 2004.
2. N. W. Gokhale, a Manual of Problems in Structural Geology, Reprinted by CBS Publishers & Distributiors Pvt. Ltd, India, 2009.
3. N. W. Gokhale, a Manual of Geological Maps, Reprinted by CBS Publishers & Distributiors Pvt. Ltd, India, 2008.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	
CO3	√	√	√	√	√	√	√	√	√		√	√
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√	√	√	√	√	√	√	√	√	√	√	√

AG5113 PLANE AND GEODETIC SURVEYING LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To familiarize students with the various surveying instruments.
- To impart practical skills on various surveying techniques.
- Provide skills to do individual and group surveys for geological explorations

EXCERCISES:

1. Chain traversing 8
2. Compass traversing 8
3. Plane table surveying – Method of intersection 4
4. Plane table surveying – Three point problem(any one method) 4

5. Plane table surveying – Two point problem 4
6. Plane table traversing 4
7. Fly levelling using dumpy/tilting level 4
8. Check levelling using dumpy/tilting level 4
9. Measurement of horizontal and vertical angles using theodolite. 8
10. Determination of tacheometric constants using horizontal and inclined line of sight. 4
11. To determine the elevation of an object using single plane method when base is accessible and inaccessible 4
12. GPS and Total Station – demonstration only. 4

TOTAL: 60 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Use various surveying instruments individually
- Have knowledge on different survey method with its merits and demerits
- Do individual field surveys
- Understand applications of Survey in geological explorations.
- Have up-to-date knowledge on advanced surveying instruments and methods

REFERENCES:

1. T.P.Kanetkar and S.V.Kulkarni, Surveying and Levelling, Parts1 & 2, Pune Vidyarthi Griha Prakashan, Pune, 2008
2. Dr.B.C.Punmia, Ashok K.Jain and Arun K Jain, Surveying Vol.I & II, Lakshmi Publications Pvt Ltd, NewDelhi, 2005
3. James M. Anderson and Edward M. Mikhail, Surveying, Theory and Practice, Seventh Edition, Mc Graw Hill 2001
4. Bannister and S. Raymond, Surveying, Seventh Edition, Longman 2004
5. David Clark, Plane and Geodetic Surveying for Engineers, Volume I, Constable and Company Ltd, London, 1952
6. David Clark and James Clendinnind, Plane and Geodetic Surveying for Engineers, Volume II, Constable and Company Ltd, London, 1958
7. S.K. Roy, Fundamentals of Surveying, Second Edition, Prentice‘ Hall of India 2004
8. K.R. Arora, Surveying Vol I & II, Standard Book house, Tenth Edition

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√	√	√	√	√	√	√	√	√
CO5	√		√	√	√	√	√	√	√	√	√	

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AG5201 EXPLORATION GEOPHYSICS AND FIELD TECHNIQUES L T P C
3 0 2 4

OBJECTIVES:

- To study the physical properties of earth and application of physics in geology,
- To understand subsurface features and structures for better understanding of subsurface geology.
- To Familiarize the students on geophysical techniques and their field setup, data processing and interpretation.

UNIT I INTRODUCTION & ELECTRICAL METHODS 9+6

Scope of exploration geophysics – physical properties of the earth – Electrical methods – SP, IP, and resistivity methods - methods of electrode arrangement – field methods – interpretation – application electromagnetic methods – case studies

FIELD TECHNIQUES:- Resistivity surveys – Wenner and Schlumberger methods – electrical sounding and profiling –- problems on these methods

UNIT II GRAVITY METHODS 9+6

Principle – field methods – gravimeters –calibration - corrections – interpretation of gravity data – determination of shape and depth of ore bodies –– corrections & applications – GRACE mission – case studies

FIELD TECHNIQUES:- Field investigation on resistivity – sounding and profiling – SP methods - Interpretation of data – standard computer packages in interpretation – Problems on gravity methods

UNIT III MAGNETIC METHODS 9+6

Magnetic methods – principle - field procedure – magnetometers – interpretation of magnetic data – size and shape of bodies – correction of magnetic data - applications - airborne geophysical surveys – case studies

FIELD TECHNIQUES:- Problems on magnetic methods – preparation of anomaly maps – methods of corrections

UNIT IV SEISMIC METHODS 9+6

Seismic waves – travel velocity in various geological formations – principles – field operation – refraction and reflection survey – correction of seismic data – methods of interpretation – determination of attitude and depth of formations – various types of shooting – case studies

FIELD TECHNIQUES:- Problems on refraction and reflection methods – 3 layer and inclined beds – calculation based on intercept time and cross over distance

UNIT V RADIOACTIVITY METHODS AND WELL LOGGING 9+6

Fundamentals of radioactivity – principle of radioactivity methods –instruments – field methods and interpretation – Well logging - Self potential – resistivity – radioactivity logging methods – caliper and other miscellaneous logging methods – field procedure and interpretation of data – case studies

FIELD TECHNIQUES:- Radioactive methods - problems on well logging – interpretation of data

TOTAL: 75 PERIODS

OUTCOMES:

On completion of this course, the students are expected to be able to:

- Have better understanding on the physical properties of earth and its layers
- Understand the geophysical anomalies and their significance in subsurface exploration
- Acquire skills on various geophysical methods and their field surveys
- Collect data using various geophysical techniques and do analysis
- Interpretation of data for exploration for minerals, oil and groundwater

Attested

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REFERENCES:

1. Burger, H.R., Exploration Geophysics of the Shallow Subsurface, Prentice Hall, 1992.
2. Dobrin, M.B An introduction to geophysical prospecting, McGraw Hill, New Delhi,1984
3. Mamdouh R. Gadallah Ray Fisher. Exploration Geophysics , Springer 2009
4. John M. Reynolds , An Introduction to Applied and Environmental Geophysics Reynolds Geo-Sciences Ltd, UK, 1997
5. Ramachandra Rao, M.B. Outline of geophysical prospecting. Wesley press, Mysore, 1975
6. Rama Rao, B.S and Murthy I.B.R Gravity and magnetic methods of prospecting. Arnold Heinmann Pub. New Delhi, 1978.
7. Robinson, Edwin S., Cahit Coruh, Basic exploration geophysics. New York : Wiley, 1988.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√		√	√	√	√	√			√		

AG5202 GEOCHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

- To study the chemical properties of earth, minerals and application of chemistry in geology.
- To understand chemistry of magma and evolution of various rock types through geochemical differentiation.
- Also to understand various surface guides for exploration of economical ores and minerals.

UNIT I PRINCIPLES OF GEOCHEMISTRY 9

Introduction – Periodic table - distribution of elements in rocks and soils. Chemical composition and characteristics of atmosphere – lithosphere - hydrosphere; geochemical cycles. meteorites-types and composition.

UNIT II GEOCHEMISTRY OF MINERALS, ROCKS AND WATERS 9

Mineral stability, compositional changes in minerals. River water, Seawater, Seafloor hydrothermal systems; Groundwater and Lakes. Characteristics of Magma, Melting of rocks, Water in Magmas, eutectic and melting. Distribution of trace components between rocks and melts. Goldschmidt's classification of elements; fractionation of elements in minerals/rocks;

UNIT III ISIOTOPE GEOCHEMSIRTY 9

Radioactive Decay, Determining Isotope Decay time, Potassium-Argon Systematics, Uranium-Thorium-Lead Systematics. Types of Isotope- Fractionation, isotope Exchange between minerals and water, Carbon, Oxygen and Sulphur isotopes, First-order decay and growth equations.

UNIT IV EXPLORATION GEOCHEMISTRY 9

Introduction – Primary dispersion pattern, Secondary dispersion pattern – background values. Geochemical anomaly – geochemical sampling-Principles and techniques used in the design and implementation of an exploration geochemical survey-Nernst's partition coefficient (compatible and incompatible elements)-Nernst-Berthelot partition coefficient and bulk partition coefficient-Fick's laws of diffusion and activity composition relation (Roult's and Henry's law).

UNIT V ENVIRONMENTAL GEOCHEMISTRY 9

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.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students are expected to:

- Familiarized withchemical properties of earth and its layers
- Understand the geochemical characteristics of minerals and rocks
- Have knowledge onisotopic methods and age determination
- Collect geochemical data for exploration of earth resources
- Analyze and Interpret geochemical data for exploration for minerals, oil and groundwater.

REFERENCES:

1. 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.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√	√	√	√	√	√	√	√	√	√		

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AG5203 **IGNEOUS AND METAMORPHIC PETROLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To familiarize the students on the igneous processes
- To provide knowledge on physical and chemical characteristics of magma, and various rock types.
- Provide information on occurrence and geological setting of igneous rocks and metamorphic rocks.

UNIT I MAGMA GENERATION AND IGNEOUS ROCKS 9

Textures and structures of igneous rocks. General classification of Igneous rocks. Interior of the earth and formation of magmas. Ascent and emplacement of magmas. Magmatic differentiation. Crystallization of magma.

UNIT II PHASE EQUILIBRIA IN IGNEOUS SYSTEMS 9

Phase Rule – Two component eutectic systems - diopside-anorthite system - incongruent melting – forsterite-silica system – Solid solution systems – albite-anorthite system – Exsolution – Albite-Orthoclase system. Crystallisation in ternary systems: diopside-wollastonite-silica System.

UNIT III PLATE TECTONICS AND IGNEOUS PETROGENESIS 9

Igneous rocks of ocean basins: Ophiolites & Basalts - Igneous rocks of Continental Lithosphere: Granitic rocks; terrestrial anorthosites, carbonatites &Alkaline rocks; Continental Rhyolites; Continental Flood Basalts - Igneous rocks of convergent margins - Distribution and tectono magmatic setting of important igneous complexes of India.

UNIT IV METAMORPHIC PETROLOGY 9

Texture and structure of metamorphic rocks. Nomenclature and description of metamorphic rocks.Basic concepts of metamorphic reactions. Diagrammatic representations of mineral reactions and mineral paragenesis – ACF, AKF, AFM diagrams.

UNIT V METAMORPHIC FACIES & METASOMATISM 9

Facies classification and systematic description of regional and thermal metamorphism pelitic, basic-ultabasic and impure calcareous rocks. Metasomatism, ultametasomatism and anatexis.Metamorphism and plate tectonics. Paired metamorphic belts – EPMA Studies – PT Estimates –ITD.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students are expected to

- Have better understanding on magma and magmatic processes
- Understand the crystallization processes of minerals and rocks
- Differentiate various Igneous types and their tectonic settings
- Understand clearly on metamorphic processes and formation of metamorphic rocks.
- Interpret magmatic and geodynamic processes and their signatures worldwide.

REFERENCES

1. Frost, R and Frost C.D., “Essentials of Igneous and Metamorphic Petrology” Cambridge University Press, USA 2014
2. Philpotts, A.R. and Ague, J.J., “Principles of Igneous and Metamorphic Petrology” Cambridge University Press, USA 2010
3. Best M.G., Igneous and Metamorphic Petrology, 2nd ed. Blackwell. UK, 2002.
4. Winter, J., “An Introduction to Igneous and Metamorphic Petrology”, Prentice-Hall 2001
5. Hall, Anthony, Igneous Petrology. Longman, UK1996.
6. Barker A.J. Introduction to Metamorphic Textures and Microstructures. 1st ed., Blackie, Glasgow; 2nd ed., Stanley Thornes, Cheltenham, 1998.
7. Mason R., Petrology of the Metamorphic Rocks, 2nd ed. Unwin Hyman, London, 1990.

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CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	
CO3	√	√	√	√	√	√	√	√		√	√	√
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√	√	√	√	√	√	√		√	√	√	√

AG5204 SEDIMENTOLOGY AND SEDMENTARY PETROLOGY L T P C
3 0 0 3

OBJECTIVES:

- To familiarize the students on Sedimentary processes
- To provide knowledge on sedimentary structure and tectonic settings
- Describe on occurrence and geological setting of igneous rocks and metamorphic rocks.

UNIT I ORIGIN AND CLASSIFICATION OF SEDIMENTS 9

Weathering and erosion process, products, principles of sedimentation process, scope, applications, classification of sedimentary rocks, sedimentary textures-grain size, roundness, sphericity, shape and fabric, quantitative grain size analysis.

UNIT II SEDIMENTARY PROCESS AND STRUCTURES 9

Sediment transport and deposition- fluid and sediment gravity flows, lamellar and turbulent flows, Reynold number, Froude number, grain entrainment, Hjulstrom diagram, bed and suspension load transport. Primary, penecontemporaneous deformation structures and biogenic structures. Paleocurrent analysis.

UNIT III SEDIMENTATION AND TECTONICS 9

Evolution of sedimentary basins. Sedimentation in major tectonic setting; principles of sequence stratigraphy- concepts and factors controlling base level changes, parasequence, clinoform, system tract, unconformity and sequence boundary. Sedimentary basins of India.

UNIT IV SEDIMENTARY ENVIRONMENT AND FACIES 9

Facies models for marine, fluvial, glacial, and deltaic. Siliciclastic shallow and deep marine environments; carbonate platforms- types and facies models.Sedimentary provenance and diagenesis of sediments.

UNIT V SEDIMENTARY PETROLOGY 9

Sandstones, mudstone, carbonate sedimentary rocks, banded iron formation, evaporates, cherts, and Phosphorites; classification, texture, structure, origin, diagenesis and depositional environment.

TOTAL: 45 PERIODS

OUTCOMES

On completion of this course, the students are expected to

- Have better understanding on sediments and classification
- Understand the processes of sedimentation and sedimentary structures
- Differentiate various tectonic settings and sedimentary processes
- Understand clearly on sedimentary environment and provenance
- Identify and distinguish sedimentary rocks on the basis of their mode of formation.

REFERENCES

1. Tucker, M.E., Sedimentary Petrology, Blackwell Science U.K., 2001.
2. F.J. Pettijohn., Sedimentary Rocks, third edition, CBS Publishers & Distributors, Reprint 2002.
3. Sam Boggs, Principles of Sedimentology and Stratigraphy. Pearson, USA, 2000.
4. Sam Boggs, Jr., Principles of Sedimentology and Stratigraphy 4th Edition, Pearson, USA, 2006.
5. Donald R. Prothero, Frederic Schwab., Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy W H Freeman, USA, 2003.
6. Bhattacharyya, C. Chakraborty., Analysis of sedimentary Successions.,Oxford and IBH Publishing Co. Pvt Ltd, New Delhi,2000
7. Mike D Blum,Susan B. Marriot, Suzanne F.Leclair, Fluvial Sedimentology ,2005., Blackwell Publishing., London
8. G. M. Friedman and F. E. Sanders, Principles of Sedimentology, Wiley, New York, 1978.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√	√	√	√	√	√	√	√	√	√	√	√

AG5211 GEOCHEMISTRY LAB L T P C
0 0 4 2

OBJECTIVES:

- To develop analytical skill and practical exposure on geochemistry to the students
- To understand the chemical properties of water, sediments and minerals.
- Training on sophisticated analytical instrument handling in geochemistry and their application in geology.

UNIT I ANALYSIS OF ORES 12

Dolomite, Galena, Haematite by titrimetric / gravimetric methods

UNIT II ANALYSIS OF METALS IN SOLUTIONS 16

Estimation of iron, copper, sodium, potassium, zinc and nickel by titrimetric / gravimetric / spectroscopy methods

UNIT III ANALYSIS OF WATER 12

Acidity, alkalinity, hardness by titrimetry method-total dissolved solids by gravimetry method-Determination of dissolved oxygen

UNIT IV ELECTROANALYTICAL METHODS 12

pHmetry, conductometry and potentiometry

UNIT V DEMONSTRATION EXPERIMENTS 8

AAS, IR, TGA, DSC, SEM, BET and Chromatographic techniques

TOTAL: 60 PERIODS

OUTCOMES

On completion of this course, the students are expected to be able to:

- Analyze different type of ores.
- Estimate the percent of metals in solution using chemical methods
- Determine the quality of water using analytical techniques.
- Have skills on electroanalytical methods
- Have up-to-date knowledge on modern and advanced equipment.

REFERENCES

1. Mendham J., Denney, R.C., Barnes J.D., Thomas M. and Sivasakar B. (2009), "Vogel's Textbook of Quantitative Chemical Analysis", 6 Edition, Pearson Education.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√		√	√	√	√	√			√		

AG5212 IGNEOUS, METAMORPHIC AND SEDIMENTARY PETROLOGY LAB L T P C 0 0 4 2

OBJECTIVES:

- To develop practical exposure and skills on Petrography of rocks
- To understand the index chemical and physical properties for mineral and rock identification
- Training on sophisticated microscopes and analytical instrument handling in Petrology

UNIT I IGNEOUS PETROGRAPHY 9

Study of textures and structures of igneous rocks. - Systematic megascopic and microscopic study of the following igneous rocks: granite, granodiorite, syenite, diorite, gabbro, dolerite, basalt and rhyolite.

UNIT II SEDIMENTARY PETROGRAPHY 9

Megascopic and microscopic identification of common sedimentary rocks, structures, textures

UNIT III METAMORPHIC PETRGRAPHY 9

Study of textures and structures of importantmetamorphic rocks - Systematic megascopic and microscopic study of important and common metamorphic rocks: Microscopic study of hornblende schist, mica-granite-schist, marble, quartzite, amphibolite, Charnockites etc.

UNIT IV PETROCHEMICAL CALCULATIONS 9

Norm calculation and interpretation of chemical analysis of representative rocks using variation diagrams – Niggli – Maniar Picolli – Harker's – Niggli basis – CIPW Norms-Plotting on ACF, AKF and AFM diagrams- interpretation.

UNIT V SEDIMENTARY TECHNIQUES 24

Sieving analysis practices- River, lake and marine sediment grain size analysis, interpretation- CM plotting, histogram, calculation of statistical parameters and interpretation of sediment depositional environment. Clay mineral separation from sedimentary mixture. Determination of sand-silt-clay ratio. Identification of clay minerals using XRD. Description of sedimentary rocks. Identification of sedimentary structures and its interpretations. Interpretation of SEM – recognisition of physical and chemical etch marks- determination of transportation and porosity. Identification of heavy minerals and interpretation of provenance history. Sediment core logging, staining technique and identification of carbonate minerals

TOTAL: 60 PERIODS

OUTCOMES:

On completion of this course, the students are expected to be able to:

- Identify different types of megascopic rock samples.
- Distinguish rock types under microscope and identify constituent minerals
- Determine the chemical composition of rocks and classify them.
- Have skills on sedimentary analysis of rocks
- Have up-to-date knowledge on modern and advanced equipment

REFERENCES

1. Frost, R and Frost C.D., "Essentials of Igneous and Metamorphic Petrology" Cambridge University Press, USA 2014
2. Philpotts, A.R. and Ague, J.J., "Principles of Igneous and Metamorphic Petrology" Cambridge University Press, USA 2010
3. Best M.G., Igneous and Metamorphic Petrology, 2nd ed. Blackwell. UK, 2002.
4. Sam Boggs, Jr., Principles of Sedimentology and Stratigraphy 4th Edition, Pearson, USA, 2006.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√		√
CO5	√		√	√	√	√	√		√	√	√	√

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AG5213 **SEMINAR** **L T P C**
0 0 2 1

OBJECTIVES

- To work on a specific technical topic in Geology and
- To acquire the skills of written and oral presentation
- To acquire writing abilities for seminars and conferences

SYLLABUS

The student will work for two hours per week guided by a group of staff members. They will be asked to give a presentation on any topic of their choice related to Geology and to engage in discussion with the audience. A brief copy of their presentation also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on a technical topic. They will defend their presentation. Evaluation will be based on the technical presentation and the report and also on the interaction shown during the seminar.

TOTAL : 30 PERIODS

OUTCOME

- The students will be trained to face an audience and to tackle any problem during group discussion in the interviews.

AG5301 **ECONOMIC GEOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To familiarize the students with the ore forming processes
- To provide knowledge onconditions and mode of occurrences of ores and minerals
- To understand geological setting of Indian and global ore and mineral reserves.

UNIT I PRINCIPLES OF ECONOMIC GEOLOGY 9

Introduction to ore and industrial minerals- Physical and optical properties of ore minerals-The nature and morphology of the principal types of ore deposit- Textures and structures of ore and gangue minerals- Classification of ore deposits Fluid inclusion studies-Wall rock alteration-Geothermometry, Geobarometry, Paragenitic Sequence, Zoning and dating of ore deposits.

UNIT II INTERNAL PROCESSES 9

Oregenesis- Ore deposits and ore minerals- source and migration of ore constituents and ore fluid-magmatic and pegmatitic deposits (chromite, Timagnetite,Diamond, Cu-Ni sulphide, PGE, REE, muscovite, rare metals)-Porphyry, skarn and hydrothermal mineralization (porphyry Cu-Mo, greisen Sn-W, skarn, VMS and SEDEX type sulphide deposits, orogenic gold)-Mineralisation associated with (i) Ultramafic, mafic and acidic rocks, (ii) greenstone belts, (iii) komatiites, anorthosites and kimberlites and (iv) submarine volcanism-Magma-related mineralisation through geological time-Stratiform and stratabound ores-Ores and metamorphism — cause and effect relations.

UNIT III SURFACE PROCESSES 9

Introduction – Principles of chemical weathering – lateritic deposits- clay deposits – calcrete-hosted deposits – supergene enrichment of Cu and other metals (Al, Ni and Fe) in near surface deposits – clastic sedimentation and heavy mineral concentration – placer deposits – chemical sedimentation – banded iron formations – phosphorites and evaporates.

UNIT IV GLOBAL TECTONICS AND METALOGENY 9

Patterns in the distribution of mineral deposits – continental growth rates - crustal evaluation and metallogenesis – metallogeny through time – plate tectonics and ore deposits. Application of fluid inclusion study and stable isotope geochemistry in understanding ore forming processes.

UNIT V INDIAN MINERAL DEPOSITS AND MINERAL ECONOMICS 9

Occurrence and distribution in India of metalliferous deposits — base metals, iron, manganese, aluminums, chromium, nickel, gold, silver, molybdenum. Indian deposits of non-metals — mica, asbestos, barytes, gypsum, graphite, apatite and beryl-Gemstones, refractory minerals, abrasives and minerals used in glass, fertilizer, paint, ceramic and cement industries and building stones-Phosphorite deposits,Placer deposits, rare earth minerals- Strategic, critical and essential minerals-India's status in mineral production-Changing patterns of mineral consumption, co-products and by-products-consumption, substitution and conservation ofminerals-National Mineral Policy. Mineral Concession Rules. Marine mineral resources and Law of Sea.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students are expected to be able to:

- Distinguish various ore minerals and gangue.
- Understand internal processes of economic ore formation
- Comprehend surface processes and related ore deposits.
- Understand global occurrence of economic minerals through geologic time
- Have up-to-date knowledge on Indian ore deposits and National mineral policy

REFERENCES

1. Bateman, A. M. and Jensen, M. L. Economic mineral deposits, John Wiley and sons, New York. 1981.
2. Gailbert, J.M., Park, C. P. Jr. and Freeman, W. H. The geology of ore deposits, John Wiley and sons, New York. 1986.
3. Krishnaswamy, S. India's mineral resources, Oxford and IBH publishing, New Delhi. 1979.
4. Edwards, R. and Atkinson, K. Ore deposit geology, Ist Edition, Chapman and Hall. New Delhi, 1986.
5. Robb, L. Introduction to ore-forming processes, Blackwell publishing, U.K., 2005.
6. Anthony Evans, Ore Geology and Industrial Mineral, Jhon Wiley & sons, USA, 1993

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√	√	√	√	√	√	√	√	√	√		
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√	√	
CO5	√	√	√	√	√	√	√	√	√	√	√	√

AG5302 ENGINEERING GEOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To provide the knowledge of geological investigation for site selection for engineering projects.
- To provide the knowledge on Rock type and their engineering properties, suitability of site conditions for dam, Tunnel, coastal structure constructions.
- To provide the knowledge to understand the recent trends in geotechnical engineering.

UNIT I SURFACE AND SUBSURFACE GEOLOGICAL INVESTIGATIONS 9

Field investigations-electrical and seismic geophysical methods in subsurface geological investigations for foundation engineering-Description of discontinuities-bed rock attitudes, thickness, calculation of True thickness and vertical thickness of bed rock-Geological information for slope stabilization.

UNIT II ENGINEERING PROPERTIES OF ROCKS AND SOILS 9

Elementary concepts of rock mechanics and soil mechanics. Rock description and engineering classification of rocks – weathering and its significance in engineering site- Engineering properties of rocks and soils, RMR, RQD methods-determination of engineering properties in field and laboratory.

UNIT III GEOLOGICAL INVESTIGATIONS FOR DAMS&TUNNELS 9

Dams -geological investigations- suitability of site, geological profile from catchment area to Dam site- lithology, structures, topography, slope, drainage system- groundwater studies in reservoir sites-reservoir site investigations, siltation analysis-Geological investigations for soft rock and hard rock tunnels construction.

UNIT IV GEOLOGICAL INVESTIGATIONS FOR COASTAL DEVELOPMENT 9

Coastal erosion and accretion process and its impact-Geological investigations for harbor construction-Coastal protection structures-Sea walls, bulk heads, groins, jetties.

UNIT V GEOTECHNICAL STUDIES OF LANDSLIDES AND SUBSIDENCE 9

Landslide - Classification, causative factors, control measures. Land subsidence, factors, causes and remedial measures. Geological considerations for monitoring of landslides. geotechnical problems related to foundation for bridge and building site investigations. Recent trends in geotechnical engineering. Geotechnical case studies of major projects in India.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will understand the field investigation techniques
- Students will able to understand the rock mechanics and soil mechanics and engineering properties of rocks and soils
- Students will understand the importance of geological considerations in dams and tunnel site investigations
- Students will understand the coastal processes and coastal protection structures
- Students will able to understand the recent trends in geotechnical engineering

REFERENCES

1. Krynine and Judd. Principles of Engineering Geology and Geotechnology. McGraw Hill, New York, 1962.
2. Chandler. R.J. Slope Stability and Engineering Developments 1992.
3. Waltham,T. Foundations of Engineering Geology, SPON Press, London 2002, ISBN 0-415-25449-3,,.
4. Bell F G Engineering Geology, Second Edition by, 2007. Butterworth-Heinemann, Oxford
5. Sathya Narayanaswami. Engineering Geology. Dhanpat Rai and Co. 1710, Nai Sarak, Delhi-110006.. 2000
6. Waltham, A.C. Foundations of Engineering Geology, Blackie Academic Professional Pub., I Ed.,UK,1994.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√	√	√	√	√	√	√	√	√		√	
CO3	√	√	√	√	√	√	√	√	√	√	√	
CO4	√	√	√		√		√	√	√	√		√
CO5	√	√	√	√	√	√	√	√	√	√	√	√

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AG5303 **HYDROGEOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To teach hydrogeological process in the earth system
- To learn estimation of aquifer parameters and potential for groundwater development using geophysical approach a
- To teach assessment of groundwater quality through hydro geochemical techniques.

UNIT I INTRODUCTION **9**

Scope - hydrologic cycle – hydrograph - origin and source - distribution of groundwater – aquifers – aquifer compressibility - porosity - rock properties – specific yield, storage coefficient – groundwater occurrence in various geological formations – geological structures – recharge estimation - discharge

UNIT II GROUNDWATER FLOW **9**

Darcy's law – validity of Darcy's law – hydraulic gradient - hydraulic conductivity – field mapping - flow nets – K estimation in lab and by tracer techniques - transmissivity – homogeneity and heterogeneity – isotropic and anisotropic formations – groundwater resources evaluation – unsaturated flow

UNIT III ESTIMATION OF AQUIFER PARAMETERS **9**

General groundwater flow equation – steady and unsteady radial flow towards wells – confined, unconfined and semi confined aquifers – effect of aquifer boundaries – multiple wells - estimation of aquifer parameters by pump tests – slug tests – well loss - groundwater modelling

UNIT IV GROUNDWATER DEVELOPMENT **9**

Groundwater use – shallow and deep well design – construction of wells –methods of well completion and development – testing for yield - safe yield – horizontal wells – galleries - aquifer response to pumping - land subsidence –aquifer mapping – Hydrogeology of India -managed aquifer recharge

UNIT V GROUNDWATER QUALITY **9**

Constituents in groundwater – dissolved ions – chemical analysis – reporting of results – groundwater quality for various uses – water quality criteria - sources of contaminants – solute and particle transport – remediation - seawater intrusion - case studies.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, students are expected to be able to:

- Understand the field investigation techniques for groundwater
- Determine the hydraulic conductivity and groundwater resources
- Estimate aquifer parameters using various methods
- Understand the well development and yield testing
- Analyze and determine water quality and do remediation.

REFERENCES

1 Domenico P.A. and F.W. Schwartz, Physical and chemical hydrogeology. John Wiley 1997.
2 Fetter,C. W.,Applied Hydrogeology, New York,Macmillan, 2001.
3 Freeze, R.A and Cherry, J.A, Groundwater, Prentice Hall, 1979
4 Elango, L and Jayakumar, R (Eds.) Modelling in Hydrogeology, Unesco-IHP Publications, Allied Publ, 2001
5 Elango, L (Ed.) Hydraulic conductivity – Issues, Determinations and applications, Intech Open Acces Publishers, ISBN 978-953-307-288-3, 434 P. 2011.
6 D. K. Todd and L. W. Mays, "Groundwater Hydrology," 3rd Edition, John Wiley & Sons, Inc., New York, 2005.
7 Hiscock, K, Hydrogeology: Principles and Practice, Wiley-Blackwell, 2005

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CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√	√	√	√	√	√	√	√	√	√	√	
CO3	√	√	√	√	√	√	√	√	√	√		√
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√		√	√	√	√	√			√		

AG5304 GEOLOGICAL REMOTE SENSING AND GIS L T P C
3 0 2 4

OBJECTIVES:

- To teach principle and concepts of Remote Sensing, Image processing and GIS,
- To train the students in aerial photo and satellite image interpretation, satellite image processing,
- To teach GIS techniques, buffering and layer analysis for geologic applications.

UNIT I REMOTE SENSING AND PHOTOGRAMMETRY 12 + 6

Introduction to remote sensing. aerial and space borne platforms. Global and Indian missions; Spectral properties of natural and geologic features, Photogrammetry – principles and concepts., Image interpretation elements.

Hands on exercise: Elements of aerial photos, satellite images and topographic maps; Setting up of stereoscope, determination of stereoscopic acuity and orientation of aerial photographs under a stereoscope; Interpretation of aerial photographs and satellite images and delineation of tonal and textural units

UNIT II DIGITAL IMAGE PROCESSING AND GIS 9 + 8

Format and Structure of multispectral digital image data; Image pre-processing: Image Enhamcements; Image classification; relevance to geology
Introduction to GIS. Components of GIS ; Type of data – spatial and non spatial data – data structure – database concepts – data input – retrieval – vector and raster formats –; standard GIS packages – buffering and overlay analysis; Assigning rank and weights for geologic studies.

Hands on exercise : Familiarisation with Image Processing and GIS softwares**;** Enhancement, Ratioing, PCA and fusion of digital images; Unsuprvised and Suprvised classification of satellite images; Digitization and generation of thematic maps in a GIS.

UNIT III GEOLOGICAL AND GEOMORPHIC MAPPING 8 + 4

Introduction to Geomorphology, Significance of landforms - Image characters of landforms. Role of aerial photographs and satellite images in Geomorphic mapping. Lithologic and structural mapping using aerial photos and satellite images.

Hands on exercise: Geomorphic, Structural and Lithologic interpretation from Aerial photos and satellite images.

UNIT IV GEOLOGICAL APPLICATIONS 8 + 6

Remote sensing and GIS for mineral exploration, ground water exploration and petroleum exploration. Case studies with methodology.

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Hands on exercise: Analysis of aerial photos and satellite for mineral exploration, ground water exploration and petroleum exploration.

UNIT V GEO HAZARDS & GEO-ENVIRONMENTAL APPLICATIONS 8 + 6

Remote sensing and GIS for Landslides and Earthquake studies, Coastal erosion and accretion studies and Coastal Zone Management.

Hands on exercise: Analysis of aerial photos and satellite for landslide, earthquake and coastal hazards study.

TOTAL: 75 PERIODS

OUTCOMES:

On completion of this course, the student can

- Recognize geological and geomorphic features in images
- Perform satellite image processing for earth resources
- Interpret satellite imageries and carry out geo- hazard studies.
- Prepare GIS based maps for various themes like Geology, Geomorphology etc
- Knowledge will be gained on GIS for earth resources and geo-hazards studies.

REFERENCES:

1. George Joseph, Fundamentals of Remote Sensing, Second Edition, Universities Press (India) Private Limited, 2005 ISBN 8173715351, 9788173715358
2. Lillesand. TM.,Kiefer, R.W and Chipman, K.W. Remote sensing and image imterpretation Fifth Edition. Wiley. 2007.
3. Ravi P. Gupta, Remote Sensing Geology, Springer-Verlag New York, 2002.
4. Burrough, PA; and RA McDonnell. Principles of Geographic Information Systems. Oxford Press, U.K., 1998.
5. Wolf. P. R. Elements of Photogrammetry. Mc Graw Hill, Japan, 1993.
6. G. Rees. Physical Principles of Remote Sensing. Cambridge University Press, U.K., 2000.
7. SN Pandey, Principles and Applications of Photogeology: New Age International (P) Ltd., New Delhi. 1988.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√		√	√	
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√	√	
CO5	√		√	√	√	√	√	√	√	√	√	√

AG5311 HYDROGEOLOGY LAB L T P C
0 0 4 2

OBJECTIVES:

- To develop analytical skill and practical exposure on hydrogeology to the students
- to understand the aquifer parametersand water budgeting
- Training on analytical instrument handling for determining groundwater quality

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UNIT I POROSITY AND HYDRAULIC CONDUCTIVITY 15

Groundwater prominence – Hydrological cycle-problems using porosity and specific yield-Hydraulic conductivity – vertical and horizontal-groundwater gradient and contour map preparation-flow velocity – properties of various geological formations-permeameter experiments

UNIT II AQUIFER PARAMETERS 15

Determination of hydraulic conductivity in lab – problems on groundwater flowto wells - steady and unsteady flow – estimation of transmissivity and storage coefficient of wells-aquifer compressibility.

UNIT III WATER BUDGETING 15

Unsteady flow - Theis recovery methods - Use of computer codes to understand groundwater flow in aquifers – slug tests-water budgeting

UNIT IV GROUNDWATER QUALITY 15

Determination of ion balance error – problems on hydrochemistry – preparation of water quality diagrams-drinking and irrigation water quality

TOTAL: 60 PERIODS

OUTCOMES:

On completion of this course, students are expected to be able to:

- Estimate groundwater parameters
- Determine the hydraulic conductivity and storativity
- Estimate aquifer parameters using various methods
- Carryout water budgeting
- Determine groundwater quality

REFERENCES

1. Fetter,C. W.,Applied Hydrogeology, New York,Macmillan, 2001.
2. D. K. Todd and L. W. Mays, “Groundwater Hydrology,” 3rd Edition, John Wiley & Sons, Inc., New York, 2005.
3. Hiscock, K, Hydrogeology: Principles and Practice, Wiley-Blackwell, 2005

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√		√
CO3	√	√	√	√	√	√	√	√	√	√	√	
CO4	√	√		√	√	√	√	√		√	√	√
CO5	√		√	√	√	√	√	√	√	√	√	√

AG5312 GEOLOGICAL FIELD WORK AND INDUSTRIAL TRAINING L T P C
0 0 2 1

OBJECTIVES:

- To train the students in the field work so as to have a firsthand knowledge of preactical problems related to geology in carrying out field and industrial geological tasks.
- To develop skills in facing and solving field problems

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SYLLABUS

The students individually undertake training in reputed industries during the summer vacation for a specified period of three to four weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

TOTAL: 30 PERIODS

OUTCOME

- They are trained in tackling a practical field/industry oriented problem related to Geology

AG5411 DISSERTATION L T P C
0 0 24 12

OBJECTIVES:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature
- To develop the methodology to solve the identified problem
- To train the students in preparing project reports and to face reviews and viva-voce examination

SYLLABUS

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the Head of the department. The students will be evaluated through a viva-voce examination by a panel of the examiners including one external examiner.

TOTAL: 360 PERIODS

OUTCOME:

- On completion of the project work students will be in a position to take up any challenging practical problem and find better solutions.

AG5001 ADVANCED REMOTE SENSING TECHNIQUES AND GIS FOR GEOLOGICAL APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:

- To teach on the hyper spectral sensors and imagine devices
- To describe the students on image processing techniques and information extraction.
- To understand various applications of remote sensing and GIS in exploration of economical ores and minerals.

UNIT I HIGH RESOLUTION SENSORS AND HYPERSPECTRAL IMAGING DEVICES **9**

Introduction - need for high resolution data.- Characteristics, specifications and applications . Spectrographic imagers-hyperspectral sensors- airborne and space borne..

UNIT II IMAGE PROCESSING AND INFORMATION EXTRACTION 9

Concept of pure and mixed pixels, Hard and soft classification – Per-pixel and Sub-pixel classification techniques - spectral unmixing- linear and non-linear, Fuzzy logic - Fuzzy land cover boundaries, Fuzzy pattern classifiers and fuzzy classification techniques. Neural network - fundamentals- applications in improving classification accuracy. Feature extraction and selection.

UNIT III GEOGRAPHIC INFORMATION SYSTEM(GIS) 9

Introduction - map - characteristics - projection - Computer Assisted cartography. GIS - Components of GIS - Integration of GIS with remote sensing. Data Base Structures, Spatial, Non spatial, Raster - Vector - Arc Node, DIME, DLG, Polygon - Topology - Data base - Hierarchical, Network & Relational.

UNIT IV DATA ANALYSIS AND MODELLINGUSING GIS 9

Analysis of Non-spatial data - SQL - Integrated analysis of spatial & Non-spatial data - Retrieval, Surface Topographic & connectivity operations - Modeling.

UNIT V APLICATIONS OF GIS 9

Application to groundwater / recharge studies - landslides - Mineral investigation - Petroleum exploration using GIS - GIS and ore- body modeling - coastal studies,

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Understand the working principles of high resolution sensors and imaging devices.
- Comprehend image processing and classification techniques
- Appreciate the advanced concepts of data analysis and retrieval of data
- Modeling using remote sensing and GIS
- Gain knowledge on role of GIS in geological hazards and its mitigation

REFERENCES

1. Schowengerdt, R. A., Remote sensing - Models and methods for image processing. Academic press. London.1997.
2. Richards,J.A, Remote Sensing Digital Image Analysis.,Springer-Verlag, London 1986.
3. Duda R.O & Hart PE,Pattern classification & Scene Analysis.. Wiley,New York, 1973.
4. Morton Nadia & Eric Smith P, Pattern Recognition Engineering. John Wiley, New York, 1993.
5. Robert Laurini and Derek Thompson, Fundamentals of Spatial Information Systems, Academic Press. London. 1996.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	
CO3	√	√	√	√	√	√	√	√	√	√		√
CO4	√	√	√	√			√	√		√	√	√
CO5	√	√	√	√	√	√	√	√	√	√	√	√

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AG5002 APPLIED MATHEMATICS FOR GEOLOGISTS L T P C
3 0 0 3

OBJECTIVES:

- To train the students to address the mathematical problems involved in geological science
- To have understanding on various sampling, quantitative techniques
- Enable them to solve statistical problems pertaining to geology.

UNIT I SYSTEM OF LINEAR EQUATIONS AND INTERPOLATION 9

Simultaneous linear equations – Direct method - Gauss elimination, Gauss - Jordan methods – Iterative method – Jacobi and Gauss - eidal methods. Difference table – Newton's forward and backward interpolation – Newton's divided differences – Lagrangian interpolation**.**

UNIT II NUMERICAL INTEGRATION AND ORDINARY DIFFERENTIAL EQUATIONS 9

Numerical integration – Trapezoidal and Simpson's 1/3 rules. Taylor serie and Euler methods-Runge – Kutta method of fourth order – Adam– Bashforth Predictor - Corrector method.

UNIT III EMPIRICAL STATISTICS 9

Types of Sampling - Description of discrete and continuous data – Measures of Central tendency and dispersion for grouped and ungrouped data – Measures of position – Box and Whisker plot.

UNIT IV ESTIMATION THEORY 9

Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation - Curve fitting by Principle of least squares – Regression Lines.

UNIT V TESTING OF HYPOTHESES 9

Sampling distributions - Type I and Type II errors - Tests based on Normal, t, χ^2 and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

TOTAL: 45 PERIODS

OUTCOMES (CO):

On completion of this course, the students expected to be able to:

- Understand the linear equation and interpolation of data
- Have better understanding of the applications of numerical integration and differential equation in Geological sciences.
- Apply statistics and sampling techniques in Geological studies
- Gain knowledge on regression and correlation analysis for Geological Data.
- Understand the quantification and error limits of geological data and gain ability for a better representation.

REFERENCES

1. Grewal ,B.S. and Grewal ,J.S. ," Numerical methods in Engineering and Science ", 6th Edition, Khanna Publishers , New Delhi ,2002.
2. P.S. Mann, "Introductory Statistics", John Wiley and Sons. Inc 5th edition, 2004.
3. D.C. Montgomery and G.C. Runger, "Applied Statistics and Probability for Engineers", Wiley Student Edition, 2007.
4. Balagurusamy, E," Numerical Methods ", Tata Mc Graw Hill Pub.Co. Ltd, New Delhi, 1999.
5. Walpole,R.E. and Myers R.H, Myers ,S.L. and Ye, K,"Probability and Statistics for Engineers and Scientists ", Pearson Education, Asia, 8th edition, 2007.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√						√	√
CO2	√	√	√		√						√	
CO3	√	√	√		√						√	
CO4	√	√	√		√						√	
CO5	√	√	√	√	√						√	√

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AG5003 **APPLIED HYDRO GEOCHEMISTRY** **L T P C**
3 0 0 3

OBJECTIVES:

- To study the chemical properties of Groundwater.
- To understand various reactions and ion exchange processes that affect quality of water.
- Also to understand interactions between water and minerals in surface and subsurface formations

UNIT I GROUNDWATER SAMPLING AND EQUILIBRIUM 9

Chemical parameters – sampling and influence of well conditions- sampling for environmental isotopes – pore water sampling – Chemical processes in relation to hydrogeology - calculation of parameters – representation of results – thermodynamics – law of mass action - activity coefficients - saturation indices with respect to common minerals.

UNIT II CARBONATE REACTIONS 9

Carbonate system - solution – precipitation – role of pH and alkalinity – carbonic acid and carbonate equilibrium constants – case studies

UNIT III REDOX REACTIONS 9

Oxidation and reduction – half reactions – balancing of reactions – examples in groundwater – Eh and pe – pH and Eh – stability of water – mineral stability diagrams

UNIT IV ION EXCHANGE PROCESSES 9

Adsoption – absorption – surface complex – reasons for surface charge – isotherms – distribution coefficient – ion exchange – cation exchange capacity – case studeis.

UNIT V SILICATE WEATHERING 9

Hydrochemical sequences – major – ion evolution – groundwater incrystalline rocks – hydrochemical processes during flow – clay minerals and changes in water chemistry due weahtering

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Groundwater sampling and calculation of chemical parameters.
- Have better understanding on role of carbonate and Redox reactions on mineral stability
- Comprehend the ion exchange processes and distribution of coefficients
- Gain knowledge on role of hydrogeochemical sequences
- Understand the relationship between clay minerals and water chemistry during weathering

REFERENCES

1. Lloyd, J. W. and Heathcote, J. A. National inorganic hydrochemistry in relation to groundwater, Oxford University press, 1985.
2. Freeze, R. A. and Cherry, J. A. Groundwater, Prentice Hall, 1979.
3. Stumm, W. and Morgan, J. J. Aquatic chemistry, An introduction emphasizing chemical equilibria in natural waters, Wiley interscience, New York, 1981.
4. Garrels, R. M. and Christ, C. L. Solutions, minerals and equilibria, Harper and Row, New York. 1965.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√		√		√	√	√	√	√	√	√
CO5	√		√	√	√	√	√	√	√	√		

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AG5004 **COAL GEOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To study the origin and formation of Coal
- To teach ranking and exploration of Coal.
- To understand occurrences and distribution of Coal

UNIT I ORIGIN AND FORMATION OF COAL 9

Origin - classification of coal, coalification process.Types of coal and its mode of occurrence physical and chemical characteristics of coal – macropetrographics – microlithotypes.

UNIT II COAL PROPERTIES 9

Proximity and ultimate analysis, ranks of coal, concept of coal maturity, bituminous and anthracite coal. Gondwana coalfields – Paleogene and Neogene coalfields. Lignite deposits in India.

UNIT III CLEAN COAL TECHNOLOGY 9

Coal Preparation; cleaning, sizing, washing. Beneficiation of Indian coals; Coal utilization – combustion, carbonization, gasification and hydrogenation.

UNIT IV INDIAN COALFIELDS 9

Lithology, stratigraphy and structures of Gondwana coalfields and Tertiary coalfields of India; its properties.

UNIT V COAL EXPLORATION METHODS 9

Exploration of coal,mining methods, drilling and logging, assessment of coal reserves; calculation of coal reserves. Mine Environment

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Differentiate between types of coal.
- Classify, rank and assess coal reserves.
- Have knowledge on coal washing techniques and beneficiation of coal.
- Gain knowledge on coal reserve management and environmental conservation.
- Have knowledge on geological and geographical distribution of Indian coal

REFERENCES

1. Chandra, D., Singh, R. M. and Singh, M. P. Text book of coal (Indian context). Tara book agency, Varanasi. 2000.
2. Stach, E. Mackowsky, M. Th., Teichmuller, M., Taylor, G.H., Chandra, D. and Teichmuller, R. Stach's Text book of coal petrology, Gebnudar Borntraeger, Stuttgart, 1982.
3. Wilfrid Francis. Coal its formation and composition. Edward Arnold (Publishers) Ltd. London 1961.
4. Van Kreuelen. Coal – Typology – Chemistry – Physics Constitution. Elsievier publishing company, London 1961.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	
CO3	√	√	√	√	√	√			√	√	√	√
CO4	√	√	√	√		√	√	√	√	√		√
CO5	√	√	√	√	√	√	√	√	√	√	√	√

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AG5005 EARTHQUAKE DISASTER AND MITIGATIONS L T P C
3 0 0 3

OBJECTIVES:

- To study the structure of the earth and plate tectonics
- To understand principles of seismic risk analysis.
- Also to teach seismic hazard assessment and management

UNIT I SEISMICITY 9

Earth structure and plate tectonics – Strain accumulation – elastic rebound and faulting – energy release and seismic waves – physical parameters of earthquake source – magnitude – seismic moment and fault plane solution – geological and seismological input for Seismicity evaluation on magnitude – frequency relations.

UNIT II SEISMIC RISK ANALYSIS 9

Intensity and earthquake strong motion – seismic hazard analysis and estimation of design ground motions – seismic hazard mapping – seismic zonation and response – design codes – protective and reducing measures for infrastructures and structures – regulation of land use – risk assessment – vulnerability analysis.

UNIT III SEISMIC HAZARD ASSESSMENT 9

Assessment of geological seismic hazards – site response and seismic microzonation – mapping of hazards due to liquefaction and earthquake – induced landslides – use of Geographical Information System for hazard mapping and seismic risk assessment.

UNIT IV SEISMIC HAZARDS IN INDIA 9

Major seismic events in India –Reservoir induced Seismicity –dam failures due to earthquakes-structural damage – lessons learnt – techniques for field investigations.

UNIT V MITIGATION AND MANAGEMENT 9

Seismic hazard zonation-Vulnerability and risk mapping-building codes and seismic zones-PGA and Seismic Microzonation-Earthquake predicitions-Impact of earthquake disasters on national development –public education – need, types of training – public awareness.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Understand the fundamentals of seismicity.
- Carryout seismic risk analysis and seismic hazard mapping.
- Estimate and assess seismic hazard and prepare seismic micro zonation maps
- Gain knowledge on use of GIS for hazard mapping and risk assessment
- Appreciate theimpact of disasters onsocio-economic system

REFERENCES

1. Bell, F. G. Geological hazards: Their assessment, avoidance and mitigation. E and FN SPON, Routledge, London, 1999.
2. David Alexander. National disasters. UCL Press, London. Research press New Delhi, 1993.
3. Moores, E. M. and Twiss, R. J. Tectonics. W. H. Freeman and company, New York, 1995.
4. Nick Carter, W. Disaster management- A disaster manager's handbook. Asian Development Bank, Phillippines, 1991.
5. Penelis, G. G. and Kappos, A. J. Earthquake-resistant concrete structures, E and FN SPON, London, 1997.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	
CO3	√	√	√	√	√	√	√	√		√	√	√
CO4	√	√	√	√	√	√	√	√	√	√	√	√
CO5	√		√	√	√	√	√	√	√	√		√

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AG5006 **ENVIRONMENTAL GEOCHEMISTRY** **L T P C**
3 0 0 3

OBJECTIVES:

- To study the chemical properties of earth, minerals and application of chemistry in geology.
- To understand chemistry of Continental and marine environment
- Also to understand effect onenvironment and guides for exploration of economical resources.

UNIT I PRINCIPLES OF ENVIRONMENTAL GEOCHEMISTRY 9

The science of Geochemistry – Its objectives, its relationship to other geosciences and its methodology. The natural workings of the Earth: Natural distributions of chemicals in global and local environments. Geochemistry of the Earth: The birth of matter in our solar nebula, formation of the solar system and early geochemical history of the earth.The geochemical cycle – Distribution of elements in rocks

UNIT II THE CONTINENTAL ENVIRONMENT 9

Hydrologic cycle – Dissolution and precipitation of silica, aluminum and iron hydroxides - Geochemistry of surface and ground waters – Rivers, ground water and lakes. Complex formation and chelation. Metals and nonmetals. Radioactive isotopes and radioactive waste.

UNIT III MARINE ENVIRONMENT 9

Physical and chemical properties of open ocean seawater chemistry. Trace metals in sea waters. Types of metal distributions. Geochemistry of marine sediments. Marginal marine environments. Perturbations caused by humans: chemical distributions in anthropogenically "perturbed" systems.

UNIT IV ENVIRONMENTAL MINERALOGY 9

Basic mineralogy – Definition of a mineral – Types of minerals – Crystal chemistry – X – ray Crystallography. Basic silicate structures – zeolites – asbestos minerals – health effects of asbestos exposure. Mineral-microorganism interactions.

UNIT V GEOCHEMICAL EXPLORATION ENVIRONMENT 9

Introduction – Primary Dispersion pattern Secondary dispersion pattern. Background values – Geochemical anomaly – Geochemical sampling - Weathering – Soils.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Understand the principles of environmental geochemistry.
- Have better understanding of chemistry of continental environment
- Comprehend the physical and chemical properties of ocean water
- Gain knowledge environmental mineralogy
- Apply the knowledge for exploration of economical minerals and ores.

REFERENCES

1. Arthur Brownlow, Geochemistry (Second edition), Pearson Education, INC., 1996.
2. Faure, G., Principles and applications of Geochemistry, Pearson Education, INC., 1998.
3. Nelson EBY, G., Principles of Environmental Geochemistry, Thomson Brooks/Cole, 2004.
4. Fraure, G, Principles of isotope geology, John Wiley, Second edition. 1986.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√		√	√
CO5	√		√	√	√	√	√			√		√

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AG5007 **ENVIRONMENTAL GEOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To provide the knowledge on Geology and environment, impacts due to mineral, soil and land degradation.
- To expose the students to assess various geological environments like terrestrial, aquatic, etc.
- To provide knowledge and guidelines to assess and plan various environmental issues.

UNIT I GEOLOGIC ENVIRONMENTS 12

Concept and scope of environmental geology –Geological characteristics of various environmental regimes – fluvial, coastal, marine, Aeolian, desert, and glacial. - Landforms as ecosystem units – Geomorphic controls on biodiversity and its conservation.

UNIT II TERRESTRIAL ENVIRONMENT 8

Environmental degradation due to mining and ore beneficiation – Air Pollution - sources of pollution - pollution due to dust and waste disposal-Mining – opencast – underground - disposal of industrial and radio-active waste - dumping stacking – rehandling – management - mineral processing - tailing ponds - acid mine drainage – siltation - soil and mineral resources and their conservation-National and International standards- impact and management – Indian case studies

UNIT III AQUATIC ENVIRONMENT 8

Geological factors influencing the formation of surface, groundwater and marine Waters – geological basis of groundwater, surface and marine water pollution and management with Indian case studies

UNIT IV GEOLOGY IN ENVIRONMENTAL PLANNING AND MANAGEMENT 8

Environmental impact assessment – geological appraisal of waste disposal sites - geology in planning and siting of land fills - problems of deep well disposal, radioactive waste management - land use planning in EIA

UNIT V GEOLOGICAL HAZARDS AND GLOBAL ENVIRONMENTAL CHANGE 9

Causes, types, Mitigation and Management of earthquakes, landslides, tsunami and volcanoes. **;** Causes and Indicators of global environmental change

TOTAL: 45 PERIODS

OUTCOMES:

- Students will understand the earth processes and landforms
- Students will able to understand the terrestrial environment issues
- Students will learn about geological factors influencing the aquatic environment
- Students will understand the roll of geology in environmental planning and management
- Students will able to understand the mitigation and management on geological hazards

REFERENCES

1. Montgomery, C.W. Environmental Geology, Won. C. Brown, Publishers, Iowa, 1989.
2. Dorothy Merritts, Andrew de Wet, Kirsten Menking, Environmental Geology W. H. Freeman & Co. and Sumanas, Inc. USA, 1997.
3. Valdiya, K. S, Geology, Environment and Society, Universities Press, India, 2004

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√		√	√	√	√
CO3	√	√	√		√	√	√	√	√	√	√	
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√		√	√	√	√	√		√	√	√	√

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AG5008 ENVIRONMENTAL HYDROGEOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To study the environmental impacts related to hydrogeology
- To teach groundwater problem in mines and slopes.
- To gain knowledge on groundwater contamination and protection

UNIT I INTRODUCTION 9

Hydrological cycle - geological formations as aquifers - aquifer parameters - their estimation - groundwater flow and recharge - environmental impacts related to hydrogeology.

UNIT II HYDROGEOLOGICAL IMPACTS 9

Mass movements - land subsidence - causes - hydro compaction – sink holes – natural compaction - groundwater problems in mines and slopes.

UNIT III GEOLOGICAL ASPECTS OF WASTE DISPOSAL SITES 9

Physiographic - nature of rock types - structure - hydrogeological considerations - data required - formation fluid tests - transport mechanisms of polluted groundwater.

UNIT IV GROUNDWATER CONTAMINATION 9

Water quality standards – transport processes – sources of contamination – oil spills – deep well disposal site locations – sea water intrusion - hydrogeological systems and monitoring.

UNIT V GROUNDWATER PROTECTION 9

Groundwater contamination - methods of assessment - application of groundwater modeling - damage prevention - remediation of aquifers – bio remediation of contaminated aquifers

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Estimate aquifer parameters, flow and recharge of groundwater.
- Have better understanding onhydrological impacts on earth.
- Locate sites for solid waste and polluted water disposal using hydrological aspects.
- Assess groundwater contamination, sea water intrusion
- Modelling of pollution transport and remediation of aquifers.

REFERENCES

1. Soliman, M.M et al . Environmental Hydrogeology, Lewis Publ., 1997
2. Freeze, R.A and Cherry, J.A Groundwater, Prentice Hall, 1979
3. Coates,D.R. Environmental Geology, John Wiley, 1981
4. Keller, E.A, Environmental Geology, Columbus, 1985
5. Marcel van der Perk, Soil and Water Contamination: From Molecular to Catchment, Scale, Taylor and Francis, 2006
6. Appelo, C.A.J. and D. Postma, Geochemistry, Groundwater and Pollution, Taylor & Francis; 2 edition,, 2005.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√		√	√	√	√	√		√	√		√

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AG5009 **FUEL GEOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To study the origin of Coal, petroleum and Nuclear minerals
- To teachIndian occurrences of hydrocarbons.
- To teach students geological and geophysical exploration techniques

UNIT I ORIGIN OFCOAL AND ITS PROPERTIES 9

Origin of coal and its type. Coalification. Coal and its properties; proximate and ultimate analysis. Different varieties and rank of coal. Concept of coal maturity, peat, lignite, bituminous and anthracite coal. Lithotypes, microlithotypes and maceral groups of coal, mineral and organic matter in coal.

UNIT II INDIAN COAL FIELDS 9

Lithology, stratigraphy and structures of Gondwana coal fields and Tertiary coal fields of India and its properties. Coal utilization, Combustion, carbonization, gasification and hydrogenation.

UNIT III ORIGIN AND PROCESS OF HYDROCARBON FORMATION 9

Fundamental concepts of organic and inorganic theories of hydrocarbon. Sedimentary processes and accumulation of organic matter-diagenesis, catagenesis and metagenesis of organic matter. Generation, migration and accumulation of oil, crude oil types.Oil fields of India.

UNIT IV GEOLOGICAL, GEOPHYSICAL AND GEOCHEMICAL METHODS 9

Sedimentary basin analysis to its Petrophysical properties, depositional environment and time line and bathymetry analysis. Seismic method of hydrocarbon reservoir exploration. Seismic reflection patterns and to decipher the depositional and structural features.Well logging techniques, interpretation of logs,geochemical parameters; determination of TOM, TOC, VRO, TTI, and TAMR.

UNIT V NUCLEAR MINERALS 9

Geological characteristics of and genesis of major types of Uranium deposits. Distribution of Uranium deposits in India and its stratigraphy and structure and properties. Placer minerals properties, distribution. Origin, physical and chemical properties of Monazite, Thorium deposits.

OUTCOMES:

On completion of this course, the students expected to be able to:

- Understand the processes of formation of coal, petroleum and nuclear minerals.
- Have knowledge on different rank of coals and Indian occurrence
- Do independent geological mapping for hydrocarbon exploration
- Gain skills on geophysical and geochemical exploration methods.
- Understand the scope of geology in strategic mineral exploration

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√		√	√	√	√	√			√	√	

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AG5010 **GEOPROSPECTING** **L T P C**
3 0 0 3

OBJECTIVES:

- To familiarize the students with geological mapping techniques.
- To teach geophysical methods of prospecting for ores and minerals
- Also to provide knowledge on geochemical prospecting methods.

UNIT I GEOLOGICAL PROSPECTING 9

Geological prospecting- field survey and mapping techniques - field equipments- methods of mapping- pits and trenches- sampling-geological map preparation.

UNIT II ELECTRICAL METHODS 9

Geophysical prospecting- electrical methods- resistivity, self potential methods- interpretation - application in mineral prospecting – groundwater targeting electrical logging methods in oil exploration.

UNIT III SEISMIC METHODS 9

Seismic methods- refraction and reflection method- interpretation of seismic data- application- identification of geological structures-oil fields location- analysis of 3-D seismic data in oil exploration.

UNIT IV MAGNETIC AND GRAVITY METHODS 9

Magnetic method - types of magnetometer-field survey- anomaly- interpretation and prospecting - gravity methods- gravimeter-identification of size and shape of bodies-correction of the data- application in mineral exploration.

UNIT V GEOCHEMICAL PROSPECTING 9

Geochemical prospecting- anomaly- background values- mobility of ions-associated elements-path finder elements-surface indicators - geobotanical methods – application in mineral exploration.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Carryout individual field study using geological mapping techniques.
- Collect, process and analyse data using various geophysical methods
- Explore the subsurface using geophysical methods
- Gain knowledge on geochemical methods
- Do accurate interpretation of data and locate economical ore reserves.

REFERENCES

1. Lahee, Field geology, CBS pub, New Delhi, 1987.
2. Dobrin, Geophysical prospecting, McGraw hill, New Delhi ,1981.
3. Mason, B., Introduction to geochemistry, John Wiley, USA, 1982.
4. Chaussier, J.B., and Mores, J Mineral Prospecting manual, North Oxford Academic press,1987.
5. Butler, B.C.M and Bell, J.D, interpretation of geological maps, Longman Scientific & technical Publ.,1st ED., New Delhi, 1988.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√		√	√		√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√		√	√	√	√	√		√	√		√

AG5011 GEOSCIENCES IN NATURAL HAZARDS MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To provide information on natural hazards and their characteristics.
- To teach significance of geology and its effect on disasters.
- To familiarize students with various mitigation methods for natural disasters.

UNIT I INTRODUCTION TO NATURAL DISASTERS 9

Concepts of Disaster, Types of Disaster -Natural Disasters records in India- Earth and its characteristics – Environmental Change and Degradation - Climate Change - Global warming- Disaster cycle: preparedness, response and recovery.

UNIT II EARTHQUAKES AND TSUNAMI 9

Causes of Earthquake and Tsunami-Intensity and Magnitude of earthquakes-Seismic waves and earthquake recording-Seismic zones of India-Seismic codes-Tsunami characteristics and warning systems.

UNIT III LANDSLIDES 9

Causes of Landslides- Nature and characteristics Human impact on the mountainous terrain- Rainfall, liquefaction etc- - Monitoring of landslides- Landslide Early warning System.

UNIT IV CYCLONES, FLOODS AND DROUGHTS 9

Severe Weather & Tornadoes -Cyclones, Floods and Droughts - nature and dimensions -Global Patterns - Mitigation & Preparation for floods- Drought Assessment and Monitoring.

UNIT V DISASTER MITIGATION 9

Mapping - Modelling, risk analysis and loss estimation – Natural disaster risk analysis - prevention and mitigation - Applications of Space Technology (Satellite Communications, GPS, GIS and Remote Sensing and Information and Communication Technologies (ICT) in Early warning Systems – Disaster Monitoring and Support Centre– Information Dissemination – Mobile Communications etc.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Understand the concepts of hazards and disasters
- Have better understanding on geological hazards and climatological hazards
- Comprehend the advanced concepts of hazard mitigation and management
- Gain knowledge on risk assessment and vulnerability mapping due to hazards
- Understand the application of Geospatial and communication technologies in hazard management.

REFERENCES:

1. Bhandari, R.K, Disaster Education and Management, A Joyride for Students, Teachers and Disaster Managers, ISBN, 978-81-322-1565-3, XXVIII, 349, Springer India, 2014.
2. Mitigating natural disasters: Phenomena, effects and options, Publisher: United Nations, New York, 1991.
3. Nick Carter, W. Disaster management, A Disaster manager's Handbook, Publisher: Asian development bank, Manila, 1992.
4. Edward A. Keller, DeVecchio. Natural Disasters: Earth's Processes as Hazards, Disasters and Catastophes, Routledge, 3rd Edition, 2011.
5. Harsh K. Gupta, Disaster Management, Indian National Science Academy, ISBN 8173714568,788173714566, 2006 second Edition, 152 Pages.
6. Ghanshyam Singh and Sandip Bhandari, Disaster Management, Gullybaba Publishing House (P) Ltd; 1st edition (2012), ISBN-13: 978-9381066492.

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CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√		√
CO5	√		√	√	√	√	√			√	√	

AG5012 GROUNDWATER CONTAMINATION L T P C
3 0 0 3

OBJECTIVES:

- To study about the sources of groundwater and its parameters
- To understand various contaminations and its sources.
- To gain knowledge on remediation methods.

UNIT I INTRODUCTION 9

Groundwater occurrence and flow – types of porosity – transmissivity and storage coefficient - significance in groundwater contamination - sources of contamination – landfills.

UNIT II TYPES OF CONTAMINATION 9

Types – point and non point sources – natural and anthropogenic - organic and poly aromatic compounds – biological – other sources –gasoline spills on the water table - chlorinated solvent spills which sink

UNIT III IDENTIFICATION OF CONTAMINATION 9

Application of electrical conductivity measurement for soil and groundwater contamination - Application of Ground Penetration Radar and other methods

UNIT IV TRANSPORT PROCESS 9

Advection, dispassion and diffusion-sorption, biodegradation, transformation, retardation and attenuation of solutes – radionuclide transport

UNIT V REMEDIATION 9

Waste site characterization-Geochemical modelling-Modeling concepts -Thermodynamics - groundwater quality - Emerging remediation methods, including surfactant and co-solvent soil flushing

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Comprehend groundwater occurrence and its parameters.
- Have better understanding various contaminants of groundwater and their sources
- Use geophysics methods to delineate contaminated sites of soil and groundwater.
- Gain knowledge contaminant transport due to groundwater
- Evaluate and suggest remediation for contaminated sites.

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REFERENCES:

1. Philip B. Bedient, Hanadi S.Rifai and Charles J. Newll Ground Water Contamination: Transport and Remediation (2nd Edition) , 1999.
2. Fetter, C.W., Contaminant hydrogeology (2nd Edition), 2008.
3. Geophysics study committee., Groundwater Contamination:National Academy Press., Washington D.C ,1984.
4. Michael J. Barcelona., Contamination of Groundwater: prevention, assessment, restoration., Noyes data corp., 1990.
5. Reza M. Khanbilvardi., John Fillos., Groundwater hydrology, contamination and remediation., Science publication, 1986

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√		√	√	√	√
CO4	√	√	√	√		√		√		√	√	√
CO5	√		√	√	√	√	√	√	√	√	√	√

AG5013 INDUSTRIAL GEOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To study the economic importance of minerals and resources
- To teach mining project evaluation and mineral conservation.
- To provide knowledge on mineral policies and environmental protection.

UNIT I ECONOMICS IN MINERAL EXPLORATION 9

Economic Considerations in Mineral Exploration; Systematic approach to Exploration Expenditure; In-situ and Mineable Reserves; Pit Optimization; Bulk Sampling; Pilot Plant Studies; Demand and Price Projections.

UNIT II MINERAL/MINE ECONOMICS AND FINANCE 9

Source of Mine Finance; Factors governing profitability; Concepts of Depreciation, Depletion, Present value, Cash Flow and DCF; Costs-Capital, Fixed / variable, Ownership; P & L Account; Balance Sheet.

UNIT III MINERAL PROJECT EVALUATION 9

Time Value of Money; Project Evaluation Technique-Pay Back, Discounted Pay Back, DCF,IRR; Project Ranking; Sensitivity analysis; Feasibility study-Prospect and Operating Mines; Preparation of Mine Plan under Mineral Concession Rules.

UNIT IV MINERAL CONSERVATION 9

Growth of the awareness; Means of conservation; Limitations in Scope; Wealth from Mineral waste; Co-products and By-products; Substitute for Minerals.

UNIT V MINERAL POLICIES AND ENVIRONMENT 9

National Mineral Policy; Prospecting License and Mining Lease; Mines Act, CMR, MMR, Mines Rules, MMRD Act and Rules, EMP, EIA.

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OUTCOMES:

On completion of this course, the students expected to be able to:

- Understand the economics involved in mineral exploration
- Have better knowledge on finance and economics of mine operation and production .
- Comprehend mineral project evaluation
- Adopt methods to conserve minerals and resources
- Understand the national mineral policy and environmental assessments.

REFERENCES

1. Gentry, D.W & O'Neill J.O 1984. Mine Investment Analysis, New York: Society of Mining Engineers of American Institute of Mining, Metallurgical and Petroleum Engineers.
2. Ian Runge, C. 1998 Mining Economics and Strategy, Littleton USA: Society of Mining, Metallurgy and Exploration, Inc.
3. Chatterjee, Kaulir Kishore, 2003, Introduction to Mineral Economics, Chennai, Wiley Eastern Limited and Lakshmi Publications.
4. Bruce, A.K. 1990 Surface Mining, Colorado, Society for Mining, Metallurgy and Exploration, Inc. Published Mines/Minerals Legislations
5. Ghosh A.K. & Bose, L.K. 2003, Mining in the 21st Century, New Delhi, Oxford & IBH Published Company Pvt Limited.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√		√		√
CO5	√		√	√	√	√	√		√	√	√	

AG5014 MARINE GEOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To understand the Ocean features, geological resources, Ocean environment, and Ocean geology.
- To understand the exploration and exploiting methods
- And to understand the various instrumentations and its techniques.

UNIT I PHYSICAL FEATURES OF THE OCEAN 9

Introduction and scope of Marine Geology; oceanic profile, oceanic features; beaches, coastal classification, erosion and accretion; waves, currents and tides, coastal protection structures

UNIT II OCEANIC CRUST, SEDIMENTS 9

Morphologic and tectonic domains of the ocean floor. Structure, composition and mechanism of the formation of oceanic crust. Ocean sediments, classification, digenesis, Ocean tectonics.

UNIT III OCEAN RESOURCES 9

Classification of marine mineral deposits. Origin and depositional system of marine resources; beach placers, shelf deposits, deep ocean Phosphatic, Polymetallic nodules, sulfate deposits, hydrocarbon deposits Sea water as a resource.

UNIT IV OCEANOGRAPHIC INSTRUMENTATIONS 9

Descriptions of research vessels, cruise, position fixing in the sea; sampling devices – Grab samplers, bottom samplers, dredges, sediment traps, boomerang samplers, water samplers, Winches, temperature measurement instruments, tools for studying ocean floor topography. POD, COD, GOD and BOD tools kit.

UNIT V OCEAN POLLUTION AND LAW OF THE SEA 9

Concept of sea level changes, physical and chemical properties of seawater. Marine pollution-pathways, residence time, pollutants in the marine environment. Law of the sea, EEZ. Fundamentals of Remote sensing applications to ocean science.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will understand the physical features of the ocean
- Students will able to understand the morphologic and tectonic domains of the ocean floor
- Students will learn about the various ocean resources
- Students will understand the various oceanographic instrumentations used for marine exploration
- Students will able to understand the law of the sea

REFERENCES

1. J.J. Bhatt. Oceanography – Exploring the Planet Ocean. D. Van. Nostrand Company, New York, 1994.
2. Shepard, F. P. Submarine Geology, Harper and Row Publ. New York, 1994.
3. Kerth. S, Ocean Science, John Wiley and Sons. Inc. New York. 1996.
4. James, K, Marine geology Prentice Hall, Inc. Englewood Clifs. N. J. 07632., 1981.
5. Eric. C. Bird Coasts: An Introduction to Coastal Geomorphology, III ed. Basil Black well Publ. 1984.
6. Suzy Bullock, Marine Geology,2017
7. Jon Erickson, Marine Geology: Exploring the New Frontiers of the Ocean, Facts On File Inc; Revised edition , 2002

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√			√	√		√	√	√
CO5	√		√	√	√	√	√		√	√		√

AG5015 MEDICAL GEOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To study the chemical constituents of earth materials and their link to health
- To understand various natural toxicants and contaminants.
- To understand various techniques and tools to identify natural toxicity

UNIT I INTRODUCTION 9

The Foundations of Medical Geology, Geochemical Classification of the Elements, Contributions to Medical Geology from Public Health and Environmental Medicine, Development of Medical Geology.

UNIT II PATHWAYS AND EXPOSURES 9

Volcanic Emissions and Health, Radon in Air and Water, Arsenic in Groundwater and the Environment, Fluoride in Natural Waters, Water Hardness and Health Effects, Bioavailability of Elements in Soil, Selenium Deficiency and Toxicity in the Environment, Soils and Iodine Deficiency.

UNIT III GEOLOGY HUMAN HEALTH 9

Natural Distribution and Abundance of Elements, Anthropogenic Sources, Uptake of Elements from a Chemical Point of View, Uptake of Elements from a Biological Point of View, Biological Functions of the Elements ,Geological Impacts on Nutrition, Biological Responses of Elements

UNIT IV GEOPATHOLOGY AND TOXICOLOGY 9

Environmental Epidemiology, Environmental Medicine, Environmental Pathology, Toxicology, Speciation of Trace Elements. Geophagy and the Involuntary Ingestion of Soil, Natural Aerosolic Mineral Dusts and Human Health, The Ecology of Soil-borne Human Pathogens, Animals and Medical Geology.

UNIT V TECHNIQUES AND TOOLS 9

Mapping Geological factors for human health using RS and GIS - Investigating Vector-Borne and Zoonotic Diseases, Mineralogy of Bone, Inorganic and Organic Geochemistry Techniques, Histochemical and Microprobe Analysis in Medical Geology.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Understand the characteristics of natural materials and their link to public health
- Have better understanding on pathways and exposures to natural toxicity
- Appreciate geology and human health relationship.
- Gain knowledge on natural toxicology and geopathology
- Use different techniques to enable probing of diseases in medical geology

REFERENCES:

1. Miomir M. Komatina, Effects Of Geological Environments On Human Health, Burgess Publishers - 2004
2. Olle Selinus, B. J. Alloway, Essentials of medical geology: impacts of the natural environment on public health, Lewis Publishers, USA - 2005
3. C. B. Dissanayake, Rohana Chandrajith, Introduction to Medical Geology , Lewis Publishers, USA - 2009
4. Rolf O. Hallberg, Medical geology , Environmental geology – Burgess Publishers, 2007
5. Miomir Komatina, Base of medical geology , Lewis Publishers, 2007.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√		√		
CO5	√		√	√	√	√	√		√	√	√	

AG5016 MICROPALAEONTOLOGY AND PALYNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To study the microfossils and their significance for petroleum exploration
- To understand different fauna and flora belong to different environment.
- To teach identification and pollens and spores and their geological application.

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UNIT I INTRODUCTION 9

Introduction to Micropaleontology-scope, use and its applications in oil industries and Paleo-ecology studies, Methodology – separation of microfossils from matrix; mounting technique; identification and classification procedures.

UNIT II MICROFOSSILS AND ITS APPLICATIONS 9

Study of microfossils from Precambrian- Quaternary; applications – age determination, paleofacies; Interpretation of tectonics from micro faunal evidence.

UNIT III FORAMINIFERA 9

Foraminifera – Diamorphism, structure and test, classification of foraminifera; distribution through geological ages; ecology of foraminifera. Uses in sequence biostratigraphic studies.

UNIT IV OSTRACODA 9

Ostracoda-classification, ornamentation, orientation of carapace, microfossiles utility-environment significance; marine, non-marine environments and mixed environments.

UNIT V PALYNOLOGY 9

Introduction–definition, concept, potential and prospects; Palynofossils classification; affinity of spore, pollen, diatoms and dinoflagellate. Maceration technique; general morphology of acritarchs, fungi, stratigraphic importance Palynology in coal and oil exploration.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Understand scope of micro fossils in oil exploration.
- Distinguish and identify various micro fossils belonging to foraminifera
- Identify ostracoda and classify
- Individually collect and identify microfossils, spores and pollens
- Gain knowledge on role of spores and pollen in oil exploration

REFERENCES

1. G. Bignot. Elements of Micro paleontology, Graham and Trotman International Student edition. Bordas Dunod Paris. 1992.
2. Tschudy, R. H. & Scott, R. A. Aspects of Palynology, wiley interscience, New York. 1999.
3. N.K.N. Aiyengar, K. N. Prasad, An Introduction to Invertebrate Paleontology, New Delhi. 1996.
4. Jones, D. J., Introduction to microfossils, Harper & Brothers, New York. 1997.
5. Headly, R. H., Adams, C. S. (Eds) Foraminifera Vols., Academic press, London. 1984.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√		√		
CO5	√		√	√	√	√	√		√	√		√

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AG5017 MINERAL EVALUATION AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To provide information on exploration of mineral and ore petroleum deposits,
- To teach methods of ore reserve estimations, mineral economics and feasibility studies,
- To describe mineral processing and beneficiation and national mineral policies.

UNIT I PRE FEASIBILITY STUDIES 9

Application of Geo Statistics Variogram Range, Kriging -Ore body Optimisation- Bulk Sampling, pilot Plant Saturation Prospecting, Categorisation curve-Block Recovery -grade Vis-à-vis In-situ grade.

UNIT II MINE MINERAL ECONOMICS 9

Source of Capital Funds-Factors Governing Profitability -Time Value of Money -Evaluating Net Profit-Capital Cost Owning Cost, Operating Cost, Amortisation -Concepts of Depreciation, Cash Flow, DCF, PV, NPV-Project and Loss Account, -Balance sheet

UNIT III MINERAL PROJECT FEASIBILITY 9

Project Evaluation Techniques – Pay Back Discounted Pay Back, DCF, NPV, IRR Sensitivity Analysis WRT Grade, Price, Cut off grade, Recovery, Cost of Production -Feasibility Studies for Prospects and Operating Mines

UNIT IV MINERAL PROCESSING/BENEFICIATION 9

Scope, Application, Brief Description of Concentrating/ Processing Methods Viz Gravity, Electrostatic, Electromagnetic, Flotation, Chemical, Ion Exchange, Roasting, Smelting-Mineral/Metal Recovery, Ratio of Concentration Selectivity Index-Flow Sheets of Important ore Minerals, Strategic Minerals.

UNIT V MINERAL POLICIES 9

Synopsis of Mineral Related Acts, Rules, Regulations - Mining Plan under MCR1961, EMP, EIA, National Mineral Policy, Mineral Conservation, PL&ML -Wealth from waste, Co Products, By-Products - Turnaround Strategy for Sick Mineral Based Industries from Geologists Perspective.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Carryout pre-feasibility studies on mineral prospecting.
- Have better understanding of mine mineral economics
- Evaluate and do feasibility studies for operating mines.
- Gain employment in mineral mining and beneficiation industries
- Carryout strategic studies for sick mineral based industries

REFERENCES:

1. McKinstry, H.E. Mining Geology, Newyork: Prentice-Hall, Inc. 1970.
2. Deshmukh, D.J.. Elements of Mining Technology, Dhanbad: Vidyaprakshan, 1998.
3. Bruce, A.K.. Surface Mining, Colarodo: Society for Mining, Metallurgy and Exploration Inc. 1990. Hustrulid, H.V and Mark Kuchta, Open Pit Mine Planning and Design Fundamentals, Brookfield USA: A.A Balkema, 1995.
4. Hartman. Howard L,. Introduction to Mining Engineering, New York: John Wiley and Sons, 1987.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√		√	√	√
CO5	√	√	√	√	√	√	√			√	√	√

AG5018 **MINING GEOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To teach students on surface and underground mining methods
- To teach ore reserve estimation and ore body modeling.
- To teach them mineral prospecting, sampling and drilling techniques.

UNIT I MINERAL EXPLORATION 9

Triangulation-Establishment of Local Base from National Grid Base-Review of Surface Mapping and Underground Mapping-Different Plans and Sections-Search for ore–Surface and Concealed Guides to ore - Persistence of ore in depth– Preliminary Investigations–Trenching, pitting, Data Interpretation – Drilling from pits.

UNIT II MINERAL PROSPECTING 9

Macro/Micro Economic Considerations-Sampling – Types-Sampling Quantity-Spacing, Sampling error of Mean-Sample Data Processing-Interpretation-Surface/underground mining terms and definition-Drilling – Core, Diamond Drilling arrangement- Core logging, Compositing- Preparation of Slice Plan-Maximising Drill Data Vis-à-vis Cost of Drilling-Preparation of Assay Plans/Sections - Cut off Grade-Determination of Mineable Limits.

UNIT II ORE RESERVE ESTIMATION 9

Reserves and Resource – Types and Classification -Geological / Techno economic Considerations in Reserve Classification-Reserve Estimation Methods – Surface and Underground Deposits.

UNIT IV OREBODY MODELLING 9

Integrating Surface/ Underground mapping-Drilling Sampling to evolve a 3D Model - Fold/Fault Interpretation from Maps and Bore hole Data - GIS Applications in mining and Mineral Projects.

UNIT V SURFACE AND UNDERGROUND MINING METHODS 9

Surface Mining – Development of Bench Mining-Concept-Height/Width/Slope of Benches- Manual and Mechanised Strip/Terrace/Open pit Mining,-Initial Mine Cut-Production per Blast, Blasting Ratio-Stripping Ratio- Breakeven Stripping Ratio-Ultimate depth-Pit Limit for Different cut-off Typical Opencast Layout.-Placer and Alluvial Mining-Delineation of Pay Streak-Estimation of Grade-Coal Mining Methods-Underground Mining-Stoping/Development activities-Typical Stoping Block-General idea of Important Stoping Methods.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Carryout individual mine survey using surveying methods
- Do sampling and prepare slice plan.
- Carryout ore reserve estimation for surface and underground deposits.
- Gain knowledge on surface mining methods
- Understand underground mining methods

REFERENCES

1. Beth Thorpe, Mining Geology-Exploration and Management, Syrawood Publishing House, 2016.
2. Robert Stevens, Mineral Exploration and Mining Essentials, Pakawau GeoManagement Inc, Reprinted, 2012.
3. R.N.P.Arogyswamy, Courses in mining geology. Oxford-IBH, New Delhi, 1994.
4. McKinstry, H.E. Mining Geology, Newyork: Prentice-Hall, Inc. 1970.
5. Deshmukh, D.J.. Elements of Mining Technology, Dhanbad: Vidyaprakshan, 1998.
6. Bruce, A.K.. Surface Mining, Colarodo: Society for Mining, Metallurgy and Exploration Inc. 1990.

7. Hustrulid, H.V and Mark Kuchta, Open Pit Mine Planning and Design Fundamentals, Brookfield USA: A.A Balkema, 1995.
8. Hartman. Howard L, Introduction to Mining Engineering, New York: John Wiley and Sons, 1987.
9. W.C.Peters, Exploration and mining geology. John Wiley & Sons, New York, 1987.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√		√	√	√
CO5	√		√	√	√	√	√		√	√		√

AG5019 NUCLEAR ISOTOPE GEOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To study the radioactive elements and different dating methods
- To understand stable isotopes and their use in Geochronology
- To teach on isotopes and their significance in geological studies.

UNIT I INTRODUCTION AND THE PHYSICS OF THE NUCLEUS 9

Radioactive Decay - Nucleosynthesis Geochronology, Basics of Radiogenic Isotope Geochemistry, The K-Ca-Ar system - The K-Ar and Rb-Sr systems - The Sm-Nd system - The U-Th-Pb system - The U-Th-Pb system: Zircon dating - U-Th decay series dating - Other decay systems.

UNIT II ISOTOPOES IN GEOCHRONOLOGY 9

Fission Track Dating - analytical Methods, Radiogenic isotope geochemistry - The Mantle the Pb Picture. Mantle Models Mantle Plumes. Subcontinental lithosphere. The continental crust. Isotope Geochemistry of subduction zone Magmas - isotope cosmochemistry. Evolution of the atmosphere and cosmogenic radionuclides.

UNIT III STABLE ISOTOPE GEOCHEMISTRY 9

Stable Isotope Theory: Equilibrium fractionations - kinetic fractionations Hydrologic system, biological system. Fractionations of stable isotopes. Stable isotope applications. Assimilations fractional crystallization - Assimilation and subduction - hydrothermal Activity, metamorphism and ore deposits.

UNIT IV STABLE ISOTOPES AND APPLICATIONS IN PALAEOCLIMATE STUDY 9

Paleontology and Archaeology, application to paleoclimatology-deep sea, continental records. The Carbon Cycle. Isotopes, and climate Tree ring studies.

UNIT V CARBON ISOTOPE AND PETROLEUM GEOCHEMISTRY 9

Sulphur isotopes, diffusion experiments in isotope geology with case studies..

TOTAL: 45 PERIODS

OUTCOMES:
On completion of this course, the students expected to be able to:

- Understand the radiogenic isotope geochemistry.
- Have better understanding of isotopes in geochronology
- Appreciate role of stable isotopes in geological studies
- Gain knowledge on stable isotopes and their application for paleoclimate studies
- Understand the role of carbon isotopes in oil exploration

REFERENCES

1. Fraure, G, Principles of isotope geology, John Wiley, Second edition. 1986.
2. Bradely, R.S, Quaternary paleoclimatology, methods of paleoclimatic reconstruction, Allen and Unwin Inc., US, 1985.
3. Criss, R.E. Pricinciples of stable Isotope distributions. Oxford University press, 1999.
4. Lajtha, J. and Michener, R. Stable isotopes in ecology and environmental Science, Blackwell, 1994.
5. Griffiths, K., Stable Isotopes: Interpretation of biological, ecological and geochemical processes, 1998.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√	√	√	√	√	√	√		
CO5	√		√	√	√	√	√			√		√

AG5020 OIL EXPLORATION AND PRODUCTION L T P C
3 0 0 3

OBJECTIVES:

- To teach prospecting methods for oil exploration.
- To teach reserve estimation for oil production
- To provide knowledge on logging and reservoir properties.

UNIT I SEISMIC PROSPECTING 9

Seismic reflection prospecting – data acquisition – receiver design and characteristics – Energy source– seismic instrumentation - survey positioning–establishment of field parameters; Seismic processing–processing steps and associated pitfalls– signal migration–improving the signal – to noise ratio – velocity stacking and verification – displaying seismic data-Interpretation–structural–stratigraphy – facies, sequence and depositional environment – hot spots for oil and gas; 3 D surveying.

UNIT II RESERVE ESTIMATION AND DRILLING OPERATION 9

Volumetric oil and gas reserve estimation – proved, probable and possible reserves – Deterministic methods, Three point estimates- Expressing uncertain in the input to volumetric estimation - Rotary Drilling rig components – Basic operations – operational practices and procedures – Drill stem and assembly – descriptions, care, maintenance and handling practices - Drill stem Design – installation of blowout prevention

UNIT III DRILLING MUD 9

Drilling mud – function, composition, properties, classification of drilling mud – Foam drilling – Packer fluids – solid removal – drilling complications and importance of mud - heaving shale , plastic flow shale – lost circulation, blowouts, Procedure for designing hydraulic program – Minimum annular velocity , circulation rate, pump characteristics calculation of system pressure losses –Equations used in hydraulic calculation – Hydraulics worksheet.

UNIT IV CASING AND CEMENTATION 9

Casing–types, policy, specifications , forces acting–Casing design – preparation of casing to be lowered. Cementation–composition, properties, types, cementation-procedures applications.

UNIT V WELL LOGGING RESERVOIR ENGINEERING AND PRODUCTION 9

Well logging – basic concepts – well bore environments – Logging Methods- Interpretation - calculation of saturation, gas saturation, water saturation porosity, permeability- finding oil, gas and water. Perforation techniques - well completion – fittings of well head, casing head housings, casing test, - transportation of oil, Reservoir engineering - principles- Oil recovery – primary, secondary enhanced oil recovery techniques – chemical methods – miscible methods - thermal method – Petroleum management and economics.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Understand the seismic method of prospecting for Oil.
- Carryout reserve estimation and understand drilling operations.
- Gain knowledge on drilling mud and its properties.
- Understand procedure involved in casing and cementation
- Comprehend well logging methods and reservoir engineering.

REFERENCES

1. Brian J. Evans A Hand book for seismic data acquisition in exploration. Geophysical Monograph Series Publisher:Society of Exploration Geophysics, Tulsa, U.S.A., 1997.
2. Robert E. Sheriff. Seismic stratigraphy, Publisher: International Human Resources Development Corporation, Boston 1980.
3. Bhagwan Shtay, Petroleum Exploration and Exploration practices, Allied Publishers Ltd., 2001.
4. Frank John, Mark Cook &Mark Gratan. Hydrocarbon exploration and production, Elsevier 2003.
5. Drilling: The mannal of methods, application & management. Australian Drilling Industry Training Committee Ltd., Publisher : Lewis publishes, 1997.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√		√
CO4	√	√	√	√	√	√	√	√	√	√	√	√
CO5	√		√	√	√	√	√		√	√		√

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AG5021 ORE GEOLOGY AND MINERAL TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To teach optical properties and identification ore minerals.
- To provide knowledge on geothermometry studies.
- To teach ore mineral beneficiation methods.

UNIT I ORE MICROSCOPY 9

Introduction to ore microscopy – preparation of samples and specimen - mineral identification – examination of optical properties – under reflected light – reflectance measurement of microindentation hardness.

UNIT II ORE FABRICS 9

Ore textures – fabric property on geometry pattern on minerals – texture of primary precipitation – transformation textures – schngiderhom's classification of ore textures and structures – magnetic sedimentary – metamorphic paragenesis.

UNIT III FLUID INCLUSION 9

Ore mineral assemblages in igneous rocks and metamorphic rocks – fluid inclusion studies – nature and location of fluid inclusion – preparation of samples – observation – composition and changes since trapping – fluid inclusion geothermo-metry – application of fluid inclusion studies.

UNIT IV MINERAL TECHNOLOGY 9

Ore microscopy usage in mineral technology – information from mineralogical studies – mineral dressing processes.

UNIT V MINERAL BENEFICATION 9

Ore microscopy in mineral beneficiation of copper ores – gold ores – chromium ores – iron ores – titanium oxides – manganese ores.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Identify minerals under reflected light.
- Classify minerals using ore textures and structures.
- Carryout geothrmo-metry studies.
- Gain knowledge on mineral dressing processes
- Understand the mineral beneficiation methods.

REFERENCES

1. Craig, J. R. and Vaughan, D. J. Ore microscopy and ore petrography. Wiley interscience publication, New York. 1981.
2. Ramdohr, P. The ore minerals and their intergrowth, II ed. Vol. I and Vol. II, Pergamon press, New York, 1980.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√		√	√	√	√	√		√	√	√	√

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AG5022 **PETROLEUM GEOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To teach Origin and formation of hydrocarbons
- To teach on petro physics and tectonic setting.
- To understand depositional systems and biostratigraphy

UNIT I ORIGIN AND PROCESS OF HYDROCARBON FORMATION 9

Fundamental concepts of organic and inorganic theories of hydrocarbon. Sedimentary processes and accumulation of organic matter-diagenesis, catagenesis and metagenesis of organic matter. Generation, migration and accumulation of oil, crude oil types.Oil fields of India.

UNIT II PETROPHYSICS AND TECTONIC SETTING 9

Characterization of sediments to its petrophysical nature, diagenesis signatures, porosity, fabric constituents, accommodation, rate of sedimentation, thickness, maturity, basin structure, tectonic history of the sedimentary basins.Interpretation of surface and subsurface stratigraphic units.

UNIT III GEOPHYSICAL AND GEOCHEMICAL METHODS 9

Seismic method of hydrocarbon reservoir exploration. Seismic profiles interpretation techniques, seismic reflection patterns and to decipher the depositional and structural features.Well logging techniques, interpretation of logs,geochemical parameters; determination of TOM, TOC, VRO, TTI, and TAMR.

UNIT IV DEPOSITIONAL SYSTEMS AND BIOSTRATIGRAPHY 9

Depositional systems, classification, significance in petroleum exploration. Stratigraphic cycles Biostratigraphy- study of planktic and benthic foraminifera, paleobathymetry analysis. Applications of Palynofossils inoil exploration.

UNIT V WELL SITE GEOLOGICAL OPERATIONS 9

Well site geological operations; GTO.Well drilling methods, drilling fluids, formation testing, well completion report.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Understand the processes involved in generation, migration and accumulation of oil.
- Have better understanding of petrophysical characteristics of oil and its tectonic setting.
- Perform geophysical and geochemical exploration studies.
- Comprehend biostratigraphy studies and its application in oil exploration
- Perform well site geological operations

REFERENCES

1. A. T. Levorsen Geology of Petroleum CBS publishers and distributors, Delhi, II Edition 1999.
2. Tissor and D. H. Welte Petroleum formation and occurrence Springer Velag, Tokyo, 1984.
3. D. W. Lewis and Mc Conchie Analytical Sedimentology Chapman & Hall, New york, 1994.
4. J. H Doveton Geological log interpretation Society of sedimentary geology, Tulsa 1994.
5 G. Henery Geophysics of sedimentary basins, Technip, Rue Ginoux, Paris 1994.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√		√		
CO5	√		√	√	√	√	√		√	√		√

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AG5023 **PLANETARY GEOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the concepts of planetary science and Geology.
- To provide information on inner planets of the solar system
- To teach planetary remotesensing

UNIT I INTRODUCTION TO PLANETARY SCIENCE 9

The sun- vital statistics of the sun- -Solar system - origin - physics, chemistry, and the surface features of the solid bodies in the solar system; Solar system. -Celestial sphere- the growth of the geocentric system- physical properties of objects in the solar system.

UNIT II PLANETS 9

Physical properties- optical properties- rotation and magnetic field-surface temperature. Surface features of the terrestrial planets; Inner planets- Geological phenomena- tectonic, volcanic, impact cratering, eolian, fluvial, glacial and possibly lacustrine and marine processes; Outer planets – formation and evolution processes –satellite-characteristic features.

UNIT III EARTH AND MOON 9

The earth: Planetary evolution- gross properties – solar terrestrial relations- earth in space-interior-geologic process; Moon-origin- basic facts- telescopic studies - internal structure-surface features-environment- surface composition and mineralogy and atmospheric conditions

UNIT IV ASTEROIDS-METEORITES- COMETS 9

Classification-physical and chemical properties, difference between asteroids-comets- meteors-geochemistry- relationship between earth and meteorite geochemistry; satellites- medium, small and tiny their- geology, interior, surface properties, atmosphere and potential for life.

UNIT V PLANETARY REMOTE SENSING 9

Study of planetary images, and construction of geological maps from orbital images and Rover (insitu); planetary data formats-Missions to - Moon- Mars-Venus- for geological exploration; Lunar return samples – Apollo-Luna.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students expected to be able to:

- Understand the Planetary science.
- Have better understanding of planets and their geomorphologic features
- Comprehend the knowledge on earth and moon and their properties
- Gain knowledge on asteroids, meteorites and comets
- Understand planetary remote sensing and its applications.

REFERENCES:

1. Gunter Faure & Teresa M. Mensing. 2007. Introduction to planetary science: the Geological perspective, Publisher Springer-Verlag New York.
2. Imke de Pater and Jack J. Lissauer. 2001. Planetary Sciences, Published by Cambridge University press.
3. A.M. Davis 2003. Meteorites, Comets, And Planets, Published by University of Chicago, IL, USA.
4. Grant H. Hieken, David T. Vaniman, Bevan M. Frech. 1991**.** Lunar Sourcebook: A User's Guide to the Moon, ***Cambridge University Press.***
5. Nadine Barlow. 2008. Mars: An Introduction to its Interior, Surface and Atmosphere. Cambridge Planetary Science (No. 8)
6. Mary Chapman. 2007. The Geology of Mars .Cambridge Planetary Science (No. 5)
7. K D Abhyankar. 1999. Astrophysics of the Solar system, Universities Press, Hyderabad, India.
8. A.N. Rencz, 1999. Manual of Remote Sensing, Third Edition, Volume 3, John Wiley & Sons, USA.
9. Encrenaz, T.; Kallenbach, R.; Owen, T.; Sotin, C. 2005. The Outer Planets and their Moons. Springer Space Science Reviews.

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CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√	√	√
CO5	√		√	√	√	√	√		√	√		√

AG5024 QUATERNARY GEOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To understand the Quaternary period and types of Quaternary deposits.
- To understand the Quaternary Study Techniques
- And to understand the Causes of Quaternary climate change.

UNIT I QUATERNARY IN INDIA 9

Definition of Quaternary- Introduction to Quaternary deposits in India-Quaternary Stratigraphy – Oxygen Isotope stratigraphy, biostratigraphy and magnetostratigraphy. Quarternary soil types.

UNIT II CHRONOLOGY OF QUTERNARY SEDIMENTS 9

Relative chronologies and correlation-use of flora and fauna-non-radioactive techniques, dating methods- radiocarbon, U/Th, Pb-Pb with case studies and dendrochronology.

UNIT III QUATERNARY CLIMATE AND EMERGENCE OF HOMINIDS 9

Causes of Quaternary climate change-manifestation of Quaternary climate change and current issues in climate change-Human and Quaternary climate change-fauna at the Pliocene-Quaternary transition-emergence of hominids and evolution of Man.

UNIT IV GLACIAL AND INTERGLACIAL CYCLES 9

Glacial-interglacial cycles-eustatic changes-proxy indicators of paleoenvironmental/ paleoclimatic changes - land, ocean and cryosphere (ice core studies)-Responses of geomorphic systems to climate, sea level and tectonics on variable time.

UNIT V NEOTECTONICS 9

Tectonic geomorphology, neotectonics, active tectonics and their applications to natural hazard assessment with case studies.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will understand theQuaternary period and types of Quaternary deposits.
- Students will able to understand the dating methods and correlation studies.
- Students will learn about the manifestation of Quaternary climate change and current issues in climate change.
- Students will understand the proxy indicators of paleoenvironmental/ paleoclimatic changes.
- Students will able to understand the Neotectonics and deformation during the Quaternary Period.

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REFERENCES

1. Bradley, R.S. Quaternary paleoclimatology, methods of paleoclimate reconstruction, Allen and Unwin, US 1985.
2. Riser, J.A.M., Quaternary Geology and the Environment, Springer, Praxis Publishing, Chichister, UK. 2001.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√		
CO5	√		√	√	√	√	√			√		√

AG5025 SEQUENCE STRATIGRAPHY L T P C
3 0 0 3

OBJECTIVES:

- To teach the sequence stratigraphy techniques and its applications
- To understand depositional systems and models.
- To teach stratigraphic cycle and biostratigraphic records.

UNIT I INTRODUCTION 9

Introduction to sequence stratigraphy, scope, applications in exploration of hydrocarbons, stratigraphic terminology, problems and research trends, stratigraphic architecture, facies and sea level cycles.

UNIT II SEQUENCE STRATIGRAPHY 9

Construction of sequence framework, importance of unconformities, assessing regional and global changes in sea level, areas and volumes of stratigraphic units, hypsometric curves, back stripping, integrated tectonic stratigraphic analysis.

UNIT III SEQUENCE DEPOSITIONAL MODEL 9

Depositional systems and systems tracts, sequence boundaries, litho-log analysis, sedimentary facies, fossil assemblages, counts and their controls, paleoecology & Milankovitch processes.

UNIT IV STRATIGRAPHIC CYCLES 9

Types of stratigraphic cycles, tectno-stratigraphic model, Eustasy, epiorogeny, global cycle chart, tectonic mechanisms.

UNIT V SEQUENCE BIOSTRATIGRAPHY 9

Determination of the biostratigraphic framework, diachroneity of the biostratigraphic record, dating and correlation of stratigraphic events, time in sequence stratigraphy. Applications of sequence bio stratigraphy.

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TOTAL: 45 PERIODS

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OUTCOMES:
On completion of this course, the students expected to be able to:

- Understand the scope of sequence stratigraphy.
- Construct sequence framework.
- Carryout litho-log analysis and mark sequence boundaries.
- Gain knowledge techno-stratigraphic models
- Understand the sequence biostratigraphy and its applications.

REFERENCES

1. Andrew D. M. Geology of stratigraphic sequences Springer Publications, New York 1997.
2. Weimer and Posmentier, Sedimentary Geology, Elsevier Publications, Netherlands 1993.
3. Emery, D., and Myers, K, Sequence Stratigraphy, Blackwell Science, Publ. 1996.
4. Seismic stratigraphy – Applications to hydrocarbon exploration, AAPG Memoir No. 26. 1977.
5. Van Wagonar., P. R. Vail an overview of the fundamentals of sequence stratigraphy and key definitions. Sea level changes – an integrated approach. SEPM Publ. No. 42, 1988.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√			√	√	√	√		
CO5	√		√	√	√	√	√			√	√	√

AG5026 SOIL MECHANICS L T P C
3 0 0 3

OBJECTIVES

- To impart knowledge to classify the soil based on index properties
- To assess their engineering properties based on the classification.
- To familiarize the students about the fundamental concepts of strength of soils

UNIT I SOIL CLASSIFICATION AND COMPACTION 9

Formation of soil - Soil description – Particle – Size shape and colour – Composition of gravel, sand, silt, clay particles – Particle behaviour – Soil structure – Phase relationship – Index properties – Significance – BIS classification system – Unified classification system – Compactionof soils – Theory, Laboratory and field tests – Field Compaction methods – Factors influencing compaction of soils.

UNIT II EFFECTIVE STRESS AND PERMEABILITY 9

Soil - water – Static pressure in water - Effective stress concepts in soils – Capillary phenomena– Permeability interaction – Hydraulic conductivity – Darcy's law – Determination of Hydraulic Conductivity – Laboratory Determination (Constant head and falling head methods) and field measurement pumping out in unconfined and confined aquifer – Factors influencing permeability of soils – Seepage - Two dimensional flow – Laplace's equation – Introduction to flow nets – Simple problems. (Sheet pile and wier).

UNIT III STRESS DISTRIBUTION AND SETTLEMENT 9

Stress distribution in homogeneous and isotropic medium – Boussinesq theory – (Point land, Lineland and udl) Use of New marks influence chart –Components of settlement –— Immediate and consolidation settlement – Terzaghi's one dimensional consolidation theory – Computation of rate of settlement. - √t and log t methods– e-log p relationship.

UNIT IV SHEAR STRENGTH 9

Shear strength of cohesive and cohesion less soils – Mohr-Coulomb failure theory – Measurement of shear strength - Direct shear, Triaxial compression, UCC and Vane shear tests – Pore pressure parameters – Cyclic mobility – Liquefaction.

UNIT V SLOPE STABILITY 9

Stability Analysis - Infinite slopes and finite slopes – Total stress analysis for saturated clay – Friction circle method – Use of stability number – Method of slices – Fellenious and Bishop's method - Slope protection measures.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

- Demonstrate an ability to identify various types of soils and its properties, formulate and solve engineering Problems
- Show the basic understanding of flow through soil medium and its impact of engineering solution
- Understand about the basic concept of stress distribution in loaded soil medium and soil settlement due to consolidation
- Show the understanding of shear strength of soils and its impact of engineering solutions to the loaded soil medium and also will be aware of contemporary issues on shear strength of soils.
- Demonstrate an ability to design both finite and infinite slopes, component and process as per needs and specifications.

REFERENCES:

1. McCarthy, D.F., "Essentials of Soil Mechanics and Foundations". Prentice-Hall, 2006.
2. Coduto, D.P., "Geotechnical Engineering – Principles and Practices", Prentice Hall of India Pvt.Ltd. New Delhi, 2010.
3. Das, B.M., "Principles of Geotechnical Engineering". Brooks / Coles / Thompson Learning Singapore, 8th Edition, 2013.
4. Punmia, B.C., "Soil Mechanics and Foundations", Laxmi Publications Pvt. Ltd. New Delhi, 2005.
5. Murthy, V.N.S., "Soil Mechanics and Foundation Engineering", CBS Publishers Distribution Ltd., New Delhi. 2015
6. Gopal Ranjan and Rao, A.S.R., "Basic and Applied Soil Mechanics", New Age Ltd. International Publisher New Delhi (India) 2006.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√		
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√	√		√	√	√	√		
CO5	√		√	√	√	√	√			√	√	√

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OPEN ELECTIVE COURSES (OEC)

MP5491 NUCLEAR ENERGY IN HEALTH CARE AND INDUSTRY L T P C
3 0 0 3

OBJECTIVES

- To provide the student about the action of radiation on living cells and the response.
- To make the student to understand the basic nuclear medicine physics and newer technology systems.
- To enable the students to understand the diagnostic and therapeutic nuclear medicine techniques.
- To provide a broad knowledge in radiation hazard evaluation and control

UNIT I BASICS OF NUCLEAR SCIENCE AND RADIATION EFFECTS 9

Radioactivity, nuclear reactions and interaction of ionizing radiation with matter, with emphasis on radiation detection, radiation shielding - photoelectric - Compton effect and pair production - biological effects on human health - Action of radiation on living cells -direct and indirect physical damage- cell response to radiation - somatic and genetic radiation effects -Radiation side effects - Acute and chronic effects of low dose effects.

UNIT II DIAGNOSTIC APPLICATIONS OF NUCLEAR ENERGY 9

Production of X rays and its applications X-ray radiography - CT scan -contrast studies in x ray imaging - fluoroscopic applications -Mammography - physics of nuclear medicine and nuclear imaging - radio isotopes in diagnosis of nuclear imaging - Tc-99m extraction - radiopharmaceuticals - scanning instruments and techniques.

UNIT III THERAPEUTIC APPLICATION OF NUCLEAR ENERGY 9

Production of nuclear radiations- alpha, beta and gamma rays and X-rays - External radiation therapy -telecobalt unit and linear accelerators - and internal radiation therapy - Iridium -192 HDR brachtherapy unit- therapeutic nuclear medicine.

UNIT IV INDUSTRIAL APPLICATIONS OF NUCLEAR ENERGY 9

Industrial applications — Non destructive testing - industrial radiography - tracing, gauging, Radiation sterilization of medical equipments - food preservation and other applications.

UNIT V NUCLEAR RADIATION SAFETY MEASURES 9

Basic concepts of radiation protection standards - ICRP recommendations - systems of radiological protection - Optimization of protection and individual dos limits - Radiation dose to individuals from natural radioactivity in the environment and man- made sources - Evaluation of external and internal radiation hazards - effect of time, distance and shielding - radioactive waste disposal and transport of radioactive nuclides.

TOTAL: 45 PERIODS

OUTCOMES

After successful completion of the course

- students will be able to handle radioactive source carefully for treatment purpose.
- will develop competence in radioactive waste disposal management
- Will be develop competency to face radiation emergency
- students will develop critical thinking skills in radiation safety and protection.
- will be able to safe guard the radioactive sources used in hospitals.

REFERENCE BOOKS:

1. W. R. Handee, Medical Radiation Physics, Year Book Medical Publishers Inc., London, 2003.
2. E. J. Hall, Radiobiology for Radiologists, J. B. Lippincott Co., Philadelphia, 2000.
3. W. N. Wagner, Principles of Nuclear Medicine, W. B. Saunders Co., London, 1990.
4. R. F. Mold, Radiation Protection in Hospitals, Adam Hilger Ltd., Bristol, 1985.
5. Fred A Mettler and Milton J Guiberteau, The essentials of nuclear Medicine imaging, 2011.

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MP5492 SMART MATERIALS FOR ENERGY AND ENVIRONMENT APPLICATIONS **L T P C 3 0 0 3**

OBJECTIVES

- To provide fundamental understanding on smart and intelligent materials.
- To enhance students' understanding on the structure-property relationship.
- To enable students appreciate novel materials and their usage in current cutting edge technologies.

UNIT I BASICS OF SMART MATERIALS AND STRUCTURES 9

Introduction - components and classification of smart structures, Requirements of Intelligent Materials – Functions: Sensor, Memory, Processor, Actuator - Common smart materials - Applications of smart systems – Energy Harvesting systems: Regenerative braking - Smart polymers: Applications in drug delivery, tissue engineering. Biomimetics and bio-inspiration.

UNIT II INTELLIGENT MATERIALS FOR ENERGY GENERATION 9

Artificial Intelligence in Materials, Ferrolectricity: Introduction - Piezoelectric effect, Piezoelectric materials as sensors, Actuators and bimorphs - Transparent Conducting Materials – Band-gap and electrical conductivity, Conditions for transparency – role of defects on conductivity - Applications: Solar cells, Touch screen, etc.

UNIT III SHAPE MEMORY MATERIALS FOR ENERGY STORAGE 9

Introduction to structure types, Structure-property relationships, Shape memory effect (SME), One way and two-way SME, Shape memory alloys (SMAs), Intelligence in the form of SMA, Functional properties of SMAs. Thermal-storage, and aerospace materials. Shape-memory polymers, and their applications.

UNIT IV MULTIFERROIC MATERIALS FOR NOVEL REFRIGERATION 9

Ferromagnetism and ferroelasticity, Magneto-electric materials: Types of magnetic ordering phenomena, Conditions for multiferroicity– Applications of multiferroic materials. Magnetostrictive smart materials – Magneto-caloric materials for emission-less refrigeration - Magneto-Optic (MO) Materials: Examples (Heusler alloys, double perovskites) and Applications.

UNIT V INTELLIGENT OPTICAL MATERIALS FOR ENVIRONMENT 9

Smart optical materials for modifying spectral shift and refractive index shift. Electro-optic and Acousto-optic materials: Definitions, examples and applications –Chromogenic Materials – Types: Photochromic, Thermochromic, Electrochromic - Devices and Applications:Radiation absorption.

TOTAL: 45 PERIODS

OUTCOMES

- The student will understand the working principle of smart materials
- The student will get an overview on various types of smart materials and their application areas.
- The student will get ideas to use smart materials in green energy and environment applications
- The student will get motivated to find novel applications of these multifunctional materials in new technologies.
- The student will get an idea on different synthesis and characterization techniques

REFERENCES

1. D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley 2007.
2. M. Addington, D.L. Schodek, Smart Materials and New Technologies, Elsevier 2005.
3. K. Otsuka, C.M. Wayman (Eds.), Shape Memory Materials, Cambridge University Press, 1998.
4. M.V. Gandhi, B. S. Thompson, Smart Materials and Structures, Springer, 1992.
5. P. Ball,Made to Measure: Materials for the 21st Century, Princeton University Press, 1997.
6. Ed. M. R. Aguilar and J.S. Roman, Smart Polymers and their Applications, Elsevier 2014.
7. Ed.: Peter L. Reece, Smart Materials and Structures: New Research, Nova Science 2007.
8. Ian Baker, Fifty Materials that Make the World, Springer, 2018.
9. Ed.: Mel Schwartz, Smart Materials, CRC Press, 2008.

EA5491 **CLIMATE JOURNALISM** **L T P C**
3 0 0 3

OBJECTIVES

- To offer a comprehensive approach to reporting of climate change.
- To impart knowledge about political, economic, and ethical questions raised by the need for transformative change of societies in the wake of climate change.
- To reflect over the development of climate change as a nature and a society issue.
- To synthesize knowledge from different areas related to climate change.
- To reflect on the norms and values of journalism in the context of climate change.

UNIT I HUMAN INFLUENCES 9

Anthropocene Era (anthropo: man, and cene: new) - Freshwater scarcity - The decline of our oceans, fish, and wildlife - Environmental health - Sustainable energy, agriculture, and food systems – Role and responsibility of journalists – Making climate change relevant as a society issue – Politics and economics of climate change – Environmental ethics – Human health – Species migration.

UNIT II PUBLIC NARRATIVES 9

Complex science and uncertainty - Public apathy and politics - Well-funded counter-narratives - Zealous stakeholders - What can (incorrectly) appear due to a lack of news hook for stories - Two centuries of CO_2emissions.

UNIT III JOURNALISTIC CHALLENGES 9

Environmental Journalism as a craft - Roles and differences between journalism and communications – Finding the most accurate, credible and timeliest information on science and issues – Essentials of environmental reporting – Discerning uncompromised expert sources – Using human narratives and descriptive storytelling to relate real-world impact – Tapping the databases, records and other tools commonly used by environmental reporters.

UNIT IV CLIMATE ISSUES 9

The lack of diversity in environmental journalism – “Junk science” – Battling climate denial - Covering GMOs – The problem of doomsday climate reporting – Digital security for journalists and researchers etc.

UNIT V JOURNALISTIC SKILLS 9

Hands-on journalistic series – Reporting, developing, funding, crafting and publishing environmental stories – Writing diverse stories on environmental history, a wildlife or ocean story, a clam-aquaculture story, a work of nature writing, etc. – A polished, fact-checked, final story with questions answered and edits made from the first draft and at least two added elements such as photos, audio or video clips, graphics, timelines or others to draw people in.

TOTAL: 45 PERIODS

OUTCOMES

- Students will understand the importance of climate issues.
- Students will understand the various aspects of climate change and its effect in society.
- Students will learn to cover the climate change issues.
- Students will understand the need of journalistic skills for covering climate issues.
- Students will learn the various strategies, approaches on covering climate issues in various media.

REFERENCES

1. Lakoff, G., Why it matters how we frame the environment. In Environmental Communication, 2010.
2. Vetlesen, A. J., Nature, technology and environmental crisis. In Bhaskar, R., Næss, P., Høyer, K.G. (eds.), Eco philosophy in a World of Crisis. Critical Realism and the Nordic Contributions. London: Routledge, 2012.
3. Ytterstad, A., The climate crisis challenges the objectivity ideal in Norwegian journalism. In Ytterstad. A., Norwegian Climate Change Policy – Between Hegemony and Good Sense, Oslo: Unipub, 2012.

4. Anker, Peder, A pioneer country? A history of Norwegian climate politics. In Climatic Change. ISSN 0165-0009. 2016.
5. Klein, N., This Changes Everything - Capitalism vs the Climate. Part 1 and 3. London: Allan Lane, 2014.
6. Stoknes, P.E., What We Think About When We Try Not to Think About Global Warming: Toward a New Psychology of Climate Action. Vermont: Chelsea Green, 2015.

EA5492 DIGITAL PHOTOGRAPHY L T P C
3 0 0 3

OBJECTIVES

- To create opportunities for professional and creative expression through the practice and art of photography.
- To inculcate aesthetic sense involved in creativity.
- To get to know the genres of photography

UNIT I CAMERA 9

Different camera formats, working of an SLR and DSLR and Mirrorless Cameras. Features and functions of SLR and DSLR Cameras. Various camera controls. Anseladams Zone system. Exposure. Image sensors. Different storage formats.

UNIT II LENS AND ELEMENTS OF PHOTOGRAPHY 9

Different type of Lenses - Basic Shots and Camera Angles, Photographic Composition - View point and Camera angle-Eye Level, Low and High, Balance- Aspects of Balancing, Shapes and Lines, Pattern, Volume, Lighting, Texture, Tone, Contrast- and Colour, Framing, various Perspectives.

UNIT III COLOUR AND LIGHTING 9

Colour Theory, Colour Temperature, Electromagnetic spectrum, Lighting Philosophies – Basic styles of Lighting – Properties of Light – Additive and Subtractive Light – Contrast and Lighting Ratios – Direct and Indirect Light – Three point and Five Point Lighting – Light Sources. Light meters and filters

UNIT IV PEOPLE AND PORTRAIT PHOTOGRAPHY 9

Indoor and outdoor lighting techniques for portraits, the Casual Portrait, Environmental Portraits, Group Portraits, Familiar Subjects, Hands and Other Details.

UNIT V GENRES OF PHOTOGRAPHY 9

Basic shooting and Lighting Techniques and Equipments required for different genres of Photography like Black and White, Landscape, Cityscape, Architecture, Advertising, Table top photography Fashion, Food, Automobile, Sports, Travel, Children, Portrait, wild life, Still Life, Event, Silhouette, Festival and Themes.

TOTAL: 45 PERIODS

OUTCOMES

- Students will be able to utilize the principles of good composition in photography.
- Students will be able to develop an individual style in representing the society through photographs.
- Students will have a thorough understanding of how to create visual variety
- Students will understand the foundation principles of design
- Students will gain understanding in Depth of field
- Students will understand the different genres of photography

REFERENCES

1. Ansel Adams, The Negative, Bulfinch press, Fourteenth Edition, 2008.
2. BalakrishnaAiyer, Digital Photojournalism, Authors press, 2005.
3. Ben long, Complete Digital Photography, Charles River Media, Third Edition, 2005.

4. Fil Hunter, Steven Biver, Paul Fuqua, Light - Science & Magic: an Introduction to Photographic Lighting, Focal Press, 2007.
5. Langford Bilissi,Langford's Advanced Photography, focal press, Seventh Edition, 2008.
6. Scott Kelby, The Digital Photography Book, Peachpit Press, 2009.

AC5491 GREEN CHEMISTRY L T P C
3 0 0 3

OBJECTIVES

- To introduce the basic concept and principles of green chemistry for environmental management.
- To make the students know about green reagents and its importance to the environment
- To acquaint the student with green solvents and its impacts in green chemistry
- To familiarize the synthesis of materials using green methods
- To impart the knowledge on applications of green synthesis technology

UNIT I PRINCIPLES OF GREEN CHEMISTRY 9

History of green chemistry and sustainability- Prevention of waste/by-products – maximum incorporation of reactants in final product-Atom economy – Prevention/minimization of hazardous products – Designing safer chemicals – optimizing reaction conditions.

UNIT II GREEN REAGENTS AND CATALYSTS 9

Choice of starting materials – reagents (Dimethyl carbonate, polymer supported reagents) – catalysts (microencapsulated Lewis acids, zeolites, basic catalysts polymer supported catalysts, introduction to biocatalysts).

UNIT III GREEN SOLVENTS 9

Aqueous phase reactions (Claisen rearrangement, Aldol condensation, wurtz reaction, reduction of carbon carbon double bond, oxidation of amines into nitro compounds – Electrochemical synthesis (synthesis of adiponitrile) - Ionic liquids – reactions in acidic ionic liquids- reactions in neutral ionic liquids (hydrogenations, diels-Alder reactions, Heck reactions, O-alkylation and N-alkylation, methylene insertion reactions.

UNIT IV GREEN SYNTHESES 9

Microwave induced green synthesis (Hoffmann Elimination and Oxidation of alcohols) – Ultra sound assisted green synthesis (Esterification, Saponification and Cannizaro reaction) – Solid state green synthesis (Dehydration of alcohols to alkenes, Grignard reaction)- Solid supported organic synthesis (Synthesis of furans and pyrrole)

UNIT V APPLICATIONS OF GREEN SYNTHESIS 9

Introduction – synthesis of styrene, adipica acid, catechol, 3-Dehydroshikimic acid, methyl methacrylate, urethane. Environmentally benign synthesis of aromatic amines – free radical bromination – synthesis of ibuprofen and paracetamol.

TOTAL: 45 PERIODS

OUTCOMES

- To be familiar with basic concepts of green chemistry and apply to them in various field
- To recognize the catalytic reaction with green reagents and its importance. To identify available green solvents and apply them to various synthesis process
- To recognize the preparations of materials with green process and its application to the environment.
- To gain the knowledge of preparation of various drugs using green synthesis methods
- To be have the skills and technology towards green chemistry and apply in industry.

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REFERENCES
1. V.K. Ahluwalia and M. Kidwai, New trends in Green Chemistry, Anamaya Publishers, 2004.
2. V. K. Ahluwalia, Green Chemistry, Narsoa publishers, 2012
3. Bela Torok and Timothy Dransfield ,Green Chemistry, An Inclusive Approach, 1st Edition, Elsevier, 2017.

AC5492 FOOD CHEMISTRY L T P C
3 0 0 3

OBJECTIVES
- To enable the students to acquire knowledge on the macro and micro constituents of the food
- To know the structure and chemical characteristics of constituents of food.
- To demonstrate the knowledge of food chemistry and applying, the principles and concepts of chemistry as they apply to food systems.
- To familiarize the student with the relationship between water and food.
- To explain the rationale for certain food processes and preservation

UNIT I INTRODUCTION TO FOOD AND ITS PROPERTIES 12

Proteins-Enzymes- Chemistry and structure, kinetics, Maillard reaction. Food carbohydrates: Structural, nutritional and functional aspects. Emulsifiers-role of emulsifiers selection of emulsifier based on hydrophilic and Lipophilic balance (HLB) and its application. Thickeners-definition, chemical structure, gel formation, list of permitted thickeners and food application. Chemical and biochemical changes: changes occur in foods during different processing.

UNIT II PROCESSING AND PRESERVATION 12

Scope and benefits of industrial food preservation. Preservation of foods by chemicals, antibodies, antioxidants, salt and sugar. Principles of food freezing: freezing point of foods Psychrometric chart, Freeze concentration, freeze drying, IQF. Nanotechnology: Principles and application in foods, Hurdle technology: Types of preservation techniques and their principles, concept of hurdle technology and its application.

UNIT III FLAVOURS AND COLOURING AGENTS 9

Chemistry of food flavor, definitions, Flavourmatics /flavouring compounds, flavor retention-off flavours and food taints. Colour -Natural and synthetic food colours, their chemical structure, stability, permitted list of colours, usage levels and food application.

UNIT IV WATER RELATIONS IN FOOD 6

Moisture in food: Structure, properties, Types of water in food and their specific function water activity and stability.

UNIT V FOOD ADDITIVES 6

Definitions, uses and functions of: Acids, Bases, Buffer system, chelating/sequestering agents, Antioxidants, Anti-caking agents, Firming agents. Flour bleating agents and Bread improvers. Anti-microbial agents/ class I & II.

TOTAL: 45 PERIODS

OUTCOMES
- Will know about the factors governing the food quality and chemical constituents.
- Will be able to name and describe the general chemical structures of the major components of foods and selected minor components
- Will come to know about the techniques involved in food processing and preservation
- Will be acquitted with food additives and their function in preservation
- Will be familiarize with the nature of packed food from industrial processes

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REFERENCES
1. Damodaran, S., Parkin, K. L., and Fennema, O.R. (2008) Fennema's Food Chemistry 4th Edition, CRC Press
2. Belitz, H-D., Grosch, W. & Schieberle, P. (2004) Food Chemistry 3rd Ed. (translation of fifth German edition), Springer
3. DeMan, J.M. Principles of Food Chemistry 4rd Ed. Aspen Publishers (2018)
4. Peter C. K. Cheng, Handbook of Food Chemistry, Vol 1, Springer Reference, 2015
5. Jaswinder Kaur and Barry H. Grump Fundamentals of Food Chemistry, Abhizeet Publications, 2010.
6. Harish Kumar Chopra and Parmjit Singh Panesar, Food Chemistry, Narosa Publication, 2010.

AG5491 NATURAL HAZARDS AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVES
- To teach characteristics of natural hazards.
- To teach mitigation methods for natural hazards.
- To provide knowledge on assessment and management of natural hazards.

UNIT I DISASTER PHENOMENON 9
Disaster threat - characteristics-parameters – mapping aspects for earthquake, landslides, tsunami, cyclones, flood, drought and epidemics.

UNIT II MITIGATION 9
Geological and hydrological hazards - Reduction of hazard proneness – reducing structural vulnerability – changing the functional characteristics of settlement – building code provisions.

UNIT III ASSESSMENT 9
Elements of risk – vulnerability analysis on dam and other infrastructures – risk assessment – plan area – organizational aspects, planning and mapping levels – socio-economic aspects – cost of risk reducing measures.

UNIT IV MANAGEMENT 9
Prevention – preparedness – response – recovery – resource utilization – international assistance – policy and legislation – training – public awareness.

UNIT V CASE STUDIES AND ADVANCED TOOLS 9
Post disaster review – role of remote sensing and GIS –National and state level case studies on various disasters.

TOTAL: 45 PERIODS

OUTCOMES
On completion of this course, the students expected to be able to:
- Gain knowledge on natural hazards and their characteristics
- Have better understanding on geological and hydrological hazards
- Appreciate various mitigation techniques.
- Carryout risk assessment and vulnerability mapping
- Understand the role of remote sensing and GIS in natural hazard risk reduction.

REFERENCES
1. Nick Carter, W. Disaster management, A Disaster manager's Handbook, Publisher: Asian development bank, Manila, 1992.
2. Mitigating natural disasters: Phenomena, effects and options, a Manual for policy makers and planners. Publisher: United Nations, Hew York, 1991.

3. Edward A. Keller, DeVecchio. Natural Disasters: Earth's Processes as Hazards, Disasters and Catastophes, Routledge, 3rd Edition, 2011.
4. Harsh K. Gupta, Disaster Management, Indian National Science Academy, ISBN 8173714568,788173714566, 2006 second Edition, 152 Pages.
5. Ghanshyam Singh and Sandip Bhandari, Disaster Management, Gullybaba Publishing House (P) Ltd; 1st edition (2012), ISBN-13: 978-9381066492.

CO-PO Mapping:

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CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√		√	√	√
CO5	√		√	√	√	√	√			√		√

AG5492 OCEAN RESOURCES AND EXPLORATION TECHNIQUES L T P C
3 0 0 3

OBJECTIVES

- To understand the Sources of Marine Minerals.
- To understand the various energy resources pertain to marine system
- To understand the importance and economic aspects of marine minerals

UNIT I INTRODUCTION 9

Marine Mineral Resources - sources of Marine Minerals -sources in ocean basins. Formation Processes of Polymetallic Sulfides (PMS) on the Ocean Floor- Plate boundaries and associated mineral and energy occurrences.

UNIT II OCEAN RESOURCES 9

Mineral deposits derived from land sources - Placer Deposits - Lime, Phosphorite and Salt Deposits - Beach Deposits of Continental Margins - rock salt (sodium chloride) - magnesium metal - magnesium compounds and bromine. metalliferous sediments-Seafloor Polymetallic Massive Sulphides - polymetallic manganese nodules. Methane hydrate.

UNIT III ENERGY RESOURCES 9

Wind Energy - Wave Energy - Tidal Energy - Ocean Current Energy - Ocean thermal energy conversion (OTEC) - osmotic power plant-Petroleum resources and radioactive nuclear mineral deposits

UNIT IV OCEAN RESOUCE EXPLORATION AND EXPLOITATION 9

Marine sampling - Water Samplers - Bottom Samplers - Instrumentation

UNIT V OCEAN MINERAL MINING 9

Mining aspects of deep-sea polymetallic sulphides - Manganese Nodules - Methane Hydrates. Sand, Sand Mining & Beach replenishment-Marine maps of Exclusive Economic Zone (EEZ)

TOTAL: 45 PERIODS

OUTCOMES

- Students will understand the various sources of marine minerals.
- Students will able to understand the Mineral deposits derived from land sources.
- Students will learn about the energy resources of marine system.
- Students will learn about various sampling methods and instrumentation.
- Students will able to understand the economic aspects of marine minerals.

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REFERENCES

1. H. Kunzendorf, Marine Mineral Exploration, Volume 41, 1st Edition, Elsevier Science, 1986
2. David Spencer Cronan, Handbook of Marine Mineral Deposits, CRC Press, 24-Nov-1999
3. Yves Fouquet , Denis Lacroix , Deep Marine Mineral Resources, 2014th Edition, Springer Dordrecht Heidelberg London New York
4. H. Kunzendorf , Marine Mineral Exploration, ISBN-10: 0444426272, Elsevier Oceanography Series

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√	√	√	√	√	√	√	√
CO2	√		√	√	√	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√	√	√	√	√	√
CO4	√	√	√	√		√	√	√	√	√		√
CO5	√		√	√	√	√	√		√	√	√	

MC5491 BASIC CRYSTALLOGRAPHY AND CRYSTAL GROWTH L T P C
3 0 0 3

OBJECTIVES

- To introduce the basics of crystal symmetry and crystal structures.
- To provide students with a background to X-ray generation and detection
- To provide instruction on the steps involved in single crystal structure determination
- To teach the concept of powder X-ray diffraction and its applications
- To teach various crystal growth techniques

UNIT I CRYSTAL SYMMETRY AND STRUCTURES 9

Crystalline and non-crystalline materials — symmetry: symmetry operations, symmetry elements - translational symmetries - point groups - space groups – equivalent positions - space lattice - crystal systems – Bravais lattices – crystal directions - crystal planes – Miller indices- interplanar spacing – coordination number– atomic radius – atomic packing factor of SC, BCC, FCC and HCP structures – linear density – planar density – close packed structures.

UNIT II X-RAYS 9

X-rays - generation of X-rays - sealed tube and rotating anode generators – synchrotron radiation – continuous and characteristic X-rays - X-ray absorption – X-ray monochromators – collimation – Soller slits - X-ray detectors (principles only)

UNIT III SINGLE CRYSTAL STRUCTURE DETERMINATION 9

Diffraction by X-rays - Bragg's law – reciprocal lattice and Ewald sphere – atomic scattering factor - intensities of diffracted X-rays -– Single crystal X-ray diffractometers – measurement of intensities – systematic absences – space group determination - factors affecting X-ray intensities – data reduction – solving the structure - phase problem in crystallography – direct methods – refining the structure – results - geometrical parameters.

UNIT IV POWDER X-RAY DIFFRACTION 9

X-ray diffraction by polycrystalline materials - formation of powder diffraction patterns - Debye-Scherrer camera – powder X-ray diffractometer – diffractograms – sample holders – sample preparation – orientation of crystallites – sample rotation – diffraction geometries – indexing of powder pattern – applications of powder diffraction.

UNIT V CRYSTAL GROWTH TECHNIQUES 9

Bridgman technique - Czochralski method - Verneuil technique - zone melting – gel growth – solution growth methods – low and high temperature solution growth methods – vapour growth - epitaxial growth techniques- LPE – MOCVD – MPE.

TOTAL: 45 PERIODS

OUTCOMES

Upon completion of the course the students will

- understand crystal symmetry, crystal planes and simple crystal structures
- gain a knowledge of X-ray generation, absorption, monochromatization and detection
- get a working knowledge of single crystal structure determination
- get some insight into the powder diffraction and its applications
- be able to understand the basics of various crystal growth techniques

REFERENCES

1. Tareen, J.A.K. and Kutty, T.R.N. A Basic course in Crystallography. University Press, 2001.
2. Cullity, B.D. and Stock,S.R. Elements of X-ray Diffraction. Pearson, 2014
3. Stout, G.H. and Jensen, L. X-ray Structure Determination, A Practical Guide. Macmillan : New York, 1989.
4. Woolfson, M.M. An Introduction to X-ray Crystallography. Cambridge University Press, New York, 1997.
5. Bhat, H.L Introduction to Crystal Growth: Principles and Practice. CRC Press, 2014.

MC5492 NONLINEAR SCIENCE L T P C

3 0 0 3

OBJECTIVES

- The students will be introduced to the basics of nonlinear dynamics and its applications.
- The students will learn about the mathematical models needed to study the concepts of fixed points, oscillations, bifurcations and integrability.
- The students will know about the nonlinear dynamical phenomena in chemical systems.
- The students will understand the importance of nonlinear dynamics in biological systems.
- The students will be introduced to the concepts of nonlinear dynamical analysis in geological systems.

UNIT I NONLINEAR DYNAMICS 9

Dynamical systems - linear systems - importance of nonlinearity - nonlinear dynamical systems - Autonomous and non-autonomous systems - phase-space, flows and limit sets . Classification of equilibrium points in planar systems – periodic and chaotic motions - fractals - pattern formation - cellular automata - self-self-organised criticality - networks - stochastic resonance.

UNIT II MATHEMATICAL MODELS 9

First-order differential equations - separation of variables - slope fields - Euler's method - equilibria and phase plane - bifurcations - higher-order equations - trace-determinant plane - harmonic oscillators - equilibrium point analysis - non-autonomous systems and chaos - finite dimensional integrable systems - dispersive systems - solitary waves - solitons - analysis of soliton solutions.

UNIT III CHEMICAL SYSTEMS 9

Chemical oscillations - waves and patterns - transport and external field effects - polymer systems - coupled oscillators - Turing patterns - stirring and mixing effects - Briggs-Rauscher reaction - Belousov-Zhabotinsky reaction - BZ waves - propagating pH front - chemical clocks.

UNIT IV BIOLOGICAL SYSTEMS 9

Biological oscillators - excitable systems - neuronal systems: HH equations - FN equations - physiological control systems - dynamics of bone remodelling - dynamics of nucleic acids:Protein complexes - patterns in biological membranes - cell replication and control - pupil light reflex - dynamical analysis of human tremor - fractals in living organisms.

UNIT V GEOLOGICAL SYSTEMS 9

Computational models of earthquakes - earthquake processes - multi fractals in geosciences - entropy analysis of seismicity - tectonics - spatial distribution of earthquakes - volcanic eruptions - short and long range interactions - RJB model - precursory dynamics - landscape dynamics - dynamics of earth's magnetosphere. Snow avalanches and system model - geomorphology: drainage networks, fractal trees, growth models, diffusion-limited aggregation.

TOTAL: 45 PERIODS

OUTCOMES

After completing this course, the students should able to

- Understand the basics of nonlinear dynamics and its applications.
- Gain knowledge on the concepts of fixed points, oscillations, bifurcations and integrability.
- Appreciate the importance of nonlinear dynamical phenomena in chemical systems.
- Understand the role of nonlinear dynamics in biological systems.
- Apply nonlinear dynamical analysis for geological systems.

REFERENCES

1. M. Lakshmanan and S. Rajasekar. Nonlinear Dynamics: Integrability Chaos and Patterns. Springer-Verlag, 2003
2. M. Lakshmanan and K. Murali. Chaos in Nonlinear Oscillators. World Scientific,Singapore, 1996.
3. S.H.Strogatz. Nonlinear Dynamics and Chaos. CRC Press, 2014.
4. Paul Blanchard, R.L.Devaney and G.R.Hall. Differential Equations. Brooks/Cole, 2012.
5. Irving R.Epstein and J.A. Pojman. An Introduction to Nonlinear Chemical Dynamics. Oxford University Press, 1998.
6. Anne Beuter, Leon Glass, M.C.Mackey and M.S.Titcombe. Nonlinear Dynamics in Physiology and Medicine. Springer, 2003.
7. Donald L. Turcotte. Fractals and Chaos in Geology and Geophysics. Cambridge University Press, 1997.

MT5491 STATISTICAL METHODS L T P C

3 0 0 3

OBJECTIVES

- To organize and describe the data and hence compute the various descriptive measures
- To give an idea of testing the statistical hypothesis claimed based on a set of data points using standard sampling distributions
- To expose to the basic principles of experimental design and hence carry out the analysis of variance
- To use non parametric methods on data sets which are not from normally distributed population
- To prepare the students to implement the various concepts in statistics using R statistical tool

UNIT I DESCRIPTIVE STATISTICS 9

Frequency distribution - Graphs of frequency distribution - Descriptive Measures - Quartiles and Percentiles - Calculation of sample mean and population mean

UNIT II HYPOTHESIS TESTING 9

Sampling Distributions- Central Limit Theorem - Testing a Statistical Hypothesis - Tests Concerning Means and variances - Independence of Attributes - Goodness of Fit

UNIT IV ANALYSIS OF VARIANCES 9

One way and two way classification - Completely Randomized Design - Randomized Block Design - Latin Square Design

UNIT V NONPARAMETRIC METHODS 9

Sign Test - Wilcoxon's Signed Rank Test - Rank Sum Tests - Tests of Randomness - Kolmogrov Smirnov and Anderson Darling Tests

UNIT V CALCULATIONS USING R 9

Classification and tabulation of data - Graphical representation - Calculation of central tendency and dispersion of data - Implementation of skewness, moments and kurtosis - Hypothesis Testing - Implementation of ANOVA, sign test and rank sum test.

TOTAL: 45 PERIODS

OUTCOMES

- It equips the student to compute mean, variances, quartiles and percentiles for a large set of data points obtained from a series of measurements
- It imparts the knowledge of various test statistics used in hypothesis testing for mean and variances of large and small samples
- It enables the students to compare several means
- It makes the students use sign test and rank test which can be applied to any raw data without the underlying assumptions that the observations are from normal population.
- It equips the students to implement the various concepts learnt using R tool for statistics

REFERENCES

1. Gupta S. C. and Kapoor V. K, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, 11th Edition, New Delhi, 2002.
2. John E. Freund ," Mathematical Statistics with Applications", 8th Edition, Pearson Education, New Delhi, 2017.
3. Richard A. Johnson, Irwin Miller and John Freund, "Miller and Freund's Probability and Statistics for Engineers", 8th edition, Pearson Education, New Delhi, 2015.

HS5491 PROFESSIONAL EMAIL COMMUNICATION L T P C

3 0 0 3

UNIT I Email as a medium of professional communication (1 hour)

a. Clear, grammatically correct sentences
b. Clear and coherent paragraphs
c. Polite and professional expression
d. Accurate punctuation

The nature of the e-mail in its present technological state

a. The pros and cons of using email for professional communication

UNIT II **Standard email conventions and etiquette**

a. Conventions for effective emailing intra and inter workplaces(inclusive of formatting)
b. Interpersonal etiquette to be used in professional emailing
c. Cross- cultural dos and don'ts when using email across borders

UNIT III **Understanding email messages accurately (2 hours)**

a. Understanding the core message
b. Understanding the writer's intention and expectation accurately
c. Interpreting the style ad tone of the message
d. Reading and understanding messages quickly

UNIT IV **Writing clear and contextually appropriate responses (12 hours)**

a. Writing appropriate opening and closing sentences
b. Structuring the email logically and coherently
c. Positioning the core message for reader attention and action
d. Writing messages for a range of professional functions such as giving an update, reporting, requesting , clarifying and confirming, giving instructions etc.

UNIT V **Using a range of professional styles (10 hours)**

a. Maintaining courtesy and professional poise in all messages
b. Being direct or indirect as necessary
c. Being elaborate or brief as necessary
d. Being assertive and decisive when needed

TOTAL: 45 PERIODS

Learning outcome: At the end of the course, the students should

- Understand email as a professional communication medium and as it is used in workplaces today.
- Use standard e-mailing conventions and etiquette used in workplaces internationally.
- Use appropriate style and tone for communicating a variety of professional messages that are generally communicated via e-mail in work and business communication.
- Read and interpret e-mail messages accurately and write contextually appropriate responses.
- Use English accurately while writing emails in generic professional contexts.
- Use punctuation accurately while writing e-mail messages.

Assessment (with individualised feedback for mid-course tests) :

Mid-course Assessment - 1 hour + 1 hour for feedback after evaluation)

Mid-course Assessment - 2 (1 hour + 1 hour for feedback after evaluation)

Final Assessment – 2 hours (inclusive of Email English test)

Classroom teaching methodology: Concept familiarisation will be accompanied with practice in generic professional emailing contexts. Practice tests and individualised feedback will be used feedback.

Material for the course will be teacher generated

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HS5492 **PROJECT REPORT WRITING** **L T P C**
3 0 0 3

OBJECTIVES

The Course aims to,

- Develop the project writing skills of engineering graduates
- Give engineering and technology students practice in writing a project report
- Enhance their awareness on the importance of report writing in the professional context

UNIT I

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing

UNIT II

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis

UNIT III

Structure of the Project Report: (Part 1)Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework

UNIT IV

Structure of the Project Report: (Part 2) – Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations - Recommendations – Conclusion – Bibliography

UNIT V

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report orally – Techniques

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course students will be able to,

- Write reports successfully
- Analyze issues threadbare and arrive at findings based on the analysis
- Write reports for different purposes

REFERENCE BOOKS

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall(2012)
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)
3. Daniel Riordan - Technical Report Writing Today (1998)
4. Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.

HS5493 **BASIC PRESENTATION SKILLS** **L T P C**
3 0 0 3

OBJECTIVES

The course aims to,

- Develop public speaking skills among students of engineering and technology
- Enhance the presentation skills of students
- Heighten the awareness related to the fundamentals of presentations

UNIT I

Presentation skills – Characteristics of an effective Oral Presentation – Audience - Context, Content, Speaker Status - Purpose – Modus Operandi – Extempore

UNIT II

Emphasis on syllable stress, pronunciation, intonation, pauses, pace - Preparation for a presentation – Avoiding plagiarism –Ample use of Referencing skills – Efficient ways of Collecting and Collating data (due emphasis on important information)

UNIT III

Impressive introduction – Body language – Use of icebreakers – "Start Proper" for the presentation – Relevant Anecdotes & Jokes - Responding constructively to questions – Time Management – Information sharing

UNIT IV

Impressive introduction – Body language – Use of icebreakers – "Start Proper" for the presentation – Relevant Anecdotes & Jokes - Responding constructively to questions – Time Management – Information sharing

UNIT V

Presentation skills – Guidelines – Group Presentation - Creative approaches to presenting – Technical presentation - Speaking under time constraint – variations in pitch, tone & intonation - Credibility in presentation (Use of authentic data/information) Podium panache – Effective Delivery

Learning Outcomes: At the end of the course, students will be able to,

TOTAL: 45 PERIODS

REFERENCE BOOKS

1. Michael Osborn, Susan Osborn, Randall Osborn & Kathleen J Turner, "Public Speaking: Finding Your Voice", 10th Edition, Pearson, 2012.
2. John Hughes & Andrew Mallett, "Successful Presentations DVD & Student's Pack", OUP, Oxford, 2012.
3. Nancy Duarte, "Resonate: Present Visual Stories That Transform Audiences", John Wiley & Sons, New Jersey, 2010.
4. Scott Berkun, "Confessions of a Public Speaker", O'Reilly Media, Inc, Canada, 2010.
5. Barbara Pease & Allan Pease, "The Definitive Book of Body Language", Bantum Books, New York, 2006.
6. Naomi Karten, "Presentation Skills for Technical Professionals: Achieving Excellence (Soft Skills for IT Professionals), IT Governance Publishing, UK, 2010.

AUDIT COURSES (AC)

AX5091	**ENGLISH FOR RESEARCH PAPER WRITING**	**L T P C** **2 0 0 0**

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

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UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX5092 DISASTER MANAGEMENT L T P C
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

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UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster

CO2: Ability to explaina critical understanding of key concepts in disaster riskreduction and humanitarian response.

CO3: Ability to illustratedisaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describean understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

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AX5093 **SANSKRIT FOR TECHNICAL KNOWLEDGE** **L T P C**
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS **6**

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES **6**

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS **6**

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE **6**

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING **6**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

AX5094 **VALUE EDUCATION** **L T P C**
2 0 0 0

OBJECTIVES

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

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UNIT I
Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III
Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.
Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV
Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to
- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

SUGGESTED READING
1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

AX5095 CONSTITUTION OF INDIA **L T P C**
2 0 0 0

OBJECTIVES
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

District's Administration head: Role and Importance, • Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION:

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX5096 PEDAGOGY STUDIES L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

AX5097 STRESS MANAGEMENT BY YOGA L T P C
2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

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UNIT II

Yam and Niyam - Do's and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses-29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses-71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and man kind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

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