Kazi Nazrul University

National Curriculum Course Framework (NCCF)

For

Eight Semester Course Under

Choice Based Credit System (CBCS)

Syllabus for B.Sc. in Geology

3-Year UG Degree /4-Year UG Degree (Honours) / 4-Year UG Degree (Honours with Research)

2023

B.Sc. in Geology
COURSE STRUCTURE
For 3-Year UG Degree / 4-Year UG Degree (Honours) / 4-Year UG Degree (Honours with Research)

Semester	Course Name	Course Type	Course Code	Course Details	Course Credit	Sem Credit	Total Marks	Sem Marks
I	Earth System Science	MAJOR	BSCGELMJ101	MJC-1	5	20	100	350
	Choose from the Pool of Minor Courses offered in 1st Semester by other Disciplines within the faculty	MINOR	See Pool	MNC-1	5		100	
	Choose from the Pool of Multidisciplinary Courses offered in 1st Semester across the faculties	MD	See Pool	MDC-1	3		50	
	English/MIL Communication	AE	See Pool	AEC-1	4		50	
	Field Geology I	SE	BSCGELSE101	SEC-1	3		50	
II	Mineral Science	MAJOR	BSCGELMJ201	MJC-2	5	20	100	350
	Choose from the Pool of Minor Courses offered in 2nd Semester by other Disciplines within the faculty	MINOR	Corresponding Course Code of Minor opted in 1st Semester	MNC-2	5		100	
	Choose from the Pool of Multidisciplinary Courses offered in 2nd Semester across the faculties	MD	See Pool	MDC-2	3		50	
	Environment Studies	VA	VA201	VAC-1	4		50	
	Field Geology II	SE	BSCGELSE201	SEC-2	3		50	
II	Vocational Course	Any One	VC	VC201	VCC-1	4	24	50	400
	Summer Internship		SI	SI201	SIC-1				
Student exiting the programmes after securing 40 credits will be awarded UG Certificate in the relevant Discipline/Subject provided they secure following 4 credits in work based vocational courses / summer internship during 1st year									
III	Elements of Geochemistry & Geophysics	MAJOR	BSCGELMJ301	MJC-3	5	22	100	400
	Structural Geology	MAJOR	BSCGELMJ302	MJC-4	5		100	
	Choose from the Pool of Minor Courses offered in 3rd Semester by other Disciplines within the faculty	MINOR	See Pool	MNC-3	5		100	
	Choose from the Pool of Multidisciplinary Courses offered in 3rd Semester across the faculties	MD	See Pool	MD-3	3		50	
	English Communication	AE	AEC301	AEC-2	4		50	
IV	Igneous Petrology	MAJOR	BSCGELMJ401	MJC-5	5	22	100	400
	Metamorphic Petrology	MAJOR	BSCGELMJ402	MJC-6	5		100	
	Choose from the Pool of Minor Courses offered in 4th Semester by other Disciplines within the faculty	MINOR	See Pool	MNC-4	5		100	
	Field Geology III	SE	BSCGELSE401	SEC-3	3		50	
	Choose from the Pool of Value-Added Course offered in 4th Semester	VA	See Pool	VAC-2	4		50	
IV	Vocational Course	Any One	VC	VC401	VCD-1	4	26	50	450
	Summer Internship		SI	SI401	SID-1	4			
Student exiting the programmes after securing 84 credits will be awarded UG Diploma in the relevant Discipline/Subject provided they secure following 4 credits in work based vocational courses / summer internship during 2nd year									

Semester	Course Name	Course Type	Course Code	Course Details	Course Credit	Sem Credit	Total Marks	Sem Marks
V	Sedimentology	MAJOR	BSCGELMJ501	MJC-7	5	20	100	400
	Palaeontology	MAJOR	BSCGELMJ502	MJC-8	5		100	
	Hydrogeology	MAJOR	BSCGELMJ503	MJC-9	5		100	
	Choose from the Pool of Minor Courses offered in 5th Semester by other Disciplines within the faculty	MINOR	See Pool	MNC-5	5		100	
VI	Remote Sensing and GIS	MAJOR	BSCGELMJ601	MJC-10	5	22	100	450
	Economic Geology	MAJOR	BSCGELMJ602	MJC-11	5		100	
	Stratigraphy	MAJOR	BSCGELMJ603	MJC-12	5		100	
	Geotectonics	MAJOR	BSCGELMJ604	MJC-13	5		100	
	Summer Internship	SI	SI601	SIMC-1	2		50	
Total Credits and Marks					**Credits**	**126**	**Marks**	**2350**

Students who want to undertake 3-year UG programme will be awarded UG Degree in the relevant Discipline / Subject upon securing 126 credits

For 4-Year UG Degree (Honours)

VII	Exploration Geology	MAJOR	BSCGELMJ701	MJC-14	5	25	100	500
	Engineering Geology	MAJOR	BSCGELMJ702	MJC-15	5		100	
	Fuel Geology	MAJOR	BSCGELMJ703	MJC-16	5		100	
	Geostatistics	MAJOR	BSCGELMJ704	MJC-17	5		100	
	Choose from the Pool of Minor Courses offered in 7th Semester by other Disciplines within the faculty	MINOR	See Pool	MNC-6	5		100	
VIII	Oceanography and Climatology	MAJOR	BSCGELMJ801	MJC-18	5	22	100	500
	Colloquium	MAJOR	BSCGELMJ802	MJC-19	4		100	
	Mineral Beneficiation and Mineral Economics	MAJOR	BSCGELMJ803	MJC-20	4		100	
	Environmental Geology	MAJOR	BSCGELMJ804	MJC-21	4		100	
	Choose from the Pool of Minor Courses offered in 8th Semester by other Disciplines within the faculty	MINOR	See Pool	MNC-7	5		100	
Total Credits and Marks					**Credits**	**173**	**Marks**	**3350**

Students who want to undertake 4-year UG Honours program will be awarded UG Degree (Honours) in the relevant Discipline / Subject provided they secure 173 credits

For 4-Year UG Degree (Honours with Research)

VII	Exploration Geology	MAJOR	BSCGELMJ701	MJC-14	5	25	100	500
	Engineering Geology	MAJOR	BSCGELMJ702	MJC-15	5		100	
	Fuel Geology	MAJOR	BSCGELMJ703	MJC-16	5		100	
	Geostatistics	MAJOR	BSCGELMJ704	MJC-17	5		100	
	Choose from the Pool of Minor Courses offered in 7th Semester by other Disciplines within the faculty	MINOR	See Pool	MNC-6	5		100	
VIII	Oceanography and Climatology	MAJOR	BSCGELMJ801	MJC-18	5	22	100	500
	Research Methodology	RP	BSCGELRP801	RPC-1	4		100	
	Dissertation	RP	BSCGELRP802	RPC-2	8		200	
	choose from the Pool of Minor Courses offered in 8th Semester by other Disciplines within the faculty	MINOR	See Pool	MNC-7	5		100	
Total Credits and Marks					**Credits**	**173**	**Marks**	**3350**

Students who want to undertake 4-year UG Honours with Research program will be awarded UG Degree (Honours with Research) in the relevant Discipline / Subject provided they secure 173 credits

Course Details: Major /SE/ SI/RP Courses

Course Name	Course Type	Course Code	Course Details	L - T - P	Course Credit	CA Marks		ESE Marks		Total Marks
						Pr	Th	Pr	Th	
Earth System Science	MAJOR	BSCGELMJ101	MJC-1	4 - 0 - 2	5	30	15	20	35	100
Field Geology I	SE	BSCGELSE101	SEC-1	0 - 0 -6	3	30	---	20	---	50
Mineral Science	MAJOR	BSCGELMJ201	MJC-2	3 - 0 - 4	5	30	15	20	35	100
Field Geology II	SE	BSCGELSE201	SEC-2	0 - 0 - 6	3	30	---	20	---	50
Elements of Geochemistry & Geophysics	MAJOR	BSCGELMJ301	MJC-3	4 - 0 - 2	5	30	15	20	35	100
Structural Geology	MAJOR	BSCGELMJ302	MJC-4	3 - 0 - 4	5	30	15	20	35	100
Igneous Petrology	MAJOR	BSCGELMJ401	MJC-5	4 - 0 - 2	5	30	15	20	35	100
Metamorphic Petrology	MAJOR	BSCGELMJ402	MJC-6	4 - 0 - 2	5	30	15	20	35	100
Field Geology III	SE	BSCGELSE401	SEC-3	0- 0 - 6	3	30	---	20	---	50
Sedimentology	MAJOR	BSCGELMJ501	MJC-7	3 - 0 - 4	5	30	15	20	35	100
Palaeontology	MAJOR	BSCGELMJ502	MJC-8	3 - 0 - 4	5	30	15	20	35	100
Hydrogeology	MAJOR	BSCGELMJ503	MJC-9	3 - 0 - 4	5	30	15	20	35	100
Remote Sensing and GIS	MAJOR	BSCGELMJ601	MJC-10	3 - 0 - 4	5	30	15	20	35	100
Economic Geology	MAJOR	BSCGELMJ602	MJC-11	4 - 0 - 2	5	30	15	20	35	100
Stratigraphy	MAJOR	BSCGELMJ603	MJC-12	5 - 0 - 0	5	---	30	---	70	100
Geotectonics	MAJOR	BSCGELMJ604	MJC-13	4 - 0 - 2	5	30	15	20	35	100
Summer Internship	SI	SI601	SIMC-1	0 - 0 - 4	2	30	---	20	---	50
Exploration Geology	MAJOR	BSCGELMJ701	MJC-14	3 - 0 - 4	5	30	15	20	35	100
Engineering Geology	MAJOR	BSCGELMJ702	MJC-15	4 - 0 - 2	5	30	15	20	35	100
Fuel Geology	MAJOR	BSCGELMJ703	MJC-16	3 - 0 - 4	5	30	15	20	35	100
Geostatistics	MAJOR	BSCGELMJ704	MJC-17	4 - 0 - 2	5	30	15	20	35	100
Oceanography and Climatology	MAJOR	BSCGELMJ801	MJC-18	5 - 0 - 0	5	---	30	---	70	100
Colloquium*	MAJOR	BSCGELMJ802	MJC-19	0 - 2 - 4	4	60	---	40	--	100
Mineral Beneficiation and Mineral Economics*	MAJOR	BSCGELMJ803	MJC-20	4 - 0 - 0	4	30	15	20	35	100
Environmental Geology*	MAJOR	BSCGELMJ804	MJC-21	3 - 0 - 2	4	30	15	20	35	100
Research Methodology **	RP	BSCGELRP801	RPC-1	4 - 0 - 0	4	---	30	---	70	100
Dissertation**	RP	BSCGELRP802	RPC-2	0 - 0 - 16	8	120	---	80	---	100
* **For Students who want to undertake 4-year UG Honours program**										
** **For Students who want to undertake 4-year UG Honours with Research program**										

Note: Minor Courses (MNC) : Students of a particular UG Course will choose from the Pool of Minor Courses offered by disciplines other than the major discipline opted by the student within the faculty. The student is required to opt the same Minor Discipline in the 2nd semester which he had opted in 1st semester. Explanation: If a student of Physics Major, opts for a Minor Course offered by Chemistry in 1st semester then that student is required to continue with the Minor Course offered by Chemistry for 2nd semester as Minor Course in the 2nd semester. **Pr.-Practical; Th.-Theory**

Course Details: Minor Course (offered by Geology)

Semester	Course Name	Course Code	Course Details	L - T - P	Course Credit	CA Marks		ESE Marks		Total Marks
						Pr	Th	Pr	Th	
I	Earth System Science	BSCGELMN101	MNC-1	4 - 0 - 2	5	30	15	20	35	100
II	Mineral Science	BSCGELMN201	MNC-2	3 - 0 - 4	5	30	15	20	35	100
III	Essentials of Petrology	BSCGELMN301	MNC-3	4 - 0 - 2	5	30	15	20	35	100
IV	Structural Geology and Geodynamics	BSCGELMN401	MNC-4	4 - 0 - 2	5	30	15	20	35	100
V	Essentials of Palaeontology	BSCGELMN501	MNC-5	4 - 0 - 2	5	30	15	20	35	100
VI	NA									
VII	Geology of India	BSCGELMN701	MNC-6	5 - 0 - 0	5	---	30	---	70	100
VIII	Economic and Fuel Geology	BSCGELMN801	MNC-7	4 - 0 - 2	5	30	15	20	35	100

Pr.-Practical; Th.-Theory

Pool of Communication Courses offered as Ability Enhancement Courses in Semester-I and III

Semester	Course Name	Course Code	Course Details	L - T - P	Course Credit	Marks		
						CA	ESE	Total
I	English Communication	AECE101	AEC-1	4 - 0 - 0	4	15	35	50
	Bengali Communication	AECB101						
	Hindi Communication	AECH101						
	Urdu Communication	AECU101						
	Alternative English	AECAE101						
III	English Communication	AECE301	AEC-2	4 - 0 - 0	4	15	35	50
	Bengali Communication	AECB301						
	Hindi Communication	AECH301						
	Urdu Communication	AECU301						
	Alternative English	AECAE301						

Pool of Value Added Courses offered in Semester-IV for all Disciplines across all Faculties

Discipline	Course Name	Course Code	Course Details	L - T - P	Course Credit	Marks		
						CA	ESE	Total
Physiology	Yoga and Health	VAC401	VAC-2	4 - 0 - 0	4	15	35	50
Philosophy	Social Values and Ethics	VAC402		4 - 0 - 0	4	15	35	
Computer Science	Digital and Technological Solutions	VAC403		4 - 0 - 0	4	15	35	
History	Understanding India	VAC404		4 - 0 - 0	4	15	35	
Economics	Sustainable Development: Issues and Challenges	VAC405		4 - 0 - 0	4	15	35	
Commerce	Goods and Services Tax	VAC406		0 - 2 - 4	4	30	20	
Political Science	Basics of Indian Constitution	VAC407		4 - 0 - 0	4	15	35	
Physical Education	Integrated Self Defence	VAC408		0 - 2 - 4	4	30	20	

Semester wise Pool of Multidisciplinary Courses offered for all disciplines across the faculties:

Semester-1

Discipline	Course Name	Course Code	Course Details	L - T - P	Course Credit	Marks		
						CA	ESE	Total
Physics	Physical Science	MDC101	MDC-1	4 - 0 - 0	3	15	35	50
BBA	E-Commerce	MDC102						
Political Science	Human Rights	MDC103						
Geography	Disaster Management	MDC104						
Physical Education	Fitness and Wellness	MDC105						
Zoology	Application of Bio-Science	MDC106						
English	Film Appreciation	MDC107						
Commerce	Accounting for All	MDC108						
History	Exploring Early Medieval Bengal: C.7th Century CE to 1206 CE	MDC109						
Bengali	Bangla Sahitya O Sanskriti	MDC110						
Economics	Money and Banking	MDC111						
Hindi	Patrakarita	MDC112						
Mathematics	Business Mathematics	MDC113						
Sociology	Indian Society	MDC114						
Philosophy	Yoga for Daily Life	MDC115						
Electronics	Electronic Measurements	MDC116						
Computer Science	Information and Communication Technology	MDC117						
Botany	Introduction to Local Flora	MDC118						
Computer Applications	Information and Media Literacy	MDC119						
Commerce	Microeconomics	MDC120						
Geology	A B C D of Geology	MDC121						

Semester-II

Discipline	Course Name	Course Code	Course Details	L - T - P	Course Credit	Marks		
						CA	ESE	Total
Mathematics	Mathematical Science	MDC201	MDC-2	2 -1 - 0	3	15	35	50
BBA	Business Environment	MDC202						
Statistics	Basic Statistics	MDC203						
History	Understanding Medieval Bengal Select Themes: 1206 CE-1727 CE	MDC204						
Commerce	Personal Finance	MDC205						
Nutrition	Nutrition and Public Health	MDC206						
Education	Educational Philosophy	MDC207						
Psychology	Stress Management	MDC208						
Computer	Social Media and Cyber Awareness	MDC209						
Bengali	Adhunik Bangla Sahitya	MDC210						
Nazrul Sangeet	Nazrul Sangeet	MDC211		0- 1 - 4	3	30	20	
Electronics	E-Waste Management	MDC212		2 -1 - 0	3	15	35	
Chemistry	Chemical Science	MDC213						
Sanskrit	Critical Survey of Sanskrit Language	MDC214						
Urdu	Asnaf- E -Adab	MDC215						
Hindi	Anuvad Vigyan	MDC216						
Botany	Herbal Home Remedies	MDC217						
English	Contemporary India: Women and Empowerment	MDC218						
Political Science	Women Empowerment in India: Issues and Dimensions	MDC219						
Physical Education	Yoga-Vyayama	MDC220						
Commerce	Macroeconomics	MDC221						
Geology	The Past Life on Earth	MDC222						

Semester-III

Discipline	Course Name	Course Code	Course Details	L - T - P	Course Credit	Marks		
						CA	ESE	Total
Geography	Bharatavarsha - A Land of Rare Natural Endowments	MDC301	MDC-1	4 - 0 - 0	3	15	35	50
Sanskrit	The Vedangas and other Streams of Indian Knowledge System	MDC302						
Physics	Indian Astronomy	MDC303						
Zoology	Indian Health Sciences	MDC304						
Mathematics	Indian Mathematics	MDC305						
Education	Indian Education	MDC306						
Political Sc	Indian Polity and Economy	MDC307						
Philosophy	Methodology of Indian Knowledge System	MDC308						
Geology	Remote Sensing and GIS	MDC309						
Physical Education	Indian Medical System and Yoga	MDC310						
Urdu	Urdu Gajal	MDC311						
Commerce	Indian Economy	MDC312						
Computer Science	Impact of Artificial Intelligence in Education	MDC313						
Physiology	Community Health Care	MDC314						

Abbreviations: MJ-= Major; MJC-= Major Course; MN= Minor; MNC= Minor Course; AE= Ability Enhancement; AEC= Ability Enhancement Course; SE= Skill Enhancement; SEC= Skill Enhancement Course; MD= Multidisciplinary ; MDC= Multidisciplinary Course; SI - Summer Internship; SIC - Summer Internship for Certificate; SID: Summer Internship for Diploma; SIMC - Summer Internship Mandatory Course; RP= Research Project ;RPC= Research Project Course; VA= Value Added; VAC= Value Added Course; VC= Vocational Course; VCC= Vocational Course for Certificate; VCD= Vocational Course for Diploma; CA= Continuous Assessment, ESE= End Semester Examination, L= Lecture Hour; T= Tutorial Hour and P= Practical Hour/ Field Work and NA= Not Applicable.

For updated list of MDC and VAC check KNU website/ the latest curriculum.

Semester- I

Discipline Specific Major (and Minor) Course

Course Name: EARTH SYSTEM SCIENCE

Course Code: BSCGELMJ101

Course Type: **MAJOR**	Course Details: **MJC-1**				L-T-P: **4- 0 - 2**
Credit: **5** Theory 4, Practical 1	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

OR

Course Code: BSCGELMN101

Course Type: **MINOR**	Course Details: **MNC-1**				L-T-P: **4 - 0 - 2**
Credit: **5** Theory 4, Practical 1	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

This course aims to explore, understand, communicate, and teach the Earth as a planet, its complex processes, past and future evolution and interactions with the society. The main objective is to study the atmosphere, hydrosphere, and lithosphere, including their interaction and interrelationships with the biosphere.

COURSE LEARNING OUTCOMES:

- Analyze the interactions between biological, chemical, and physical processes that shape and define the earth system
- Correlate between the past Earth's evolution and its current changes; and
- Develop effective communication skills to help diffusing major current environmental problems.

THEORY

Unit 1: Introduction **(Credit Hours – 10)**

Earth System Science – Definition, history of evolution of Earth Sciences, and its different branches; Brief idea about the origin of the Universe, Solar System and its planets; the Terrestrial and Jovian planets; Meteorites and Asteroids; Earth: origin, size, shape, mass, density, rotational and revolution parameters.

Unit 2: Solid Earth and its fluid cover **(Credit Hours – 10)**

Internal constitution - its recognition vis-à-vis solid earth geophysics: crust, mantle, core, evidence from seismic waves and rocks, lithosphere and asthenosphere; Elementary idea about the hydrosphere, atmosphere and biosphere: Nature of Earth's magnetic field.

Unit 3: Crust and the supracrustal materials **(Credit Hours – 10)**

Major constituents of the crust; Minerals - definition and classification; Rocks – Types, rock cycle, brief idea about their origin, general classification; Fossil: Definition, broad idea about different types.

Unit 4: Tectonics **(Credit Hours – 10)**

Brief idea about the Continental Drift Theory, Sea-floor Spreading and Plate Tectonics.

Unit 5: Earth surface processes (Credit Hours – 10)

Rock weathering; Formation of soil, soil profile and soil types; Erosion; mass wasting; Geological work of wind, river and glacier; coastal processes, oceanic current system and effect of Coriolis force; Concepts of eustasy.

Unit 6: Introduction to the concept of deep time in geological studies (Credit Hours – 10)

Stratigraphy: definition and scope, Brief history of development of stratigraphic principles; concepts of Neptunism, Plutonism and Uniformitarianism

Geological Time Table, introduction to geochronological methods and their application in geological studies

Fundamental laws of stratigraphy: Superposition, Faunal succession and correlation.

PRACTICAL

(Credit Hours-30)

Study of major geomorphic features and their relationships with outcrops through physiographic maps; Principles of Topographic Sheet indexing; Detailed study of topographic sheets and preparation of physiographic description of an area, Preparation of topographic profile.

SUGGESTED READINGS

1. Duff, P. M. D., & Duff, D (Eds.),1993. *Holmes' principles of physical geology*. Taylor & Francis
2. Emiliani, C.,1992. *Planet earth: cosmology, geology, and the evolution of life and environment*. Cambridge University Press.
3. Faure, Gunter. 1986. "Principles of isotope geology". Wiley International.
4. Gross, M. G. ,1977. *Oceanography: A view of the earth*.
5. Grotzinger, J., Jordan, T. H., Press, F. & Siever, R. (2007). Understanding Earth (5th Ed.). W.H. Freeman & Co.
6. Levin, H. L. (2002). The Earth Through Time. John Wiley & Sons.
7. Plummer, Charles C., Carlson, Diane H. & Hammersley, L. (2016) Physical geology (15th Ed.). McGraw-Hill Education.
8. Robert S. Anderson and Suzzane P. Anderson, 2010. *Geomorphology - The Mechanics and Chemistry of Landscapes.* Cambridge University Press.
9. Skinner, B. J., Porter, S. C. & Park, J. (2003). Dynamic Earth: An Introduction to Physical Geology (5th Ed.). John Wiley & Sons.
10. Skinner, B.J., Porter, S.C., Botkin, D.B. (1999) The Blue Planet – An Introduction to Earth System Science. John Wiley & Sons.
11. Thompson, G. R. & Turk, J. (1997). Introduction to Physical Geology. Brooks/Cole

Skill Enhancement Course

Course Name: FIELD GEOLOGY- I

Course Code: BSCGELSE101

Course Type: **Skill Enhancement Course**	Course Details: **SEC-1**			L-T-P: **0 - 0 - 6**	
Credit: **3** (Practical)	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**….**	**20**	**…..**

COURSE OBJECTIVES:

Students will be acquainted with the equipment used in the geological fieldwork. They will also understand how preliminary surveys are carried out especially in geological terrains. The students will be imparted practical training mainly in the classroom so that they can work independently in the field under the guidance of faculty members.

COURSE LEARNING OUTCOMES:

This course is devised to provide basic knowledge of geological equipment and surveying techniques. It also will upgrade and relate the theoretical knowledge of geological aspects to field observations.

Unit 1: Basic idea about field geology **(Credit Hours 20)**

Field work ethics: dos and don'ts in field; Determination of topographic sheet number; Study of topographic sheets; Comparison of topographic sheet of a specific area with satellite imagery (Google Earth); Basic principles of clinometer compass and Brunton compass

Unit 2: Field work **(Credit Hours 70)**

Field reconnaissance and identification of reference unit; Basic techniques of fixation of location on the reference toposheet or satellite imagery; study of different types of outcrops, rock types and their disposition; acquisition of basic field data; collection of samples (including oriented samples); basic principles of field photography.

Multi-Disciplinary Course

Course Name: A B C D OF GEOLOGY

Course Code: MDC-121

Course Type: **MD**	Course Details: **MDC-1**			L-T-P: **2 - 1 - 0**	
Credit: **3**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		-	**15**	**-**	**35**

COURSE OBJECTIVES:

This course gives an overall introduction to Geology. The course presents an understanding of the processes in action on the earth's surface and their impact on man and his institutions

COURSE LEARNING OUTCOMES:

- Strengthens students' knowledge with respect to understanding the essentials of the structural dynamics of the earth.
- Understand the origin of our solar system and planets, including earth.

- Exposed to the Geological time scale and be able to appreciate the dynamics of earth evolution through time.

THEORY

Unit 1:Introduction (Credit Hours – 08)

General idea about Earth and solar system; The concept of lithosphere, hydrosphere, biosphere and atmosphere.

Unit 2: Geology and its branches (Credit Hours – 06)

Definition; The basic units of studying geology; Branches of geology and what do these different units tell us.

Unit 3: Natural resources and their use (Credit Hours – 20)

The definition of natural resources; Mineral resources, their use and distribution of mineral resources found in India.

Energy resources: Non-renewable and renewable energy resources; Coal, Petroleum, Nuclear fuel: their occurrence and use; The scope of renewable energy resource in India

Unit 4: Natural disaster and their effects (Credit Hours – 11)

Earthquake, landslide, flood, Tsunami, and volcanism and their effects on human life.

SUGGESTED READINGS:

1. Coch, N.K. (1994): Geohazards: Natural and Human, Pearson College.
2. Duff, P. M. D., & Duff, D (Eds.),1993. *Holmes' principles of physical geology*. Taylor & Francis.
3. Mukherjee, P.K. Introduction to Geology
4. Tarbuck, E. J. & Lutgens, F. K. (2006) Earth Science (11th Ed.). Pearson Prentice Hall.
5. Thompson, G. R. & Turk, J. (1997). Introduction to Physical Geology. Brooks/Cole
6. Valdiya K.S. 2013 Environmental Geology: Ecology, Resource and Hazard Management. McGraw Hill Education (India)Private Limited.

Semester- II

Discipline Specific Major (and Minor) Course

Course Name: MINERAL SCIENCE

Course Code: BSCGELMJ201

Course Type: **MAJOR**	Course Details: **MJC-2**			L-T-P: **3 - 0 - 4**	
Credit: **5** Theory 3, Practical 2	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

OR
Course Code: BSCGELMN201

Course Type: **MINOR**	Course Details: **MNC-2**			L-T-P: **3 - 0 - 4**	
Credit: **5** Theory 3, Practical 2	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

This course helps to understand the fundamentals of crystallography and structural chemistry of minerals along with descriptive mineralogy. The students will be able to learn the optical and crystallographic properties of the minerals and their occurrences. The course provides better understanding of crystallography, mineralogy and optical mineralogy and their application involved during the origin and evolution of the rocks.

COURSE LEARNING OUTCOMES:

- Describe and recognize various physical properties of minerals, including lustre, cleavage, hardness, density etc. as well as optical properties; and
- Explain different symmetry elements of the crystals and how these relate to crystal systems.

THEORY

Unit 1: Crystallography **(Credit Hours-12)**

Elementary ideas about crystal morphology in relation to internal structures; Crystal parameters and indices; Crystal symmetry and classification of crystals into point groups, space groups; Stereographic projections of symmetry elements and forms; Characteristics of crystal systems; Crystal defects; X-ray crystallography.

Unit 2: Rock forming minerals **(Credit Hours-20)**

Physical and chemical properties; Substitution principles – Goldschmidt's rule of substitution of elements; partitioning of elements between coexisting phases; Brief idea about Isomorphism, Solid solution, Pseudomorphism and Polymorphism: elementary concept on principle types – common polymorphic forms of C, SiO_2 and Al_2SiO_5; Crystal structure and its controls: bonding and coordination principles.

Classification of silicate groups based on structure and derivation of structural formulae based on composition with example of common rock-forming minerals from each group, Non-silicate structures; CCP and HCP structures.

Unit 3: Optical mineralogy **(Credit Hours-13)**

Optical behaviour of crystals – Isotropic and anisotropic minerals; Nicol prism and its principle of construction; Polaroid; Refractive index of minerals; Uniaxial & Biaxial minerals; Optical indicatrix of

uniaxial and biaxial minerals; Birefringence, Interference colour and use of interference colour chart; Relation between crystallographic and optical axes of crystals; Pleochroism and pleochroic scheme; Extinction; Study of interference figures; Optic sign of uniaxial and biaxial minerals .

PRACTICAL (Credit Hours-60)

Unit 1: Study of physical properties of common rock-forming minerals in hand specimen
Unit 2: Study of the symmetry of crystals in hand specimen; Solution of crystallographic problems through stereographic projection.
Unit 3: Study of optical properties of common rock-forming minerals: quartz, orthoclase, microcline, plagioclase, perthite, nepheline, olivine, orthopyroxene, clinopyroxene, hornblende, staurolite, garnet, muscovite, biotite, calcite
Unit 4: Determination of extinction angle and pleochroic scheme; Determination of optic sign from interference figures

SUGGESTED READINGS:

1. Deer, W. A., Howie, R. A., and Zussman, J., 1992. *An introduction to the rock-forming minerals*. London, Longman.
2. John Mason (2014). Introducing Mineralogy. Liverpool University Press.
3. Kerr, P. F., 1959. *Optical Mineralogy*. McGraw-Hill.
4. Klein, C. & Philpotts, A. (2013). Earth Materials: Introduction to Mineralogy and Petrology. Cambridge University Press.
5. Klein, C., Dutrow, B., Dwight, J., & Klein, C., 2007. *The 23rd Edition of the Manual of Mineral Science (after James D. Dana)*. J. Wiley & Sons.
6. Nesse, W. D. (1999). Introduction to Mineralogy. Oxford University Press.
7. Nesse, W. D. (2011). Introduction to Optical Mineralogy (4th Edition). Oxford University Press.
8. Verma, P. K., 2010. *Optical Mineralogy (Four Colour)*. Ane Books Pvt Ltd.

Skill Enhancement Course

Course Name: FIELD GEOLOGY - II

Course Code: BSCGELSE201

Course Type: **Skill Enhancement Course**	Course Details: **SEC-2**			L-T-P: **0 - 0 - 6**	
Credit: **3** Practical	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**….**	**20**	**…..**

COURSE OBJECTIVES:

Thiscourseprovidesthestudentsenhancedlearningopportunitieswithflexibilityforworkingstudentstocompletethe program over an extended period of time along with inter-institutional transferability. This system seems to be providing the students opportunity to choose the subjects of their interest.

COURSE LEARNING OUTCOMES:

- Understanding and use of soft skills to motivate team members for improved productivity.
- Understanding the link between people, processes and technology to effectively execute projects towards stakeholder's satisfaction.

Unit 1: Field work **(Credit Hours 70)**

Usage of topographic sheet and satellite imagery in the field; Usage of GPS
Study of different types of rock outcrop; study of different rock types (Igneous, Metamorphic and Sedimentary) in the field; Acquisition of different field data and collection of samples including oriented ones; field photography.

Unit 2: Sample processing **(Credit Hours 20)**

Preparation of thin sections of collected samples and study under microscope; Sampling protocol, recovery and restoration of fossil samples.

Multi-Disciplinary Course

Course Name: THE PAST LIFE ON EARTH

Course Code: MDC-222

Course Type: **MD**	Course Details: **MDC-2**			L-T-P: **2 - 1 - 0**	
Credit: **3** Theory	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		-	**15**	**-**	**35**

COURSE OBJECTIVES:

The course aims to equip students with knowledge about the progression of life forms and the fossil record's significance in understanding Earth's biological history. This course introduces the principles and scope of palaeontology, focusing on the origin and evolution of life on Earth. It explores the major geological eras—Paleozoic, Mesozoic, and Cenozoic—through the study of key fossil groups and extinction events.

COURSE LEARNING OUTCOMES:

- Explain the fundamental concepts and scope of palaeontology and geological time,
- Analyze the major events and fossil groups across different geological eras,
- Interpret extinction events and their impact on biodiversity through geological time,
- Evaluate fossil evidence to understand the development and adaptations of early human ancestors.

THEORY

Unit 1. Introduction **(Credit Hours – 04)**

Scope and purpose of Palaeontology; Geological time, dating methods

Unit 2. Origin and Evolution of Life **(Credit Hours – 06)**

Early Earth conditions and origin of life; Evolution of prokaryotes, eukaryotes, and multicellular organisms

Unit 3. Paleozoic Era **(Credit Hours – 10)**

Key events and fossil groups (trilobites, brachiopods, early fishes); - Paleozoic extinction events

Unit 4. Mesozoic Era **(Credit Hours – 11)**

Major events and fossil groups (ammonites, dinosaurs, early mammals, birds); Impact of Mesozoic extinction events

Unit 5. Cenozoic Era and Modern Life **(Credit Hours – 08)**

Diversification of mammals and birds; Development of modern ecosystems and Cenozoic extinction events

Unit 6. Human Evolution **(Credit Hours – 06)**

Fossil evidence of early human ancestors; Key discoveries in paleoanthropology

SUGGESTED READINGS:

1. "Invertebrate Paleontology and Evolution" by E. N. K. Clarkson
2. "Vertebrate Paleontology" by Michael J. Benton
3. Principles of Paleontology" by M. Foote and A. Miller, Freeman, NYC, (2008)
4. Ray, A. K. (2008) Fossils in Earth Sciences. PHI Learning
5. Benton, M. J. & Harper, D. A. T. (2016). Introduction to Paleobiology and the fossil record. Wiley

Semester- III

Discipline Specific Major Course

Course Name: ELEMENTS OF GEOCHEMISTRY & GEOPHYSICS

Course Code: BSCGELMJ301

Course Type: **MAJOR**	Course Details: **MJC-3**			L-T-P: **4- 0 - 2**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
Theory 4, Practical 1		**30**	**15**	**20**	**35**

COURSE OBJECTIVES:

Geochemistry aims to give an introduction in how chemical principles are used to explain the formation of the elements and solar system, the Earth's geochemical composition and differentiation into different reservoirs, the age of rocks, the surface environment and the chemical traces of early life. Geophysics aims to give an idea in how measurement of physical properties can be used to decipher the earth's structure, mineralization etc.

COURSE LEARNING OUTCOMES:

- Demonstrate the behavior of elements in geochemical context and relate this to hoe elements redistribute with in the earth.
- EstablishtheEarth'schemistryintermsofinteractionsbetweenreservoirs.
- Analyze the major processes operating in the Earth's crust and mantle.
- Use isotopes to trace geological processes and age date specific events.
- Provide idea about the earth's internal structure and composition
- Helps in exploration of mineral deposits.

THEORY

Geochemistry:

Unit 1: Concepts of geochemistry **(Credit Hours – 6)**

Nucleosynthesis, Cosmic abundance of elements: Distribution of elements in solar system and in Earth; Introduction to chemical differentiation and composition of the Earth, Composition of the bulk silicate Earth, Atomic environment of elements. Geochemical classification of elements.Uses of major, minor trace and REE in magmatic evolution, concept of Kd and D.

Unit 2 : Isotope Geology **(Credit Hours – 11)** Internal structure of atoms, nuclear systematics, atomic weights, and isotopes (Stable and radioactive isotopes), nuclear stability and abundance. Decaying mechanism-Beta decay, positron decay, electron capture decay, alpha decay, nuclear fission. Decay laws and half-life. Geochronology-K-Ar, Rb-Sr, Sm-Nd, and U-Pb dating and their application in Geology.

Unit 3: Aqueous geochemistry **(Credit Hours – 3)**

Role of ionic potential; hydrogen ion concentration and oxidation-Reduction potential in sedimentation; Eh- pH diagrams of Mn- H_2O systems and Fe-H_2O systems with and without CO_2.

Unit 4: General concepts about geochemical cycles **(Credit Hours – 10)**

The atmosphere: Structure and composition of atmosphere; geochemical cycle of nitrogen. The evolution of atmosphere Formation and destruction of ozone layer, Ozone hole. The Hydrosphere: Distribution of water on the earth; average compositions of sea water, river water and ground water; origin and evolution

of sea water, chemical evolution of ground water, The Biosphere: Concept of biosphere, Geochemical cycle of carbon.

Geophysics:

Unit5: **Introduction to Geophysics** **(Credit Hours – 1)**

General introduction; Different branches of Geophysics. Relationship between Geology and Geophysics.

Unit 6:GravityMethod **(Credit Hours – 4)**

Gravity and its variation over the surface of the Earth. Principle of Gravimeters; Gravity field surveys. Gravity reduction, Gravity anomaly, Isogal maps and their interpretation.

Unit 7: **Magnetic Method** **(Credit Hours – 3)**

Geomagnetic field, Principle of Magnetometers. Magnetic field survey, preparation of magnetic anomaly maps and their interpretation.

Unit 8: Electrical Methods **(Credit Hours – 3)**

Electrical properties of rocks. Resistivity method, Induced Polarisation Method and Self potential method. Field procedure, interpretation of electrical profile.

Unit 9: **Seismic Method** **(Credit Hours – 3)**

Refraction and Reflection seismic surveys. Seismic data acquisition and interpretation.

Unit 10: Welllogging **(Credit Hours – 7)**

Principle of electrical logging. Types of logging: Open hole, cased hole logging; Caliper, Induction, Spontaneous Potential, Sonic, Neutron; Gamma Ray log.

Unit 11: Application of Geophysics (Credit Hours –9) Groundwater prospecting, Mineral exploration, Engineering Geology, Petroleum exploration, Archeological studies, Environmental studies.

PRACTICAL **(Credit Hours – 30)**

Geochemistry

Interpretation of geochemical data: Bivariate and trivariate plots to delineate the control of different compositional variables: Harker variation diagram, AFM diagram, MgO diagram, compatible and incompatible element variation.

Simple examples of determining radiometric age from given data on appropriate mother & daughter isotopes.

Geophysics

Anomaly and background- Graphical method

Study and interpretation of seismic reflector geometry

Problems on gravity anomaly

SUGGESTED READINGS:

1. Exploration Geophysics - An Outline by Bhimasarikaram V.L.S., Association of Exploration Geophysicists, Osmania University, Hyderabad, 1990.
2. Faure, Gunter and Teresa M. Mensing (2004). Isotopes: Principles and Applications, Wiley India Pvt. Ltd
3. Haldar, S.K., 2013. Mineral Exploration: Principles and Applications. Elsevier.
4. Lowrie, W. (2007). Fundamentals of geophysics. Cambridge University Press.
5. Mason, B. (1986) Principles of Geochemistry. 3rd Edition, Wiley New York.
6. Rollinson, H. (2007) Using geochemical data – evaluation, presentation and interpretation. 2nd Edition. ROUTLEDGE.
7. Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). Applied geophysics (Vol. 1). Cambridge University Press.

8. Walther, J. V. (2009). Essentials of geochemistry. Jones and Bartlett Publishers, Inc
Albarède, F. (2003). Geochemistry: an introduction. Cambridge University Press.

Discipline Specific Major Course

Course Name: STRUCTURAL GEOLOGY

Course Code: BSCGELMJ302

Course Type: **MAJOR**	Course Details: **MJC-4**			L-T-P: **3 - 0 - 4**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
Theory 3, Practical 2		**30**	**15**	**20**	**35**

COURSE OBJECTIVES:

The objectives of this course are to make students able to understand the Concepts of stress, strain, and deformation.; Significance of brittle, plastic and ductile deformation and their products, Origin and mechanisms of faults, fractures, and folds, Processes and fabrics that occur in shear zones and their kinematic significance; Deriving tectonic histories from analysis of geological maps.

COURSE LEARNING OUTCOMES:

- Understand the structure of the rocks in the earth's crust and mantle.
- Determine the deformational history based on fabrics and geometric relationships.
- Quantitatively describe stress and strain transformation.

THEORY

Unit 1: Introduction to structural geology **(Credit Hours – 3)**

Different schemes of classifying geological structures. Attitudes of planar and linear structures; concepts of dip, strike, plunge, pitch (or rake), trend etc. Basic principles of stereographic and equal area projection.

Unit 2: Unconformity **(Credit Hours – 1)**

Definition, types, and significance of each type

Unit 3: Rock deformation and Rheology **(Credit Hours – 8)**

Concept of Stress: normal stress, shear stress, concept of stress ellipsoid, principal axes of stress, planes of maximum shear stress, Mohr circle of stress.

Concept of strain: Longitudinal and shear strain, principal axes of strain, concept of strain ellipsoid, Mohr circle for strain

Homogenous and inhomogeneous strain, Rotational and irrotational strain in rocks. Strain ellipsoids of different types and their geological significance. Flinn and Ramsay's diagram.

Basic methods of strain analysis.

Rheological properties of rocks, Concept of rock deformation- brittle and ductile deformation, Factors controlling deformation behaviour of rocks.

Unit 4: Folds **(Credit Hours – 9)**

Fold morphology and structural elements; Morphological classification of folds

Outcrop patterns of folds, Geometric classification of folds

Mechanics of folding- buckling, bending. Kinematics of folding- flexural folding, flexural slip and flow folding, shear folding and passive folding
Superposed folding, morphological types, classification and basic geometric analysis in polydeformed terranes

Unit 5: Foliation and lineation (Credit Hours – 8)

Morphological features of foliations and lineations; Tectonic significance of foliation and lineation, Relation of foliation and lineation with folds; Brief idea of origin of foliation, Deformation mechanism, microstructure and fabric development

Unit 6: Fractures, Joints and Faults (Credit Hours – 8)

Classification of fractures- Faults and Joints; Joint- common terminology, characteristics and classification; Relation of Joints to Folds, exhumation and igneous bodies; Fault zone terminology, Geometric classification of faults; Effects of faulting on the outcrops, Criteria for recognition of faults, Fault zone rocks; Anderson dynamic analysis of faulting, Characteristics of Normal, Reverse and Strike slip fault systems; Thrust and thrust related deformation; Mechanics of fracturing and faulting.

Unit 7: Ductile shear zones (DSZ) (Credit Hours – 8)

Types of Shear zones and their kinematics, Shear zone rocks, classification of mylonitic rocks; shear sense indicators.

PRACTICAL (Credit Hours – 60)

Topographic maps. General idea about the outcrop patterns of different structures.
Stereographic projections of planes and lines
3-point problems, fold-fault problems and their solutions through graphical methods and stereographic projection methods.
Interpretation of geological maps with unconformity, fault, fold and igneous bodies. Construction of structural cross section.
Completion of outcrop.
Application of Borehole and Rotational Problems in Structural analyses
Simple strain analysis problems.
Recognition of fold interference from outcrop patterns.

SUGGESTED READINGS:

1. Billings M.P. (1987). Structural Geology, 4th edition Prentice-Hall.
2. Davis,G.H., Reynolds, S.J., and Kluth,C.F. (2012). Structural Geology of Rocks and Region. 3rd edition. John Wiley and Sons, lnc.
3. Fossen,H. (2016). Structural Geology. Second Edition. Cambridge University Press.
4. Ghosh, S.K (1993). Structural Geology Fundamentals and Modern Development. PergamonPress.
5. Twiss R. J. and Moores E.M. (2007). Structural Geology, Second Edition,W.H. Freeman and Company.
6. Ramsay, J.G., 1967. Folding and fracturing of rocks. McGraw-Hill.
7. Ramsay, J.G. and Huber, M.I., 1984 & 1987. The Techniques of Modern Structural Geology – Volumes 1 & 2, respectively. Academic Press.
8. Ragan, D. M., 2009. Structural Geology: an introduction to geometrical techniques. 4th Edition, Cambridge University Press (For Practical)

9. Park, R.G. (2005). Foundation of Structural Geology, 3rd Edition, Routledge.
10. Marshak, S and Mitra G. (1988) Basic Methods in Structural Geology, Prentice Hall.
11. Ben A. van der Pluijm and Stephen Marshak (2004) Earth Structure: An Introduction to Structural Geology and Tectonics (Second Edition) 2nd Edition
12. Passhier, C. and Trouw, RAJ, 2005. Microtectonics. Springer, Berlin.
13. Pollard, D.D. and Fletcher, R.C., 2005. Fundamentals of structural geology, Cambridge University Press.
14. Rowland, S.M., Duebendorfer, E. and Schiefelbein, I.M., 2007. Structural analysis and synthesis: a laboratory course in structural geology, Blackwell Pub.
15. Ghosh, S. K. (1993). Structural Geology: Fundamentals & Modern Development. Pergamon Press

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Discipline Specific Minor Course

Course Name: ESSENTIALS OF PETROLOGY

Course Code: BSCGELMN301

Course Type: **MINOR**	Course Details: **MNC-1**		L-T-P: **4 - 0 - 2**	
Credit: **5** Theory 4, Practical 1	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

This course aims to appraise the different types of rocks found in the earth; to know about the petrogenesis, structure and texture of the rocks; to understand the basic metamorphism of rocks and their genetic classification

COURSE LEARNING OUTCOMES:

- have an idea about the rock types fabricating the earth,
- have a knowledge regarding the process of formation of these rocks and
- build a brief idea about the conditions of rocks to get metamorphosed. Students also analyse the rock types and their textures by examining the hand specimen.

THEORY

Unit 1 Introduction **(Credit Hours – 05)**

Rocks: Definition, the major rock types, Distinction between three types of rocks; Crustal abundance of rocks

Unit 2 Igneous rocks **(Credit Hours – 08)**

Field observations of igneous rocks; Large scale features: Extrusive vs Intrusive structures; Small scale features; Classification of igneous rocks; Textures and structures in igneous rocks

Unit 3 Petrogenesis of igneous rocks **(Credit Hours – 07)**

Origin of common igneous rocks like granite, basalt, anorthosite; Plate tectonics and emplacement of igneous rocks

Unit 4 Sedimentary rocks **(Credit Hours – 08)**

Sediments: Types of terrigenous and chemical sediments; origin of sediments, deposition and lithification; Depositional environment of sedimentary rocks

Unit 5 Metamorphic rocks and metamorphism **(Credit Hours – 06)**

What is metamorphism and metamorphic rock; Classification of metamorphic rocks; Factors of metamorphism.

Unit 6 Structure and texture in metamorphic rocks (Credit Hours – 10)
Foliated and non-foliated metamorphic rocks and structure and texture found therein; Interpretation of temporal relation between metamorphism and deformation from textures.

Unit 7 Genetic classification of metamorphism (Credit Hours – 08)
Grade, zone, Barrovian Zonal Scheme and Facies concept in metamorphism; Different facies types and facies series.

Unit 8 Progressive metamorphism (Credit Hours – 08)
Progressive metamorphism of basic, pelitic rocks. Relationship between tectonism and metamorphism.

PRACTICAL (Credit Hours – 30)

Study of common igneous and metamorphic rocks in hand specimens.
Study of hand specimens of sedimentary rocks and primary structure therein
Petrographic study of common igneous, metamorphic and sedimentary rocks.

SUGGESTED READINGS:

1. Ehlers, E.G. & Blatt, H. (1987) Petrology Igneous, Sedimentary and Metamorphic W. H. Freeman and Company (USA), Indian Edition CBS Publishers and Distributors, New Delhi
2. Frost, B. R. and Frost, C. D. (2019). Essentials of Igneous and Metamorphic Petrology, 2nd ed. Cambridge University Press
3. Myron G. Best (2001). Igneous and Metamorphic Petrology, 2nd ed. Wiley-Blackwell
4. Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
5. Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Earth Science Series.

Multi-Disciplinary Course

Course Name: REMOTE SENSING AND GIS

Course Code: MDC-309

Course Type: **MD**	Course Details: **MDC-3**			L-T-P: **2 - 1 - 0**	
Credit: **3** Theory	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		-	**15**	**-**	**35**

COURSE OBJECTIVES:
Remote Sensing provide exposure to students in gaining knowledge on concepts and applications leading to modeling of earth resources management, to acquire skills in storing, managing digital data for planning and development, to acquire skills in advance techniques such as hyper spectral, thermal and LiDAR scanning for mapping, modeling and monitoring.

COURSE LEARNING OUTCOMES:
- recognize and explain at a basic level fundamental physical principles of remote sensing, including the electromagnetic spectrum; the emission, scattering, reflection, and absorption of electromagnetic (EM)radiation;
- Learn how EM radiation interactions vary across a limited number of substances, geometries, and temperatures; and geometric properties of photographs and imagery.

THEORY

Unit 1: What is remote sensing (Credit Hours – 12)

Remote Sensing Process, Electromagnetic Spectrum; Electromagnetic Interactions, Interactions with the Atmosphere, Interactions with the Target, Spectral response (Spectral Signatures). Remote Sensing Platforms Systems, Ground based platforms, Airborne platforms, Satellite; Remote Sensing Sensors, Passive Remote Sensing, Active Remote Sensing, Sensors' resolution, Examples of Remote sensing satellites.

Unit 2: Aerial and Satellite Images (Credit Hours – 08)

Types of Remotely sensed images, Aerial photography, Satellite imagery, Differences between Aerial photography and Satellite imagery. Colour Composites, Natural or True Colour Composites, False Colour Composites.

Unit 3: Remote Sensing Image Processing (Credit Hours – 09)

Pre-processing: Radiometric correction, Atmospheric correction, Geometric corrections; Image Transformation, Image Classification.

Unit 4:What is Geographic Information System (GIS) (Credit Hours – 08)

Basic concepts of GIS. GIS data, spatial and attribute data; Spatial data model: Raster & Vector; GIS components: Hardware for GIS, GIS Software, Data and GIS.

Unit 5: Applications of Remote Sensing and GIS techniques (Credit Hours – 08)

Watershed Studies, Flood Studies, Utility Studies, Security and Defence Studies, Urban and infrastructure Studies, Disaster Relief Management

SUGGESTED READINGS:

1. Paine, D.P., 1986. Aerial photography and image interpretation for resource management, Wiley and Sons, New York.
2. Ramasamy, SM., 1999. Trends in Geological Remote Sensing - Rawat Publishers, Jaipur
3. Rolf, A. de, 2001. Principles of Geographic Information Systems-An introductory textbook. ITC Educational Textbook Series. Enschede, The Netherlands.
4. Wilhelm Burger; Mark J. Burge, 2007. Digital Image Processing: An Algorithmic Approach Using Java. Springer.
5. Lo C.P. and Albert K. W. Yeung, 2002. Concepts and Techniques of Geographic Information System. Prentice –Hall, India.

Semester- IV

Course Code: BSCGELMJ401

Course Name: IGNEOUS PETROLOGY

Discipline Specific Major Course

Course Type: **MAJOR**	Course Details: **MJC-5**			L-T-P: **4- 0 - 2**	
Credit: **5** Theory 4, Practical 1	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

Igneous petrology in the field of geology, the objective of the study to gain an appreciation for how the final appearance of characteristics of igneous rocks is controlled by chemical and physical properties of magmas.

COURSE LEARNING OUTCOMES:

- Study of igneous rocks is a key component of geology curriculum (because these rocks not only abundant throughout the crust of the Earth, but, dominate some crustal and upper mantle environments).
- Application knowledges of melt generation and crystallization mechanisms, diverse rock types and their link to tectonic settings in different earth processes.

THEORY

Unit 1: Introduction to Igneous Petrology (Credit Hours – 2)

Modes of magma generation in the lower crust, upper mantle and core mantle boundary.

Definition of magma and lava, physical properties of magma, temperature, viscosity , volatile content and density of the magma. Concept of plutonic, volcanic and hypabyssal igneous rock. Mode of emplacement of magma. Different types of lava.

Unit 2: Forms and Structures of Igneous Rock Bodies (Credit Hours – 8)

Concordant and Discordant form of igneous body. Dykes and Sills, Cone sheet and Ring Dyke, Laccoliths, Lopoliths, Phacoliths, Bysmaliths, Batholiths,

Mode of occurrence of Extrusive rock

Lava Flows, Pahoehoe lava, Aa lava, Pillow lava, Buried lava flow, pyroclastic rocks

Unit3: Texture and Microstructure of Igneous Rock (Credit Hours – 8)

Crystallinity, Granularity, Shape and mutual relations among the grains, nucleation and rate of growth of minerals.

Description of the following texture and microstructure with their occurrences in the different rocks – Panidiomorphic granular, hypidiomorphic granular, allotriomorphic granular, porphyritic, vitrophyric, poikilitic, ophitic, sub ophitic, intergranular, Intersertal, pilotaxitic, trachytic,graphic,granophyric, rapakivi, orbicular, corona and keliphitic rims, perthitic, myrmekitic, variolitic, spherulitic and spinifex, vesicular and amygdaloidal structures.

Unit 4: Classification of Igneous rocks and petrographic description (Credit Hours – 10)

Bases of classification of Igneous rocks, mineralogical, textural, chemical, chemico-mineralogical, associational and tectonic, IUGS classification, TAS diagram

Description of following rocks in terms of mineralogy, texture and Indian occurrences. Granite, Granodiorite, Tonalite, Diorite, Monzonite, Pegmatite, Aplite, Norite, Gabbro, Dolerite, Syenite, Nepheline

syenite, Anorthosite, Peridotite, Pyroxenite, Dunite, Lherzolite, Harzburgite, Wehrlite, Lamprophyre, Carbonatite, Komatite, Basalt, Andesite, Rhyolite, Dacite, Phonolite, Carbonatite.

Unit 5: Phase Diagrams (Credit Hours – 12)

Phase rules and its application in Eutectic, Peritectic and solid solution system. Phase equlibria in the following binary and ternary systems and their significance diopside-anorthite, forsterite-silica, Nepheline-silica, albite-anorthite, albite-orthoclase, diopside-albite-anorthite, anorthite-forsterite-silica, quartz -albite-orthoclase, forsterite-diopside-silica, nepheline-kalsilite-silica.
Bowen's reaction series.

Unit 6: Petrogenesis of Igneous rocks (Credit Hours – 12)

Magmatic processes, crystal settling by gravitational process, filter pressing, magma convection, flowage differentiation, mixing of magma, magmatic assimilation, magmatic differentiation and diversity of igneous rocks and fractional crystallization
Petrogenesis of felsic and mafic igneous rocks: granitoids (I-, S-, M-, and A-type), basalt, anorthosite, alkaline rocks, carbonatites.

Unit 7: **Magmatism in different tectonic setting (Credit Hours – 8)**

Basic ideas on Mantle convection, Mantle melting, batch melting and partial melting
MORB and IAB. Large igneous province and mantle plume, Deccan Basalt.
General idea about layered complexes and Ophiolite complexes.

PRACTICAL (Credit Hours – 30)

Study of important igneous rocks in hand specimens and thin sections - granite, granodiorite, diorite, syenite, nepheline syenite, gabbro, anorthosites, ultramafic rocks, basalts, andesites. Determination of normative composition and nomenclature of igneous rocks from given bulk rock chemical analyses.

SUGGESTED READINGS:

1. Philpotts, A., and Ague, J., 2009. Principles of igneous and metamorphic petrology. Cambridge University Press.
2. Winter, J. D., 2014. Principles of igneous and metamorphic petrology. Pearson.
3. Rollinson, H. R., 2014. Using geochemical data: evaluation, presentation, interpretation. Routledge.
4. Raymond, L. A., 2002. Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
5. McBirney, A. R., 1984. Igneous Petrology. San Francisco (Freeman, Cooper & Company) and Oxford (Oxford Univ. Press),
6. Best, M. G., 2001. Igneous and Metamorphic Petrology.
7. K. G. Cox, J. D. Bell., 1979. The Interpretation of Igneous Rocks. Springer/Chapman & Hall.
8. Bose M.K., 1997. Igneous Petrology.
9. Tyrrell, G.W., 1926. Principles of Petrology. Springer

Discipline Specific Major Course

Course Name: METAMORPHIC PETROLOGY

Course Code: BSCGELMJ402

Course Type: **MAJOR**	Course Details: **MJC-6**			L-T-P: **4 - 0 - 2**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
Theory 4, Practical 1		**30**	**15**	**20**	**35**

COURSE OBJECTIVES:

Dynamicnatureoflithosphereleadstosolidstatetransformationsofrockswhichholdcluetothepast processes which are not possible to reconstruct by other means. This course aims to enable students to identify critical data as well as provide theoretical basis for interpreting this data for past geodynamic processes, especially the orogenic events.

COURSE LEARNING OUTCOMES:

- Identifyingequilibriummineralassemblagesthroughtexturalandmineralogicalobservations
- Plottingthequantitativeaswellasqualitativemineralandmineralassemblagedatatointerpretthediscontinuous reactions and to infer the nature of continuous reactions
- Apply the basics of Schreinemakers geometric plots for a set of reactions

THEORY

Unit 1: Introduction to Metamorphism (Credit Hours – 6)

Definition of metamorphism; factors controlling metamorphism; limits of metamorphism. Types of metamorphism – on the basis of factors (dynamic, thermal, dynamothermal); on the basis of settings (contact, regional, fault zone metamorphism, impact metamorphism); Protoliths of metamorphic rocks; Progressive and Retrogressive metamorphism; Metamorphic mineral reactions.

Unit 2: Phase equilibria in metamorphism (Credit Hours – 12)

Concept of equilibrium; Gibbs Phase Rule and Mineralogical phase rule of closed and open system, Graphical relations in metamorphic assemblages – Interpretation and representation of mineral assemblages; ACF, AKF and AFM diagrams; Schreinemakers' analysis for simple systems; Quantification of equilibrium in metamorphism Metamorphic rocks as geochemical systems; Application of chemical thermodynamics in homogeneous phase equilibria; Geothermobarometry

Unit 3: Genetic classification of metamorphism (Credit Hours – 6)

Grade, Zone and metamorphic facies; metamorphic zones and isograds; Metamorphic Facies Series; Paired Metamorphic Belt.

Unit 4: Metamorphismvis-à-vis Deformation (Credit Hours – 8)

Relationship between metamorphism and deformation; structure and textures of metamorphic rocks, Interpretation of porphyroblast – Si – Se relations.

Unit 5: Types of Metamorphism (Credit Hours – 10)

Progressive metamorphism of pelitic and basic rocks; Contact metamorphism of impure limestone.

Unit 6: Granulites and Crustal anatexis (Credit Hours – 8)

Introduction, mode of occurrence, lithology, structure, P-T estimation in granulite, origin; Role of fluids in granulite petrogenesis. Crustal anatexis, Partial melting in metamorphic rocks; Migmatites: Definition, types and their origin.

Unit 7: Metasomatism **(Credit Hours – 4)**

Role of fluids in metamorphism; Origin of skarn, fenite and spilite.

Unit 9: Metamorphic rock associations and plate tectonic settings **(Credit Hours – 6)**

Heat flow and metamorphism. Role of plate tectonics in metamorphism; Pressure-Temperature-time paths and their interpretation; Types of metamorphism in plate boundaries (subduction zone, mid oceanic rift and continent-continent collision zone) and plate interior.

PRACTICAL **(Credit Hours – 30)**

Megascopic and microscopic study (textural and mineralogical) of common metamorphic rocks: Slate, phyllite, chlorite schist, muscovite-biotite schist (+garnet, staurolite, andalusite), sillimanite-kyanite schist, amphibolites, marble, garnet-biotite gneiss, metagranitoid, orthopyroxene granulite, 2-pyroxene granulite, khondalite, calc granulite.

Laboratory exercises in graphic plots for composition paragenesis diagrams.

Determination of equilibrium P-T-fluid composition using thermodynamic expressions.

SUGGESTED READINGS:

1. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
2. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
3. Frost, B. R. and Frost, C. D. (2019). Essentials of Igneous and Metamorphic Petrology, 2nd ed. Cambridge University Press
4. Vernon, R. H. & Clarke, G.L. (2008) Principles of Metamorphic Petrology, Cambridge University Press.
5. Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
6. Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Earth Science Series.
7. Myron G. Best (2001). Igneous and Metamorphic Petrology, 2nd ed. Wiley-Blackwell

Discipline Specific Minor Course

Course Name: STRUCTURAL GEOLOGY AND GEODYNAMICS

Course Code: BSCGELMN401

Course Type: **MINOR**	Course Details: **MNC-4**		L-T-P: **4 - 0 - 2**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
Theory 4, Practical 1		**30**	**15**	**20**	**35**

COURSE OBJECTIVES:

The objectives of this course are to make students able to understand Concepts of linear and planar structures; dip, strike, rake, plunge etc.; significance of brittle and ductile deformation and their products, origin and mechanisms of faults, fractures, and folds, Concept of continental drift and plate tectonic theory, deriving tectonic histories from analysis of geological maps.

COURSE LEARNING OUTCOMES:

- Understand the structure of the rocks in the earth's crust and mantle.
- Determine the deformational history based on fabrics and geometric relationships.

- Quantitatively describe geodynamics of the earth: Understanding the concept of plates on earth and how their movement is involved in formation of ocean, faults and mountains.

THEORY

Unit 1: Introduction to Structural Geology (Credit Hours – 10)

Definition and Classification of geological structures. Preliminary concept of dip, strike of planar structure and plunge and rake of linear structures. Methods of determination of stratigraphic right way up. Unconformity – types and origin.

Unit 2: Folds (Credit Hours – 12)

Definition of fold. Different parts of fold. Geometric Classification of Folds.

Unit 3: Fault and Joint (Credit Hours – 08)

Definition of fault and Joint. Different parts of fault. Geometrical classification of Fault and Joint. Columnar joint.

Unit 4: Introduction to Geodynamic (Credit Hours – 08)

Definition of "Global tectonics ", Asthenosphere and Lithosphere. Brief ideas about the major, intermediate and minor plates on the globe.

Unit 5: Continental drift theory and formation of ocean (Credit Hours – 10)

Wegner's concept of continental drift theory. Special example of drifting between South America and African continents. Brief idea of seafloor spreading with example of formation of Atlantic Ocean.

Unit 6: Plate tectonic theory (Credit Hours – 12)

Plates and their margins, different types of plate boundaries. Plate motions and their driving forces. Brief ideas of formation of Himalayan Mountain belt, Andes Mountain belt, San Andreas Fault and Red Sea.

PRACTICAL (Credit Hours – 30)

Three points drill holes problems for the determination of dip and strike of a plane. Bed thickness problem with drill hole. Simple homoclinal dipping beds map and section. Marking different plates on global map. Marking the position of Red Sea, Alpine Himalayan Belt, Mid Atlantic Ridge and San Andreas fault.

SUGGESTED READINGS:

1. Billings. M.P,1987. Structural Geology,4th edition, Prentice-Hall.
2.Keary,P., Klepies, K.A and Vine,F.J.,2009. Global Tectonics 3rd Edition, Wiley Blackwell.

Skill Enhancement Course

Course Name: FIELD GEOLOGY - III

Course Code: BSCGELSE401

Course Type: **Skill Enhancement Course**	Course Details: **SEC-3**			L-T-P: **0 - 0 - 6**	
Credit: **3** Practical	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**….**	**20**	**…..**

COURSE OBJECTIVE:

The course provides comprehensive knowledge of geological mapping and the construction of geological maps. The main objective is to develop skills of geological mapping techniques in an area with lithological and structural diversity. The course focuses on developing the skills to build the relationship between the lithologic units and geological structures and their stratigraphic correlation to interpret and discuss the results in a regional tectonic context.

COURSE LEARNING OUTCOME:

- Recognize minerals and lithologies in the field (and document them);
- Measure and properly record structural orientation information;
- Can apply outcrop mapping techniques and create a geological map;
- Can construct geological cross-sections and can develop a geological history.

PRACTICAL **(Credit Hours – 90)**

Unit 1: Geological mapping, stratigraphic correlation and/or Economic geological field work
Unit 2: Primary (scalars and vectors) and secondary structures (linear and planar)
Unit 3: Trend, plunge, Rake/Pitch
Unit 4: Stereoplots of linear and planar structures, Orientation analyses.

Semester- V

Discipline Specific Major Course

Course Name: SEDIMENTOLOGY

Course Code: BSCGELMJ501

Course Type: **MAJOR**	Course Details: **MJC-7**			L-T-P: **3 - 0 - 4**	
Credit: **5** Theory 3, Practical 2	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

To develop an understanding of s near-surface processes of the planet 'Earth Learning to decode signatures of exogenic processes including climate and tectonics.

COURSE LEARNING OUTCOMES:

- Understanding basic processes of sedimentation (physical and chemical) including behaviour of fluids, fluid-grain interaction, structures formed thereof and processes control chemical sedimentation viz. carbonates etc. is the goal of this course.
- Exposure to different kinds of sedimentary rocks, their structures, textures and variability. Attempt will be made to provide students a holistic understanding of sedimentation process from deposition to diagenesis.

THEORY

Unit 1: Origin of sediments **(Credit Hours – 05)**

Weathering and sedimentary flux: Physical and chemical weathering, Role of climate and Tectonics.

Unit 2: Sediment granulometry **(Credit Hours – 08)**

Grain size scales Udden-Wentworth and Krumbein (phi) scale, particle size distribution; mean, median, mode. Environmental connotation; particle shape and fabric (Grain roundness and sphericity).

Unit 3: Basic hydraulics, Sedimentary textures, structures and environment

(Credit Hours–16)

Fluid flow: Types of fluids, Laminar and turbulent flow, subcritical, critical and supercritical flows; concept of mean flow velocity, unit discharge and bed shear stress; flow profile and flow separation; particle entrainment, transport (bedload, saltation and suspension) and deposition sedimentary structures. Penecontemporaneous Deformation Structures (PCD) Bedform stability diagram. Palaeocurrent analysis-Scalar and Vector attributes; different paleocurrent patterns. Trace fossils.

Unit 4: Varieties of sedimentary rocks **(Credit Hours – 11)**

Siliciclastic rocks: conglomerates, sandstones, mudrocks -composition and texture, provenance, classification. Carbonate rocks: controls of carbonate deposition, components and classification of limestone, dolomitization and dedolomitization.

Unit 5: Diagenesis **(Credit Hours – 05)**

Concepts of diagenesis, Controlling factors, Stages of diagenesis in siliciclastics and carbonates.

PRACTICAL **(Credit Hours – 60)**

Unit 1: Exercises on sedimentary structures
Unit 2: Particle size distribution and statistical treatment
Unit 3:Palaeocurrent analysis
Unit4: Petrography of selected clastic and non-clastic rocks through hand specimens and thin sections

SUGGESTED READINGS:

1. Allen, P.A., 1997. Earth Surface Processes, Blackwell publishing.
2. Boggs, S. Jr. (2010). Principles of Sedimentology and Stratigraphy. 4th Ed. Pearson Prentice Hall
3. Collinson, J. D. &Thompson, D. B. (1988) Sedimentary structures, Unwin-Hyman, London.
4. Folk, R. L. (1980) Petrology of Sedimentary Rocks. Hemphill Publishing Company, Austin, 184 p
5. Lewis, D. W. and McConchie, D., (1984) Practical sedimentology Wiley Blackwell.
6. Nichols, G. (2009) Sedimentology and Stratigraphy Second Edition. Wiley Blackwell
7. Pettijohn, F.J., 1975. Sedimentary Rocks, Harper and Row Publ. New Delhi.
8. Prothero, D. R. & Schwab, F. (2004). Sedimentary geology. Macmillan.
9. Sengupta, S. M. Introduction to Sedimentology,2nd Edition.CBS Publishers & Distributors
10. Tucker, M. E. (2006) Sedimentary Petrology, Blackwell Publishing.

Discipline Specific Major Course

Course Name: PALAEONTOLOGY

Course Code: BSCGELMJ502

Course Type: **MAJOR**	Course Details: **MJC-8**			L-T-P: **3 - 0 - 4**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
Theory 3, Practical 2		**30**	**15**	**20**	**35**

COURSE OBJECTIVES:

On completion of the course, the student will be able to learn how fossilization processes operate in nature and what early planetary conditions led to the origin and evolution of early life. The student will also be able to understand mass extinction events in the Phanerozoic Era and their causes, and how various geological and climatic events influenced the evolution of life and how life itself has influenced the geological processes.

COURSE LEARNING OUTCOMES:

- To learn evolution of life through geological time from simple prokaryotic to complex multicellular life forms, and the
- To learn role of geological processes and climatic events in shaping the evolution of life on the Earth.

THEORY

Unit 1: Fossilization and fossil record (Credit Hours – 03)

Fossilization processes and modes of fossil preservation, exceptional preservation.

Unit 2: Taxonomy and Species concept (Credit Hours – 04)

Species concept with special reference to palaeontology; Taxonomic hierarchy; Binomial nomenclature.

Unit 3: Invertebrate Palaeontology (Credit Hours – 06)

Brief introduction to important invertebrate groups (e.g., Trilobita, Brachiopoda, Mollusca); their biostratigraphic and evolutionary significance.

Unit 4: Micropalaeontology (Credit Hours – 06)

Brief introduction to important microfossil groups (Foraminiferida); their biostratigraphic and evolutionary significance; introduction to palynology.

Unit 5: Introduction to Vertebrate Palaeontology (Credit Hours – 10)

Origin and divisions of vertebrates; Major turning points in vertebrate evolution – evolution of jaw, terrestrialization, amniote evolution, evolution of mammals, Rise and fall of dinosaurs, evolution of flight.

Unit 6: Life through ages (Credit Hours – 11)

Geological Time Table with emphasis on major bio-events.

Palaeozoic Life: The Cambrian Explosion of Life; Biomineralisation and the fossil record. Palaeozoic Marine Life.

Mesozoic Life: Invertebrate life after the largest (P/T) mass extinction, Invertebrate life in the Jurassic seas.

Cenozoic Life: Radiation of placental mammals following K/Pg mass extinction; Evolution of modern grasslands and co-evolution of hoofed grazers; Back to water – Evolution of Whales; The age of humans; Hominid dispersals and climate setting.

Unit 7: Introduction to Palaeobotany (Credit Hours – 05)

Early plant life, colonization of land, important stages in plant evolution, Gondwana flora: role of climate in its evolution.

PRACTICAL (Credit Hours – 60)

Study of fossils showing various modes of preservation, Morphology of invertebrates (bivalves, cephalopods, gastropods, brachiopods), Plant morphology, Vertebrate teeth morphology.

SUGGESTIVE READINGS

1. Clarkson, E. N. K. 2013. Invertebrate Palaeontology and Evolution, Blackwell Science
2. Armstrong, H. A., & Brasier, M. D. (2005) Microfossils. Blackwell Publishing.
3. Arnold, C. A. (2018) An Introduction to Paleobotany. Surjeet Publications

4. Benton, M. J. & Harper, D. A. T. (2016). Introduction to Paleobiology and the fossil record. Wiley
5. Canfield, D. E. &Konhauser, K.O. (2012). Fundamentals of Geobiology, Blackwell.
6. Clarkson, E. N. K. (2012) Invertebrate paleontology and evolution. 4th Edition by Blackwell Publishing.
7. Cockell, C., Corfield, R., Edwards, N. & Harris, N. (2007). An Introduction to the Earth-Life System Cambridge University Press.
8. Cowen, R. (2000). History of Life. Wiley-Blackwell.
9. Doyle, P. 1996. Understanding Fossils: An Introduction to Invertebrate Palaeontology, John Wiley and Sons
10. Lieberman, B. S. &Kaesler, R. (2010). Prehistoric Life-Evolution and the Fossil Record, Wiley-Blackwell.
11. Lumine, J. I. (1999). Earth-Evolution of a Habitable World, Cambridge University Press.
12. Ray, A. K. (2008) Fossils in Earth Sciences. PHI Learning
13. Saraswati, P. K. & Srinivasan, M. S. (2016). Micropaleontology: Principles and Applications, Springer International Publishing Switzerland.
14. Shukla, A. C. & Misra, S. P. (1975). Essentials of paleobotany. Vikas Publisher
15. Stanley, S. M. &Luczaj, J. A. (2014). Earth System History (4th Edition), W. H. Freeman (Macmillan)
16. Stewart, W. N. and Rothwell G.W. (2001). Paleobotany and the evolution of plants, Cambridge University Press.
17. Taylor, Edith L., Taylor, Thomas N. & Krings, M. (2009). Paleobotany: The Biology and Evolution of Fossil Plants (2nd Ed.). Academic Press

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Discipline Specific Major Course

Course Name: HYDROGEOLOGY

Course Code: BSCGELMJ503

Course Type: **MAJOR**	Course Details: **MJC-9**			L-T-P: **3 - 0 - 4**	
Credit: **5** Theory 3, Practical 2	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

Water is a basic life supporting system. The rising global population and the quest for better living standard has greatly stressed the water resources. The course content primarily focuses on groundwater, which being easily available is amenable to greater exploitation. Thus, this course aims to enable students to acquire knowledge about the physical and chemical attributes, occurrence, movement, and exploration of the ground water resources.

COURSE LEARNING OUTCOMES:

- access the occurrence of groundwater, water bearing properties of formations, aquifer types and aquifer parameters.

- Develop an idea about construction, design and development of water wells. Aquifer parameter estimation and the science of ground waterflow under different conditions.
- use the concepts of ground water exploration.

THEORY

Unit1: Introduction and basic concepts (Credit Hours – 09)

Scope of hydrogeology and its societal relevance, Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration, and subsurface movement of water. Rock properties affecting groundwater, Vertical distribution of groundwater, Types of aquifer, aquifer parameters, anisotropy, and heterogeneity of aquifers

Unit2: Groundwater flow (Credit Hours – 08)

Darcy's law and its validity, Intrinsic permeability and hydraulic conductivity,Groundwater flow rates and flow direction, Laminar and turbulent ground water flow

Unit3: Well hydraulics and Ground water exploration (Credit Hours – 10)

Basic Concepts (draw down; specific capacity etc., Elementary concepts related to equilibrium and non-equilibrium conditions for water flow to a well in confined and unconfined aquifers. Surface-based groundwater exploration methods Introduction to subsurface borehole logging methods.

Unit4: Groundwater chemistry (Credit Hours – 08)

Physical and chemical properties of water and water quality, Introduction to methods of interpreting groundwater quality data using standard graphical plots. Seawater intrusion in coastal aquifers.

Unit5: Groundwater management (Credit Hours – 10)

Surface and subsurface water interaction, Groundwater level fluctuations, Basic concepts of water balance studies, issues related to ground water resources development and management,Rainwater harvesting and artificial recharge of groundwater, Brief idea about ground water pollution and its mitigation.

PRACTICAL (Credit Hours – 60)

Preparation and interpretation of water level contour maps and depth to water level maps
Study, preparation and analysis of hydrographs for differing groundwater conditions
Determination of hydraulic gradient/slope from water table depth data.
Three-point problems and determination of groundwater flow direction.
Numerical problems related to Well Hydraulics, Groundwater Flows etc.
Presentation of rainfall data-arithmetic mean, isohytal and Thiessen Polygon methods.
Chemical analyses of water. Piper Trilinear Diagram.

SUGGESTED READINGS:

1. Bear,Jacob, 1979. Hydraulics of Groundwater, Dover Publications
2. Brassington, Rick (2017) Field Hydrogeology (Fourth Edition), Wiley-Blackwell
3. Das, Subhajyoti (2011) Groundwater Resources of India (First Edition), National Book Trust

4. Davis, S. N. and De Weist, R.J.M. 1966. Hydrogeology, John Wiley & Sons Inc., N.Y.
5. Domenico, Patrick A. and Scbwartz,Franklin W. (1998) Physical and Chemical Hydrogeology (Second Edition), John Wiley
6. Freeze, R. Allan and Cherry,John A. (1979) Groundwater, Prentice Hall
7. Hiscock, Kevin M. and Bense, Victor F. (2014) Hydrogeology – Principles and Practice (Second Edition), Blackwell
8. Hudak,Paul F. (2000) Principles of Hydrogeology (Second Edition), CRC Press
9. Karanth K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.
10. Kresic,Neven (2007) Hydrogeology and Groundwater Modeling (Second Edition), CRC Press
11. Mukherjee,Abhijit (2018) Groundwater of South Asia, Springer
12. Patra, H.P., Adhikari, Shyamal Kumar and Kunar, Subrata (2016): Groundwater Prospecting and Management, Springer
13. Pawar, N.J, Das, S. and Duraiswami R.A. (2012) Hydrogeology of Deccan Traps and associated Formations in Peninsular India (Memoir – 80), Geol. Soc. India, Bangalore.
14. Raghunath, H.M.,1987, Groundwater, New Age International
15. Stober, Ingrid and Bucher,Kurt (2000) Hydrogeology of Crystalline Rocks, Springer
16. Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.

Discipline Specific Minor Course

Course Name: ESSENTIALS OF PALAEONTOLOGY

Course Code: BSCGELMN501

Course Type: **MINOR**	Course Details: **MNC-5**			L-T-P: **4 - 0 - 2**	
Credit: **5** Theory 4, Practical 1	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

The objective of the course is to introduce fundamental concepts of palaeontology, including fossilization, evolution, and paleoecology; to familiarize students with major fossil groups and their significance in understanding Earth's history, to develop practical skills in fossil identification, interpretation, and application in biostratigraphy and palaeoenvironmental reconstructions.

Course Learning Outcomes:

- Define and explain the fundamental concepts of palaeontology, including its scope, branches, and the nature and significance of fossils.
- Describe the processes of fossilization and interpret the principles of taphonomy and biostratigraphy, including the importance of index fossils.
- Analyse the evolution of life through geological time, including the origin of life, major evolutionary milestones, and mass extinction events.
- Differentiate between major fossil groups, including invertebrates, vertebrates, and plants, and assess their evolutionary significance.

- Evaluate the applications of fossils in palaeo environmental reconstructions and stratigraphic correlations.
- Demonstrate practical skills in identifying and describing fossil specimens and interpreting modes of preservation.
- Apply theoretical knowledge to classify fossils and infer their geological and environmental significance.

THEORY

Unit 1: Introduction to Palaeontology (Credit Hours – 13)

- Definition, scope, and branches of palaeontology
- Fossils: Definition, types, and significance
- Taphonomy: Processes of fossilization and exceptional preservation
- Principles of biostratigraphy and index fossils

Unit 2: Evolutionary Biology and Palaeontology (Credit Hours – 17)

- Concept of species in Palaeontology
- Life through ages: Brief introduction on Origin of Life, Precambrian Life, Paleozoic Life, Mesozoic Life, Cenozoic Life
- Mass extinction events

Unit 3: Major Fossil Groups (Credit Hours – 24)

- Invertebrate Palaeontology: Brief introduction to major invertebrate groups (Bivalvia, Echinodermata)
- Vertebrate Palaeontology: Evolution of Humans and Horse
- Plant Fossils: Major plant fossil groups and their significance

Unit 4: Applications of Palaeontology (Credit Hours – 06)

- Fossils in Palaeo environment reconstruction and stratigraphic correlation

PRACTICAL (Credit Hours – 30)

1. Fossilization Processes: Understanding different modes of preservation
2. Fossil Identification: Study and description of major fossil groups

SUGGESTED READINGS:

1. Armstrong, H. A., &; Brasier, M.D. (2005) Microfossils. Blackwell Publishing.
2. Benton, M. (2009). Vertebrate paleontology. John Wiley & Sons.
3. Clarkson, E. N. K. (2012) Invertebrate paleontology and evolution 4th Edition by Blackwell Publishing.
4. Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) Principles of Paleontology
5. Ray, A. K. (2008) Fossils in Earth Sciences. PHI Learning
6. Shukla, A. C., &; Mishra, S. P. (1975). Essentials of paleobotany. Vikas Publisher

Semester- VI

Discipline Specific Major Course

Course Name: REMOTE SENSING & GIS

Course Code: BSCGELMJ601

Course Type: **MAJOR**	Course Details: **MJC-10**			L-T-P: **3 - 0 - 4**	
Credit: **5** Theory 3, Practical 2	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

The main aim of this course is to 1) learn about the fundamentals of remote sensing, photogeology, GIS, and GPS, 2) learn basics remote sensing and GIS techniques, and 3) learn use of remote sensing and GIS in different fields.

COURSE LEARNING OUTCOMES:

- The basic concepts of remote sensing,
- Basic concepts of Photogeology and Photogrammetry,
- the basic concepts of GIS,
- GIS softwares viz., QGIS, Basic concepts and functioning of Global Positioning System (GPS).

THEORY

Unit 1:Basics of Remote Sensing & Its Applications in Geosciences (Credit Hours – 11)

Definition and development of Remote Sensing; its advantages and limitations; Properties of electromagnetic waves; electro-magnetic spectrum, Energy sources, energy interaction in the atmosphere, atmospheric windows, atmospheric effects on remotely sensed data, signatures in remote sensing, sensors and sensor platforms. Thermal Infrared remote sensing and microwave remote sensing for geological applications. Remote sensing satellites, Indian Remote Sensing Satellite programme.

Unit 2: Photogeology (Credit Hours – 07)

Types and acquisition of aerial photographs; Scale and resolution; Principles of Stereoscopy, relief displacement, vertical exaggeration and distortion, Elements of aerial photo interpretation, Identification of sedimentary, igneous and metamorphic rocks.

Unit 3: Fundamentals of remote sensing (Credit Hours – 10)

Electromagnetic Radiation (EMR), Basic concepts of Remote Sensing, Satellites and their characteristics, Indian Space Program, sensors and scanners, data formats - Raster and Vector; Remote sensing techniques: Optical, thermal and hyperspectral remote sensing.

Unit 4: Digital Image Processing (Credit Hours – 07)

Various processes of Digital Image Processing – Pre-processing, Image Enhancement, Transformation. Filtering, Image Rationing, Image classification, and accuracy assessment (Errors calculation).

Unit 5: GIS **(Credit Hours – 06)**

Datum, Coordinate systems and Projection systems, spatial data models and data editing, Introduction to DEM analysis, GIS integration and Case studies-Indian Examples.

Unit 6: GPS **(Credit Hours – 04)**

Basic concepts of GPS, Integrating GPS data with GIS Applications in earth system Sciences.

PRACTICAL **(Credit Hours – 60)**

Aerial Photo interpretation, identification landforms; Introduction to QGIS software;
Geo-referencing of satellite data with a toposheet of the area, Creating FCC from raw data, Digital Image Processing exercises including analysis of satellite data in different bands and interpretation of various objects on the basis of their spectral signatures.

SUGGESTED READINGS:

1. Bhatta, B., 2008. Remote Sensing and GIS. Oxford, New Delhi.
2. Demers M., Fundamentals of GIS
3. Demers, M.N., 1997. Fundamentals of Geographic Information System, John Wiley & sons. Inc.
4. Gupta, R.P., 1990. Remote Sensing Geology. Springer Verlag.
5. Hoffmann, W.B., Lichtenegger, H. and Collins, J., 2001. GPS: Theory & Practice, Springer Wien New York.
6. Jensen, J.R., 1996. Introductory Digital Image Processing: A Remote Sensing Perspective, Springer- Verlag.
7. Joseph, George 2018, Fundamentals of Remote Sensing, The Orient Blackswan.
8. Lillesand, T. M. & Kiefer, R.W., 2007. Remote Sensing and Image Interpretation, Wiley.
9. Millor, V.C., 1961 Photogeology. Mc Graw Hill
10. Moffitt, F.H. and Mikhail, E.M., 1980 Photogrammetry-Harper and Row
11. Pandey, S.N., 1987. Principles and Application of Photogeology. Wiley Eastern, New Delhi.
12. Rampal K.K. 1999. Handbook of aerial photography and interpretation. Concept publication.
13. Sabbins, F.F., 1985. Remote Sensing – Principles and Applications. Freeman.
14. Siegal, B.S. and Gillespie, A.R., 1980. Remote Sensing in Geology. John Wiley.
15. Richards, J.A. and Jia, X., 1999. Remote Sensing Digital Image Analysis, Springer-Verlag.

Discipline Specific Major Course

Course Name: Economic Geology

Course Code: BSCGELMJ602

Course Type: **MAJOR**	Course Details: **MJC-11**			L-T-P: **4- 0 - 2**	
Credit: **5** Theory 4, Practical 1	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

The objectives of this course are to: (a) familiarize with common ore minerals and their identifying criteria at various scales of study; (b) demonstrate knowledge of the variety of ore-forming processes; understand the control of ore in different rock association with respect to time and space.

COURSE LEARNING OUTCOMES:

- Recognize common ore minerals in hand samples and under microscope.
- To describe the mode of occurrence and paragenesis of ore deposits
- To classify ore deposits based on major ore forming processes
- To apprehend pattern of distribution of mineral deposits in India.

THEORY

Unit 1: Ores and gangues **(Credit Hours – 08)**

Ores, gangue minerals, tenor, assay value and grade, Resources and reserves- Definitions and classifications.

Unit 2: Mineral deposits and classical concepts of Ore formation **(Credit Hours – 36)**

Magmatic processes: fractional crystallization, liquid immiscibility; hydrothermal processes: characteristics, origin, movement, metal solubility, precipitation mechanism and alteration processes: magmatic hydrothermal deposits, metamorphic hydrothermal deposits, seawater hydrothermal deposits, meteoric water hydrothermal deposits, connate water hydrothermal deposits; sedimentary processes: clastic sedimentary processes, chemical sedimentary processes; weathering processes: laterites, clay deposits, calcrete hosted deposits; surficial processes: supergene and hypogene enrichment.

Unit 3: Structure and tectonics of ore deposits **(Credit Hours – 04)**

Concordant and discordant ore bodies, lodes, tectonic control of mineralization.

Unit 4: Ore textures **(Credit Hours – 02)**

Different type of ore textures due to free growth and constrained growth.

Unit 5: Metallic and Nonmetallic ores **(Credit Hours – 10)**

Metallogenic provinces and epochs, Important metallic deposits of India. including atomic minerals, Non-metallic and industrial rocks and minerals, in India, Geology of the State and its resources.

PRACTICAL **(Credit Hours – 30)**

Mesoscopic identification of ores; study of microscopic properties of ore forming minerals (Oxides and sulphides); preparation of maps showing distribution of important ores and other economic minerals in India.

SUGGESTED READINGS:

1. Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.
2. Deb, S. (1980) Industrial minerals and rocks of India. Allied Publishers.
3. Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley
4. Gokhale, K.V.G.K. and Rao, T.C. (1978) Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi.
5. Guilbert, J.M. and Park Jr., C.F. (1986) The Geology of Ore deposits. Freeman & Co.
6. Laurence Robb. (2005) Introduction to ore forming processes. Wiley.
7. Mookherjee, A (1999) Ore genesis: a holistic approach. Allied Publishers.
8. Sarkar, S.C. and Gupta, A. (2012) Crustal Evolution and Metallogeny in India. Cambridge

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Discipline Specific Major Course

Course Name: Stratigraphy

Course Code: BSCGELMJ603

Course Type: **MAJOR**	Course Details: **MJC-12**			L-T-P: **5 - 0 - 0**	
Credit: **5** (Theory)	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		-	**30**	**-**	**70**

COURSE OBJECTIVES:

Objective of this course is to perform lithostratigraphic correlation, construct rank charts for lithostratigraphy, biostratigraphy and chronostratigraphy and to have an idea about different stratigraphic successions of India.

COURSE LEARNING OUTCOMES:

- Analyze basic principles of stratigraphy, different types of stratigraphic units and how they are named.
- Use the fossil record in establishing age of the rock unit and correlation with other area.
- Give an account of criteria of stratigraphic correlation.
- Appreciate how plate tectonic movements separated India from contiguous landmasses and shaped the depositional basins of the Indian Phanerozoic, and what were their effects on climate and life.

THEORY

Unit 1: Stratigraphy **(Credit Hours – 16)**

Definition, Walther's Law; Stratigraphic classifications: lithostratigraphic, biostratigraphic and chronostratigraphic classifications; International Code of Stratigraphic Nomenclature; Concepts of Stratotypes. Global Stratotype Section and Point (GSSP). Introduction to concepts of: chemostratigraphy, seismic stratigraphy, sequence stratigraphy, Magnetostratigraphy; Principles of stratigraphic correlation.

Unit 2: Physiographic and tectonic subdivisions of India **(Credit Hours – 05)**

Brief introduction to the physiographic and tectonic subdivisions of India.

Unit 3: Precambrian evolution of Peninsular India **(Credit Hours – 20)**

Stratigraphy and evolution of the Precambrian cratons, Dharwar, Singbhum, Aravalli, Bastar; Central Indian Suture Zone; Introduction to Proterozoic basins of India, Vindyan and Cuddapah.

Unit 4: Introduction to Himalayas **(Credit Hours – 10)**
Divisions and tectono-magmatic evolution of the Himalayas: Paleozoic & Mesozoic Succession of Spiti; Cenozoic succession of Lesser Himalaya and Sub-Himalaya (Siwalik)

Unit 5: Phanerozoic evolution of Peninsular India **(Credit Hours – 10)**
Gondwana basin-fills of Peninsular India; Mesozoic basins of India: Kutch, Cauvery Basin; Cenozoic basins of India: Assam, Bengal Basin

Unit 6: Volcanic provinces of India **(Credit Hours – 03)**
Deccan Trap, Rajmahal Trap, Sylhet Trap

Unit 7: Important Stratigraphic boundaries in India **(Credit Hours – 11)**
Precambrian-Cambrian boundary, Permian-Triassic boundary, and Cretaceous-Tertiary boundary

SUGGESTED READINGS:

1. Doyle, P. & Bennett, M. R. (1996). Unlocking the Stratigraphic Record. John Wiley
2. Hedberg, H.D. (Editor), 1976. International stratigraphic guide. John Wiley & Sons, New York, 200.
3. Krishnan, M. S. (1982). Geology of India and Burma, C.B.S. Publishers, Delhi
4. Krumbein, W. and Sloss, L. (1963) Stratigraphy and Sedimentation. W.H. Freeman and Co., San Francisco, 660 p.
5. Ramakrishnan, M. &Vaidyanadhan, R. (2008). Geology of India Volumes 1 & 2, Geological Society of India, Bangalore.
6. Ravindra Kumar. Fundamentals of Historical Geology and Stratigraphy of India. 3rd Ed. New Age International Private Limited
7. Schoch, Robert, M. (1989): Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.
8. Valdiya, K. S. (2010). The making of India, MacMillan India Pvt. Ltd.

Discipline Specific Major Course

Course Name: Geotectonics

Course Code: BSCGELMJ604

Course Type: **MAJOR**	Course Details: **MJC-13**			L-T-P: **4- 0 - 2**	
Credit: **5** Theory 4, Practical 1	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:
The objectives of this course are to make students able to understand the following:Brief idea on basic difference between structural geology and tectonics,Concept of continental drift and plate tectonic theory, understanding geomagnetism, sea floor spreading, isostasy.Origin of supercontinents and ideas on elements of neotectonics

COURSE LEARNING OUTCOMES:
- Understanding the concept of plates on earth and how their movement is involved in formation of ocean, faults and mountains.

- Develop ideas on geomagnetism and paleomagnetism
- Understanding the seismic activities and the relationship between geological structures and geomorphic evolution
- Idea about the pattern of changing of global tectonics with progressive ageing of the Earth.

THEORY

Unit 1: **Introduction** **(Credit Hours –09)**

Definitions of 'Tectonics' and 'Global Tectonics'; Similarities and differences between Structural Geology and Tectonics; Asthenosphere and Lithosphere in the context of global tectonics; A brief introduction to how our ideas of tectonics on global scale evolved progressively from continental drift concept through sea-floor spreading concept to the comprehensive plate tectonics concept.

Unit 2: **Continental drift Theory** **(Credit Hours –04)**

Wegner's and Du Toit's concepts

Unit 3: **Geomagnetism** **(Credit Hours – 09)**

The concept of geomagnetism; geomagnetic anomaly and geomagnetic polarity reversals; Paleomagnetism; Concept of fossil magnetism, paleo-lattitude and plaeomagnetic evidences in favor of continental drift theory.

Unit 4: **Seafloor spreading** **(Credit Hours – 5)**

Its concept; Linear Magnetic Anomalies; Vine & Mathew's hypothesis

Unit 5: Isostasy **(Credit Hours – 03)**

Concept of isostasy, its development; proposed models explaining isostatic equilibrium – comparative analysis; isostatic condition of India

Unit 6: **Plate Tectonics** **(Credit Hours – 15)**

Theory of plate tectonics, Plates; Different types of plate boundaries and their characteristic features; Plate motions and driving forces and mechanisms; Special discussion on island arcs and collisional orogenic belts (with the Himalayas in focus); Earthquake focal mechanism; relative plate motions via seafloor spreading and earthquake focal mechanisms; satellite geodetic measurements of relative plate motions; reconstruction of past plate motions; finite rotations.

Unit 7: **Changing global tectonics with time** **(Credit Hours – 07)**

The location, extent and age of the major orogenic belts of the Earth in geological history (referring only to the respective classical occurrences); General idea about the changing pattern of global tectonics with progressive ageing of the Earth.

Unit 8: **Supercontinents** **(Credit Hours – 05)**

Supercontinents through Geological time; concept of assembly and break-up of supercontinents – evidence and explanations.

Unit 9: **Elements of Neotectonics** **(Credit Hours – 03)**

Seismic activity, fault systems, landform features and the relationship between geological structures and geomorphic evolution

PRACTICAL **(Credit Hours – 30)**

The technique of locating the focus and epicenter of earthquakes using focal mechanism solutions; Plotting on an outline map of the world: major plates on the Earth, nature of plate boundaries and relative plate motion; study of paleotectonic map of India; interpretation of Isogal maps (i.e. Bouguer Gravity Anomaly maps).

SUGGESTED READINGS:

1. Condie,K.C., 1982.PlateTectonicsand CrustalEvolution.2nd Edition,Pergamon Press.
2. Keary,P.,Klepeis,K.A.andVine,F.J.,2009.GlobalTectonics.3rd Edition,Wiley- Blackwell.
3. Brown,G.C.andMussett,A.E.,1993.TheInaccessibleEarth.2nd Edition,Chapman&Hall, London.
4. Fossen, Haakon & Teyssier, Christian (2024). Plate Tectonics. Cambridge University Press.
5. Windley, B. F (1984). The Evolving Continents (2nd Ed.) John Wiley and Sons.
6. Cox, A. & Hart, R. B. (1986). Plate Tectonics: How It Works. Wiley-Blackwell
7. Moores, E.M. and Twiss,R.J., 1995. Tectonics. W.H. Freeman.

Summer Internship

Course Name: Summer Internship

Course Code: SI601

Course Type: **SI**	Course Details: **SIMC-1**		L-T-P: **0 - 0 - 4**	
Credit: **2**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**------**	**20**	**------**

Introduction:

A key aspect of the new UG programme is induction into actual work situations**.** All students will also undergo internships / Apprenticeships in a firm, industry, or organization or Training in labs with faculty and researchers in their own or other HEIs/research institutions during the summer term.

Students will be provided with opportunities for internships with home institutions/College, University,local industry, business organizations, health and allied areas, local governments (such as panchayats, municipalities), Parliament or elected representatives, media organizations, artists, crafts persons, and a wide variety of organizations so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability.

OBJECTIVES:

The internship programs for Employability are to be conceptualized and interactive for building research capabilities/aptitude/skills for

1. Development of project and its execution
2. Decision-making
3. Confidence development
4. Working/coordinating in a team

5. Creative and critical thinking and problem-solving
6. Ethical values
7. Professional development
8. Understanding government/local bodies world of work
9. Reference of resource persons in the field
10. Development of online/ simulation-based module for a virtual research internship
11. Understanding the nuances of building a deep-technology start-up
12. Entrepreneurship
13. Study of the enterprises, farmers, artisans, etc.

Duration of Internship:

60 working Hours for 2 Credits

The course may be conducted during the semester or within one month after completion of 6th Theory ESE (End Semester Examinations) including Evaluation.

Internship Domains for Geology

1. Study of rocks and minerals and preparation of thin section of rocks.
2. Geological activities in mining or oil (Petroleum) sector.
3. Groundwater survey using resistivity method.
4. Gemology and examination of authenticity of gems.
5. Study of Remote Sensing and GIS related packages/softwares.
6. Environmental studies.

Internship opportunities/ Organization:
Students will undergo internship at home institutions/ College,University,local industry, business organizations, health and allied areas, local governments (such as panchayats, municipalities), Parliament or elected representatives, media organizations, artists, crafts persons, and a wide variety of organizations

Internship may be as field-work training/training in the laboratory under the supervision of Supervisor from the parent institution (own college) and Mentor from host Institution.

For Examination/ Evaluation

- A report within 3000 to 5000 words to be prepared by the intern under the supervision **of Supervisor from the parent institution** (own college) and **Mentor from host Institution**
- Internship Completion Certificate by the Mentors/ Mentor. and Supervisor /Supervisor
- **Self-assessment and feedback form to be submitted by the Intern.**
- CA :30 Marks will be assessed by the **Supervisor from the parent institution as Continuous assessment in consultation with the Mentor, depending upon performance and attendance of the intern, and report**
- ESE: 20 Marks will be assessed by the External and Internal faculty through seminar presentation and/or viva-voce at the parent institution,
- All Evaluation process along with mark capture for the Cours :**SummerInternship**

(SI601) must be completed by June every year.

Nodal Officer

Internship Programme will be fully organised, executed and monitored by the R&D cell of Institution through a Nodal Officer, Nodal Officer to be appointed by the Vice Chancellor/ Director/ Principal/ Head of the Institution.

If possible, make a registration system for internship program each year in the website of the parent Institutions so that next year onwards students may get help

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Students who want to undertake 3-year UG programme will be awarded UG Degree in the relevant Discipline / Subject upon securing 126 credit.

Semester- VII

Discipline Specific Major Course

Course Name: Exploration Geology

Course Code: BSCGELMJ701

Course Type: **MAJOR**	Course Details: **MJC-14**			L-T-P: **3- 0 - 4**	
Credit: **5** Theory 3, Practical 2	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

To understand the concept of exploration, different techniques used to find out a hidden mineral treasure, advantages and disadvantages of these techniques and to estimate the content of the treasure.

COURSE LEARNING OUTCOMES:

- to judge the suitability of a technique for a particular type of deposit and its limitation.
- to be aware of the required information that to be collected for reserve estimation.

Unit 1: Mineral Resources **(Credit Hours – 07)**

Definitions of resource and reserve, classification of resources, UNFC-classification, Mineral resources in industries - historical perspective and present; brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies.

Unit 2: Prospecting and Exploration **(Credit Hours – 10)**

Prospecting and exploration-conceptualization, methodology and stages; Sampling, subsurface sampling including pitting, trenching and drilling: Geochemical exploration, geochemical dispersion, back ground value, threshold value, anomaly identification, geochemical sampling.

Unit 3: Evaluation of data **(Credit Hours – 06)**

Evaluation of sampling data, Mean, mode, median, standard deviation and variance.

Unit 4: Drilling and Logging **(Credit Hours – 05)**

Core and non-core drilling, Planning of bore holes and location of boreholes on ground Core-logging.

Unit 5: Reserve estimation **(Credit Hours – 08)**

Principles of reserve estimation, density and bulk density, tonnage factor, grade of a deposit, factors affecting reliability of reserve estimation, reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks), reserve estimation based on graphical methods.

Unit 6: Elements of Mining(Credit Hours – 09)

Principles of Mining, Surface Mining; Underground Mining; Mine Machinery; Mine Explosive; Rock Mechanics and Support System; Mine Ventilation; Mine Closure.

PRACTICAL **(Credit Hours – 60)**

Concept of weighted average, calculation of average grade from sampling data, calculation of grade from groove sampling, calculation of grade and reserve from exploratory mining, models of reserve estimation.

SUGGESTED READINGS:

1. Arogyaswami, R.P.N. 1996 Courses in Mining Geology. 4th Ed. Oxford-IBH.
2. Clark, G.B. 1967. Elements of Mining. 3rd Ed. John Wiley & Sons.
3. Haldar, S.K., 2013. Mineral Exploration: Principles and Applications. Elsevier.
4. Marjoribanks, R., 2010. Geological Methods in Mineral Exploration and Mining, Second Edition, Springer-Verlag.
5. Moon, C.J., Whateley, M.K.G., Evans, A.M., 2006, Introduction to Mineral Exploration, Blackwell Publishing.
6. Sinha, R. K. and Sharma, N. L. 1988 Mineral Economics, fourth edition. Oxford and IBH Publishing Co. Private Ltd.

Discipline Specific Major Course

Course Name: Engineering Geology

Course Code: BSCGELMJ702

Course Type: **MAJOR**	Course Details: **MJC-15**		L-T-P: **4 - 0 - 2**	
Credit: **5** Theory 4, Practical 1	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

Theobjectivesofthecoursearetostudyandidentifydifferenttypesnatural materials like rocks and minerals and soil, to understand the various natural dynamic processes their influence on the surfacial features, natural material and their consequences and to know the physical properties of rocks and minerals.

COURSE LEARNING OUTCOMES:

- Abilitytocategorizerocksandmineralsbytheiroriginandengineeringproperties.
- Ability to apply geological principles to rock masses and discontinuities for use in engineering design. e. g. rockslopes, foundation.

THEORY

Unit 1: Introduction **(Credit Hours – 13)**

Role of engineering geologists in planning, design and construction of major man-made structural features, applications of engineering geology in civil constructions e.g. geological considerations (types, methods, problems related to geological point of views) of river valley projects— dam, reservoirs, tunnels, bridges etc.

Applications of Engineering Geology in civil constructions e.g. geological considerations (types, methods, problems related to geological point of views) of river valley projects— Dam, reservoirs, tunnels, bridges etc.

Unit 2: Foundation treatment (Credit Hours – 07)
Grouting, rock bolting and other support mechanisms; slope stability and mass wasting; types of block failure, factor of safety.

Unit 3: Intact Rock and Rock Mass properties (Credit Hours – 10)
Significance as construction material; properties of building materials: physical properties; compositions and structures of materials; significance of building or dimension stone: roofing and facing materials; armourstone; crushed rock – concrete aggregate; road aggregate; gravels and sands; lime; cement and plaster; clays and clay products.

Unit 4: Rock Quality Designation (RQD) (Credit Hours – 06)
Concept, Mechanism and Significance of: Rock Structure Rating (RSR), Rock Mass Rating (RMR), Tunnelling Quality Index (Q)

Unit 5: Dams and Reservoirs (Credit Hours –12)
Geological conditions for the selection of dam and reservoir sites; terminology associated with dams; types of dams – masonry, gravity, buttress, arch and earthdams; types of spillway; causes of dam failures. problems affecting dams and their remedial measures; case studies of dam construction and failures; geological, geotechnical and environmental considerations for dams and reservoirs.

Unit 6: Tunnel (Credit Hours – 05)
Tunnel: different parts; types; geological investigations for site selection for tunnel; tunnelling problems; factors effectıng excavatıon of rocks while tunnelling; effects of fold, fault, bed attitude on tunnelling.

Unit 7: Landslides (Credit Hours – 04)
Different parts of landslide body; inducing factors for landslides; role of gravity and water

Unit 8: Earthquakes (Credit Hours – 03)
Causes, Factors and corrective / preventive measures

PRACTICAL (Credit Hours –30)

Selection of sites using topographic maps for dams, tunnels, bridges and similar civil structures; Computation of reservoir area, catchment area, reservoir capacity and reservoir life; Merits, demerits and remedial measures based upon geological cross sections of project sites; Computation of Index properties of rocks; Evaluation of mechanical properties of concrete aggregates; Surveying related exercises; Computation of RQD, RSR, RMR and 'Q'

SUGGESTED READINGS:

1. Bell, Fred G, (2007) Engineering Geology (Second Edition), Elsevier.
2. Bell, Fred G. (2007) Basic Environmental and Engineering Geology, Whittles Publishing.
3. Blyth, F.G.H. and de Freitas, M. (1984) A Geology for Engineers, Elsevier.
4. Fletcher, Chris J.N. (2016) Geology for Ground Engineering Projects, CRC Press.
5. Gangopadhyay, S. (2013) Engineering Geology, Oxford India.

6. Goodman, R.E., 1993. Engineering Geology: Rock in Engineering constructions. John Wiley & Sons, N.Y.
7. Johnson, R.B. and De Graf, J.V. 1988. Principles of Engineering Geology, John Wiley.
8. Krynine, D.P. and Judd W.R. 1957. Principles of Engineering Geology and Geotechnique, McGraw Hill (CBS Publ).
9. Smith, M.R. (1999) Stone – Building Stone, Rock Fill and Armourstone in Construction, Geological Society of London.
10. Waltham, T., (2009) Foundations of Engineering Geology (Third Edition) Taylor & Francis.
11. Waltham, T., 2009. Foundations of Engineering Geology (3rd Edn.) Taylor & Francis.
12. Zhang, H. (2011) Building Materials in Civil Engineering, Woodhead Publishing.

Discipline Specific Major Course

Course Name: Fuel Geology

Course Code: BSCGELMJ703

Course Type: **MAJOR**	Course Details: **MJC-16**		L-T-P: **3 - 0 - 4**	
Credit: **5** Theory 3, Practical 2	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

The objectives of this course are to: (a) To introduce conventional and non-conventional geological energy sources; (b) To understand formation, classification, distribution of energy sources especially in India; (c) To familiarize with the fundamentals of petroleum prospecting.

COURSE LEARNING OUTCOMES:

- Characterize each type of fuel deposit
- Demonstrate the occurrence, setting and components of different fuels
- Apprehend the distribution of fuel in India

THEORY

Unit 1: Coal **(Credit Hours – 10)**

Definition and origin of coal; coalification; fundamentals of coal petrology: lithotypes, micro lithotypes and macerals in coal; proximate and ultimate analysis of coal, classification of coal: Seyler's, ASTM and Indian

Unit 2: Coal bed methane (CBM) **(Credit Hours – 08)**

Introduction; origin of methane; adsorption – Langmuir model; production; global and Indian scenario, underground coal gasification (UCG): UCG and SCG; advantages and disadvantages; Indian scenario, coal liquefaction: processes; advantages and disadvantages; Indian scenario.

Unit 3: Petroleum **(Credit Hours – 06)**

Chemical and physical properties of crude oil in nature, origin of petroleum; Kerogen: types and relation to the origin of petroleum hydrocarbons

Unit 4: Petroleum System **(Credit Hours – 08)**

Source rock; reservoir rocks; cap rocks; migration of petroleum hydrocarbons and entrapment; traps: structural, stratigraphic, combination and hydrodynamic trap, petroliferous basins of India

Unit 5: Nuclear fuel **(Credit Hours – 06)**

Nuclear fuel*:* types of nuclear reactions; fuel types – uranium and thorium; important minerals and types of uranium deposits, nuclear raw material resources of India; usage of nuclear energy.

Unit 6: Other fuels **(Credit Hours – 07)**

Shale Gas: introduction, advantages and disadvantages; Indian scenario, gas hydrate*:* introduction, occurrence, stability of gas hydrates; advantages and disadvantages; Indian scenario.

PRACTICAL **(Credit Hours – 60)**

Petrographic study of coal, reserve estimation of coal, outcrop completion, fault and borehole problems; seismic profile interpretation; panel and fence diagrams, section correlation and identification of hydrocarbon prospect

SUGGESTED READINGS:

1.Thomas, L., 2020. Coal Geology (Third Edition), Wiley-BlackwelSuarez-Ruiz, I. and Crelling, J.C., 2008.
2. Demirbas, A., 2010. Methane Gas Hydrate. Springer
3.Chandra D., 2007. Chandra's Textbook on Applied Coal Petrology. Jijnasa Publishing House
4.Chandra, D., Singh, R.M. and Singh, M.P., 2000. Textbook of Coal (Indian Context). Tara Book Agency, Varanasi
5.Diessel, C.F.K., 1992. Coal-Bearing Depositional Systems. Springer
6.Francis, W., 1964. Coal its Formation and Composition. Edward Arnold
7.Singh, M.P., 1998. Coal and Organic Petrology. Hindustan Publ. Corp., New Delhi.
8. Ward, C.R., 1984. Coal Geology and Coal Technology. Blackwell Science
9.Thakur, P., Schatzel, S.J., Aminian, K., Rodvelt, G., Mosser, M.H., D'Amico, J.S., 2020. Coal Bed Methane – Theory and Applications (Second Edition), Elsevier
10.Flores, R.M., 2014. Coal and Coalbed Gas – Fueling the Future. Elsevier
11. Singh, Ajay Kumar and Hajra, Partha Narayan, 2018. Coalbed Methane in India – Opportunities, Issues and Challenges for Recovery and Utilization. Springer
12. Letcher, T.M., 2020. Future Energy – Improved, Sustainable and Clean Options for our Planet (Third Edition). Elsevier
13. Bell, D.A., Towler, B.F. and Fan, M., 2011. Coal Gasification and Its Applications. Elsevier
14. Massey, L.G., 1973. Coal Gasification. American Chemical Society
15. Whitehurst, D.D., 1980. Coal Liquefaction Fundamentals. American Chemical Society
16. Shelly R.C., 2014. Elements of Petroleum Geology (Third Edition). Academic Press
17. Bjorlykke, K., 1989. Sedimentology and Petroleum Geology. Springer
18. Tissot, B.P. and Welte, D.H., 1984. Petroleum Formation and Occurrence. Springer
19. Levorsen, A.I., 2004. Geology of Petroleum; CBS Publishers and Distributors, India
20. North, F.K., 1986. Petroleum Geology, Allen & Unwin
21. Bastia, R. and Radhakrishna, M., 2012. Basin Evolution and Petroleum Prospectivity of the Continental Margins of India. Elsevier
22. Doveton, J.H., 1986. Log Analysis of Subsurface Geology. Wiley-Interscience
23. Hobson, G.D., 1977. Developments in Petroleum Geology. Applied Science Publishers
24. Aswathanarayana, U., 1985. Principles of Nuclear Geology. Oxford
25. Boyle, R.W., 1982. Geochemical Prospecting for Thorium and Uranium Deposits. Elsevier

26. Dahlkamp, F.J., 1993. Uranium Ore Deposits. Springer

Discipline Specific Major Course

Course Name: Geostatistics

Course Code: BSCGELMJ704

Course Type: **MAJOR**	Course Details: **MJC-17**			L-T-P: **4 - 0 - 2**	
Credit: **5** Theory 4, Practical 1	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

This course helps to introduce the learners different statistical and mathematical tools used in geological studies. It aims to develop proficiency in data interpretation, probability theory, multivariate statistical techniques, with applications in spatial data analysis and geostatistical modelling.

COURSE LEARNING OUTCOMES:

- Apply basic statistical tools to analyse and interpret geological data,
- Use probability distributions and statistical tests to solve geological problems,
- Analyse spatial data using geostatistical techniques such as kriging and Semivariograms
- Employ multivariate techniques like cluster analysis, and discriminant functions in geological studies.

THEORY

Unit 1: Introduction **(Credit Hours – 04)**

Definition purpose and scope; Measurement Systems.

Unit 2: Elementary Statistics **(Credit Hours – 16)**

Population, Sample; Continuous Random Variables; Transformation of data; Central Limits Theorem: Measures of central tendency-Mean, median and mode; Measures of variability-variance, standard deviation; Geological interpretation of skewness and kurtosis, Correlation and regression- simple linear model.

Unit 3: Concept of probability **(Credit Hours – 14)**

Concept of probability; Population distribution- normal, binomial and Poisson; Principles of statistical tests and their use in geology; Chi-square test, F-test, t-test; Analyses of variance (ANOVA).

Unit 4: Analysis of Sequences of Data **(Credit Hours – 18)**

Least-Squares Methods and Regression Analysis; Trend Surface Analysis, Interpolation by distance method, moving average method. Autocorrelation and Cross-correlation; Semivariograms and Kriging.

Unit 5: Analysis of multivariate data **(Credit Hours – 08)**

Discriminant functions, Cluster Analysis, Factor Analysis — geological applications.

PRACTICAL **(Credit Hours – 30)**

Term paper and presentation on a topic assigned by the Teacher(s)

SUGGESTED READINGS:

1. Armstrong, M. (1998) Basic Linear Geostatistics, Springer Verlag, Berlin.
2. Cooley, W.W. and Lohnes, P.R. (1971) Multivariate data analysis, John Wiley and Sons.
3. Creighton, J.H.G. (1994) First course in probability models and statistical inference, Springer Verlag.
4. Davis, J.G. (1986) Statistics and data analysis in geology, John Wiley.
5. Journel, A.G. and Huijbregts, Ch. (1978) Mining Geostatistics, Academic Press,
6. Kubackova, L., Kubacek, L. and Kukuca, J. (1987) Probability and Statistics in Geology and Geophysics, Elsevier.
7. Pitman, J. (1993) Probability, Springer Verlag, (also Narosa Publishers).
8. Saals, E.A. and Srovastav, R.M. (1990) An Introduction to Geostatistics, Oxford University Press.
9. Spiegel, M.R. (1982) Probability and Statistics, Schaums Outline Series, McGraw-Hill Int., Singapore, Asian Students Edn.
10. Walpole, R.E. and Myers, R.H. (1982) Applied multivariate statistical analysis, Prentice Hall Inc., New Jersey.

Discipline Specific Minor Course

Course Name: Geology of India

Course Code: BSCGELMN701

Course Type: **MINOR**	Course Details: **MNC-6**			L-T-P: **5 - 0 - 0**	
Credit: **5** Theory	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		-	**30**	**-**	**70**

COURSE OBJECTIVES:

Through this course students will gain a foundational understanding of India's tectonic history, stratigraphic principles, and regional geology. This course provides an overview of India's stratigraphy and physiographic divisions. It covers the major geological provinces, Precambrian cratons, various mobile belts and Phanerozoic basins.

COURSE OBJECTIVES:

- Describe the tectonic and geological framework of the Indian subcontinent,
- Interpret the geological evolution of Precambrian and Phanerozoic terrains in India,
- Identify the major cratons, sedimentary basins, and orogenic belts of India,
- Apply principles of stratigraphy and methods of correlation to Indian geological sequences.

Unit: 1 Introduction **(Credit Hours – 10)**

Brief idea about craton, shield, platform, mobile belts, folded mountain chains, greenstone belt, bathymetric divisions, marine life, types of marine sediments and tectonic divisions,

Unit: 2 Principles of Stratigraphy (Credit Hours – 27)

Fundamental laws of stratigraphy: Concept of Uniformitarianism, Law of superposition, Law of faunal succession; Intrusion and inclusion in relative age determination, Basic concept of absolute age determination by radioisotope (only the relation of time with decay constant), Stratigraphic classification: Lithostratigraphic, biostratigraphic, chronostratigraphic and geochronologic classification, Chronostratigraphic chart (only the broad framework),Correlation: Lithostratigraphic, biostratigraphic and chronostratigraphic methods of correlation.

Unit: 3 Physiographic divisions of India (Credit Hours – 10)

Peninsular India, Extra-peninsular India and Indo-Gangetic plains, Western desert area, Coastal areas.

Unit:4 Precambrian geology of India (Credit Hours –14)

Singhbhum, Rajasthan, Dharwar and Bastar cratons, Cuddapah and Vindhyan basins

Unit:5 Phanerozoic geology of India (Credit Hours – 14)

Paleozoic of Kashmir, Gondwana basins, Jurassic of Kutch, Deccan trap, Cretaceous of Trichinopoly, Siwalik, Bengal Basin

SUGGESTED READINGS:

1. Krishnan, M. S. (1982). Geology of India and Burma, C.B.S. Publishers, Delhi
2. Ravindra Kumar. Fundamentals of Historical Geology and Stratigraphy of India. 3rd Ed. New Age International Private Limited
3. Valdiya, K. S. (2010). The making of India, MacMillan India Pvt. Ltd.

Semester- VIII

FOR

4 - Year UG Degree (Honours)

Discipline Specific Major Course

Course Name: Oceanography and Climatology

Course Code: BSCGELMJ801

Course Type:**MAJOR**	Course Details: **MJC-18**			L-T-P: **5 - 0 - 0**	
Credit: **5** Theory	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		-	**30**	**-**	**70**

COURSE OBJECTIVES:

The objective of this course is to provide students with a wide-ranging understanding of the physical, chemical, biological, and geological aspects of the ocean and its interactions with the atmosphere. It aims to develop introductory knowledge of oceanographic and climatological processes and their roles in Earth's climate system. Students will learn topics such as ocean currents, waves, tides, marine ecosystems, climate variability, global climate change, and the tools used in ocean and climate studies

COURSE LEARNING OUTCOMES:

- Explain the essential principles of oceanography and climatology, including the structureand composition of the ocean and atmosphere.
- Describe the important physical, chemical, biological, and geological processes in the oceansand how they interact with atmospheric systems.
- Gain fundamental knowledge about the role of oceanic and atmospheric circulation in globalclimate regulation and weather patterns.
- Discuss the significance of ocean-atmosphere interactions in phenomena such as El Niño, LaNiña, monsoons, and hurricanes.
- Understand and address the contemporary environmental challenges and policy issues fromtheir knowledge of ocean and climate.

Oceanography

Unit 1: Introduction to the Oceans **(Credit Hours – 03)**

Oceanography – the concept, brief historical review; Origin of Ocean Basins; Physiography of the Ocean Floor

Unit 2: Waves and Tides in the Ocean **(Credit Hours – 08)**

Properties of Ocean Waves; Wave Motions; Standing Waves, Internal Waves, Tsunamis, Origin of the Tides, Equilibrium Model of Tides, Dynamic Model of the Tides; Tidal Currents

Unit 3: The Dynamic Shoreline **(Credit Hours – 12)**

Coastal Water Movement, Shoaling Waves and Refraction, Circulation in the Surf Zone; Beaches; Coastal Dunes; Barrier Islands; Deltas; Estuaries; Lagoons; Mangrove swamps; Anthropogenic impact on the Coastline

Unit 4: Marine Resources (Credit Hours – 06)

Types of marine resources; Physical, energy, biological and non-extractive resources; Mineral resources; Laws of the sea

Climatology

Unit 1: Atmosphere – Hydrosphere (Credit Hours – 14)

Atmospheric Processes - Air Pressure, Coriolis Deflection, General Wind Circulation; Atmosphere and ocean interaction and its effect on climate; Heat transfer in ocean; Global oceanic conveyor belt and its control on earth's climate; Surface and deep circulation; Sea ice and glacial ice; Brief introduction to Monsoon system, mechanism of monsoon, special emphasis on Indian Monsoon,

Unit 2: Climate system (Credit Hours – 10)

Forcing and Responses; Components of the climate system; Climate forcing, Climate controlling factors; Climate system response, response rates and interactions within the climate system; Feedbacks in climate system

Unit 3: Heat budget of Earth (Credit Hours – 08)

Incoming solar radiation, receipt and storage of heat; Heat transformation; Earth's heat budget. Interactions amongst various sources of earth's heat

Unit 4: Orbital cyclicity and other controls on climate (Credit Hours – 08)

Milankovitch cycles and variability in the climate; Glacial-interglacial stages; The Last Glacial maximum (LGM); Pleistocene Glacial-Interglacial cycles; Younger Dryas; Snow Ball Earth.

Unit 5: Response of biosphere to Earth's climate (Credit Hours – 06)

Climate classification schemes; Climate Change: natural vs. anthropogenic effects; Humans and climate change; Future perspectives; Brief introduction to archives of climate change; Archive based climate change data from the Indian continent.

SUGGESTED READINGS:

1. Aguado, E., and Burt, J., (2009). Understanding weather
2. Alan P. Trujillo & Harold V. Thurman. (2011). Essentials of Oceanography, 10th ed. Pearson
3. Gross, M. G., 1977. Oceanography: A view of the earth.
4. Lal, D. S., 2001. Climatology and oceanography: Sharda Pustak Bhawan
5. Lutgens, F., Tarbuck, E., and Tasa, D. (2009). The Atmosphere: An Introduction to Meteorology. Pearson Publisher
6. Pinet, Paul R. (2016). Invitation to Oceanography, Seventh edition. Jones & Bartlett Learning.
7. Rohli, R. V. and Vega, A. J. (2007). Climatology. Jones and Barlatt
8. Rudiman, W.F. (2001). Earth's climate: past and future: 2nd ed., Freeman Publisher.

Discipline Specific Major Course

Course Name: Colloquium

Course Code: BSCGELMJ802

Course Type: **MAJOR**	Course Details: **MJC-19**		L-T-P: **0- 2 - 4**	
Credit: **4** Practical	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		60	**-**	**40**	**-**

COURSE OBJECTIVES:

The objective of this course is to nurture critical thinking, academic dialogue through structured presentations, discussions, and insightful engagement with current topics in the field. The colloquium offers students with the opportunity to explore advanced concepts, interact with experts and peers, and develop professional communication skills.

COURSE LEARNING OUTCOMES:

- Engage in informed and respectful academic discussions on current topics and research
- within the field.
- Demonstrate effective oral communication skills through presentations and group
- dialogues.
- Critically evaluate scholarly work and research presentations by peers and guest speakers.
- Develop confidence in presenting ideas, asking questions, and responding thoughtfully in academic settings.
- Reflect on the relevance of current developments in the field to their own academic andcareer interests

Literature Review and Colloquium

Each student is to submit a term paper on an exhaustive review on any specific topic and to present it in an open session before a board of Five Members (Comprising Internal Faculty Members and at least one External Subject Expert).

Discipline Specific Major Course

Course Name: Mineral Beneficiation and Mineral Economics

Course Code: BSCGELMJ803

Course Type: **MAJOR**	Course Details: **MJC-20**		L-T-P: **4 - 0 - 0**	
Credit: **4** (Theory)	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
			30		**70**

COURSE OBJECTIVES:

The course objective is to provide a possibility to understand mineral processes for ores, industrial minerals, recycling products and mineral fuel. The theoretical aspects of common mineral

processing techniques are covered. Students will have an idea about equipment utilized nowadays in mining and extractive metallurgy practices. They will be acquainted with the solid separation principles when applied to ores and minerals, from the mine down to concentrates production.

COURSE LEARNING OUTCOMES:

- Understand the basic principles of mineral separation processes and the respective equipment used;
- Analyze reasons for selection of processes based on raw material properties,
- Make a logical link between applied mineralogy, mineral processing and economics of metal production

Mineral Beneficiation

Unit 1: Introduction (Credit Hours – 04)

Necessity of beneficiation; advantages, Ore dressing; Ore processing; Smelting, Stages of beneficiation, Choice of a mineral processing method.

Unit 2: Comminution (Credit Hours – 10)

Stages of size reduction, Primary crushing; jaw crushers, gyratory crushers; construction and operation, Secondary crushing; cone crushers and roll crushers; construction and operation, Fine crushing machines, Grinding theory; ball mills, rod mills; construction and operation.

Unit 3: Sizing (Credit Hours – 06)

Liberation size (mesh); middling particle, tailings, Laboratory sizing; Hand screens, mechanical shaker, variety of sieves, Industrial screening; fixed screens, moving screens, Classification; sorting and sizing classifiers, Sub-sieve sizing

Unit 4: Concentration processes (Credit Hours – 10)

Size, specific gravity and surface property dependent beneficiation processes-gravity concentration-theory and practice of Jigging, heavy media separation and flowing film concentration. Froth flotation. Drying and dewatering.

Mineral Economics

Unit 1: Introduction (Credit Hours – 10)

Introduction; Concepts of mineral economics, Growth of mineral industry and the economy. Reserves and resources of world mineral supplies, Assessment of Indian mineral reserves. Energy demand and future supplies, Valuation of mineral property.

Unit 2: Mineral legislation (Credit Hours – 05)

Mining laws, Mineral legislation, Mineral taxation, Mineral conservation laws, Mineral concession systems.

Unit 3: National mineral policy (Credit Hours – 07)

Peculiarities inherent in mineral industry. Strategic, critical and essential minerals. Objectives of national mineral policy. Structure and organization of mineral industry.

Unit 4: Marine mineral resources (Credit Hours – 08)

Territorial jurisdiction; law of the sea. Exclusive economic zone. Management of resources of international sea bed. Marine pollution. Rights of landlocked countries.

SUGGESTED READINGS:

Mineral Beneficiation

1. Gaudin, A.M. (1975) : Principles of mineral dressing. Tata Mcgraw-Hill.
2. Gokhale, K.V.G.K. and Rao, T.C. (1973): Ore deposits pf India-their distribution and precessing. Thompson press (India) ltd., Delhi.
3. Jain, S.K. (2008): Mineral processing. CBS publishers and distributers, New Delhi.
4. Lele, A, Palet, S and Rao, V (2017) : Mineral processing (including mineral dressing, experiments and numericals). I.K. international publishing house.
5. Richards, R.H. (2022): A text book of ore dressing. Legare street press.
6. Taggort, A.F. (1945) : Hand book of mineral dressing. Wiley, New York.

Mineral Economics

1. Chatterjee, K.K. (2004) : An introduction to mineral economics. New Age International Private Ltd..
2. Gupta, V. (2018) : The mines and minerals (Developments and Regulations) act 1957. 2nd edition. Commercial Law House publishers.
3. Halder, S.K. (2013): Mineral exploration – principles and applications. Elsevier publications.
4. Ray, S.C. and Sinha, I.N. : Mine and mineral economics. PHI Learning Publishers. E-Book ISBN: 9789354436819.
5. Seshagiri Rao, P. (2023) : Law of mines and minerals (in 2 volumes). 23rd edition. Asia Law House publishers.
6. Sinha , R. K. and Sharma, N. L. (1988) : Mineral Economics, fourth edition. Oxford and IBH Publishing Co. Private Ltd.

Discipline Specific Major Course

Course Name: Environmental Geology

Course Code: BSCGELMJ804

Course Type: **MAJOR**	Course Details: **MJC-21**			L-T-P: **3 - 0 - 2**	
Credit: **4** Theory 3 Practical1	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

This course aims to investigate the interaction between geologic principles, environments, humans, and the Earth. The course is designed to provide the students with the tools necessary to interpret change in global environments. The use of fundamental geologic knowledge is investigated to encourage critical thinking & effective problem-solving methodologies for sustainability in human-landscape interactions.

COURSE LEARNING OUTCOMES:

- Describe the scientific method as applied in the earth sciences;
- Demonstrate about common earth materials and their relationship to environmental hazards;
- Explain how the occurrence and formation of earth resources and significant environmental effects caused by their extraction, processing, and use;
- Describe the major sources of water, soil, and sediment pollution and methods for their management;

- Explain the causes and effects of global climate change;
- Demonstrate an understanding of data collection, interpretation, and concluding specific to natural and anthropogenic processes that are relevant to humans and the environment;
- Scrutinize how the earth system process is instrumental in formulating public policy or law to deal with a variety of environmental problems and the delineate role of geoscientist in management of solving environmental problems.

THEORY

Unit 1: Introduction (Credit Hours – 12)

Concepts of Environmental Geology. Domains of Environmental Geology. Time scales of global changes in the ecosystem and climate. Impact of circulations in atmosphere and oceans on climate and rain fall. Levels of Present and past atmospheric carbon-dioxides. Global warming caused by CO_2 increase in the present atmosphere. Carbon Sequestration.

Unit 2: Role of different factors and pollution (Credit Hours – 14)

Role of physical, chemical and biological parameters influencing environment. Riverine and marine environments and their important characteristics. Air, water and noise pollution and their major causes**.** Pollution in the mining areas. Parameters influencing weathering, development of soils and soil profiles.

Unit 3: Natural and Anthropogenic Hazards (Credit Hours – 11)

Distribution, magnitude and intensity of earthquakes. Seismic hazard zones. Neotectonics in seismic hazard assessment. Landslide, Floods and volcanic hazards their causes and control. Coastal erosion its causes and control. Anthropogenic effects.

Unit 4: Urban Environment (Credit Hours – 08)

Problems of urbanization, human population and their impact on environment. Alternative sources of energy.

Waste disposal and related problems. Environmental legislation.

PRACTICAL (Credit Hours – 30)

Term paper and presentation on assigned topics

SUGGESTED READINGS:

1. Bell, F.G. (1999) Geological Hazards, Routledge, London
2. Bryant, E. (1985) Natural Hazards, Cambridge University Press
3. Keller, E.A. (1978) Environmental Geology, Bell and Howell, USA
4. Patwardhan, A.M. (1999) The Dynamic Earth System. Prentice Hall
5. Smith, K. (1992) Environmental Hazards. Routledge, London
6. Subramaniam, V. (2001) Textbook in Environmental Science, Narosa International

Semester- VIII

FOR

4 - Year UG Degree (Honours with Research)

Course Name: Oceanography and Climatology

Course Code: BSCGELMJ801

Course Type:**MAJOR**	Course Details: **MJC-18**			L-T-P: **5 - 0 - 0**	
Credit: **5** Theory	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		-	**30**	**-**	**70**

COURSE OBJECTIVES:

The objective of this course is to provide students with a wide-ranging understanding of the physical, chemical, biological, and geological aspects of the ocean and itsinteractions with the atmosphere. It aims to develop introductory knowledge of oceanographic andclimatological processes and their roles in Earth's climate system. Students will learn topics such asocean currents, waves, tides, marine ecosystems, climate variability, global climate change, and thetools used in ocean and climate studies

COURSE LEARNING OUTCOMES:

- Explain the essential principles of oceanography and climatology, including the structureand composition of the ocean and atmosphere.
- Describe the important physical, chemical, biological, and geological processes in the oceansand how they interact with atmospheric systems.
- Gain fundamental knowledge about the role of oceanic and atmospheric circulation in globalclimate regulation and weather patterns.
- Discuss the significance of ocean-atmosphere interactions in phenomena such as El Niño, LaNiña, monsoons, and hurricanes.
- Understand and address the contemporary environmental challenges and policy issues fromtheir knowledge of ocean and climate.

Oceanography

Unit 1: Introduction to the Oceans **(Credit Hours – 03)**

Oceanography – the concept, brief historical review; Origin of Ocean Basins; Physiography of the Ocean Floor

Unit 2: Waves and Tides in the Ocean **(Credit Hours – 08)**

Properties of Ocean Waves; Wave Motions; Standing Waves, Internal Waves, Tsunamis, Origin of the Tides, Equilibrium Model of Tides, Dynamic Model of the Tides; Tidal Currents

Unit 3: The Dynamic Shoreline **(Credit Hours – 12)**

Coastal Water Movement, Shoaling Waves and Refraction, Circulation in the Surf Zone; Beaches; Coastal Dunes; Barrier Islands; Deltas; Estuaries; Lagoons; Mangrove swamps; Anthropogenic impact on the Coastline

Unit 4: Marine Resources (Credit Hours – 06)

Types of marine resources; Physical, energy, biological and non-extractive resources; Mineral resources; Laws of the sea

Climatology

Unit 1: Atmosphere – Hydrosphere (Credit Hours – 14)

Atmospheric Processes - Air Pressure, Coriolis Deflection, General Wind Circulation; Atmosphere and ocean interaction and its effect on climate; Heat transfer in ocean; Global oceanic conveyor belt and its control on earth's climate; Surface and deep circulation; Sea ice and glacial ice; Brief introduction to Monsoon system, mechanism of monsoon, special emphasis on Indian Monsoon,

Unit 2: Climate system (Credit Hours – 10)

Forcing and Responses; Components of the climate system; Climate forcing, Climate controlling factors; Climate system response, response rates and interactions within the climate system; Feedbacks in climate system

Unit 3: Heat budget of Earth (Credit Hours – 08)

Incoming solar radiation, receipt and storage of heat; Heat transformation; Earth's heat budget. Interactions amongst various sources of earth's heat

Unit 4: Orbital cyclicity and other controls on climate (Credit Hours – 08)

Milankovitch cycles and variability in the climate; Glacial-interglacial stages; The Last Glacial maximum (LGM); Pleistocene Glacial-Interglacial cycles; Younger Dryas; Snow Ball Earth.

Unit 5: Response of biosphere to Earth's climate (Credit Hours – 06)

Climate classification schemes; Climate Change: natural vs. anthropogenic effects; Humans and climate change; Future perspectives; Brief introduction to archives of climate change; Archive based climate change data from the Indian continent.

SUGGESTED READINGS:

9. Aguado, E., and Burt, J., (2009). Understanding weather
10. Alan P. Trujillo & Harold V. Thurman. (2011). Essentials of Oceanography, 10th ed. Pearson
11. Gross, M. G., 1977. Oceanography: A view of the earth.
12. Lal, D. S., 2001. Climatology and oceanography: Sharda Pustak Bhawan
13. Lutgens, F., Tarbuck, E., and Tasa, D. (2009). The Atmosphere: An Introduction to Meteorology. Pearson Publisher
14. Pinet, Paul R. (2016). Invitation to Oceanography, Seventh edition. Jones & Bartlett Learning.
15. Rohli, R. V. and Vega, A. J. (2007). Climatology. Jones and Barlatt
16. Rudiman, W.F. (2001). Earth's climate: past and future: 2nd ed., Freeman Publisher.

Discipline Specific Major Course

Course Name: Research Methodology

Course Code: BSCGELRP801

Course Type: **RP**	Course Details: **RPC-1**		L-T-P: **4 - 0 - 0**	
Credit: **4**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		---	**30**	**---**	**70**

COURSE OBJECTIVES:

Objective of the course is to provide students or researchers with the essential knowledge and skills to conduct systematic and scientific investigations.

COURSE LEARNING OUTCOMES:

- Understand and explain key concepts of research methodology, including research plan,
- methods, and techniques.
- Frame research problems, hypotheses, and objectives relevant to their field of study.
- Design an organized research plan using appropriate qualitative, quantitative, or mixed
- methods.
- Apply various data collection techniques, especially experiments, and observations.
- Analyse and interpret research data using statistical and analytical tools.
- Demonstrate the ability to write clear and brief research proposals and reports.
- Critically evaluate existing research literature to formulate research questions.

Unit 1: Research plan **(Credit Hours 10)**

Research - definition; identification of research area and problem; literature survey; definition of the specific research problem; definition of scope and purpose of a research problem; definition of research plan and objectives; conditions and criteria for good research.

Unit 2: Field work **(Credit Hours 12)**

Basic objectives of the field work; identification and delineation of the field area; acquisition and recording of field data; documentation – basic principles of mapping, logging, field photography and field sketching; method of rock/mineral sampling; collection of oriented rock samples; collection of fossils; collection of unconsolidated sediments - collection of peels and box cores; collection of water samples.

Unit 3: Sample preparation **(Credit Hours 10)**

Brief idea about the preparation of samples in the laboratory for different analyses.

Unit 4: Sample analysis **(Credit Hours 10)**

Brief idea about different analytical methods.

Unit 5: Development of power of expression **(Credit Hours 8)**

Preparation of presentation, research proposal, report/thesis

Unit 6: Research ethics **(Credit Hours 10)**

Suggested Readings

1. Carry. J., 2016. Geoscience: Instrumentation and Analytical Techniques. Syrawood Publishing House, New York, 212p.
2. Compton, R. R., 1962. Manual of Field Geology. New York: Wiley, 378p.
3. Hutchison, C. S., 1974. Laboratory handbook of petrographic techniques. London and New York, Wiley-Interscience, 527p.
4. Lahee, F. H., 1961. Field Geology. New York: McGraw-Hill, 926p.
5. Langstaff, C. S., and Morrill, D., 1981. Geologic Cross Sections. Boston: International Human Resources Development Corporation, 108p.
6. Moseley, F., 1981. Methods in Field Geology. San Francisco: W. H. Freeman, 211p.
7. Roberts, J. L., 1982. Introduction to Geological Maps and Structures. Oxford, England: Pergamon Press, 332p.
8. Shelton, H., 1966. Geology Illustrated. San Francisco: W. H. Freeman, 434p.
9. Shrock, R. R., 1948. Sequence in layered rocks: A study of features and structures useful for determining top and bottom or order of succession in bedded and tabular rock bodies. New York: McGraw-Hill, 507p.
10. Thomas, J. A. G., 1979. An Introduction to Geological Maps. London: Allen and Unwin, 67p.

Discipline Specific Major Course

Course Name: Dissertation

Course Code: BSCGELRP802

Course Type:**RP**	Course Details: **RPC-2**			L-T-P: **0 - 0 - 16**	
Credit: **8**	Full Marks: **200**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		120	**-----**	**80**	**----**

Details of this course will be provided shortly.

Discipline Specific Minor Course

Course Name: Economic and Fuel Geology

Course Code: BSCGELMN801

Course Type: **MINOR**	Course Details: **MNC-7**			L-T-P: **4- 0 - 2**	
Credit: **5** Theory 4, Practical 1	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

COURSE OBJECTIVES:

The objectives of this course are to: (a) familiarize with common ore minerals and their identifying criteria at various scales of study; (b) demonstrate knowledge of the variety of ore-

forming processes;(c) understand the control of ore in different rock association with respect to time and space. (d) to introduce conventional and non-conventional geological energy sources.

COURSE LEARNING OUTCOMES:

- Recognize common ore minerals in hand samples and under microscope.
- To describe the mode of occurrence and paragenesis of ore deposits
- To classify ore deposits based on major ore forming processes
- Demonstrate the occurrence, setting and components of different fuels (Coal, Petroleum and other fuels)

THEORY

Economic Geology

Unit 1: Ores and gangues (Credit Hours – 05)

Ores, gangue minerals, tenor, assay value and grade, Resources and reserves- Definitions and classifications.

Unit 2: Mineral deposits and classical concepts of Ore formation (Credit Hours – 12)

Ore deposits formed by magmatic processes-fractional crystallization, liquid immiscibility, Ore deposits formed by hydrothermal processes -magmatic, metamorphic, seawater, meteoric water and connate water hydrothermal deposits; Ore deposits formed by sedimentary processes- Clastic sedimentary processes and chemical sedimentary processes; Ore deposits formed by weathering processes; Ore deposits formed by surficial processes.

Unit 3: Structure and tectonics of ore deposits (Credit Hours – 04)

Concordant and discordant ore bodies, lodes, Tectonic control of mineralization.

Unit 4: Ore textures (Credit Hours – 04)

Different type of ore textures due to free growth and constrained growth.

Unit 5: Metallic and Nonmetallic ores (Credit Hours – 05)

Metallogenic provinces and epochs, Important metallic deposits of India, Non-metallic and industrial rocks and minerals, in India

Fuel Geology

Unit 1: Coal (Credit Hours – 05)

Definition and origin of Coal; Basic classification of coal; Fundamentals of Coal Petrology – Lithotypes, microlitho types and macerals in coal

Unit 2: Coal as a fuel (Credit Hours – 04)

Brief idea about Coal Bed Methane (CBM), Underground Coal Gasification; Coal Liquefaction

Unit 3: Petroleum (Credit Hours – 04)

Chemical and physical properties of crudes oil, Origin of petroleum; Maturation of kerogen

Unit 4: Petroleum Reservoirs and Traps (Credit Hours – 12)

Migration of Hydrocarbons, Reservoir rocks: general attributes and petrophysical properties;

Hydrocarbon traps: definition, classification of hydrocarbon traps, Time of trap formation and time of hydrocarbon accumulation Cap rocks: definition and general properties;

Unit 5: Other fuels(Credit Hours – 05)
Gas Hydrate; Nuclear Fuel

PRACTICAL (Credit Hours – 30)

Mesoscopic identification, Study of microscopic properties of ore forming minerals (Oxides and sulphides).

Study of hand specimens of coal; Section correlation and identification of hydrocarbon prospect; Panel and Fence diagrams

SUGGESTED READINGS

Economic Geology

1. Guilbert, J.M. and Park Jr., C.F. (1986) The Geology of Ore deposits. Freeman & Co.
2. Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.
3. Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley
4. Laurence Robb. (2005) Introduction to ore forming processes. Wiley.
5. Gokhale, K.V.G.K. and Rao, T.C. (1978) Ore deposits of India their distribution and processing,
Tata-McGraw Hill, New Delhi.
6. Deb, S. (1980) Industrial minerals and rocks of India. Allied Publishers.
7. Sarkar, S.C. and Gupta, A. (2012) Crustal Evolution and Metallogeny in India. Cambridge Publications.
8. Mookherjee, A (1999) Ore genesis: a holistic approach. Allied Publishers.

Fuel Geology

1. Thomas, L. (2020) Coal Geology (Third Edition), Wiley-Blackwell
2. Chandra, D., Singh, R.M. and Singh, M.P. (2000) Textbook of Coal (Indian Context).
Tara Book Agency, Varanasi
4. Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.
5. Shelly, R.C. (2014). Elements of Petroleum geology: Third Edition, Academic Press
6. Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer
7. Letcher, T.M. (2020) Future Energy – Improved, Sustainable and Clean Options for our Planet (Third Edition). Elsevier