MAHATMA GANDHI UNIVERSITY

KOTTAYAM, KERALA, INDIA

SYLLABUS

UNDER GRADUATE PROGRAMMES (HONOURS)

MGU-UGP (Honours)

(2024 Admission Onwards)

Faculty : Earth and Environmental Sciences

BoS : Geology

Subject : Geology

MAHATMA GANDHI UNIVERSITY
Priyadarshini Hills
Kottayam 686560, Kerala, India

Contents

Preface

Geology is the study of the components, processes, structure and crustal resources of the Earth. It includes various fields of study that confines the principles of various endogenic and exogenic Earth's processes, types of rocks, economic mineral resources, fossils, exploration & mining, geomorphic features, hydrogeologic parameters, geological factors of environment, geoinformatics techniques, natural disasters, disaster Management, and history of the Earth's evolution. This syllabus serves as a guide to the captivating world of geology, and provide an enriched and comprehensive understanding of Earth as a system.

The course is tailored for those who has a deep curiosity to know our planet Earth in deep, through a combination of theoretical knowledge, practical applications, study tours, fieldworks, and critical thinking. The curriculum is structured to explore a wide array of topics such as Earth formation, its internal and external structures, endogenic and exogenic Earth's processes, Mineralogy, Petrology, Sedimentology, Stratigraphy, Geomorphology, Palaeontology, Environmental Geology, Structural Geology, Economic Geology, Fuel Geology, Exploration Geology, Mining Geology, Engineering Geology, Hydrogeology, Marine Geology, Geoinformatics, Natural Hazards, Disaster Management, and Research Methodology in Geology.

The field of geology offers a wide array of job opportunities across various sectors such as Mining, Exploration and Geotechnical industries, Academia & Research, Water Resources Management, Remote Sensing & GIS, Environmental Regulatory Agencies and Environmental Consulting. Therefore, the course emphasis on fostering linkage between the analytical thinking, problem-solving skills, and aptitude for scientific inquiry in the students, through both the classical and contemporary methods of study to optimize the performance in their professional endeavours. Moreover, the course encourages active participation, collaborative learning, and independent research initiatives, provided with the opportunity to excite intellectual curiosity of learners, not only through the field work and laboratory experiments, but also through the project works that reinforce theoretical concepts, and foster a holistic understanding of the Geology.

List of Members of Board of Studies in Geology

Sl No	Name	Address
1	Dilip Kumar P. G.	HOD Department of Geology Government College, Kottayam
2	Dr. Anish A. U.	Associate Professor of Geology Department of Civil Engineering Government College, Thrissur
3	Dr. Ajay K. K.	Associate Professor Department of Geology Government College, Kottayam
4	Dr. V. Santhosh	Assistant Professor Department of Geology M.E.S College Ponnani, Malappuram
5	Dr. K. S. Arunkumar	Assistant Professor Department of Geology M.E.S College Ponnani, Malappuram
6	Dr. Sreela S. R.	Assistant Professor S. N. College, Vakala Kollam
7	Suraj P. R.	Assistant Professor Department of Geology Government College Kasaragod
8	Priya P. N.	Assistant Professor Department of Geology Government College, Kottayam
9	Arun J. John	Assistant Professor Department of Geology University College, Thiruvananthapuram
10	Tharun R.	Assistant Professor Department of Geology and Environmental Science Christ College, Irinjalakkuda
11	Sanoop Salam T. A.	Assistant Professor Department of Geology Government College, Kottayam

List of Experts

Sl No	Name	Address
1	Dr. S. N. Kumar	Professor (Rtd) University of Kerala, Thiruvananthapuram
2	Dr. Baiju K. R.	Associate Professor School of Environmental Sciences MG University, Kottayam

SYLLABUS INDEX

Name of the Major: **Geology**

Semester: 1

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG1DSCGEO100	The Earth: An introduction	DSC A	4	5	3		2	
MG1MDCGEO100	Understand the Earth	MDC	3	4	2		2	

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester: 2

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG2DSCGEO100	Exogenous Earth Processes	DSC A	4	5	3		2	
MG2MDCGEO100	Natural Hazards	MDC	3	4	2		2	

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester: 3

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG3DSCGEO200	Mineralogy	DSC A	4	5	3		2	
MG3DSCGEO201	Study Tour with Field Training*	DSC A	4	5*	3		2	
MG3DSEGEO200	Endogenous Earth Processes	DSE	4	4	4			
MG3DSEGEO201	Hydro-Agro Management (Water Management Specialization)							
MG3DSEGEO202	Geo- heritage and Geo tourism							
MG3DSCGEO202	Mineral Science	DSC B	4	5	3		2	
MG3VACGEO200	Sustainable Resource Management	VAC	3	3	3			
MG3MDCGEO200	Groundwater and Management	MDC	3	3	3			

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester: 4

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG4DSCGEO200	Stratigraphy and Sedimentary Petrology	DSC A	4	5	3		2	
MG4DSCGEO201	Invertebrate Paleontology	DSC A	4	5	3		2	
MG4DSEGEO200	Environmental Geology	DSE	4	4	4			
MG4DSEGEO201	Climatology							
MG4DSEGEO202	Groundwater Hydrology (Water Management Specialization)							
MG4DSCGEO202	Fossilology	DSC C	4	5	3		2	
MG4VACGEO200	Geology and Environment	VAC	3	3	3			
MG4SECGEO200	Journey through Geological Time	SEC	3	3	3			
MG4INTGEO200	Internship		2					

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

INTERNSHIP: 2 Credit

Semester: 5

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG5DSCGEO300	Structural Geology	DSC A	4	5	3		2	
MG5DSCGEO301	Study Tour with Field Training*	DSC A	4	5 *	3		2	
MG5DSEGEO300	Geology and Geomorphology of Kerala	DSE	4	4	4			
MG5DSEGEO301	Gemmology							
MG5DSEGEO302	Phanerozoic Stratigraphy of India	DSE	4	4	4			
MG5DSEGEO303	Planetary Geology							
MG5DSEGEO304	Mining Geology	DSE	4	4	4			
MG5DSEGEO305	Groundwater Exploration and Management (Water Management Specialization)							
MG5SECGEO300	Geoinformatics	SEC	3	3	3			

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester: 6

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG6DSCGEO300	Igneous and Metamorphic Petrology	DSC A	4	5	3		2	
MG6DSCGEO301	Fuel Geology	DSC A	4	5	3		2	
MG6DSEGEO300	Marine Geology and Climatology	DSE	4	4	4			
MG6DSEGEO301	Perspectives in Water Management (Water Management Specialization)							
MG6DSEGEO302	Engineering Geology	DSE	4	4	4			
MG6DSEGEO303	Field mapping and Digital survey							
MG6VACGEO300	Management of Natural Disasters	VAC	3	3	3			
MG6SECGEO300	Economic Geology	SEC	3	4	2		2	

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester: 7

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG7DCCGEO400	Precambrian Geology	DCC	4	4	4			
MG7DCCGEO401	Geochemistry and Isotope Geology	DCC	4	5	3		2	
MG7DCCGEO402	Research methodology in Geology	DCC	4	4	4			
MG7DCEGEO400	Natural hazards and Disaster Management	DCE	4	4	4			
MG7DCEGEO401	Crystallography	DCE	4	4	4			
MG7DCEGEO402	Ore Genesis	DCE	4	4	4			

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester: 8

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours / week	Hour Distribution /week			
					L	T	P	O
MG8DCCGEO400	Hydrogeology	DCC	4	5	3		2	
MG8DCCGEO401	Exploration Geology	DCC	4	5	3		2	
MG8DCEGEO400	Geochemical Analytical Techniques	DCE	4	5	3		2	
MG8DCEGEO401	Hydro resources of India	DCE	4	4	4		0	
MG8DCEGEO402	Eco hydrology	DCE	4	4	4		0	
MG8PRJGEO400	Project*	PRJ	12					

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

*** Study Tour with Field Training:** *The hours allotted may be used to engage other courses during the semesters; and these accumulated hours may be utilized for the study tour cum field work for 10-15 days in the respective semesters. Students should submit a report on the study tour at the end of the semesters.*

*** Project**: *Under the topics of Petrology, Geomorphology, Mineralogy, Geochemistry, Hydrogeology, Mining & Exploration Geology, Sedimentology, Stratigraphy, Environmental Geology, Natural hazards, Disaster management, Structural Geology, Palaeontology, and Geoinformatics with the application of GIS essentially in the fields of Geology.*

Semester-I

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Geology**				
Course Name	**THE EARTH: AN INTRODUCTION**				
Type of Course	**DSC** A				
Course Code	**MG1DSCGEO100**				
Course Level	**100-199**				
Course Summary	The course provides an introduction to the Earth by understanding the materials with which the earth is made of, the external and internal processes operating in/on it, structures noticed in the rocks, and the representation of features on maps.				
Semester	**1**	Credits		**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others
		3		1	**75**
Pre-requisites, if any	Knowledge in basic science				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the various branches of geology and geologic timescale; the dimensions, origin and general characteristics of the Earth; and internal structure of the Earth.	U	PO 1 PO 2
2	Distinguish exogenic and endogenic processes of the earth.	U	PO 2 PO 3
3	Understanding of mineral classification, rock types, and basic identification techniques, applying knowledge to differentiate between igneous, metamorphic, and sedimentary rocks based on their distinct properties.	U	PO 1 PO 2
4	Understand the fossils, their uses, processes of fossilization, and branches of Palaeontology.	U	PO 2 PO 3
5	Basic understanding of major geological structures; joints, fractures, foliations, folds, and faults	U	PO 1 PO 2
6	Read and interpret SOI Toposheets, apply geological map symbols, create thematic maps,	A	PO 1 PO 2

	and accurately measure strike and dip using a Brunton compass and clinometer.		
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Introduction to Geology; scope, and branches of Geology: Physical Geology, Geomorphology, Mineralogy, Petrology, Palaeontology, Structural Geology, Remote Sensing and Geoinformatics, Engineering Geology, Exploration Geology	3	CO 1
	1.2	Origin of Earth: Big Bang theory, Nebular hypothesis.	3	CO 1
	1.3	Geologic timescale	2	CO 1
	1.4	Basic facts about the earth: Size, Shape, Volume, Density, Rotation, and Revolution of the Earth	2	CO 1
	1.5	Internal Structure of the Earth: Crust, Mantle, Core; Lithosphere, Asthenosphere, Mesosphere	3	CO 1
	1.6	Introduction to geomorphic processes: exogenic and endogenic processes.	2	CO 2
	1.7	Introduction to weathering and soil formation	2	CO 2
2	2.1	Introduction to Mineralogy: definition and general classification of minerals; Identification based on distinguishing properties	3	CO 3
	2.2	Rock cycle	2	CO 3
	2.3	Petrology: definition; broad classification of rocks: Igneous, Metamorphic, and Sedimentary	2	CO 3
	2.4	Introduction to Igneous rocks**:** Intrusive and extrusive forms; Granite, and Basalt	2	CO 3
	2.5	Introduction to Metamorphic rocks: Slate, Schist, Marble, Charnockite, and Gneiss.	2	CO 3
	2.6	Introduction to Sedimentary rocks: Shale, Sandstone, Limestone, and Conglomerate.	2	CO 3
	3.1	Fossils and Palaeontology: definition; uses of fossils	2	CO 4
	3.2	Processes of fossilisation	2	CO 4

3	3.3	Branches of Palaeontology: Invertebrate Palaeontology, Vertebrate Palaeontology, Palynology, Ichnology and Micropaleontology (definitions only)	2	CO 4
	3.4	Geological structures, and Structural Geology: definition; Attitude of beds: Strike and dip	3	CO 5
	3.5	Joints, and foliation in rocks: definition	3	CO 5
	3.6	Folds and faults in rocks: definition	3	CO 5
Practical Contents **4**	4.1	Map Reading using SOI Toposheet: Scale, Legends, Rock symbols in geological maps, geographical coordinates; Toposheet Indexing	20	CO 6
	4.2	Use of brunton compass and clinometer; Measurement of strike and dip.	10	CO 6
5	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURE** Lectures, Demonstrations, Assignments, Hands on training
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12 **Practical: 35 Marks** Examination: 25, Viva:10

References

- Mahapatra, G. B. A Textbook of Geology. CBS New Delhi, 2019
- Anantharaman, M. S. & Jain, P. C. Paleontology (Palaeobiology) Evolution and Animal Distribution. Vishal Publishing. Co., 2014
- Billings, M. P. Structural Geology. Pearson, 2016.
- Mathur, S. M. Elements of Geology, PHI New Delhi, 2008.
- Carlson, Plummer & McGeary. Physical Geology: Earth Revealed. McGraw-Hill, 2006.
- Gribble, C. D. Rutley's Elements of Mineralogy. 27th ed., CBS New Delhi, 2005.

- Berry, L. G. Mason, B. & Dietrich, R. V. Mineralogy. CBS Publishers and Distributors Pvt. Ltd., 2004
- Marshak, S. Essentials of Geology, W. W. Norton & Company, 2003.
- Ehlers, E. G. & Blatt, H. Petrology: Igneous, Sedimentary and Metamorphic. CBS New Delhi, 1999.
- Holmes, A. Principles of Physical Geology. Ronald Press, 1993.

Mahatma Gandhi University Kottayam

Programme						
Course Name	**UNDERSTAND THE EARTH**					
Type of Course	**MDC**					
Course Code	**MG1MDCGEO100**					
Course Level	**100-199**					
Course Summary	The course offers an overview of the origin and structure of the Earth; and the materials and processes with which the dynamic Earth is constituted. Also, the course deals with the relevance of Geology in the fields of exploration, Geotectonics, disaster management, engineering, geoinformatics, environmental and groundwater studies, for the development of humanity.					
Semester	**1**	credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	0	1	0	**60**
Pre-requisites, if any	Basic knowledge of Earth as a planet, and Geography					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the origin, age, dimension, internal structure, and spheres of the Earth	U	PO 1 PO 2 PO 10
2	Recognize minerals & rocks on Earth, and various branches of the Geology	U	PO 1 PO 2
3	Understand the endogenous and exogenous processes, and natural resources of the Earth	U	PO 1 PO 2 PO 10
4	Realize the natural disasters, disaster management, and National & State level policies	U	PO 2 PO 3

			PO 6
5	Understand the elements of toposheets to interpret SOI Toposheets, and identify the minerals based on their distinguishing properties.	A	PO 2 PO 3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Origin of Earth: Big Bang theory and Nebular hypothesis	2	CO 1
	1.2	Dimension of the earth: size, shape, volume and density; Age, rotation and revolution of the Earth	1	CO 1
	1.3	Internal Structure of the Earth: Crust, Mantle, Asthenosphere and Core;	1	CO 1
	1.4	Introduction to Lithosphere, Biosphere, Hydrosphere and Cryosphere	1	CO 1
	1.5	Introduction to Geology, and its various branches: Petrology, Exploration Geology, Environmental Geology, Mining Geology, Hydrogeology, Engineering Geology, Petroleum Geology, Geotectonics, and Geoinformatics	2	CO 2
	1.6	Introduction to Minerals: rock-forming, ore minerals and industrial minerals; and their distinguishing properties (only);	2	CO2
	1.7	Rocks: basics of igneous, metamorphic and sedimentary	2	CO2
	1.8	Introduction to fossil fuels: Coal, Petroleum and Natural gas; Basic concepts of their origin	2	CO3
2	2.1	Introduction to Earth processes: Exogenous processes	3	CO 3
	2.2	Introduction to Earth processes: Endogenous processes	3	CO3
	2.3	Plate tectonics, and its major evidences	3	CO 3
	2.4	Hydrological cycle, and introduction to groundwater and hydrogeology	3	CO3
	2.5	Introduction to natural disasters: Volcanism, Earthquake, and landslide	4	CO 4
	2.6	Types of landslides; major causes of landslides, and methods of mitigation of its impacts	4	CO 4

	2.7	Disaster Management Cycle; Institutional framework, and policies to manage disasters in national and state level	2	CO4
Practical Content **3**	3.1	Map reading using Survey of India Toposheets: elements of toposheets	15	CO 5
	3.2	Identification of minerals based on their distinguishing physical properties	15	CO5
4	Teacher specific content			

CLASSROOM PROCEDURE

Lectures, demonstrations, assignments, class tests and practical training

MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)

Theory: 15 Marks

Assignments, Viva/Seminar, Class Tests

Practical: 15 Marks

Lab Report, Viva, Lab involvement

B. End Semester Evaluation (ESE) Theory: 35 Marks

Short Answer in 60 words (7 out of 8): 7x2=14

Short Notes in 230 words (3 out of 5): 3x7 = 21

Practical: 35 Marks

Examination: 25, Viva:10

References

- Thornbury, W. D. Principles of Geomorphology. Wiley. 2004.
- Mahapatra, S. Basics of Geology. Anmol Publications Pvt Ltd, New Delhi, 2017.
- Hyndman, Donald, and David Hyndman. Natural Hazards and Disasters. 3rd ed., Brooks Cole, 2011.
- Carlson, Plummer, & McGeary. Physical Geology – Earth Revealed. McGraw-Hill., 2006.
- Mathur, S. M. Elements of Geology. PHI New Delhi, 2008.
- Berry, L. G., Mason, B., & Dietrich, R. V. Mineralogy. CBS Publishers and Distributors Pvt. Ltd, 2004.
- Holmes, A. Principles of Physical Geology. Edinburgh: Thomas Nelson and Sons. New York: Ronald Press, 1978.
- Berry, L. G. Mason, B. & Dietrich, R. V. Mineralogy. CBS Publishers and Distributors Pvt. Ltd., 2004
- Gribble, C. D. Rutley's Elements of Mineralogy. 27th ed., CBS New Delhi, 2005.

Semester-II

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Programme	**BSc (Hons) Geology**					
Course Name	**EXOGENOUS EARTH PROCESSES**					
Type of Course	**DSC** A					
Course Code	**MG2DSCGEO100**					
Course Level	**100-199**					
Course Summary	This course explores the external processes that shape the Earth's surface, including weathering, erosion, transportation, and deposition. Students will examine the impact of these exogenic processes on landscapes, landforms, and geological features.					
Semester	**2**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		**75**
Pre-requisites, if any	Basic knowledge in geography.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the interconnectedness of Earth's systems, including the Atmosphere, Hydrosphere, Lithosphere, and Biosphere, and their role in shaping the environment.	U	PO 1 PO 2
2	Understand various types of weathering, factors influencing weathering, and their resultant products. Conduct soil profile analysis, emphasizing texture to comprehend soil properties.	U	PO 1 PO 2
3	Understand the various geomorphic agents such	U	PO 1

	as rivers, glaciers, wind, and gravity, and their respective roles in shaping landforms.		PO 2 PO 3
4	Apply morphometric analysis techniques to interpret geological features, including stream ordering, slope calculation, and topographic profile construction, for understanding landscape dynamics.	A	PO 1 PO 2 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Earth system: Atmosphere, Hydro-sphere, Lithosphere, Biosphere; Hydrologic cycle	2	CO1
	1.2	Geomorphic processes: Exogenic processes; geomorphic agents: River, wind, glacier, coastal, groundwater	3	CO3
	1.3	Geological work of agents: erosion, transportation and deposition	2	CO3
	1.4	Denudation, weathering, Types of weathering	2	CO2
	1.5	Factors of Weathering and Products of Weathering	2	CO2
	1.6	Soil Profile and soil texture analysis	2	CO2
2	2.1	Geological work of streams: erosion, transportation and deposition	3	CO3
	2.2	Fluvial erosional landforms	3	CO3
	2.3	Fluvial depositional landforms	3	CO3
	2.4	Geological work of wind: Erosion, transportation and deposition	2	CO3
	2.5	Aeolian erosional and depositional landforms	3	CO3
	2.6	Geological work of glacier: erosion, transportation, and deposition	2	CO3
	2.7	Glacial erosional landforms	3	CO3

	2.8	Glacial depositional landforms	2	CO3
3	3.1	Coastal processes	2	CO3
	3.2	Geological work of wave: erosion, transportation and deposition	2	CO3
	3.3	Coastal erosional and depositional landforms	3	CO3
	3.4	Geological work of groundwater- erosion and transportation-karst topography.	2	CO3
	3.5	Cave deposits- Stalagmite and stalactite	2	CO3
Practical Contents **4**	4.1	Morphometric analysis: Stream ordering, stream numbering, length ratio, bifurcation ratio, texture of stream.	15	CO4
	4.2	Slope calculation from contour.	5	CO4
	4.3	Topographic profile construction	5	CO4
	4.4	Identification of geomorphic features from aerial photographs using stereoscopes.	5	CO4
5	Teacher Specific Content			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Class Tests and Practical
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12 **Practical: 35 Marks** Examination: 25, Viva:10

References

- Carlson, Plummer, and McGeary. Physical Geology – Earth Revealed. McGraw-Hill, 2006.
- Thornbury, W. D. Principles of Geomorphology. Wiley, 2004.
- Marshak, S. Essentials of Geology. W.W. Norton & Company, 2003. New York.
- Huggett, R. J. Fundamentals of Geomorphology. Routledge Taylor & Francis Group, 2003. London, New York.
- Mahapatra, G. B. A Textbook of Geology. CBS, 2019. New Delhi.
- Duff, P. and Holms, A. Principles of Physical geology, Nelson Thornes Ltd, 1993.
- Holmes, A. Principles of Physical Geology, 3rd Ed., A Halsted Press Book, 1978.

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Programme						
Course Name	**NATURAL HAZARDS**					
Type of Course	**MDC**					
Course Code	**MG2MDCGEO100**					
Course Level	**100-199**					
Course Summary	This course deals with the natural hazards, their causes, impacts, and strategies for mitigation and management. The course will examine geological, meteorological, hydrological, climatological gaining insights into the interconnectedness of these phenomena.					
Semester	**2**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2		1		**60**
Pre-requisites, if any	Basic knowledge on hazards					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the various natural Hazards	U	PO 1 PO 2
2	Understand the impact of natural hazards on communities and the environment	U	PO 1 PO 2 PO 6
3	Understand the Meteorological processes and related hazards	U	PO 1 PO 3 PO 6
4	Identify anthropogenic factors contributing to natural hazards	An	PO 1 PO 2 PO 6

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S),

Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Definition of natural hazards Differentiating between natural hazards and disasters	2	1
	1.2	Types of natural hazards: Geological	2	1
	1.3	Types of natural hazards: Meteorological and climatological	2	1
	1.4	Types of natural hazards: Biological	2	1
	1.5	Historical context and examples of major natural hazards	2	1
	1.6	Impact of natural hazards on communities and the environment	1	1
	1.7	Geological processes and hazards Earthquake-risk and impact	3	2
	1.8	Impacts of Tsunami	2	2
	1.9	Landslide risk: causes, effects and impacts	2	2
2	2.1	Engineering solutions for hazard mitigation	2	2
	2.2	Preparedness and Mitigation measures with special reference to Kerala	1	2
	2.3	Anthropogenic factors contributing to natural hazards: deforestation and urbanization	1	2
	2.4	Cyclone: preparedness and mitigation	2	3
	2.5	Cyclone: early warning system and communications with special reference to Kerala	2	3
	2.6	Flood: Types of floods, major causes, Preparedness and Mitigation measure	2	3
	2.7	Biological health hazards	2	3

	2.8	Community-based approaches to hazard mitigation	2	3
Practical Content **3**	Identify the types of natural hazards prevalent in Kerala, and develop an emergency plan for household and community; make a case study on any of the natural hazard occurrence; or conduct a field visit to a location of natural hazard, and prepare a report on it.		30	4
4	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURE** Lectures, Demonstrations, Assignments, Class Tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 15 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 35 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 230 words (3 out of 5): 3x7 = 21 **Practical: 35 Marks** Examination: 25, Viva:10

References

- Rathore B. S. A concise Text book of Environmental Geology, Norton Press, 2022.
- Hyndman, Donald, and David Hyndman. Natural Hazards and Disasters. 3rd ed., Brooks Cole, 2011.
- Keller, E.A. Environmental Geology. 9th ed., Pearson Publisher, 2010.
- National Disaster Management Authority. National Disaster Management Guidelines-Management of Disasters. Government of India, 2008.
- Montz, B. E. and Tobin, G. A. and Ronald R. Natural Hazard: Explanation and Integration. 1st ed., Guilford Press, 1997, New York.
- Coates, D. R. Environmental Geology. John Wiley and Sons, 1981, New york.
- Valdia, K.S. Environmental Geology - Indian Context. 2nd ed., Tata McGraw Hill, 1987.

Semester-III

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Geology**				
Course Name	**MINERALOGY**				
Type of Course	**DSC** A				
Course Code	**MG3DSCGEO200**				
Course Level	**200 - 299**				
Course Summary	This course explores the fundamentals of mineralogy focussing on crystallography, principles of optics, and petrological microscopy. It covers the mineral characteristics, silicate structures, and methods of identification of minerals based on their physical and optical properties.				
Semester	**3**	Credits		**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others
		3		1	**75**
Pre-requisites, if any	Basics knowledge in physical mineralogy.				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Distinguish the elements of symmetry in different minerals using axial relationships and symmetry operations.	U	PO 1 PO 2 PO 10
2	Realize the concepts of polymorphism, isomorphism, and solid solutions in minerals, and distinguishing physical properties of minerals	Ap	PO 1 PO 2 PO 10
3	Demonstrate the use of petrological microscope	Ap	PO 1

	and optical accessories in the identification of minerals based on their optical properties.		PO 2
4	Classify minerals based on anion groups and; and understand silicate structures.	Ap	PO 1 PO 2
5	Distinguish the important silicate minerals based on their physical and optical properties	An	PO 1 PO 2 PO 10
6	Distinguish the important non-silicate minerals based on their physical and optical properties	An	PO 1 PO 2 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Scope of Mineralogy, physical Properties of minerals: colour, lustre, streak, diaphaneity, cleavage, fracture, hardness and tenacity	2	CO 2
	1.2	Physical Properties of minerals - electric, heat, magnetic and radioactive properties	2	CO 2
	1.3	Introduction to crystallography. Crystall-ographic axes. Crystal symmetry: Point symmetry: reflection, rotation, inversion, roto-inversion. Weiss parameters, Miller Indices and Herman-Maugin symbols	3	CO 1
	1.4	Symmetry elements and forms present in the normal classes of Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinic and Triclinic systems	5	CO 1
	1.5	Polymorphism, Isomorphism, Exsolution, Pseudomorphism, and Solid solution	2	CO 2
2	2.1	Optical Mineralogy: scope and significance. Nature of light: ordinary and polarized light; refraction and reflection; refractive index, critical angle, total internal reflection. Concept of vibration direction of light.	2	CO 3
	2.2	Nicol Prism and Double refraction. Plane polarization by reflection, refraction, and absorption.	1	CO 3

	2.3	Petrological microscope and its parts. Conoscopic and orthoscopic illumination.	2	CO 3
	2.4	Classification of minerals based on their behaviour with polarized light: Isotropic and anisotropic minerals. Concept of Optical Indicatrix	2	CO 3
	2.5	Optical properties under plane polarised and crossed polarised light: colour, relief, pleochroism, interference colour, extinction- types, angles and their determination, and applications in mineral identification; birefringence	2	CO 3
	2.6	Optical accessories: quartz wedge, gypsum plate and mica plate and their uses	2	CO 3
3	3.1	Crystal co-ordination: radius ratio, co-ordination number and co-ordination polyhedra.	2	CO 4
	3.2	Classification of minerals based on anion or anionic groups. Structural diversity and significance of silicates	1	CO 4
	3.3	Structure, chemistry, optical and physical properties, modes of occurrence and uses of the following groups of minerals: Nesosilicates: Olivine, Garnet group, Al_2SiO_5 polymorphs	3	CO 5
	3.4	Inosilicates - Pyroxenes and Amphiboles	3	CO 5
	3.5	Phyllosilicates: Structure, chemistry and optical and physical properties, modes of occurrence and uses of members of Clay and Mica groups. Sheet structures in minerals - Brucite and Gibbsite sheet, TO, TOT, TOT+C and TOT+O structures.	3	CO 5
	3.6	Tectosilicates - Structure, chemistry and optical and physical properties, modes of occurrence and uses of members of Silica group, Feldspars, Feldspathoids and Zeolites	3	CO 5
	3.7	Introduction to the chemistry, physical properties, modes of occurrence and uses of members of the group of Native elements, Oxides	2	CO 6

	3.8	Introduction to the chemistry, physical properties, modes of occurrence and uses of members of the group of Carbonates, Sulphates, Sulphides, Phosphates, Halides.	3	CO 6
Practical content **4**		Identification of minerals in mineral groups (mentioned in module 3) based on their physical and optical properties	30	CO 5
5	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminar/Viva & Practical
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12 **Practical: 35 Marks** Examination: 25, Viva:10

References

- C. Moon, M. Whateley, A. Evans. Introduction to Mineral Exploration, Black Well Publishing Willey India PVT (Ltd),2017
- Dana. A Textbook of Mineralogy. Asia Publishing House, 2006.
- Deer, Howie, and Zussman. An Introduction to Rock Forming Minerals. 3rd ed., The mineralogical society, 2013, London.
- Manson, Berry, and Dietrich. Mineralogy. CBS Publishers, 2004.
- Nesse, W. D. Introduction to Mineralogy. Oxford University Press, New Delhi.2008.
- Paul F Kerr. Optical Mineralogy, M C Graw Hill Education, 2014
- Read, H. H. Rutley's Elements of Mineralogy. Thomas Murby Publishers, 2013.

Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**STUDY TOUR WITH FIELD TRAINING**					
Type of Course	**DSC** A					
Course Code	**MG3DSCGEO201**					
Course Level	**200-299**					
Course Summary	The course is designed to provide field training in the geological works, focusing mainly on the application of geological principles to study landforms, mineralogy, mineral deposits and major rock types in the South Indian states. The course integrates theoretical knowledge with fieldwork to generate observational, analytical and reporting skills.					
Semester	**3**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		These hours may be engaged for other courses; and the study tour for the field work may be carried out for up to 10-15 days during the semester, using these cumulative hours.				**75**
Pre-requisites, if any	Knowledge in Geomorphology, Mineralogy, Use of toposheets, Brunton Compass, and Clinometer.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No.
1	Develop skills in field techniques for geological data collection.	A	PO 1 PO 2
2	Understand the processes of shaping various	A	PO 1 PO 2

	geomorphic features		PO 10
3	Identify and classify minerals and associate rock types found in the field, and analyse their geological significance.	An	PO 1 PO 2
4	Generate teamwork, communication, and problem solving skills through collaborative field studies, and interpretation of the geological data, for the presentation of the field report.	E	PO 1 PO 2 PO 4 PO 5 PO 9 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

	Course description	**CO No.**
1	Application of map reading, and techniques of data collection and location mapping in the field	CO 1
2	Identification of land forms in the field with the process of their formation	CO 2
3	Classification of rocks, and minerals in the field, based on their physical and chemical properties	CO 3
4	Synthesise and analysis of field data, for the preparation of the filed report with field photos, appropriate diagrams and geological interpretation.	CO 4

Content for Classroom transactions (Units)

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Report writing
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA): Study tour and field work activities: 30 Marks** (Discipline: 10 Marks, Involvement: 20 Marks) **B. End Semester Evaluation (ESE) : 70 Marks** **Evaluation of study tour report: 50 Marks** (Structure: 10 Marks, Content: 30 Marks, Neatness: 10 Marks)

	Specimen display: 20 Marks

References

- Soman, K. Geology of Kerala, Geol. Soc. India, 2013, Bangalore.
- Frost, C.D., and Frost, B.R. Essentials of Igneous and Metamorphic Petrology. Cambridge University Press, 2013.
- Winter, J.D. Principles of Igneous and Metamorphic Petrology. Prentice-Hall, 2011.
- Carlson, Plummer & McGeary. Physical Geology: Earth Revealed. McGraw-Hill, 2006.
- Dana, A. Textbook of Mineralogy, Asia Publishing House, 2006.
- Berry, L. G. Mason, B. & Dietrich, R. V. Mineralogy. CBS Publishers and Distributors Pvt. Ltd., 2004
- Huggett, R. J. Fundamentals of Geomorphology. Routledge Taylor & Francis Group, 2003. London, New York.
- Wicander, R. and Monroe, J. Essentials of Geology, 4th Edition. Thomson Learning Inc., USA, 2006.
- Ken McClay. The mapping of Geological Structures. Geological Society of London. John Wiley and Sons, 1991.
- Gribble, C. D. Rutley's Elements of Mineralogy. 27th ed., CBS New Delhi, 2005.

Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**ENDOGENOUS EARTH PROCESSES**					
Type of Course	**DSE**					
Course Code	**MG3DSEGEO200**					
Course Level	**200-299**					
Course Summary	This course offers a comprehensive exploration of Earth's dynamic processes, including plate tectonics, volcanic activity, and seismic events. It discusses the principles of geology, such as Uniformitarianism and Catastrophism, continental drift and plate tectonics. Through a detailed discussions on volcanic eruptions, earthquakes, and mountain-building processes, learners will gain insight into the forces shaping our planet's surface.					
Semester	**3**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic knowledge in Earth processes					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the dynamic nature of the earth from Geologic Time scale added with geological events	U	PO 1 PO 2 PO 3
2	Identify the major theories and principles in physical geology, including uniformitarianism, catastrophism	U	PO 1 PO 2 PO 10

3	Analyze the processes related to plate tectonics	An	PO 1 PO 2 PO 3
4	Evaluate the characteristics, features and types of of volcanoes to find the relation with Plate tectonism.	E	PO 1 PO 2 PO 3
5	Evaluate the mechanism and causes involved in earthquake generation, and methods of measurements to find relation with plate tectonics, and be aware of earthquake prone area.	E	PO1 PO 2 PO 6 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	The dynamic Earth: changes through geologic Time	2	CO 1
	1.2	Principle of Uniformitarianism and Catastrophism	2	CO 2
	1.3	Geomorphic Processes: Endogenous processes and their features	3	CO 2
	1.4	Geothermal gradient, Mantle convection current and Mantle plume	2	CO 2
	1.5	Continental drift and evidences	3	CO 2
2	2.1	Plate tectonics: continental plates, oceanic plates; major plates, minor plates; types of plate boundaries	3	CO 3
	2.2	Plate margins and associated landforms	3	CO 3
	2.3	Plate tectonics as a global link for earthquakes, volcanoes and orogeny	2	CO 3
	2.4	Sea floor spreading and evidences	2	CO 3
	2.5	Mid oceanic ridge system	3	CO 3
	2.6	Orogeny types: Himalayan, Andes and Japan type	2	CO 3
	2.7	Epeirogeny, Isostasy concepts: Airy, Pratt, Heiskanen	3	CO 3

3	3.1	Volcanoes: parts, products; volcanic gases, lava, volcanic ash, pyroclastic materials	3	CO 4
	3.2	The behavior of Magma: Temperature, Viscosity, composition	3	CO 4
	3.3	Types of lava, rocks formed from lava, structures in lava	3	CO 4
	3.4	Volcano: classification based on the frequency of eruption, mode of eruptions and form, structure and composition	3	CO 4
	3.5	Global distribution of volcanoes	2	CO 4
4	4.1	Earthquakes: Terminologies, Causes	3	CO 5
	4.2	Mechanism of earthquake;	3	CO 5
	4.3	Classification of Earthquake based on causes and depth	3	CO 5
	4.4	Measuring earthquake: Seismogram and Seismograph, Magnitude and Intensity: Ritcher and Mercalli ' s Scales; Moment Magnitude scale	4	CO 5
	4.5	Earthquake Prediction and Seismic Zones of India.	3	CO 5
5	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURE** Lectures, Demonstrations, Class tests, Assignments, Seminar/Viva
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B. End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

- Carlson, Plummer, and McGeary. Physical Geology – Earth Revealed. Published by McGraw-Hill, 2006.
- Condie, K.C. Earth as an Evolving Planetary System, 3rd Edition. Academic Press, USA, 2015.
- Holmes, Arthur. Principles of Physical Geology. Willey Publishers, 1978.
- Marshak, S. Earth: Portrait of a Planet. W.W. Norton & Co., Inc., USA, 2001.
- Strahler, Arthur Newell. The Earth Sciences. New York: Harper & Row.
- Tarbuck, E.J. and Lutgens, F.K. Earth: An Introduction to Physical Geology, 9th Edition. Pearson Education, Inc., New Jersey, USA, 2008.
- Wicander, R. and Monroe, J. Essentials of Geology, 4th Edition. Thomson Learning Inc., USA, 2006.
- William D. Thornbury, "Principles of Geomorphology". CBS Publishers & Distributors Pvt Ltd, 2004.

Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**Hydro - Agro Management**					
Type of Course	**DSE**					
Course Code	**MG3DSEGEO201**					
Course Level	**200-299**					
Course Summary	Hydro-Agro Management equips students with the knowledge and skills necessary to address water-related challenges in agricultural production while promoting sustainability, resilience, and food security. Techniques and strategies for optimizing water use in agriculture, including irrigation methods, water-saving technologies, and precision agriculture. Study of the interactions between soil, water, and plants, including soil moisture dynamics, plant water uptake, and crop water requirements.					
Semester	**3**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic science knowledge					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basic concepts of irrigation; identify ~~its~~ benefits and ill-effects of irrigation.	U	PO 1
2	Differentiate and classify different irrigation systems, principal components of hydroelectric power scheme	U	PO 6
3	Evaluate the quality of irrigation water and	E	PO 1

	analyze its physical and chemical parameters. Evaluate the various types of Irrigation Canals		
4	Understand the essentiality of water for the germination of seeds, growth of plant roots, and recognize different crop seasons and various crops of India.	U	PO 2 PO 10
5	Recognize and describe different methods of rain water harvesting; Identify the applications of remote sensing and GIS in water resource management.	A	PO 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Introduction to irrigation- Necessity of Irrigation, Scope of Irrigation, Benefits of irrigation, ill-effects of irrigation	3	CO 1
	1.2	Types of irrigation systems: Flow, Perennial, Inundation	3	CO 1
	1.3	Direct/Diversion Scheme, Storage scheme, combined storage and Diversion scheme: Lift Irrigation	3	CO 2
	1.4	Classification of irrigation methods- surface irrigation methods	3	CO 2
	1.5	Sprinkler and drip irrigation	3	CO 2
2	2.1	Quality of irrigation water: physical and chemical parameters: soluble salt concentration, salt concentration, sodium concentration, boron content.	4	CO 3
	2.2	Irrigation canals- Canal classification	4	CO 3

	2.3	Hydropower- Principal components of hydroelectric power scheme	4	CO 2
	2.4	Soil-water-plant relationship	1	CO 4
	2.5	soil type, composition of soil, properties of soil	2	CO 4
3	3.1	Depth of water applied during irrigation and frequency of irrigation	2	CO 4
	3.2	Crop seasons Crop period and base period	2	CO 4
	3.3	Crops of India and specific to Kerala.	3	CO 4
	3.4	Duty and Delta of water Relation between duty and delta	4	CO 4
	3.5	Irrigation requirement of crops Irrigation schedule	4	CO 5
4	4.1	Rainwater harvesting: introduction	2	CO 5
	4.2	Rainwater harvesting traditional methods	4	CO 5
	4.3	Rainwater harvesting- modern methods	4	CO 5
	4.4	Introduction of remote sensing and GIS in water resources-applications.	3	CO 5
	4.5	Participatory irrigation management	2	CO 5
5		Teacher Specific content		

Teaching and Learning Approach	**CLASS ROOM PROCEDURE** Lectures, Demonstrations, Assignments, Seminars/Viva, Class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests

	B End Semester Evaluation (ESE) **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

- Dr. P. N. Modi, “Irrigation”. Water Resources and Water Power Engineering. Standard Book House Delhi,2019.
- Hillier and L. Leiberman, Introduction to Operations Research. McGraw Hill India, 2017.
- K.R. Arora. Irrigation: Water Power and Water Resources Engineering, Standard Publishers Distributors, Delhi,2007
- Mujumdar. Kumar Dilip, Irrigation Water management Principles and Practice. Prentice Hall of India Pvt Ltd,2001.
- Punmia and Lal. Irrigation and water Power Engineering. Laxmi Publications,2021

SUGGESTED READINGS

- Ravidran, Phillips and Solberg. *Operations Research-Principles and practices*. John Wiley and Sons,1991

Mahatma Gandhi University
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Programme	**BSc (Hons) Geology**					
Course Name	**GEOHERITAGE AND GEOTOURISM**					
Type of Course	**DSE**					
Course Code	**MG3DSEGEO202**					
Course Level	**200-299**					
Course Summary	Geotourism encompasses the exploration and appreciation of geological features spread across the world.This course provides an insight to the fundamental concepts of geotourism, geologic history and significance of the National Geologic monuments spread across the Indian states. Strategies for development, and guidelines for conservation of geologically significant sites are discussed. This course also provides an outlook on the global research trends in geotourism, by reviewing case studies, and the overall prospects for geotourism contribute to the evolving field's future.					
Semester	**3**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the fundamental concepts of Geotourism, including its focus on exploring geological features in India.	An	PO 1 PO 2

	Recall the names and locations of National Geologic monuments in the states of India. Analyse the geologic history and significance of National Geologic monuments in various Indian states.		
2	Apply strategies for responsible Geotourism by designing plans and initiatives aimed at minimizing the negative impact of tourism on geological sites.	A	PO 1 PO 2
3	Evaluate the impact of global research trends on the development of Geotourism destinations. Critically assess case studies to determine the success and challenges associated with different approaches to Geotourism.	E	PO1 PO2 PO6
4	Apply comprehensive plans for sustainable development in regions with significant Geotourism potential. Develop proposals that integrate guidelines for conservation and protection.	A	PO1 PO2 PO6
5	Analyze information from diverse sources to form a well-rounded understanding of the future of Geotourism. Develop informed perspectives on how Geotourism can adapt to global trends and contribute to sustainable development in regions worldwide.	An	PO1 PO2 PO6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	Geotourism: definition and scope; Geodiversity of India	2	1
	1.2	Geological approach to Geotourism	2	1
	1.3	Strategies for Geo conservation and responsible Geotourism	2	4
	1.4	Prospects of Geotourism and sustainable development of a region	4	5
	1.5	Geotourism and management strategies: Case studies	2	2

2	2.1	Geoheritage and society; Measures for safe Geotourism	3	4
	2.2	Global Geopark Network:Fossil parks, Rock monuments, Geological marvels in India	3	1
	2.3	Geologic significance of National Geologic monuments in Karnataka: Peninsular Gneiss, Lalbagh, Bangalore, Columnar Basaltic Lava, Coconut Island (St.Mary’ s island), Udupi District,Pillow Lavas, Maradihalli, Chitradurga District.	4	1
	2.4	National Geologic monuments in Andrapradesh: Geologic history of Natural Arch, Tirumala Hills, Chittoor District;Geologic significance of Eparchaean Unconformity, Tirumala-Tirupati road, Chittoor District; Characteristics of Bedded Barytes, Mangampeta, Cuddapah District	4	1
	2.5	Significance of National Geologic monuments in Chhattisgarh: Marine Gondwana fossil park, Manendragarh, Sarguja District	3	1
3	3.1	Geology and significance of Malani Igneous Suite Contact, Jodhpur District, Rajasthan.	2	1
	3.2	National Geologic monuments in Gujarat: Eddy Current Markings, Panchmahal District; National Geologic monuments in Himachal Pradesh: Siwalik Fossil Park, Saketi,Sirmur District	4	1
	3.3	Geologic significance of Stromatolite Park, Bhojunda, Chittaurgarh District, Rajasthan, Gossan, Rajpura,Dariba, Rajsamand District, Stromatolite Park, Jhamarkotra, Udaipur District	3	1
	3.4	Geology and importance of National Geologic monuments in TamilNadu: Charnockite, St. Thomas Mount, Chennai, National Fossil Wood Park, Thiruvakkarai, Villupuram District, National Fossil Wood Park, Sathanur, Perambalur District; Cretaceous geologic history of Trichinopoly and fossil records; Characteristics of Teri sand deposits, Kanyakumari district.	4	1
	3.5	Geologic significance of Laterite, Angadipuram,	3	1

		Malappuram District, Kerala; Stratigraphy and significance of Warkalli cliff, Quilon district, Kerala		
4	4.1	Significance of Lonar Lake, Buldhana District, Maharashtra.	3	1
	4.2	Geologic significance of Pillow Lava, Iron Ore Belt, Nomira, Keonjhar District, Orissa	3	1
	4.3	Guidelines for conservation, protection and maintenance of geological sites, related features of National importance	4	3
	4.4	Development of Geotourism destinations: Success and challenges, case studies.	3	3
	4.5	Global research trends in Geotourism	2	3
5	5.1	Teacher Specific Content		

Teaching and Learning Approach	**CLASSROOM PROCEDURE** Lectures, Demonstrations, Assignments, Seminars /Viva, Class Test
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

- *A monograph on National Geoheritage Monuments of India*. Indian National Trust for Art and Cultural Heritage Natural Heritage Division, 2016.
- Igor S Zekster .*Geology and Ecosystems*.Springer Science + Business Media Inc.2006.
- Rannveig Ólafsdóttir and Edita Tverijonaite, Geotourism: A Systematic Literature Review.Geosciences,2018.

- Thompson and Turk “Physical Geology”.Saunders College Publication, 1998.
- John Bridge and Robert Demicco "Earth Surface Processes, Landforms and Sediment Deposits".Cambridge University Press,2008.
- Burbank, Douglas West"Tectonic geomorphology" Blackwell Publishing,2008.

Suggested readings

1. Geoheritage-https://link.springer.com/journal/12371/volumes-and-issues.
2. International Journal of Geoheritage and Parks-https://www.sciencedirect.com/journal/international-journal-of-geoheritage-and-parks.
3 Geoheritage, Geoparks and Geotourism-https://www.mdpi.com/journal/geosciences/sections/geoheritage_geoparks_geotourism.

Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**MINERAL SCIENCE**					
Type of Course	**DSC B**					
Course Code	**MG3DSCGEO202**					
Course Level	200-299					
Course Summary	This course explores the fundamentals of mineralogy focussing on crystallography, principles of optics, and petrological microscopy. It covers the mineral characteristics, silicate structures, and methods of identification of minerals based on their physical and optical properties.					
Semester	**3**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		**75**
Pre-requisites, if any	Basics knowledge in physical mineralogy.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Distinguish the elements of symmetry in different minerals using axial relationships and symmetry operations.	U	PO 1 PO 2 PO 10
2	Realize the concepts of polymorphism, isomorphism, and solid solutions in minerals, and distinguishing physical properties of minerals.	A	PO 1 PO 2 PO 10

3	Demonstrate the use of petrological microscope and optical accessories in the identification of minerals based on their optical properties.	A	PO 1 PO 2
4	Classify minerals based on anion groups and; and understand silicate structures.	A	PO 1 PO 2
5	Distinguish the important silicate minerals based on their physical and optical properties.	An	PO 1 PO 2 PO 10
6	Distinguish the important non-silicate minerals based on their physical and optical properties.	An	PO 1 PO 2 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Scope of Mineralogy, physical Properties of minerals: colour, lustre, streak, diaphaneity, cleavage, fracture, hardness and tenacity	2	CO 2
	1.2	Physical Properties of minerals - electric, heat, magnetic and radioactive properties	2	CO 2
	1.3	Introduction to crystallography. Crystall-ographic axes. Crystal symmetry: Point symmetry: reflection, rotation, inversion, roto-inversion. Weiss parameters, Miller Indices and Herman-Maugin symbols	3	CO 1
	1.4	Symmetry elements and forms present in the normal classes of Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinic and Triclinic systems	5	CO 1
	1.5	Polymorphism, Isomorphism, Exsolution, Pseudomorphism, and Solid solution	2	CO 2
	2.1	Optical Mineralogy: scope and significance. Nature of light: ordinary and polarized light; refraction and reflection; refractive index,	2	CO 3

		critical angle, total internal reflection. Concept of vibration direction of light.		
2	2.2	Nicol Prism and Double refraction. Plane polarization by reflection, refraction, and absorption.	1	CO 3
	2.3	Petrological microscope and its parts.	2	CO 3
	2.4	Classification of minerals based on their behaviour with polarized light: Isotropic and anisotropic minerals.	2	CO 3
	2.5	Optical properties under plane polarised and crossed polarised light: colour, relief, pleochroism, interference colour, extinction- types, angles and their determination, and applications in mineral identification;	2	CO 3
	2.6	Concept of optical indicatrix and birefringence	2	CO 3
3	3.1	Crystal co-ordination: radius ratio, co-ordination number and co-ordination polyhedra.	2	CO 4
	3.2	Classification of minerals based on anion or anionic groups. Structural diversity and significance of silicates	1	CO 4
	3.3	Structure, chemistry, optical and physical properties, modes of occurrence and uses of the following groups of minerals: Nesosilicates: Olivine, Garnet group, Al_2SiO_5 polymorphs	3	CO 5
	3.4	Inosilicates - Pyroxenes and Amphiboles	3	CO 5
	3.5	Phyllosilicates: Structure, chemistry and optical and physical properties, modes of occurrence and uses of members of Clay and Mica groups.	3	CO 5
	3.6	Tectosilicates - Structure, chemistry and optical and physical properties, modes of occurrence and uses of members of Silica group, Feldspars, Feldspathoids and Zeolites	3	CO 5
	3.7	Introduction to the chemistry, physical properties, modes of occurrence and uses of members of the group of Native elements,	2	CO 6

		Oxides		
	3.8	Introduction to the chemistry, physical properties, modes of occurrence and uses of members of the group of Carbonates, Sulphates, Sulphides, Phosphates, Halides.	3	CO 6
Practical Content **4**		Identification of minerals in the mineral groups mentioned in module 3 based on their physical and optical properties	30	CO 5
5	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Seminar/Viva, Assignments, and Practical
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12 **Practical: 35 Marks** Examination: 25, Viva:10

References

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- Dana. A Textbook of Mineralogy. Asia Publishing House, 2006.
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Mahatma Gandhi University
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Programme						
Course Name	**SUSTAINABLE RESOURCE MANAGEMENT**					
Type of Course	**VAC**					
Course Code	**MG3VACGEO200**					
Course Level	**200-299**					
Course Summary	Sustainable Resource Management is an interdisciplinary field that examines the utilization, conservation, and regeneration of natural resources to ensure their availability for current and future generations. This course provides students with an understanding of the principles, practices, and challenges associated with managing various types of resources sustainably					
Semester	**3**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		0		**45**
Pre-requisites, if any	General awareness about natural resources					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the concepts of natural resources with their management, and human impact on natural resources	U	PO 1 PO 2 PO 6
2	Distinguish various natural resources such as water, solar energy, oil, soil and minerals	U	PO 1 PO 6 PO 10
3	Analyze the environmental impacts of non-renewable energy and integrated resource management strategies	An	PO 1 PO 3 PO 6 P O 10

4	Apply the concepts of sustainable resource management and future energy options	A	PO 1 PO 2 PO 6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (45)	CO No.
1	1.1	Introduction - Resource and reserves	3	1
	1.2	Resource - Degradation, Conservation methods	2	1
	1.3	Resources - Availability and Factors influencing; Land resources; Water resources	3	1
	1.4	Human impact on natural resources; Ecological, social and economic dimension of resource management	3	1
	1.5	Green revolution - Technological Innovations, environmental concerns	3	1
	1.6	Natural resources and conservation:	2	1
2	2.1	Renewable energy resources: Energy efficiency	2	2
	2.2	Water resources - Types of water resources, and Sustainable water management practices and hydropower	2	2
	2.3	Solar energy: Tidal energy; Wave energy; Ocean thermal energy conversion	3	2
	2.4	Non-renewable energy resources: Oil, Natural gas and Coal resources	2	2
	2.5	Soil resources - Soil degradation and erosion, Soil conservation techniques	2	2
	2.6	Mineral resources - Types and conservation methods	3	2
3	3.1	Forest resources - Deforestation and its impact, Forest conservation strategies	2	2
	3.2	Environmental impacts of non-renewable energy consumption;	3	3
	3.3	Resource management - Approaches in	3	3

		resource management. Integrated resource management strategies		
	3.4	Concept of Sustainability Science-different approach towards sustainable development and its different constituents	2	3
	3.5	Indian renewable energy programmes - challenges and opportunities	3	3
	3.6	Future energy options and challenges	2	3
4		Teacher specific content		

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminar/Viva and Class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **B.End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12

References

- Craig, J. R., Vaughan D. J., and Skinner B. J. Resources of the Earth: Origin, Use, and Environmental Impacts. 3rd ed., Prentice Hall, 2000.
- Dalal-Clayton, Barry, and Stephen Bass. Sustainable Development Strategies: A Resource Book. Earthscan Publications Ltd, 2002.
- Klee, G. A. Conservation of Natural Resources. Prentice Hall, 1991.
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Programme						
Course Name	**GROUNDWATER AND MANAGEMENT**					
Type of Course	MDC					
Course Code	**MG3MDCGEO200**					
Course Level	**200-299**					
Course Summary	The course deals with the comprehensive understanding of groundwater system, groundwater flow, storage, and the quality of groundwater for house hold and irrigation purposes. Also, the course addresses groundwater fluctuations, and various types of recharge methods with its significance in water resources management and environmental sustainability.					
Semester	**3**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		0		**45**
Pre-requisites, if any	Basic science knowledge.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the fundamentals of hydrological cycle with its components, and distribution of groundwater	U	PO 6, PO 7
2	Realize the physical and chemical properties of water, and water quality for house hold and irrigation purposes	An	PO 1, PO 6,
3	Examine the groundwater level fluctuations and type of wells	An	PO 1, PO 6,
4	Understand the management of ground water and regulations	U	PO 1, PO 6,
5	Differentiate the artificial recharge methods, and its significance in groundwater replenishment	U	PO 1, PO 6

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (45)	CO No.
1	1.1	Hydrogeology definition, occurrence of groundwater: Aquifer, Aquiclude, Aquifuge and Aquitard, Global distribution of groundwater	3	CO 1
	1.2	Introduction to hydrologic cycle; Processes of Hydrologic cycle: Precipitation, Run-off, Infiltration, Evaporation, Transpiration-Evapotranspiration, and Condensation	4	CO 1
	1.3	Vertical distribution of Groundwater; Zone of aeration, zone of saturation, water table	3	CO 1
	1.4	Geological formations as aquifers; confined and unconfined aquifers; Porosity, void ratio, effective porosity and representative porosity range; Primary and secondary porosities; Specific retention, specific yield	3	CO 1
	1.5	Concept of Darcy's law, Permeability, Intrinsic permeability, Hydraulic conductivity, Transmissivity	2	CO 1
2	2.1	Water quality, Physical and chemical properties of water, ; water quality parameters and their standards proposed by WHO and BIS. Physical, Chemical and biological parameters	3	CO 2
	2.2	Groundwater composition, quality criteria for domestic irrigation and industrial uses	3	CO 2
	2.3	Groundwater contamination from mining, quarrying and waste disposal, and its remedial measures	3	CO 2
	2.4	Groundwater fluctuations: Secular, Seasonal and Short-term fluctuations due to stream flow, Evapotranspiration, Meteorological phenomena	3	CO 3
	2.5	Water table fluctuations and causative	3	CO3

		factors for over exploitation		
	2.6	Wells and its types: open, bored, tube and filter point well; Test holes; Well logs	2	CO3
3	3.1	Ground water management - significance	3	CO4
	3.2	Groundwater conservation techniques	2	CO4
	3.3	Artificial Recharge of Groundwater: Concept, Recharge methods, Surface methods - Basin method, Stream channel method, Ditch and Furrow method, Irrigation method	2	CO 5
	3.4	Subsurface methods - infiltration basins, percolation ponds, Recharge Wells or Injection Wells, Artificial Recharge Trenches, Subsurface Dams	3	CO 5
	3.5	Kerala groundwater control and regulation act 2003	3	CO4, CO 5
4	Teacher specific content			

Teaching and Learning Approach	**CLASS ROOM PROCEDURES** Lecture, Demonstration, Assignment, Seminar / Viva, Class tests, and practical
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests B.**End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12

References

- Ackerman A. Steven and Knox A. John. *Meteorology*. Jones and Bartlett Learning publications, USA, 3rd edition, 2011.
- Davis N Stanley, M. J. Roger Davis, DeWeist. *Hydrogeology*. New York, John Wiley & Sons,1966.

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Semester-IV

Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**STRATIGRAPHY AND SEDIMENTARY PETROLOGY**					
Type of Course	**DSC** A					
Course Code	**MG4DSCGEO200**					
Course Level	**200-299**					
Course Summary	The course deals with the principles and methods of Stratigraphy by studying the sedimentary layers, fossils contained in them, and depositional environments to reconstruct past environments and events. It also focuses on the study of various sedimentary rocks, their formation, distribution, and interpretation to study the Earth's history and geological processes.					
Semester	**4**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		**75**
Pre-requisites, if any	Basic science knowledge					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand, the basics principle of Stratigraphy, their use and correlation, a brief idea about the Geological Time Scale.	U	PO 1 PO 2
2	Realize the origin of sediments; identify and describe key diagenetic processes.	U	PO 1 PO 2 PO 3
3	Understand the characteristics, classifications, and origins of different sedimentary rocks.	U	PO 1 PO 2 PO 3

4	Recognize the structures and textures in sedimentary rocks and apply this knowledge to geological interpretations in stratigraphy.	An	PO 1 PO 2 PO 4 PO 10
5	Identify the clastic and non-clastic sedimentary rocks based on macroscopic and microscopic analyses.	A	PO 2 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Concept of stratum: its delineation and general nomenclature; Brief study of the guiding Principles of Stratigraphy: Principle of uniformitarianism, superposition, original horizontality, truncation by erosion or structural complexity, cross cutting relationships, included fragments, faunal succession and faunal assemblage	2	CO 1
	1.2	Breaks in stratigraphic records: Unconformities: types; Non-sequences, diastems, hiatus-overlap, offlap	4	CO 1
	1.3	Concepts of facies: lithofacies, and biofacies.	4	CO 1
	1.4	Principles of lithostratigraphy, biostratigraphy, and chronostratigraphy.	3	CO 1
	1.5	Standard Stratigraphic Column, Geological Time Scale.	2	CO 1
2	2.1	Origin of sediments, diagenesis, compaction, cementation, authigenesis, recrystallization, replacement; key diagenetic processes	3	CO 2
	2.2	Classification of sedimentary rocks: Clastic and non-clastic rocks	3	CO 3
	2.3	Sedimentary rock types: argillaceous, arenaceous, and rudaceous rocks	1	CO 3
	2.4	Study of sandstone, shale, breccias, and conglomerate	3	CO 3

	2.5	Limestone and its classification: Folk scheme; Dunham scheme	3	CO 3
	2.6	Chemical and biochemical sedimentary rocks: calcareous and siliceous	2	CO 3
	2.7	Ferruginous deposits	1	CO 3
	2.8	Phosphatic and evaporate deposits.	2	CO 3
3	3.1	Clastic texture: concept of grain size; Udden-Wentworth and Phi scale schemes; grain shape, morphology and fabric.	3	CO 4
	3.2	Non clastic texture; types of crystalline textures.	2	CO 4
	3.3	Classification of sedimentary structures	2	CO 4
	3.4	Details of primary, secondary and organic structures.	2	CO 4
	3.5	Principles and methods of local and regional correlation of sedimentary formations.	3	CO 4
Practical Content **4**	4.1	Megascopic identification of Conglomerate, breccias, sandstone, limestone (micrite, dolomite, marl, pelitic, fossiliferous), mudstone, shale, fossiliferous shale, black shale.	15	CO 5
	4.2	Microscopic study of conglomerate, breccias, sandstone, limestone and shale	15	CO 5
5	Teacher specific contents			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Seminar/Viva, Assignments, Class tests and Practical
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12

	Practical: 35 Marks Examination: 25, Viva:10

References

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Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**INVERTEBRATE PALAEONTOLOGY**					
Type of Course	**DSC** A					
Course Code	**MG4DSCGEO201**					
Course Level	**200-299**					
Course Summary	The course introduces a fascinating world of invertebrate fossils and their importance in deciphering Earth's history. It covers the processes of fossilization, and different modes of preservation that contribute to our understanding of geological time. Hands-on laboratory exercises provide practical experience in identifying, describing, and interpreting invertebrate fossils.					
Semester	**4**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		**75**
Pre-requisites, if any	Basic knowledge in science					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the fossils, methods of fossilization, taxonomy, and nomenclature of organisms	U	PO 1 PO 3
2	Realize the morphological characteristics and stratigraphic range of various phylum, with their paleo-environmental relevance.	U	PO 1 PO 2 PO 3
3	Applications of plant fossils and microfossils	A	PO 1 PO 2

4	Examine the geological significance of the fossils.	E	PO 1 PO 2 PO 10
5	Identify the fossils of invertebrate organisms, correlating their taxonomy and stratigraphic range.	A	PO 1 PO 2 PO 3 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Introduction to Palaeontology	2	CO 1
	1.2	flora and fauna; vertebrates and invertebrates	2	CO 1
	1.3	Types of Fossils	3	CO 1
	1.4	Uses of fossils: stratigraphic indicators; climatic indicators: indicators of palaeogeography, indicators of evolution and migration of life forms.	3	CO1
	1.5	Fossilization; Nature and modes of preservation of fossils: unaltered hard parts, altered hard parts, petrifaction, perminer-alization, carbonisation, silicification, recrystallisation, mould, casts, tracks, trails, borings	3	CO 1
	1.6	Taxonomic divisions and Nomenclature	2	CO 1
	2.1	Phylum Arthropoda: Class Trilobita; General morphology: Cephalon, glabella, facial suture, free cheek, fixed cheek, genal angle, genal spine, cranidium, thorax, pygidium; classification; geological history	2	CO 2
	2.2	Phylum Brachiopoda: General morphology: umbo, hinge line, pedicle opening, delthyrium, deltidium, pseudo deltidium, Brachial skeleton, morphometric details, ornamentation; classification; geological history.	2	CO 2

2	2.3	Phylum Mollusca: Class Pelecypoda: General characters: umbo, Hinge line aligament, lunule, escutcheon, adductor impressions, pallial line, pallial sinus, dental patterns, ornamentation; classification; and geological history	2	CO 2
	2.4	Class Gastropoda: General morphology: shell forms, whorl, spire, spiral angle, suture, aperture, columella, umbilicus, peristome, aperture, Holostomatus and siphonostomatus; types of coiling: Dextral and sinistral; ornamentation; classification; geological history	2	CO 2
	2.5	Class Cephalopoda: General morphology: siphuncle, septa, septal necks, connecting rings, chambers, shell forms, suture lines: Nautilitic, Goniotitic, Ceratitic and Ammonitic; Ornamentation; classification; evolution and geological history	2	CO 2
	2.6	Phylum Echonodermata: Class Echinoidea, General morphology: periproct, apical system, corona, Ambulacra, inter ambulacra, peristome; Regular and irregular echinoids; geological history	3	CO 2
	2.7	Introduction to corals, and their Environmental significance	3	CO 2
3	3.1	General classification of plant kingdom; plant fossils of India	3	CO 3
	3.2	A brief account of the following plant fossils: Glossopteris, Gangamopteris, Ptilophyllum, Calamites, Lepidodendron and Sigillaria	3	CO 3
	3.3	Introduction to Palynology	2	CO 3
	3.4	Introduction to Micropalaeontology	2	CO 3
	3.5	Application of Micropalaeontology. Indicators of new deposits of coal and petroleum	2	CO 3
	3.6	Geological significance of invertebrate, plant, and micro - fossils	2	CO 4

Practical Content **4**	Identification and description of general morphological features of Phylum Mollusca, Phylum Brachiopoda, Phylum Echinidermata: Echinoidea, Phylum Arthropoda:Trilobites, Plant Fossils:Glossopteris, Ptillophyllum	30	CO 5
5	Teacher specific contents		

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminars / Viva, Hands on Training
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12 **Practical: 35 Marks** Examination: 25, Viva:10

References

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Programme	**BSc (Hons) Geology**					
Course Name	**ENVIRONMENTAL GEOLOGY**					
Type of Course	**DSE**					
Course Code	**MG4DSEGEO200**					
Course Level	**200-299**					
Course Summary	This course explores the interdisciplinary field of Environmental Geology, covering concepts, geology's role in environmental studies, and the physical environment. It deals with the natural resource conservation, environmental hotspots, causes and effects of pollution, and the legal framework. Addresses human rights, international documents, and their application in various contexts, fostering an understanding of sustainable development and responsible resource management.					
Semester	**4**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic knowledge on environment, pollution and natural resources					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the fundamental concepts of Global warming, environmental geology, including the scope, importance, and role of geology in environmental studies and environmental laws.	U	PO 1 PO 2 PO 3
2	Distinguish the renewable and non-renewable resources, and protection and conservation strategies of the resources.	U	PO 1 PO 2 PO 6
3	Understand the concept of sustainable develop-	U	PO 1 PO 2

	ment and environmental consequences of natural hazards		PO 3
4	Analyze the causes and effects of environmental pollution, and distinguish environmental hotspots, and pin-pointing areas of ecological concern.	An	PO 1, PO 3 PO 6 PO 10
5	Evaluate the sustainable development and responsible resource management, synthesizing comprehensive knowledge on environmental impacts of natural hazards, mining, and human rights principles	E	PO 1 PO 2 PO 6 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	Concept, definition, scope and importance.	3	1
	1.2	Role of geology in environmental studies.	3	1
	1.3	The physical environment - Atmosphere, hydrosphere, lithosphere and biosphere.	2	1
	1.4	Anthropogenic environment, Environmental Hotspots.	2	1
	1.5	Environmental laws.	2	1
2	2.1	Conservation and preservation of non-renewable resources.	3	2
	2.2	Global warming: Greenhouse effect, ozone depletion.	4	2
	2.3	Causes of ground water pollution	3	4
	2.4	Heavy metal pollution, causes and effect. .	3	4
	2.5	Health hazards due to groundwater pollution	3	4
3	3.1	Solid waste management. Concept of sustainable development.	3	3

	3.2	Environmental impacts of natural hazards - Earthquakes	3	3
	3.3	Impacts of flood and draught	3	3
	3.4	Landslides: causes and impacts	4	3
	3.5	Introduction to Environmental Impact Assessment	3	5
4	4.1	An Introduction to Human Rights- meaning, concept and development	3	5
	4.2	History of Human Rights, Different generations of Human Rights-	3	5
	4.3	Basic International Human Rights documents-UDHR, ICCPR, ICESCR – value dimensions of Human Rights	4	5
	4.4	Human Rights in Indian Constitution	3	5
	4.5	Human Rights of women – children-minorities	3	5
5	Teacher specific contents			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminars/viva
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

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- Dhiman, O.P. Understanding Human Rights: An Overview, Kalpaz Pub., 2011.
- Valdia, K.S. Environmental Geology - Indian Context. Tata McGraw Hill, 2013.
- Keller, E.A. Environmental Geology. 9th ed., Bell & Howell USA, 2010.
- Bryante. Natural Hazards. Cambridge University Press, 2004.
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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**CLIMATOLOGY**					
Type of Course	**DSE**					
Course Code	**MG4DSE GEO201**					
Course Level	**200-299**					
Course Summary	The course offers the concept of solar energy, radiation, and atmospheric processes. It covers the fundamental laws governing solar radiation, understand insolation patterns, and analyses different atmospheric processes and their effects. The heat budget, temperature distribution, and atmospheric circulations are discussed emphasizing on global patterns and variations. In addition, the course explains the Earth's complex climatic systems, consists of cyclones, monsoons, and cloud formations, and their broader environmental implications.					
Semester	**4**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basics Knowledge about atmosphere and climate					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the atmosphere and its structure: solar radiation laws, insolation, and atmospheric effects.	U	PO 1 PO 2
2	Understand the knowledge of heat budget, temperature distribution, and atmospheric	U	PO 1 PO 2

	circulation: Milankovitch cycle, Climate Zone Classification.		PO 3
3	Analyze the variations in atmospheric circulation, including Walker circulation and ENSO.	An	PO 1 PO 2 PO 10
4	Understand and analyze the concepts of cyclones, anticyclones, monsoons, and cloud classifications.	U	PO 1 PO 2 PO 6 PO 10
5	Evaluate the precipitation mechanisms and artificial precipitation methods: Concepts of monsoon system.	E	PO 1 PO 2 PO 6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	Atmosphere and Atmospheric Processes: Structure and Composition of atmosphere	2	CO 1
	1.2	Insolation: solar constant, distribution of insolation, it's factors: Atmospheric effect on solar radiation	2	CO 1
	1.3	Heat budget and radiation balance: Latitudinal heat balance	2	CO 2
	1.4	Temperature of the atmosphere: Heat flow mechanisms, heating and cooling of the atmosphere, controls of temperature	3	CO 2
	1.5	Solar energy and radiation: Nature of radiation and basic Laws: Stefan Boltzman Law, Kirchhoff's Law, Plank's Law and Weins Displacement Law	5	CO 1
2	2.1	Distribution of temperature: Horizontal, vertical distribution of temperatures; temperature inversion and types	3	CO 2
	2.2	Milankovtich Cycle: Eccentricity, Obliquity, Precession	2	CO 2

	2.3	Climate Zone Classification by Koppens and Thornthwaite (in brief)	4	CO 2
	2.4	An overview of Atmospheric circulation: Atmospheric pressures and winds. Global pressure belts	3	CO 3
	2.5	Atmospheric motion/wind motion, Factors controlling atmospheric motion: Pressure gradient force, Coriolis force, frictional force, centrifugal action-geostrophic wind, gradient wind, Ekman Spiral	3	CO 3
3	3.1	General circulation of the atmosphere: Scales of atmospheric circulation. Primary, secondary and tertiary circulation. meridional circulation	3	CO 2
	3.2	Primary circulation or planetary wind systems: Inter Tropical Convergent Zone (ITCZ), doldrum, trade winds or tropical easterlies, prevailing westerlies, polar easterlies	4	CO 2
	3.3	Tri-circular meridional circulation: Tropical cell/Hadley cell, polar front cell/ Ferrel cell, polar or subpolar cell. Jet streams: origin and types. Rossby waves	3	CO 2
	3.4	Variations in Atmospheric circulation: Walker circulation, El Nino Southern oscillation (ENSO)	3	CO 3
	3.5	Secondary circulation: cyclones, anticyclones and fronts	4	CO 4
4	4.1	Cyclones and anticyclones. Tertiary circulation: local and diurnal winds	3	CO 4
	4.2	Atmospheric humidity, Condensation, forms of condensation: Dew, frost, drizzle, rime, mist and fog	2	CO 5
	4.3	Clouds. Cloud classification. Precipitation: Precipitation mechanisms: Bergeron, Findeisen process, coalescence process	3	CO 4
	4.4	Forms of precipitation, types of precipitation. Artificial precipitation	2	CO 5

	4.5	Monsoon system: Concepts of Origin of Monsoon, Indian Monsoon and theory of origin	4	CO 5
5	Teacher Specific Content			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lecture, Demonstration, Assignment, Seminar/ Viva, Class test
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **C. End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

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- Edward J. Tarbuck, Frederick. K Lutgens. Foundations of Earth Science. 8th ed., Macmillan College Publishing Company, 2016.
- Bradley, R. S. Palaeoclimatology: Reconstructing climate of the Quaternary. Academic Press, 3rd ed., 2014.
- Singh Savindra. Climatology. Prayag Pustak Bhavan, 2005.
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- Burroughs James William. Climate Change: A Multidisciplinary Approach. Cambridge University Press, 2001.
- Bradley, R. S. Quaternary Palaeoclimatology. Allen & Unwin, London, 1985.
- Herbert Riehl, Introduction to the Atmosphere, 3rd ed., MacGraw Hill, 1978.

Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**GROUNDWATER HYDROLOGY**					
Type of Course	**DSE**					
Course Code	**MG4DSEGEO202**					
Course Level	**200-299**					
Course Summary	The course focuses on the study of groundwater concept, its significance and occurrence around the globe. Detailed study of water-related problems in society, factors affecting quality of ground water. Explains about different generic types of water and hydrological cycle and the basic concepts of geological formations its parameters and its importance.					
Semester	**4**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic knowledge in groundwater and types of rocks					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No.
1	Distinguish the fundamental principles and concepts of hydrogeology.	U	PO 1 PO 2
2	Recognize the groundwater potential zones using geological and geophysical methods.	U	PO 1 PO 2 PO 10
3	Realize the Groundwater quality parameters and their graphical representations	U	PO 1 PO 2 PO 6 PO 10

4	Analyze groundwater contamination, and artificial recharge methods of ground water.	An	PO 1 PO 2 PO 3 PO 6
5	Recognize ground water provinces of India with groundwater quality issues, and major groundwater aquifers of Kerala.	U	PO 1 PO 2 PO 6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	**Units**	**Course description**	**Hrs** (60)	**CO No.**
1	1.1	Hydrogeology and Groundwater Hydrology; Groundwater in Hydrologic cycle; Occurrence of Groundwater: Aquifer, Aquiclude, Aquifuge and Aquitard, confined and unconfined aquifers	3	CO 1
	1.2	Vertical distribution of Groundwater: Zone of aeration, zone of saturation; Division of subsurface water	3	CO 1
	1.3	Origin of water on earth: meteoritic, juvenile and connate waters; Ground water occurrences in igneous, sedimentary and metamorphic rocks	2	CO 1
	1.4	Aquifer properties: Porosity, void ratio, effective porosity and representative porosity range; Primary and secondary porosities; Specific retention, specific yield	3	CO 1
	1.5	Darcy's law and its applications;	2	CO 1
	1.6	Groundwater Basins and springs;	1	CO 1
2	2.1	Geologic and hydrogeologic methods of ground water exploration	4	CO 2
	2.2	Role of remote sensing in groundwater exploration	3	CO 2
	2.3	Surface geophysical methods: seismic, gravity, geo-electrical and magnetic methods	4	CO 2

	2.4	Sub-surface geophysical methods	3	CO 2
3	3.1	Water quality; rock water interactions; Water quality parameters for drinking; water and their standards proposed by WHO and BIS	3	CO 3
	3.2	Physical, chemical and biological parameters of water quality, and methods for the determination of water quality	3	CO 3
	3.3	Water quality parameters for irrigation: SAR, sodium percentage, residual sodium carbonate, potential salinity and permeability index	4	CO 3
	3.4	Graphical representation of water quality data: Piper Trilinear Diagram, stiff diagram,Piper Durov Diagram,Gibbs diagram, Histograms, and spider diagrams, USSL diagram;	4	CO 3
4	4.1	Groundwater contamination from mining, quarrying and waste fell sites; Liquid waste disposal and groundwater quality;	3	CO 4
	4.2	Radioactive contamination (non-power generative sources)	2	CO 4
	4.3	Saline water intrusion in coastal and other aquifers and its prevention;	2	CO 4
	4.4	Artificial Recharge methods of Groundwater	3	CO 4
	4.5	Groundwater quality issues and its mitigation measures	2	CO 4
	4.6	Ground water provinces of India; and major aquifers of Kerala	3	CO 5
	4.7	Groundwater quality in different provinces of India: problems of arsenic and fluoride contaminations	3	CO 5
5	Teacher Specific Content			

Teaching and Learning Approach	**CLASSROOM PROCEDURE** Lectures, Demonstrations, Assignments, Seminars and Practical, Class Tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

- K. D. Todd. Groundwater hydrology, 2nd Edition. New York,John Wiley and Sons, 2006.
- N. S. Davis,M. J. R. DeWeist. Hydrogeology.New York, John Wiley and Sons, 1991.
- R. K. Karanth. Groundwater: Assessment, Development and management. Tata McGraw Hill Pub. Co. Ltd, 1987.
- F. C. Tolman. Groundwater. McGraw Hill Pub. Co. Ltd,1937, New York.
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Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**FOSSILOLOGY**					
Type of Course	**DSC C**					
Course Code	**MG4DSCGEO202**					
Course Level	**200-299**					
Course Summary	The course introduces a fascinating world of invertebrate fossils and their importance in deciphering Earth's history. It covers the processes of fossilization, and different modes of preservation that contribute to our understanding of geological time. Hands-on laboratory exercises provide practical experience in identifying, describing, and interpreting invertebrate fossils.					
Semester	**4**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		**75**
Pre-requisites, if any	Basic knowledge in science					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the fossils, methods of fossilization, taxonomy, and nomenclature of organisms	U	PO 1 PO 3
2	Realize the morphological characteristics and stratigraphic range of various phylum, with their paleo-environmental relevance.	U	PO 1 PO 2 PO 3
3	Applications of plant fossils and microfossils	A	PO 1 PO 2

4	Examine the geological significance of the fossils.	E	PO 1 PO 2 PO 10
5	Identify the fossils of invertebrate organisms, correlating their taxonomy and stratigraphic range.	A	PO 1 PO 2 PO 3 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Introduction to Palaeontology	2	CO 1
	1.2	flora and fauna; vertebrates and invertebrates	2	CO 1
	1.3	Types of Fossils	3	CO 1
	1.4	Uses of fossils: stratigraphic indicators; climatic indicators: indicators of palaeogeography, indicators of evolution and migration of life forms.	3	CO1
	1.5	Fossilization; Nature and modes of preservation of fossils: unaltered hard parts, altered hard parts, petrifaction, perminer-alization, carbonisation, silicification, recrystallisation, mould, casts, tracks, trails, borings	3	CO 1
	1.6	Taxonomic divisions and Nomenclature	2	CO 1
	2.1	Phylum Arthropoda: Class Trilobita; General morphology: Cephalon, glabella, facial suture, free cheek, fixed cheek, genal angle, genal spine, cranidium, thorax, pygidium; classification; geological history	2	CO 2
	2.2	Phylum Brachiopoda: General morphology: umbo, hinge line, pedicle opening, delthyrium, deltidium, pseudo deltidium, Brachial skeleton, morphometric details, ornamentation; classification; geological history.	2	CO 2

2	2.3	Phylum Mollusca: Class Pelecypoda: General characters: umbo, Hinge line aligament, lunule, escutcheon, adductor impressions, pallial line, pallial sinus, dental patterns, ornamentation; classification; and geological history	2	CO 2
	2.4	Class Gastropoda: General morphology: shell forms, whorl, spire, spiral angle, suture, aperture, columella, umbilicus, peristome, aperture, Holostomatus and siphonostomatus; types of coiling: Dextral and sinistral; ornamentation; classification; geological history	2	CO 2
	2.5	Class Cephalopoda: General morphology: siphuncle, septa, septal necks, connecting rings, chambers, shell forms, suture lines: Nautilitic, Goniotitic, Ceratitic and Ammonitic; Ornamentation; classification; evolution and geological history	2	CO 2
	2.6	Phylum Echonodermata: Class Echinoidea, General morphology: periproct, apical system, corona, Ambulacra, inter ambulacra, peristome; Regular and irregular echinoids; geological history	3	CO 2
	2.7	Introduction to corals, and their Environmental significance	3	CO 2
3	3.1	General classification of plant kingdom; plant fossils of India	3	CO 3
	3.2	A brief account of the following plant fossils: Glossopteris, Gangamopteris, Ptilophyllum, Calamites, Lepidodendron and Sigillaria	3	CO 3
	3.3	Introduction to Palynology	2	CO 3
	3.4	Introduction to Micropalaeontology	2	CO 3
	3.5	Application of Micropalaeontology. Indicators of new deposits of coal and petroleum	2	CO 3
	3.6	Geological significance of invertebrate, plant, and micro - fossils	2	CO 4

4	Identification and description of general morphological features of Phylum Mollusca, Phylum Brachiopoda, Phylum Echinidermata: Echinoidea, Phylum Arthropoda:Trilobites, Plant Fossils:Glossopteris, Ptillophyllum	30	CO 5
5	Teacher specific contents		

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminars / Viva, Hands on Training
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12 **Practical: 35 Marks** Examination: 25, Viva:10 marks

References

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- Woods, H. Paleontolgy-Invertebrate. Cambridge University Press, 2004.
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Kottayam

Programme						
Course Name	**GEOLOGY AND ENVIRONMENT**					
Type of Course	**VAC**					
Course Code	**MG4VACGEO200**					
Course Level	**200-299**					
Course Summary	This course explores the interdisciplinary field of Environmental Geology, covering concepts, geology's role in environmental studies, and the physical environment. Delve into natural resource conservation, environmental hotspots, pollution causes and effects, and the legal framework.					
Semester	**4**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		0		**45**
Pre-requisites, if any	Basic knowledge of environment					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand concepts of environmental geology, including the scope, importance, and role of geology in environmental studies.	U	PO 1 PO 3
2	Uunderstanding of the interconnections of Earth's physical environment, distinguishing the components of the atmosphere, hydrosphere, lithosphere, biosphere, and anthropogenic environment.	U	PO 1 PO 3

3	Ddistinguish between renewable and non-renewable resources, and conservation strategies for non-renewable resources.	A	PO 1 PO 2
4	Evaluate the causes and effects of environmental pollution in air and water; and causes and management of draught.	E	PO 1 PO 6
5	Understand the Environmental Impact Assessment; environmental Impacts of landslides and floods, mining, and Environmental Laws.	U	PO 1 PO 3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	**Hrs** (45)	**CO No.**
1	1.1	Concept, definition, scope of Environmental Geology	2	CO 1
	1.2	Geology and environmental studies.	3	CO 1
	1.3	The physical environment: Atmosphere, hydrosphere	3	CO 2
	1.4	Lithosphere and biosphere	3	CO 2
	1.5	Anthropogenic environment	2	CO 2
	1.6	Environmental Hotspots	2	CO 2
2	2.1	Natural Resources: Renewable and nonrenewable.	2	CO 3
	2.2	Conservation and preservation of non - renewable resources.	3	CO 3
	2.3	Global warming: Greenhouse effect and ozone depletion.	3	CO 4
	2.4	Environmental pollution: causes and effect of water pollution	4	CO 4
	2.5	Causes and effect of air pollution,	4	CO 4
	2.6	Health hazards due to groundwater pollution	4	CO 4
	2.7	Causes of draught, and its management	2	CO 4
3	3.1	Brief description of Environmental Impact	3	CO 5

		Assessment (EIA)		
	3.2	Environmental Impacts Landslides	1	CO 5
	3.3	Environmental Impacts of floods	1	CO 5
	3.4	Environmental Impacts of mining	2	CO 5
	3.5	Environmental Laws	1	CO 5
4	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lecture, Demonstration, Seminar/viva, Assignment, Class test
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests B.**End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12

References

- Brownlie, Ian. Basic Documents in Human Rights. Oxford: Clarendon Press; New York: Oxford University Press, 2018.
- Donelly, Jack. Universal Human Rights in Theory and Practice. Cornell University Press, 2013.
- Valdia, K.S. Environmental Geology - Indian Context. Tata McGraw Hill, 2013.
- Bryant, Edward. Natural Hazards. Cambridge University Press, 2004.
- Coates, Donald R. Environmental Geology. John Wiley and Sons, 2020.
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- Keller, E.A. Environmental Geology. 9th ed., Bell & Howell USA, 2010.

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Programme					
Course Name	**JOURNEY THROUGH GEOLOGICAL TIME**				
Type of Course	**SEC**				
Course Code	**MG4SECGEO200**				
Course Level	**200-299**				
Course Summary	The course offers a captivating expedition into the depths of the Earth's history, inspiring wonder and curiosity about the processes that have shaped our world over millennia. The course provides an in-depth exploration of the geological time, tracing the evolution of the Earth and its life forms through billions of years, investigating major geological events, changes in climate, and the development of life ever since the formation of the Earth to the present day.				
Semester	**4**	Credits		**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others
		3		0	**45**
Pre-requisites, if any	Geological Time Scale, Earth processes, biological evolution, and biodiversity				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the concept of Geological Time Scales; explain the significance of each division in Earth's history.	U	PO 1 PO 2 PO 3
2	Realise major geological and climatic events since the formation of the Earth, and the origin of	U	PO 2 PO 3 PO 10

	life, and the mass extinction events in its history.		
3	Distinguish the processes and conditions on the Earth, and the prominent forms of life in Precambrian, Paleozoic, Mesozoic and Cenozoic	U	PO1 PO2 PO 3
4	Examine the relationship among Geology, Human civilization, and Environmental changes.	An	PO1 PO 2 PO 6 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (45)	CO No.
1	1.1	Introduction to Geological Time Scale: eon, era, period and epoch.	2	CO1
	1.2	Formation of the Universe, Earth, and early atmosphere	3	CO 2
	1.3	Origin of life and evolution of prokaryotes	2	CO 2
	1.4	Rise of oxygen and development of eukaryotic life	2	CO 2
	1.5	Importance of the Palaeozoic Era in Earth's history	2	CO 2
	1.6	Explosion of life: Cambrian Explosion	2	CO 2
2	2.1	Brief study of major groups of Cambrian invertebrates: trilobites, brachiopods, molluscs, and arthropods	4	CO 2
	2.2	Major themes and events throughout the Palaeozoic Era	3	CO 2
	2.3	Age of fishes, amphibians and rise of forest plants	2	CO 3
	2.4	Permian-Triassic extinction event	2	CO 2
	2.5	Evolution of early dinosaurs: Ecological significance, diversity and adaptation	3	CO 3
	2.6	Rise of flowering plants: angiosperms and	2	CO 3

		their ecological dominance		
3	3.1	Rise of mammals: Evolution of mammals (An overview)	3	CO 3
	3.2	Golden age of mammals- Miocene epoch	2	CO 3
	3.3	Cretaceous-Paleogene extinction event: causes and consequences	2	CO 2
	3.4	Overview of the Holocene epoch: from the end of the last ice age to the present; appearance of homo sapiens	3	CO 3
	3.5	Relationship between Geology and human civilization	3	CO 4
	3.6	Environmental challenges through geological time; Use of geological information in understanding the future environmental conditions.	3	CO 4
4	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lecture, demonstration, Assignment, seminar / Viva and Class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests B.**End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12

References

- Monroe, Wicande, Historical Geology- Evolution of Earth and Life Through Time, Sixth Edition, Brooks/Cole, Cengage Learning, 2010.
- Forefront. Michae, Time Matters: Geology's Legacy to Scientific Thought Teaching, Resources Ltd, Washington, Tyne and Wear, UK, Blackwell Publishing, 2010.
- Rollinson. H, Early earth System, Blackwell Publishing, 2007.
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- Langmuir C. H. and Broecker W. How to build a habitable planet, Princeton

University Press, 2012.

Semester-V

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**STRUCTURAL GEOLOGY**					
Type of Course	**DSC** A					
Course Code	**MG5DSCGEO300**					
Course Level	**300-399**					
Course Summary	The course offers the study of various planar, linear and curvy linear structures, such as lineations, foliations, fractures, joints, folds, faults and unconformity surfaces, formed in the rocks as a result of the episodes of deformations. The course covers various stages of deformations shown by the rocks, and the classification of the geological structures based on their geometrical parameters. The course discusses methods of identification various structures with their geological significances.					
Semester	**5**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		**75**
Pre-requisites, if any	Basic knowledge on geometry, deformation, structures and rock beds					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Realize the study of deformational structures in the rocks, and the attitude of linear and planar features of rocks.	U	PO 1 PO 2

2	Understand the stages of deformation of rocks, and stress-strain distribution within them.	U	PO 1 PO 2
3	Distinguish the various types of planar and linear structures in the rock with their origin and characteristics.	U	PO 1 PO 2 PO 10
4	Differentiate the formation, classification and recognition of folds, faults and unconformities, with their geological significance.	A	PO 1 PO 2 PO 10
5	Apply the structural data to find out the attitude of various geological structures, and the interpretation of geological history from the geological maps.	An	PO 1 PO 2 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Attitude of planar and linear structures: strike, dip, trend, plunge and pitch	2	1
	1.2	Calculation of the thickness of a bed w.r.t the width of its outcrop; Concept of stereographic projection using Schmidt's Net	3	1
	1.3	Primary and secondary structures, Rule of V	2	1
	1.4	Stages of rock deformation; factors affecting deformation; types of stress and strain in the rocks.	2	2
	1.5	Stress & strain ellipsoids, and their significance in the study of rock deformation	2	2
2	2.1	Foliations: Types and origin	2	3
	2.2	Lineations: Types and origin	2	3
	2.3	Lineations associated to shear zones	1	3
	2.4	Tectonites: Classification based on the fabrics present	2	4
	2.5	Folds: origin, geometrical parts, and Terminology based on their forms, and the order of the folded strata	2	4
	2.6	Types of folds: classification based on the geometry of their axis, axial plane, hinge,	4	4

		limbs and interlimb angle. Compound forms: Similar, Parallel, Box & En-echelon folds, and Kink bands; Drag folds: uses, and Pumpelley's Rule		
	2.7	Donath and Parker's genetic classification of folds	2	4
	2.8	Identification of folds in the field and maps; Geological significance of folds	2	4
3	3.1	Types of fractures in the rocks	2	3
	3.2	Types of joints in the rocks	2	3
	3.3	Faults: Origin, geometry and parts	2	4
	3.4	Genetical classification and mechanism of faulting	2	4
	3.5	Classification of faults: Based on the Net slip, and the attitude of the adjacent beds	4	4
	3.6	Identification of faults in the field and maps; fault systems, Geological importance of faults	3	4
	3.7	Unconformities: Types, origin and geological significance	2	4
4 Practical Content	4.1	Three-point problems to find out the actual attitude of the strata exposed at various depths at three triangulated locations, using the relationship between strike and dip.	5	5
	4.2	Interpretation of geological history of the area presented in the geological maps, preparing the geological profiles out of the information drawn from the maps (≥8 Maps).	20	5
	4.3	Basic concept of stereographic projection in the Structural Geology: Plot strike, dip and plunge of linear and planar features in the Schmidt's Net.	3	5
	4.4	Problems connecting the strike, dip, true and exposed thicknesses of strata, and the slope of the surface of exposure.	2	5
5	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURE** Lectures, Demonstrations, Assignments, Seminars/Viva, Class tests and Practical

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12 **Practical: 35 Marks** Examination: 25, Viva:10

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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**				
Course Name	**STUDY TOUR WITH FIELD TRAINING**				
Course Code	**MG5DSCGEO301**				
Course Level	**300-399**				
Course Summary	The course is designed to provide hands-on training in the techniques of fieldwork, focusing on the identification and collection of fossils, rocks, economic minerals and mineral deposits. It establishes the skills of identification, mapping, and measuring of the attitudes of rock beds and geological structures, using field equipments. The course integrates theoretical knowledge with the field data to generate a field report with geological interpretations				
Semester	**5**	Credits		**4**	Total Hours
Course Details	Learning Approach	Lecture / Tutorial / Practical		Others	
		These hours may be engaged for other courses; and the study tour for the field work may be carried out for up to 15 days during the semester, using these cumulative hours.			**75**
Pre-requisites, if any	Knowledge in Geomorphology, Mineralogy, Use of toposheets, Brunton Compass, and Clinometer.				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No.
1	Develop skills in the field techniques for various geological data collection.	A	PO 1 PO 2
2	Identify the economic minerals, mineral deposits	An	PO 1 PO 2

	and various fossils, and analyse the significance of their occurances.		PO 10
3	Identify various types of rocks in the field with various structural features associated with them, and analyse the geological processes involved with the formation and deformation of the rocks.	An	PO 1 PO 2
4	Generate teamwork, communication, and problem solving skills through collaborative field work, and interpretation of the geological data, for the presentation of the field report.	E	PO 2 PO 4 PO 5 PO 9 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

	Course description	**CO No.**
1	Application of toposheets, geological maps and various field techniques for data & sample collection, and mapping of locations in the field.	CO 1
2	Identification of economic minerals, mineral deposits and fossils in the field.	CO 2
3	Identification and classification of the geological structures and the rock types during field work	CO 3
4	Synthesise and analysis of field data, in order to prepare a field report with field photos, appropriate diagrams, and geological interpretations.	CO 4

Content for Classroom transactions (Units)

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Report writing
Assessment Types	**MODE OF ASSESSMENT** C. **Continuous Comprehensive Assessment (CCA): Study tour and field work activities: 30 Marks** (Discipline: 10 Marks, Involvement: 20 Marks) **D. End Semester Evaluation (ESE) : 70 Marks**

	Evaluation of study tour report: 50 Marks (Structure: 10 Marks, Content: 30 Marks, Neatness: 10 Marks) **Specimen display: 20 Marks**

References

- Anantharaman, M. S. & Jain, P. C. Palaeontology (Palaeobiology) Evolution and Animal Distribution. Vishal Publishing. Co., 2014
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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**				
Course Name	**GEOLOGY AND GEOMORPHOLOGY OF KERALA**				
Type of Course	**DSE**				
Course Code	**MG5DSE GEO300**				
Course Level	**300-399**				
Course Summary	The course provides in depth knowledge of geomorphological scenario, and physiographic divisions of Kerala. Also, it covers various geological facts about Kerala including its rock types, Tertiary sedimentary formations and economic mineral resources.				
Semester	**5**	Credits		**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others
		4		0	**60**
Pre-requisites, if any	Basic knowledge of geomorphology, rocks & minerals, and Stratigraphy.				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the location, physiography and geomorphic features of Kerala; including its drainage system, soil types, laterite,climate, vegetation and Natural Hazards of Kerala.	U	PO 3 PO 6
2	Realize major crystalline rock formations of Kerala	U	PO 1 PO 10

3	Distinguish various Tertiary and Quaternary formations of Kerala	U	PO 1 PO 2 PO 6
4	Differentiate basic-ultrabasic and acidic-alkaline intrusives of Kerala	A	PO 1 PO 2
5	Recognize important metamorphic rock types, and age relations of Kerala	U	PO 1 PO 2
6	Realize the mineral resources, and mining activities of Kerala	U	PO 2 PO 6 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Area & Location of Kerala Major landforms: Western Ghats, Palghat Gap and Plateaus	3	1
	1.3	Physiographic divisions of Kerala: Highland, Midland, Lowland and Coastal plains	3	1
	1.2	Drainage, backwaters and estuaries of Kerala	2	1
	1.3	Soil types of Kerala, Laterite, Climate and Vegetation	2	1
	1.4	Coastal landforms, coastal classification, Coastal Erosion, and CZR; evolution of Kerala coast	2	1
	1.5	Natural hazards of Kerala: Floods, landslides and earthquakes	3	1
	1.6	Archaean Supracrustals: Wayanad Group, and Vengad Formation	3	2
	1.7	Charnockite-Gneiss Association: Mode of occurrence, distributions, petrography and origin	4	2
	1.8	Khondalite Group: Mode of occurrence, distributions, petrography and origin	4	2
2	2.1	Introduction to Tertiary formations of Kerala	1	3
	2.2	Vaikom and Warkalli formation	4	3
	2.3	Quilon formation	2	3
	2.4	Quaternary Formation of Kerala	2	3
	2.5	Offshore sediments and Mud Banks	2	3

3	3.1	Basic and Ultrabasic Intrusives: Gabbro and Anorthosite complex	4	4
	3.2	Acidic and Alkaline Intrusives: Granite/Syenite Plutons, Ambalavayal Granite, Munnar Granite, Kalpatta Granite and Chengannur Granite	4	4
	3.3	Pegmatites and Dolerite Dykes of Kerala	2	4
	3.4	Important metamorphic rocks of Kerala and age relations of Kerala	2	5
4	4.1	Introduction to mineral resource of Kerala	2	6
	4.2	Exogenous mineral deposits: Bauxite, china clay & GEM minerals	2	6
	4.3	Gold, Graphite and Iron ore, Limestone, soap stones, and placer deposits of Kerala	4	6
	4.4	Sand mining, clay mining and Quarrying	3	6
5	Teacher Specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminars/Viva & Class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **D. End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

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Programme	**BSc (Hons) Geology**					
Course Name	**GEMMOLOGY**					
Type of Course	**DSE**					
Course Code	**MG5DSE GEO301**					
Course Level	**300 -399**					
Course Summary	Gemmology involves the study of the geological processes that lead to the formation of gemstones and the conditions under which minerals crystallize to create gemstones, as well as the locations around the world where different types of gemstones are found. The course offers study of specialized tools and instruments for gemstone analysis. These may include microscopes, refractometers, spectrometers, and polariscopes.					
Semester	**5**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				**60**
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basics of Gemmology	U	PO 1
2	Identify and distinguish various gemstones based on their physical properties.	U	PO 2
3	Identify and distinguish various gemstones based on their optical properties.	U	PO 2
4	Analyse the quality of gemstones	An	PO 2

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C),

Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Introduction to Gemmology; The evolution of the science of gemmology; History of Gem industry In India: ancient and recent; diamond cutting industry; coloured stone industry; gems in ayurveda	3	CO 1
	1.2	Basic qualities of gemstone jewellery : Chemical Composition, Weights and measures, Navaratnas	3	CO 1
	1.3	Factors that influence the value of gemstones: beauty, durability, rarity and acceptability; Geological distribution	2	CO 1
	1.4	The geological sources of gem rock; processes involved in the formation of gem rock; gem regions; gem recovery methods	3	CO 1
	1.5	The formation of gemstones in the earth crust; essential qualities of gem materials; organic and inorganic gems; gem testing.	3	CO 1
2	2.1	Physical properties of gemstones: specific gravity, hardness, cleavage and fracture, tenacity; Magnetism ,Electricity	3	CO 2
	2.2	The use of high destroy liquids in gem testing, flotation and pycnometer method	3	CO 2
	2.3	Chemical bonding and crystallography: atomic structure, types of Chemical bonds, shape of molecules, crystalline and amorphous materials	3	CO 2
	2.4	Crystal symmetry (Plane, axis, centre); crystal forms; crystal habits; seven crystal systems; twinning; isomorphous substitution; crystalline polymorphism	3	CO 2
	2.5	Natural gemstones: The Earth ' s structure and geological activities, the origin and occurrence of gem minerals	3	CO 2
3	3.1	Optical properties: importance of light in	4	CO 3

		gemmology; transparency: its degree as an observation for gem identification, cutting and grading; laws of refraction, refractive index, reflection and its effects, refractometer; birefringence		
	3.2	Polarized light: Nature and production, isotropic and anisotropic behavior, optic axes; use of polariscope in gemmology	3	CO 3
	3.3	Absorption of light, allochromatism, idiochromatism, differential absorption of light, pleochroism; Dichroscope: construction and use; Interference and diffraction, play of colour, dispersion, use the Chelsea colour filter, luminescence	3	CO 3
	3.4	Important Physical and optical properties of gemstones; Groups, species and varieties of gemstones with special reference to Ruby, Sapphire, Aquamarine, Alexandrite, Emerald, Opal, Topaz, Tourmaline and Diamonds	3	CO 3
	3.5	Differentiating natural gemstones from its synthetic; Identify the different types of synthetics	3	CO 3
4	4.1	Pleochroism and luster of important gem varieties	5	CO 4
	4.2	Gem materials of organic origin: Formation, structure, recovery; Artificial gem materials: Methods of manufacture, identification of synthetic composite, imitation stones.	3	CO 4
	4.3	Fashioning of gem stones: Description of gem stone cuts;	3	CO 4
	4.4	Valuation standards and appraisal procedures of gemstones; marketing and export procedures	2	CO 4
	4.5	Treatment of gemstones: Dyeing, bleaching, impregnation, coating, heat treatment; Irradiation, laser treatment, fracture filling and diffusion treatment.	2	CO 4
5		Teacher Specific Contents		

Teaching and Learning Approach	**CLASSROOM PROCEDURE** Lectures, Demonstrations, Assignments, Seminars /Viva, Class Test
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

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Programme	**BSc (Hons) Geology**					
Course Name	**PHANEROZOIC STRATIGRAPHY OF INDIA**					
Type of Course	**DSE**					
Course Code	**MG5DSEGEO302**					
Course Level	**300-399**					
Course Summary	The course deals with the divisions and subdivisions of the Phanerozoic Eon, and stratigraphic sequences and formations formed during the Palaeozoic, Mesozoic, and Cenozoic eras in India.The course discusses significant geological events, such as mass extinctions, the migration of fauna and flora, and evolutionary milestones recorded in the Phanerozoic stratigraphy of India.					
Semester	**5**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic science knowledge					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Comprehend Phanerozoic stratigraphy, the geological time scale, and Indian physiographic divisions.	U	PO1 PO2
2	Understand the distribution, age, geological and economical significance of Palaeozoic formations in India.	U	PO1 PO2

3	Understand and analyze Mesozoic formations in India, focusing on Spiti, Kutch, Tiruchirapalli-Pondicherry, Cauvery, and Narmada valleys, Deccan traps, and K-Pg boundary.	An	PO1 PO2
4	Analyze Cenozoic geological events in India, focusing on Himalayan rise and regional formations.	An	PO1 PO2
5	Understand and interpret Cenozoic oil-bearing formations in key Indian basins	An	PO2 PO3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Introduction to Phanerozoic Stratigraphy in relation to Geological Time Scale, major geological events of Phanerozoic eon	3	CO 1
	1.2	Physiographic and Geologic divisions of India	3	CO 1
	1.3	Distribution of Palaeozoic formations in India	2	CO 2
	1.4	Detailed study of Palaeozoic successions of Salt range; Age of Saline series	3	CO 2
	1.5	Detailed study of Palaeozoic successions of Kashmir valley	3	CO 2
	1.6	Detailed study of Palaeozoic successions of Spiti and Zanskar region	3	CO 2
	1.7	Gondwana Supergroup: The Depositional Environment, distribution, life, classification and economic importance of Gondwana formations of India	5	CO 2
	1.8	Permian – Triassic Boundary	3	CO 2
	2.1	Distribution of Mesozoic formations in India	2	CO 3
	2.2	Detailed study of Mesozoic successions of Spiti valley	2	CO 3

2	2.3	Detailed study of Mesozoic successions of Kutch basin	3	CO 3
	2.4	Detailed study of Mesozoic successions Tiruchirapalli – Pondicherry and successions of Cauvery basins	3	CO 3
	2.5	Detailed study of Mesozoic successions of Narmada valley: Bagh beds, Lameta beds	2	CO 3
	2.6	Deccan traps of India: Distribution and Structural features; Infra and intertrappean beds; age of Deccan traps	3	CO 3
	2.7	Cretaceous – Paleogene boundary (K-Pg)	3	CO 3
3	3.1	Distribution and account of the Geological events took place during Cenozoic era of India. Comprehensive studies of rise of Himalayas	3	CO 4
	3.2	Distribution, Classification, lithology, Structural features and flora and fauna of the Siwalik successions	3	CO 4
	3.3	Distribution, Classification, lithology of tertiaries of Assam, Karewa and Tamil Nadu	3	CO 4
	3.4	Tertiary formations of Kerala	2	CO 4
	3.5	Quaternary formations of India: Indo-Gangetic plain; Thar desert	2	CO 4
4	4.1	Cenozoic oil-bearing formations of India: Bombay offshore, Cambay, Cauvery, Krishna Godavari, Assam – Arakan and Tripura basins	4	CO 5
5		Teacher Specific content		

Teaching and Learning Approach	**CLASS ROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminars/Viva
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **E. End Semester Evaluation (ESE)**

	Theory: 70 Marks Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

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Programme	**BSc (Hons) Geology**					
Course Name	**PLANETARY GEOLOGY**					
Type of Course	**DSE**					
Course Code	**MG5DSEGEO303**					
Course Level	**300-399**					
Course Summary	The field of planetary geology encompasses the study of the geology of celestial bodies beyond Earth, including planets, moons, asteroids, and comets. A course in planetary geology typically covers a wide range of topics related to the geological processes, surface features, and evolution of these celestial bodies					
Semester	**5**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic knowledge of solar system					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the Solar System, and its origin with Earth System.	U	PO1 PO2
2	Realize the geological characteristics of the lunar surface, including the distribution of surface features, and composition of surface materials	U	PO1 PO2
3	Distinguish the terrestrial planets	U	PO1
4	Realize the outer planets with their significance in	U	PO1

	the Solar System		
5	Differentiate the planetary objects: meteors, asteroids, and comets; classification of meteorites.	Ap	PO1 PO2
6	Discuss the motives and status of planetary exploration, and Indian initiatives	U	PO1 PO2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Earth in space-Universe, Milky Way, Solar system, Sun	3	CO1
	1.2	Astronomical units. Inner planets, Outer planets, planetoids, moons	3	CO1
	1.3	Double star hypothesis, condensation hypothesis, Urey's hypothesis	2	CO1
	1.4	Origin of Earth's atmosphere	3	CO1
2	2.1	Origin of lunar surface. Geology of surface cover, sediment, volcanic flows, lunar craters	3	CO2
	2.2	Structure of moon - crust and interior. Absence of atmosphere, origin and evolution of moon.	3	CO2
	2.3	Terrestrial planets: Mercury, Venus, and Mars - physical attributes	2	CO3
	2.4	General survey of atmosphere, atmospheric temperature, planetary surfaces and morphology of terrestrial planets	3	CO3
	2.5	Structure of terrestrial planets: lithological make up of crust and interior, and origin of the crust.	3	CO3
3	3.1	Outer planets: Jupiter, Uranus, Saturn and Neptune with their physical attributes.	3	CO4

	3.2	General survey of atmosphere, atmospheric temperature of outer planets	3	CO4
	3.3	Planetary surface and morphology of outer planets; lithological make up of crust and interior.	4	CO4
	4.1	Outer planetary objects: meteors, meteorites; classification of meteorites.	3	CO5
4	4.2	Asteroids, comets, their origin, evidence of giant impacts, spinifex texture, tektites, petrology of meteorites.	4	CO5
	4.3	Closer look on Saturn: Saturn's rings and moons; Kuiper Belt	4	CO5
	4.4	Planetary exploration: Indian initiatives	3	CO6
	4.5	Space crafts: Gemini series, Apollo missions, lunar rovers, First lunar landing.	4	CO6
	4.6	International Space station and various space exploration missions	3	CO6
	4.7	Seismic method of exploration, Remote Sensing of physical and chemical attributes of Planets	4	CO6
5		Teacher Specific content		

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminars/viva & Class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**MINING GEOLOGY**					
Type of Course	**DSE**					
Course Code	**MG5DSEGEO304**					
Course Level	**300-399**					
Course Summary	The course offers different terminology of mining, from mine planning and design to different methods of mining. Also, the course deals with different types of machinery used for mining, drilling and blasting. The course discusses the different type of coal mining, mineral dressing principles, and separation methods, considering the environmental aspects with EMP and EIA. It also explores mining legislation in India and the impact of mining on the economy and the environment.					
Semester	**5**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisite, if any	Basic knowledge in science					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Discuss elements of mining.	U	PO 2 PO 3
2	Demonstrate planning and design principles of mines	A	PO 1 PO 2
3	Analyse sustainable mine development programme.	An	PO 1

			PO 2
4	Appraise different types of mining including coal mining techniques, mineral dressing principles, and separation methods.	An	PO 1 PO 2
5	Integrate the knowledge of environmental management plans, mining legislation, and the economic impact of the mineral industry.	An	PO 5
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
	1.1	Mining Terminology	3	CO 1
1	1.2	Elements of mining; stages in the life of a mine; mine machinery.	3	CO 1
	1.3	Planning and design of mine; mining method selection; mine safety; unit operations and auxiliary operations in mining;	3	CO 2
	1.4	Mine development and design; mine openings	3	CO 3
	1.5	Drilling and blasting techniques.	3	CO 4
2	2.1	Surface mining: open pit mining, quarrying, open cast mining, auger mining, placer mining, solution mining.	5	CO 4
	2.2	Underground mining: unsupported methods, supported method, caving methods.	4	CO 4
	2.3	Coal mining methods	3	CO 4
	2.4	Sea bed mining basic ideas	3	CO 4
	2.5	Shaft sinking: Mining support and ventilation	2	CO 4
3	3.1	Principles of mineral dressing. Types and uses of Crushers, Grinding mills, Screens and Classifiers.	3	CO 4

	3.2	Physical methods of separation by grain size, gravity and magnetism	3	CO 4
	3.3	Chemical methods – reagents and their functions. Floatation	3	CO 4
	3.4	Flow sheets and their importance	2	CO 4
	3.5	Mineral inventory and their economic significance.	2	CO 5
4	4.1	EMP (Environmental Management Plan) Mining plan, Mine closure plan, Surface plan etc.	3	CO 5
	4.2	EIA (Environmental Impact Assessment)	3	CO 5
	4.3	Mineral industry in India and national economy	3	CO 5
	4.4	Mining legislation in India – National Mineral Policy.	3	CO 5
	4.5	Mining hazards. Mining and environment.	3	CO 5
5		Teacher Specific content		

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminars/Viva & Class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**GROUNDWATER EXPLORATION AND MANAGEMENT**					
Type of Course	**DSE**					
Course Code	**MG5DSEGEO305**					
Course Level	**300-399**					
Course Summary	The course covers the principles and techniques involved in locating, assessing, and sustainably managing groundwater resources. The course includes topics such as hydrogeology, groundwater flow, aquifer properties, exploration methods, groundwater quality assessment, contamination remediation, and sustainable groundwater management practices.					
Semester	**5**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic knowledge about groundwater and wells					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the hydrogeological conditions that favour the occurrence of groundwater, with respect to types of wells, method of construction and well completion methods.	U	PO2 PO 6
2	Recognize the hydrogeological conditions that favor the occurrence of groundwater, with respect to well development and Well rehabilitation.	U	PO 3 PO 6
3	Apply the quantitative occurrence of groundwater with various methods of groundwater exploration.	A	PO 1 PO 2

4	Realize Subsurface investigation-logging method.	U	PO2 PO 3
5	Analyze the effects of groundwater level fluctuations.	An	PO6 PO 7
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Introduction to water resources; Wells and its types: open, bored, tube and filter point well; Test holes; Well logs	2	CO 1
	1.2	Horizontal wells: Surangams, horizontal pipes, infiltration galleries, collector wells	4	CO 1
	1.3	Methods of construction of wells: shallow and deep wells	4	CO 1
	1.4	Well construction: general introduction	2	CO 1
	1.5	Well completion: casing, cementing, screens and gravel packs	4	CO 1
2	2.1	Well development: pumping, surging, surging with air, backwashing with air, hydraulic jetting	4	CO 2
	2.2	Well development using chemicals	1	CO 2
	2.3	Well rehabilitation	1	CO 2
	2.4	Investigation of groundwater: Surface investigation: geologic, geomorphologic, remote sensing, geophysical methods	3	CO 3
	2.5	Geophysical methods and its types: Electric resistance, Seismic refraction, Gravity, Magnetic methods	3	CO 3
3	3.1	Subsurface investigation of groundwater	3	CO 4
	3.2	Logging: process	2	CO 4
	3.3	Logging methods: geologic log, drilling time log, resistivity log, spontaneous potential log, caliper log	4	CO 4
	3.4	Logging methods: radiation log-natural log, Gamma-gamma and neutron log	4	CO 4
	3.5	Water witching method	2	CO 4
4	4.1	Ground water level fluctuations	2	CO 5

	4.2	Factors for ground water level fluctuations: stream flow, evapotranspiration, meteorological phenomenon, tides, urbanization	4	CO 5
	4.3	Ground water level measurements	3	CO 5
	4.4	Kerala groundwater control and regulation act 2003	3	CO 5
	4.5	Ground water level fluctuations and Management of ground water	3	CO 5
5	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lecture, Demonstration, Assignment, Seminar / Viva, and Class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

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Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**GEOINFORMATICS**					
Type of Course	**SEC**					
Course Code	**MG5SECGEO300**					
Course Level	**300-399**					
Course Summary	The course covers the fundamental concepts and tools related to the Geographic Information System (GIS), Remote Sensing, and Spatial data analysis. It also deals with the applications of the geomatics and remote sensing methods in the various fields of geology, disaster management, and urban planning.					
Semester	**5**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		0		**45**
Pre-requisites, if any	Basic knowledge in physics, software applications, and type of disasters					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basic concepts of Remote sensing, GPS, and GIS.	U	PO 1 PO 2
2	Explain the fundamentals of geospatial analysis.	U	PO 1 PO 2
3	Acquire, manage, and preprocess geospatial data using appropriate tools and techniques.	A	PO 1 PO 3 PO 10
4	Apply geomatics and remote sensing for disaster management.	A	PO 1 PO 2 PO 6
5	Apply the basic concepts of Geomatics in Geosciences to resolve real world problems with the aid of GIS and Remote sensing.	C	PO1 PO3 PO 10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (45)	CO No.
1	1.1	Basic principles of remote sensing, Electromagnetic spectrum	1	CO 1
	1.2	Remote Sensing data products	2	CO 1
	1.3	Indian Remote Sensing Satellites, recent remote sensing satellites of the world	1	CO 1
	1.4	Application of remote sensing in geologic mapping, groundwater exploration, geomorphologic mapping and disaster management	4	CO 5
	1.5	Aerial photography- basic principles, types; Tilt, drift and crab in aerial photographs.	2	CO1
	1.6	Stereoscopes: types- pocket and mirror stereoscopes	2	CO 4
2	2.1	Geoinformatics: Definition, and various disciplines constituting it	1	CO 2
	2.2	Geographic Information System (GIS): The purpose of GIS; Components of GIS, GPS- An Introduction	2	CO 2
	2.3	An introduction to GIS softwares: ARC GIS, ERDAS, Q GIS	4	CO 3
	2.4	Types of Data: Raster and Vector	2	CO 3
	2.5	Spatial data input: Digitizing paper maps	2	CO 3
	2.6	Georeferencing, Transformation and Projection	3	CO 3
3	3.1	Spatial data analysis: analytical capabilities of a GIS	3	CO 3
	3.2	Overlay functions, Mapping qualitative and quantitative data.	3	CO 3
	3.3	Overview of zone delineation and its importance in spatial analysis	3	CO 4
	3.4	GIS Applications in Geosciences- An Introduction	3	CO 4
	3.5	GIS Applications in Geology, Groundwater and Mineral Exploration	4	CO 5

	3.6	GIS Applications in Disaster Management and urban planning.	3	CO 5
4	Teacher Specific content			

Teaching and Learning Approach	**CLASS ROOM PROCEDURES** Lecture, Demonstration, Assignment, Seminars/Viva, and Class test
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests B.**End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12

References

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  Systems. Prentice Hall of India. 2005.
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Semester-VI

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**IGNEOUS AND METAMORPHIC PETROLOGY**					
Type of Course	**DSC A**					
Course Code	**MG6DSCGEO300**					
Course Level	**300-399**					
Course Summary	This course provides a comprehensive understanding of igneous and metamorphic processes, including partial melting mechanisms, rock classification, crystallization principles, metamorphic phenomena, and advanced mineralogical techniques for rock identification.					
Semester	**6**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		**75**
Pre-requisites, if any	Basic knowledge of mineralogy					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand mechanisms of partial melting, magma formation, and petro-tectonic settings in geology.	U	PO 1 PO 2 PO 3
2	Identify and classify igneous rocks based on texture, structure, mineralogy, and chemistry.	An	PO1 PO 2 PO 3

3	Understand and apply principles of Bowen's reaction series, phase rule, and binary systems in the crystallization of igneous rocks	A	PO 1 PO 2 PO 3
4	Understand metamorphic processes, types, and associated geological phenomena in diverse geological settings.	U	PO 1 PO 2 PO 3
5	Understand Goldschmidt's mineralogical phase rule, metamorphic paragenesis, mineral stability, geothermobarometry, textures, and structures.	U	PO 1 PO 2 PO 3
6	Demonstrate proficiency in megascopic and microscopic identification of various igneous and metamorphic rocks.	A	PO 1 PO 2 PO 3
`*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Partial Melting and Magma formation; Mechanism of Partial melting - Thermal perturbation, Adiabatic decompression, Flux melting.	2	CO 1
	1.2	Petro tectonic settings of magma: mid-oceanic ridges and subduction zones only; Diversity of igneous rocks: magmatic differentiation process, assimilation/contamination.	2	CO 1
	1.3	Igneous textures: definition and description based on crystallinity, granularity, shapes of crystals, and mutual relationship of minerals.	3	CO 2
	1.4	Igneous structures: definition and description; Forms of igneous rocks: intrusive and extrusive.	3	CO 2
	1.5	Classification of igneous based on mineralogy: felsic and mafic minerals, IUGS - QAPF (Ultramafic, Plutonic and Volcanic);	3	CO 2
	1.6	Classification based on the chemistry of igneous rocks: silica saturation basis, alkali & silica basis (brief introduction), total alkali vs silica classification for volcanic rocks, CIPW classification - norm and normative minerals.	2	CO 2

2	2.1	Bowen ' s reaction series, Phase rule, Crystallisation of Unicomponent system - Water system	2	CO 3
	2.2	Binary system: Introduction, influence of pressure; Binary System with eutectic: Diopside - Anorthite system; Binary System with incongruent melting: Forsterite - Silica	3	CO 3
	2.3	Binary system with solid solution: albite - anorthite, Binary system with solvus: orthoclase - albite.	3	CO 3
	2.4	Metamorphism; Factors of metamorphism: pressure, temperature, chemically active fluids, time, and parent rock composition.	2	CO 4
	2.5	End of metamorphism: Anatexis and Palingenesis; Migmatization; Metasomatism	2	CO 4
	2.6	Types of metamorphism: progressive, retrogressive, contact, regional - orogenic & ocean floor, Burial, cataclastic, hydrothermal, Impact/shock, plutonic and poly metamorphisms	3	CO 4
	2.7	Metamorphism associated with convergent and divergent plate margins.	1	CO 4
3	3.1	Goldschmidt' s mineralogical phase rule; metamorphic paragenesis, Metamorphic differentiation	2	CO 5
	3.2	Stability of minerals in P-T field; Metamorphic mineral zone concept: index minerals & Isograd, Barrovian and Buchan mineral zones.	2	CO 5
	3.3	Metamorphic grade and facies concepts.	3	CO 5
	3.4	Concept of geothermobarometry.	1	CO 5
	3.5	Metamorphic textures: Crystalloblastic, Relict, and cataclastic textures.	3	CO 5
	3.6	Metamorphic structures: foliations, lineations, cataclastic and miscellaneous.	3	CO 5
Practical Content **4**	4.1	Megascopic identification of following igneous rocks: Mica Granite, Hornblende Granite, Graphic granite, Granite Porphyry, Pegmatite, Aplite, Syenite, Syenite porphyry, Diorite, Gabbro, Anorthosite, Dunite, Pyroxenite, Dolerite, Basalt, Rhyolite, Felsites, Obsidian, Pumice.	7	CO 6

	4.2	Megascopic identification of following metamorphic rocks: Slate, Phyllite, Schist (different types), Gneiss, Quartzite, Marble, Amphibolite, Eclogite, Leptynite, Charnockite, Khondalite, Mafic Granulite, Schorl rock, Banded Magnetite Quartzite	7	CO 6
	4.3	Microscopic identification of following igneous rocks: Mica Granite, Hornblende Granite, Graphic Granite, Granite-porphyry, Syenite, Diorite, Gabbro, Dunite, Pyroxenite, Dolerite, Anorthosite, Basalt.	8	CO 6
	4.4	Microscopic identification of following metamorphic rocks Slate, Chlorite schist, Mica schist, Kyanite schist, Garnetiferous schist, Charnockite, Ecologite, Amphibolite, Leptynite, Khondalite, Cordierite gneiss, Garnet-sillimanite gneiss,	8	CO 6
5	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURE** Lectures, Assignments, Seminar/ Viva, Class tests and Practical
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12 **Practical: 35 Marks** Examination: 25, Viva:10

References

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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**FUEL GEOLOGY**					
Type of Course	**DSC A**					
Course Code	**MG6DSCGEO301**					
Course Level	**300-399**					
Course Summary	The course covers the origin, properties, geologic history, spatial distribution and significance of fuel minerals in the Earth. An overview of the data analysis, exploration techniques and mining methods are included. The current status and future prospects of fuel mineral exploration and mining, and the role of geologists in this domain, are discussed in this course.					
Semester	**6**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		**75**
Pre-requisites, if any	Basic knowledge in fuel minerals and atomic minerals					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the geological processes and classifications related to coal, petroleum, and atomic minerals.	U	PO 2 PO 3 PO 4 PO 6
2	Understand the history, geologic processes, and exploration techniques in petroleum geology.	U	PO 2 PO 3

3	Understand the genesis, distribution, and exploration prospects of unconventional petroleum and atomic minerals.	U	PO 1 PO 2 PO 3
4	Develop expertise in coal analysis, covering proximate analysis and well-log data interpretation.	A	PO 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Fuel Geology: An introduction to Coal, Petroleum and Atomic minerals.	2	CO1
	1.2	Coal bearing strata; Coalification process; In situ and transported theory of coal formation. Coal varieties: Humic and sapropelic coal, Cannel and bog head coals; Coal maturity, rank and fuel ratio; Peat, lignite, bituminous and anthracite coal.	2	CO1 CO1
	1.3	Macroscopic and microscopic constituents of coal; Macerals and its type; Microlitho type and Lithotype; Origin and properties of macerals.	2	CO1
	1.4	Geologic history and temporal distribution of coal: Gondwana and Tertiary coal; Major coal fields in India and the world	2	CO1
	1.5	Underground coal gasification; Coal Bed Methane (CBM): Global and Indian scenario.	3	CO1
	1.6	Coal quality analysis and assessment: proximate and ultimate analysis; Impurities in coal.	3	CO1
	1.7	Thermal maturity indicator: vitrinite reflectance; International and Indian classification of coal.	2	CO1

	1.8	Coal mining methods: open and underground; Coal mining: Environmental impact and human health.	2	CO1
2	2.1	History of crude oil drilling; Crude oil: physical properties; Chemistry of crude oil; Crude oil types; Natural Gas: Geologic history and global spatial distribution of crude oil.	2	CO2
	2.2	Origin of Petroleum: concepts, arguments in favour of and against various theories; Tectonics and hydrocarbon entrapment; Petroleum exploration: Geophysical surveys, surface and sub-surface methods.	2	CO2
	2.3	Formation of crude oil: diagenesis, catagenesis and metagenesis stages; Kerogen types; Oil window.	3	CO2
	2.4	Source, reservoir rocks and traps; Properties of rocks in the petroliferous basins; Petroliferous sedimentary basins in India and their Stratigraphy; Types of traps; Primary and secondary migration of crude oil and accumulation: mechanism.	3	CO2
	2.5	Duties of a Petroleum Geologist; Reservoir Engineering: An introduction.	2	CO2
	2.6	Profile of an oil well; Types of oil wells; Drilling methods: vertical, directional and horizontal drilling; Drilling parameters and mud parameters.	2	CO2
	2.7	Well logging methods: Mud logging; Shale factor and shale density analysis; Master log: Interpretation of resistivity, self-potential, gamma, neutron and density log.	2	CO2
3	3.1	An introduction to non-conventional petroleum resources: shale gas, gas hydrates, tar sands and oil shale.	2	CO3
	3.2	Atomic minerals: primary and secondary radioactive minerals; Properties of Uraninite, Pitchblende, Allanite, Monazite and Thorium.	3	CO3
	3.3	Genesis of Thorium and Uranium deposits and their distribution in India.	2	CO3

	3.4	Radioactive minerals in the beach placer deposits of Kerala and Tamil Nadu.	2	CO3
	3.5	Status and prospects of fuel mineral exploration in India and the world.	2	CO3
Practical Contents **4**	4.1	Coal analysis: Proximate analysis; Analysis and interpretation of well-log data	30	CO4
5	Teacher Specific Contents			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminars/Viva, Class Test
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12 **Practical: 35 Marks** Examination: 25, Viva:10

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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**				
Course Name	**MARINE GEOLOGY AND CLIMATOLOGY**				
Type of Course	**DSE**				
Course Code	**MG6DSEGEO300**				
Course Level	**300-399**				
Course Summary	This course covers the topics such as ocean basin structure, basin types, ocean mineral resources, drilling methods, atmospheric dynamics, climate classification, greenhouse gas effects and palaeoclimatic studies. It also discusses the physical and chemical characteristics of seawater and phenomena like waves, tides, and ocean currents. Additionally, the course explores the applications of remote sensing in marine geology. Overall, this course provides a solid foundation for comprehending and addressing the complexities of marine and climatic processes.				
Semester	**6**	Credits		**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others
		4		0	0	**60**
Pre-requisites, if any	Basic knowledge about earth				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the fundamental concepts in marine geology including expeditions, structure, evolution, types of ocean floor and marine sediments	U	PO 1 PO 2
2	Classify the types of marine mineral resources and	U	PO 1

	understand the instruments used for sampling, drilling projects and sea laws		PO 2
3	Understand the physical and chemical properties of ocean water, waves and ocean currents	U	PO 1 PO 2
4	Apply the basic knowledge of climatology to understand the climatic variation	A	PO 1 PO 2 PO 6
5	Evaluating evidence from proxy data and reconstructing paleoclimates	E	PO 1 PO 2 PO 6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Ocean Basin: origin, evolution Structure of the ocean floor: continental shelf; slope and rise; Submarine canyons; Abyssal plain: ridges, Submarine volcanoes, Island arcs, Guyots and seamounts, Trenches	3	CO 1
	1.2	Types of ocean basins: fore arc basin, back arc basin, conjugate basin, deep oceanic basin with examples	3	CO 1
	1.3	Eustatic sea level changes and its global impacts; Relation of onlap and offlap with marine transgression and regression	3	CO 1
	1.4	Marine sediments and their distribution: Lithogenous, biogenous, hydrogenous, cosmogenous and volcanic sediments; siliceous and calcareous oozes; sedimentation rates (Bay of Bengal and Arabian Sea)	3	CO 1
	1.5	Ocean floor Survey: Single and Multi-beam echo sounding methods, sidescan sonar, ROVs & AUVs, and scuba diving. Position fixing systems: GPS and DGPS	2	CO 1

	1.6	Ocean expeditions and development of Marine Geology; Ocean floor drilling programmes: DSDP, ODP and JOIDES.	2	CO 1
2	2.1	Marine mineral resources: distribution and controlling factors; placer deposits at the coastal zone	2	CO 2
	2.2	Resources in the continental shelves: Phosphorites, Petroleum, Natural gas, Gas hydrates, calcareous sediments (lime mud),	3	CO 2
	2.3	Heavy metals on the deep sea floor: polymetallic nodules, Red mud, hydrothermal sulphide deposits	3	CO 2
	2.4	Instruments used for offshore sampling: grabs, dredgers and corers	2	CO 2
	2.5	Marine Pollution and Cleanup Methods Laws of Sea CZ, EEZ, CRZ	2	CO 2
3	3.1	Physical properties of seawater: Salinity and chlorinity; temperature; density; conductivity; viscosity	3	CO 3
	3.2	Vertical profiles of pressure, temperature and salinity of ocean water	3	CO 3
	3.3	chemical composition of seawater and the factors affecting the composition	2	CO 3
	3.4	Ocean waves: progressive waves, shallow water waves, seismic sea waves (Tsunami), wind waves, and deep and shallow water waves; Tides and tidal currents	3	CO 3
	3.5	Ocean Circulation: wind-induced currents, upwelling, downwelling, warm and cold currents	3	CO 3
	3.6	Causes of ocean currents: Thermohaline circulation; Surface and deepwater circulation.	3	CO 3
4	4.1	Origin of atmosphere, composition and Structure of atmosphere: variation with altitude, latitude and season	3	CO 4
	4.2	Insolation: factors and distribution, Heat Budget, Temperature Inversion	2	CO 4
	4.3	Atmospheric pressure and winds : Planetary Winds, forces affecting winds, general	3	CO 4

		circulation, Jet Streams		
	4.4	Milankovitch cycle; Koppen system of climate classification	2	CO 4
	4.5	Greenhouse effect and global warming; Basics of El Nino and La Nina: ENSO cycle	2	CO 4
	4.6	Paleoclimatology: climate change and variation in earth's orbit; Proxy data for reconstruction of paleoclimate: ice cores, tree rings, sediment cores	3	CO 5
5	Teacher Specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminars/Viva & Class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

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- Goosse, Hugues. Climate System Dynamics and Modelling. Cambridge University Press, 2015.
- Vallis, Geoffrey K. Climate and the Oceans. Princeton Primers in Climate, 2012.
- Reddy, M. P. M. Descriptive Physical Oceanography. Oxford & IBH, 2000.
- Talley, Lynne D., et al., editors. Descriptive Physical Oceanography: An Introduction. 6th ed., Elsevier, 2011.
- Stewart, R. H. Introduction to Physical Oceanography. E-book, 2005.

Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**PERSPECTIVES IN WATER MANAGEMENT**					
Course Code	**MG6DSEGEO301**					
Course Level	**300-399**					
Course Summary	The course deals with hydrology, water governance, water law, water infrastructure, water conservation, water reuse, integrated water resources management (IWRM), and stakeholder engagement.					
Semester	**6**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic knowledge of hydrosphere and climate					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand hydrosphere, its importance, component and their impact on climate change which effect the global distribution of water resources.	U	PO 1 PO 2 PO 6 PO 7
2	Understand the fundamentals of Earth ' s Hydrological cycle and its component and their important factors in the natural water cycle.	U	PO 1 PO 2 PO 10
3	Differentiate climate and weather and its factors that influencing them.	U	PO 1 PO 2 PO 10
4	Recognize the importance of clouds with respects to their types based on their height.	U	PO 1 PO 2

			PO 6 PO 10
5	Analyse the significance of harvesting methods: traditional and modern methods with examples; Rain water as a resource of water.	An	PO 1 PO 6 PO 9 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Hydrosphere: Components of Hydrosphere: Oceans, Freshwater, Surface Water, Groundwater, Glacial Water, Atmospheric Water (Briefly Explain)	5	CO 1
	1.2	Brief study of Streams, lagoons, backwaters, springs: Hot springs, Fumaroles, Geysers and Ocean as a resource of water	4	CO 1
	1.3	Introduction to hydrologic cycle: Name the Processes of Hydrologic cycle: Precipitation, Run-off, Infiltration, Evaporation, Transpiration, Evapotranspiration, Condensation with figure	5	CO 2
	1.4	Precipitation: Factors affecting Precipitation	2	CO 2
	1.5	Forms of Precipitation: Drizzle, Rain, Glaze, Sleet, Snow, Snowflakes, Hail (brief definition)	2	CO 2
2	2.1	Run-off: Factors affecting Run-off	3	CO 2
	2.2	Infiltration: Factors affecting infiltration	3	CO 2
	2.3	Evaporation: Factors affecting evaporation	2	CO 2
	2.4	Transpiration: Factors affecting Transpiration, Evapotranspiration	2	CO 2
	2.5	Condensation: Process, Factors affecting condensation	2	CO 2
3	3.1	Climate And Weather: Difference between Climate and Weather; Factors influencing climate and weather, Temperature, Pressure, Humidity, Cloud, Wind Direction	5	CO 3

		(briefly explain)		
	3.2	Cloud: Importance of clouds; Classifications for clouds: Low cloud, Middle Cloud, High Cloud (brief explanation)	3	CO 4
	3.3	Low cloud: Height, types of clouds with figure	2	CO 4
	3.4	Middle cloud: Height, types of clouds with figure	2	CO 4
	3.5	High cloud: Height, types of clouds with figure	2	CO 4
4	4.1	Water harvesting Methods: types: Surface and Groundwater harvesting (brief description)	3	CO 5
	4.2	Rain water harvesting: Methods Traditional and Modern methods (briefly explain)	3	CO 5
	4.3	Traditional methods of rain water harvesting: Tankas, Khadin, Kunds, Surangams, Kuis, Bhandharas (briefly explain)	5	CO 5
	4.4	Modern methods of rain water harvesting: Roof water harvesting, Insitu water harvesting	3	CO 5
	4.5	Rain water as a resource of water	2	CO 5
5	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lecture, Demonstration, Assignments, Seminars/Viva, and Class test
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

- Athalve R. N. Water harvesting and sustainable supply in India. Rawat publication, 3rd edition, 2003
- Ackerman A. Steven, Knox A. John. Meteorology. Jones and Bartlett Learning publications, USA, 3rd edition, 2011.
- Gupta P. Ravi. Remote sensing Geology. Springer publication, 2nd edition, 2003.
- H. M. Reghunath. Ground Water. Wiley Eastern Ltd, 2007
- Punmia B. C. and Lal. B. B. Pande. Irrigation and Water Power Engineering.. 16th ed., Laxmi Publication, 2009.
- Trujillo P. Alan, Thurman V. Harold. Essentials of Oceanography. 13th Edition, Pearson Publications. Prentice hall 2011.
- Walton C. William, Ground Water Resources Evaluation, Mc Graw Hill Kogakuzhalid, 1970.

Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**ENGINEERING GEOLOGY**					
Type of Course	**DSE**					
Course Code	**MG6DSEGEO302**					
Course Level	**300-399**					
Course Summary	This course explores the fields encompassing the fundamentals of rock and soil properties, slope stability analysis, and geotechnical considerations crucial for various engineering projects. The syllabus delves into the geotechnical intricacies of specific projects like dams, reservoirs and tunnels, incorporating real-world Indian case studies. The program concludes with advanced topics, including ground improvement techniques and site investigation.					
Semester	**6**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Students should have in-depth knowledge of Petrology, Structural Geology, and Environmental Geology.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	understand the key principles and concepts related to engineering geology.	U	PO 1 PO3
2	Evaluate the engineering properties of rocks using appropriate testing methods.	E	PO 2
3	Apply soil mechanics principles to classify and characterize different soil types.	A	PO 2 PO 3

4	Demonstrate the ability to conduct slope stability analyses.	A	PO 1 PO 9
5	Evaluate and recommend mitigation measures for potential slope instability.	E	PO 3 PO 4 PO 6 PO 10
6	Evaluate the geotechnical considerations for dam construction, reservoirs, tunnels, and bridges.	E	PO 2 PO 3 PO 6 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Definition and scope of engineering Geology.	3	CO 1
	1.2	Role of engineering geologist in civil engineering projects: Analysis of remote sensing data, geological maps, cross sections and written reports.	4	CO 1
	1.3	Engineering properties of rocks; Physical properties of rocks.	3	CO 2
	1.4	Rock mechanics: strength: uniaxial compressive strength, shear strength and tensile strength.	3	CO 2
	1.5	Rock deformation: elastic module, modulus of elasticity, Poisson's ratio.	3	CO 2
	1.6	Soil: Engineering classification: Unified Soil classification system; physical properties of soil.	3	CO 3
	1.7	Soil mechanics fundamentals: Compressibility, consolidation, compaction, shear strength (cohesive and non-cohesive soil) and measurement of shear strength.	4	CO 3
2	2.1	Slope: terminology, causes of slope instability.	3	CO 4
	2.2	Methods of slope stability analysis: quantitative analysis	3	CO 4

	2.3	Stabilization measures for slope: unloading, buttressing, retaining walls, drainage, reinforcement and vegetation.	3	CO 5
	2.4	Case studies on landslides in engineering projects	3	CO 5
3	3.1	Dam construction: site selection and design considerations. Parts of dams. Types of dam with example from India.	5	CO 6
	3.2	Reservoir geology: Impacts on reservoir construction; reservoir induced seismicity (RIS) with Indian examples; causes of reservoir sedimentation and remedial measures.	3	CO 6
	3.3	Types and parts of tunnel; tunneling in different geological formations with case studies.	5	CO 6
4	4.1	Ground improvement techniques	3	CO 6
	4.2	Geotechnical site investigation and Instrumentation: Jack test, shear test and seismic test.	3	CO 6
	4.3	Geotechnical challenges in urban development projects	3	CO 6
	4.4	Case studies of geotechnical failures	3	CO 6
5	Teacher specific content			

Teaching and Learning Approach	**Classroom Procedure** Lectures, Demonstrations, Assignments, Seminars/ Viva, class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

- Bell, F. G. Engineering Geology. Butterworth-Heinemann, 2007.
- Coduto, Donald P. Geotechnical Engineering: Principles and Practices. Prentice Hall of India Pvt. Ltd, 2001.
- Johnson, and Jerome V. Degraff. Principles of Engineering Geology. John Wiley & Sons, 2011
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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**FIELD MAPPING AND DIGITAL SURVEY**					
Type of Course	**DSE**					
Course Code	**MG6DSEGEO303**					
Course Level	**300-399**					
Course Summary	This course offers comprehensive training in field mapping techniques crucial for geologists, covering reconnaissance, detailed, and structural mapping. It provides basic knowledge in identifying geological features such as rock types, sedimentary structures, faults, and folds, using compasses, GPS devices, and digital surveying tools for precise data collection. Additionally, the course develops skills in data processing and analysis with GIS software, to interpret geological features and generate geological maps.					
Semester	**6**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic knowledge about the identification of minerals, rocks and map reading.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basic techniques in field geology and in field observation	U	PO 1 PO 2
2	Apply the basic knowledge in data measurement	A	PO 1 PO 2 PO 10

3	Understand the traditional surveying techniques utilizing chain and tape for linear measurements and implementing error correction methods with EDMI instruments.	U	PO 1 PO 2
4	Apply knowledge and expertise in surveying with GPS, the field procedures, mapping, levelling, error corrections, data transfer and preparation of layouts	A	PO 1 PO 2 PO10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Overview of field geology and its importance in geological studies.	3	CO 1
	1.2	Interpretation of topographic maps and understanding of map symbols, coordinates and scale	3	CO 1
	1.3	Concepts of map reading, distance, height and pace approximation	4	CO 1
	1.4	Field observation techniques: identification of geological features with close examination by using geological tools	3	CO 1
	1.5	Identification techniques of minerals and rocks	2	CO 1
2	2.1	Field data measurement: field notebook, sketching, method of note taking, photography, description	3	CO 2
	2.2	Fundamental data collection: latitude, longitude, and altitude or location marking on the toposheet	2	CO 2
	2.3	Strike, dip, trend, plunge, rake/pitch measurement; use of clinometer compass and brunton compass	2	CO 2
	2.4	Measurements of lithology details: thickness of strata, mineralogy, texture, structure, type of rock and other additional observations if any	2	CO 2

3	3.1	Stages of survey operations: linear measurement: distance measurement devices: chain, tape: merits and demerits	3	CO 3
	3.2	EDMI: instrument characteristics: field procedures: focusing and sighting: measurement techniques: error correction	3	CO 3
	3.3	Field survey techniques using automatic level: automated Dumpy level: digital level: Micrometer Theodolite: Field procedures: Measuring single angles, Sets of direction and vertical angles ; Horizontal collimation error and its adjustments	3	CO 3
4	4.1	Surveying with GPS: Elements of GPS Survey	3	CO 4
	4.2	Survey design: Field procedure: measuring techniques: RTK systems	3	CO 4
	4.3	Integrating GPS and GIS: Mapping and map layout	3	CO 4
	4.4	Surveying using Total Station: Field Procedure: Measurements: Traversing: Controlling errors: data transfer	3	CO 4
	4.5	Preparation of layout: Trigonometric levelling	3	CO 4
5	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURE** Lectures, Demonstrations, Assignments, Seminars /Viva, and Class test
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

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- F. H. Lahee, Field Geology. cbs Publisher and distributers pvt ltd, 2002
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Programme	**BSc (Hons) Geology**					
Course Name	**MANAGEMENT OF NATURAL DISASTERS**					
Type of Course	**VAC**					
Course Code	**MG6VAC GEO300**					
Course Level	**300-399**					
Course summary	The course on Natural Disaster Management covers various aspects related to the mitigation, preparedness, response, and recovery from natural disasters. Overall, the course equips students with the knowledge, skills, and tools necessary to mitigate the impacts of natural disasters, and build resilient communities and systems capable of effectively responding to the recovery from such events.					
Semester	**6**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		0		**45**
Pre-requisites, if any	General awareness about natural disasters					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Understand the geological phenomena leading to hazards such as earthquakes and knowledge and skills to analyze, and respond to seismic events.	U	PO 1 PO 2 PO 10
2	Understand the causes, mechanisms, and impacts	U	PO 1

	of volcanoes, landslides and coastal hazards as well as strategies for assessment, mitigation, and management.		PO 2 PO 10
3	Realize the knowledge and skills necessary to effectively prepare for, respond to, recover from, and mitigate the impacts of natural disasters	An	PO 1 PO 3 PO 6 PO 10
4	Evaluate the knowledge of Disaster Management and its mitigation methods in policymaking of the Union, States and Local self-governments to control natural disasters.	A	PO 1 PO 6 PO 10
M ****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (45)	CO No.
1	1.1	Hazardous natural processes and energy sources. Hazard, risk, disaster, and catastrophe;	3	CO 1
	1.2	Magnitude and frequency of hazardous events	3	CO 1
	1.3	Fundamental concepts for understanding natural processes as hazards, Risk assessment.	2	CO 1
	1.4	Major natural disasters in India	3	CO 1
	1.5	Earthquake: magnitude and intensity; seismicity of the world; reduction of earthquake hazard.	3	CO 1
	1.6	Causes of tsunamis; tsunami risk and its minimization- early warning systems	3	CO 1
2	2.1	Volcanoes and volcanic eruptions; distribution of volcanoes	3	CO 2
	2.2	Coastal hazards; coastal processes; sea-level change	3	CO 2
	2.3	Perception and mitigation of coastal hazards; early warning systems	2	CO 2
	2.4	Introduction to landslides; types of	2	CO 2

		landslides; identification of potential landslides; prevention of landslides		
	2.5	landslide warning systems; Mitigation process.	2	CO 2
	2.6	Landslide hazard zonation mapping	2	CO 2
3	3.1	River flooding as natural hazard; magnitude and frequency of floods.	3	CO 3
	3.2	Nature and extent of flood hazards; adjustments to flood hazards.	3	CO 3
	3.3	Cyclones: classification and nomenclature; cyclone development; cyclone prone regions	2	CO 3
	3.4	Effects of cyclones; cyclone forecasts and warnings, Climate change and related hazards.	2	CO 3
	3.5	Disaster Management Cycle, Disaster management Act	2	CO 4
	3.6	Role of the Union, States and Local self-government in Disaster Management, National Disaster Management Policy. State Disaster Management Policy.	2	CO 4
4	Teacher specific contents			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminar/Viva
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests B.**End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12

References

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- Bryante E. Natural Hazards. Cambridge University Press, 2004.
- Donald R. Coats. Environmental Geology. John Wiley and Sons, 2020.
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- National Disaster Management Authority. National Disaster Management Guidelines – Management of Disasters, 2008. Pub. Of National Disaster Management Authority, Government of India, 2008, New Delhi.
- Peter, T. Flawn. Environmental Geology. John Wiley and Sons, 1970.
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- Valdia, K.S. Environmental Geology – Ecology Resource and hazard management McGraw Hill, Edition 2013.

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Programme	**BSc (Hons) Geology**					
Course Name	**ECONOMIC GEOLOGY**					
Type of Course	**SEC**					
Course Code	**MG6SEC GEO300**					
Course Level	**300-399**					
Course Summary	The course comprehends the mineral resources and ore deposits of India and their economic significance. The course creates basic awareness of ore and gangue minerals, estimation of ore grades, and assessment of mineral reserves. It also deals with various ore-forming processes such as magmatic, hydrothermal, metamorphic, and sedimentary, and the geological conditions favouring their formation. The course is designed to provide practical training on the identification of economic minerals based on their physical and optical properties					
Semester	**6**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	0	1	0	**60**
Pre-requisites, if any	Basic knowledge of Petrology and Mineralogy					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basic features of ore deposits, minerals used in certain industrial purpose and metallogenic provinces and epochs of India	U	PO1 PO2
2	Differentiate the ore deposits based on the processes of formation and the physico-	U	PO1

	chemical environment of ore formation		PO2
3	Understand the occurrence, distribution in India and uses of major metal ores	U	PO1 PO2
4	Apply the knowledge about physical and diagnostic properties of minerals to identify economic minerals.	A	PO1 PO2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Scope and significance of Economic Geology	2	CO 1
	1.2	Ore and Gangue Minerals, Tenor of an ore, grade and grade estimation,	2	CO 1
	1.3	Mineral Resources and reserves; Strategic minerals and Critical minerals	2	CO 1
	1.4	Minerals used for Abrasives, Refractories and Gemstones	1	CO 1
	1.5	Minerals used in the Ceramics, Cement, and fuel industries	1	CO 1
	1.6	Metallogenic Provinces and Epochs of India	2	CO 1
2	2.1	Classification of ore-forming processe: endogenic and exogenic; syngenetic and epigenetic deposits; Lindgren ' s classifycation of ore deposits	3	CO 2
	2.2	Magmatic processes and deposits: Early magmatic deposits, late magmatic deposits;	3	CO 2
	2.3	Hydrothermal processes and deposits: conditions favouring hydrothermal deposits; Types of hydrothermal processes	3	CO 2
	2.4	Metamorphic deposits: Graphite, Asbestos, Talc, Magnesia, Clay	3	CO 2
	2.5	Sedimentary deposits: mechanical	3	CO 2

		concentration: Placer deposits; residual concentration: Bauxite, Laterite		
	2.6	Oxidation and Supergene Sulphide enrichment; Gossan	3	CO 2
	2.7	Occurrence, distribution in India and important economic uses of following ore minerals: Aluminium, Chromium, Gold, Iron, Copper, Lead, Manganese, Silver, Thorium, Titanium, Uranium and Zinc.	2	CO 3
Practical content **3**		Megascopic identification of ore minerals: Diagnostic properties, occurrence, uses, mineral paragenesis, and important economic deposits in India Realgar, Orpiment, Stibnite, Molybdenite, Galena, Sphalerite, Chalcophyrite and Pyrite; Barite, Celestite and Gypsum; Corundum, Hematite, Ilmenite, Magnetite, Chromite, Pyrolusite, Psilomelane, Goethite, Limonite and Bauxite; Calcite, Dolomite, Magnesia, Aragonite, and Malachite; Halite, Fluorite, Phosphatic Nodule, Monazite, Graphite, Asbestos and Talc	30	CO 4
4	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminars/Viva, Class tests and Practical
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 15 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B End Semester Evaluation (ESE)** **Theory: 35 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 230 words (3 out of 5): 3x7 = 21 **Practical: 35 Marks** Examination: 25, Viva:10

References

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Semester-VII

Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**PRECAMBRIAN GEOLOGY**					
Type of Course	**DCC**					
Course Code	**MG7DCCGEO400**					
Course Level	**400-499**					
Course Summary	The course covers the evolution and characteristics of the Precambrian Eon, focusing on the nature and evolution of the primitive crust, which includes the Archean Crust and the evolution of Greenstone Belts. The course explores the significance of mid-oceanic ridges, island arcs, and shields in continental growth. In addition, the course discusses the Precambrian Stratigraphy of India, and the Proterozoic sedimentary basins, such as Cuddapah, Kurnool, and Vindhyan basins; and examines the Southern Granulite Terrain and the evolution of mobile belts like the Eastern Ghats, Central Indian Tectonic Zone, and Aravalli Mobile Belt, concluding with a study of Precambrian stratigraphy in Kerala.					
Semester	**7**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic knowledge about Geologic Time Scale, Petrology and Plate tectonics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the evolution of continental crust	U	PO 1 PO 2

2	Understand the features of Dharwar craton	U	PO 1 PO 2
3	Analize the features of Aravalli, Bundelkhand, Bastar and Singhbhum cratons	An	PO 1 PO 2 PO 4
4	Analize the features of the Cuddapah, Vindhyan and Kurnool basins.	An	PO 1 PO 2 PO 4
5	Analyze the features of Indian mobile belts	An	PO 1 PO 2 PO 4
6	Realize the Precambrian Stratigraphy of Kerala	U	PO 1 PO 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Introduction to Precambrian Eon	3	CO 1
	1.2	Precambrian crust: nature, and evolution of the primitive crust and characteristic features of Archean crust	3	CO 1
	1.3	Evolution of Greenstone belt	3	CO 1
	1.4	Significance of Mid-Oceanic Ridges and Island arcs in continental growth	3	CO 1
	1.5	Worldwide distribution of major and minor shields: basic outline	3	CO 1
2	2.1	Detailed study of Precambrian stratigraphy of Dharwar craton	3	CO 2
	2.2	Lithology, Stratigraphy and Structure of Western Dharwar Craton	3	CO 2
	2.3	Lithology, Stratigraphy and Structure of Eastern Dharwar Craton	3	CO 2
	2.4	Age, organic remains and economic resources of Dharwar craton; Equivalents of Dharwar rocks in Kerala	2	CO 2

	2.5	Structure and significance of Aravalli, Bundelkhand, Bastar and Singhbhum cratons	3	CO 3
3	3.1	Proterozoic sedimentary basins of India	3	CO 4
	3.2	Structure and stratigraphy of Cuddapah Basin	4	CO 4
	3.3	Lithology and economic resources of the Cuddapah Basin	3	CO 4
	3.4	Stratigraphy, lithology, structure and economic resources of the Kurnool basin	3	CO 4
	3.5	Stratigraphy, lithology, structure and economic resources of the Vindhyan basin	3	CO 4
4	4.1	Southern Granulite Terrain: Divisions, geological activities and economic mineral resources	3	CO 5
	4.2	Lithology, structure and evolution of Eastern Ghats Mobile Belt	3	CO 5
	4.3	Lithology, structure and evolution of Central Indian Tectonic Zone	3	CO 5
	4.4	Lithology, structure and evolution of Aravalli Mobile Belt	3	CO 5
	4.5	Precambrian stratigraphy of Kerala	3	CO 6
5	Teacher specific contents			

Teaching and Learning Approach	**CLASSROOM PROCEDURE** Lectures, Demonstrations, Assignments, Seminars/Viva and Class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**GEOCHEMISTRY AND ISOTOPE GEOLOGY**					
Type of Course	**DCC**					
Course Code	**MG7DCCGEO401**					
Course Level	**400-499**					
Course Summary	The course explores the origin of elements, electronic configurations, and periodic table arrangements. It covers the chemistry of solar system, Earth's composition, and crystal chemistry; including the methods of geothermobarometry, radiogenic and stable isotope systematics for rock dating, and geochemical analytical techniques.					
Semester	**7**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
Pre-requisites, if any	Basic knowledge of fundamental chemistry.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the geochemical principles governing the origin and distribution of elements in Earth's materials and their application in interpreting geological processes.	U	PO 1 PO 2 PO 3
2	Understand crystal chemistry, thermodynamics, geothermobarometry for geological analysis.	U	PO 1 PO 2 PO 3

			PO 10
3	Realize the applying radiogenic isotope systematics for geochronological age determinations in various geological contexts.	A	PO 1 PO 2 PO 4 PO 10
4	Understand stable isotope systematics, including non-traditional isotopic systems and their geological applications.	E	PO 1 PO 2 PO 4
5	Apply modern analytical techniques, including flame photometer, spectrophotometer, AAS, XRF, ICP-MS, TIMS, SIMS, SHRIMP.	A	PO 1 PO 2 P O 10
6	Analyzing and interpreting geochemical data, constructing variation diagrams, and estimating elemental compositions in natural samples	A	PO 1 PO 2 P O 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Overview of the origin of the elements; Nuclides and atoms; Electronic configuration of atoms arrangement of atoms in periodic table, electronegativity, ionization potential, chemical bonding.	3	CO1
	1.2	Chemistry of the universe, stars, nucleosynthesis; origin of the solar system; meteorites	4	CO1
	1.3	Mineralogy and Chemistry: Crust, Mantle, Core; Rheology of Lithosphere and Asthenosphere,	3	CO1
	1.4	Classification of elements as major, minor, trace elements; REE, compatible and incompatible elements, LILE, HFSE; PGE	4	CO1
	1.5	Application of major, minor, trace elements, REE on variation and discriminant diagrams for presentation of geochemical data (bivariate, multivariate, element ratio variation, enrichment-	4	CO1

		depletion, and vector diagrams) and their importance in fractional crystallization during magmatic/partial melting		
2	2.1	Elementary crystal chemistry and thermodynamics: Temperature and Equations of State; Laws of thermodynamics; Entropy; Enthalpy; Gibbs free energy	2	CO2
	2.2	Application of mineral chemistry in P-T estimates of rocks: Geothermobarometry	2	CO2
	2.3	Isotopes, Isobars, Isotones, Stability of nuclide and Z- N diagram, Radioactivity, Mechanism of radioactive decay (alpha, Positron, Negatron, Gamma decays, Electron capture and nuclear fission).	4	CO3
	2.4	Geochronology as a tool in geology; Law of Radioactivity; Principles of isotopic dating and Derivation of equation for modal age.	3	CO3
	2.5	Radiogenic isotope systematics: K-Ar; Rb-Sr (Model age and Isochron age), Sm-Nd; Lu-Hf (Model age, Isochron age, CHUR model, Epsilon notation and its application in Petrology)	3	CO3
	2.6	Radiogenic isotope systematics: Re-Os; U-Th-Pb (Special reference to age determination using Concordia & Discordia methods)	3	CO3
	2.7	Fission track and other radiation damage methods of dating	2	CO3
3	3.1	Stable isotope systematics; Permil Notation, Mass independent fractionation; H, C, O, N and S isotopic systems.	4	CO4
	3.2	Modern Analytical techniques: Methods based on Flame photometer, Spectrophotometer, AAS, XRF, ICP-MS	2	CO5
	3.3	Modern Analytical techniques: Methods based on TIMS, SIMS, SHRIMP.	2	CO5
Practical 4	4.1	CIPW Norm and related calculations of persalic rocks (5 exercises)	10	CO6
	4.2	Calculation of elemental and mineral composition from oxide data; Problems on bulk distribution coefficient, Fractional and Batch melting.	10	CO6

	4.3	Analysis of cations and anions in water using volumetric methods.	10	CO6
5	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURE** Lectures, Demonstrations, Assignments, Practicals, Seminars/Viva, class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12 **Practical: 35 Marks** Examination: 25, Viva:10

References

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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**RESEARCH METHODOLOGY IN GEOLOGY**					
Type of Course	**DCC**					
Course Code	**MG7DCCGEO402**					
Course Level	**400-499**					
Course Summary	The course deals with the research process in Geology, focusing on scientific and creative thinking to enhance subject knowledge. Topics include methodology, data collection, literature surveys, academic and scientific writing, statistical analysis software, and reference management. Also, it covers the publication process, research metrics, plagiarism awareness, ethics, and introduces intellectual property rights, including concepts, types, and the patent process.					
Semester	**7**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic knowledge in geology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the key elements of the research process in Geology, the process of scientific and creative thinking involved.	U	PO 1
2	Understand the methodology for data collection, literature surveys, academic writing, and scientific writing.	U	PO 1 PO 3

3	Apply the knowledge by utilizing software for statistical analysis and graphical representation, as well as employing reference management tools in the context of geological research.	A	PO 2
4	Analyse the publication process, showcasing the ability to evaluate and choose appropriate journals, review research articles critically, and understand the steps involved in realizing a research article.	An	PO 1
5	Examine well-structured and academically sound review and research articles, theses, and reports, to create standard scholarly outputs in the field of Geology.	E	PO 1 PO 2 PO 4
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Research: definition. Scope of research in Geology. Meaning, objectives, and significance of research. Research hypothesis.	3	CO 1
	1.2	Attitude and aptitude for research. Motivation for research.	2	CO 1
	1.3	Thinking process and styles. Scientific and creative thinking.	2	CO 1
	1.4	Types of research. Methods of research (Survey, observation, case studies, experimental, historical, and comparative methods).	2	CO 2
	1.5	Essential quality of research- validity and reliability.	2	CO 2
	1.6	Literature survey and review.	2	CO 2
	1.7	Introduction to reference managing software tools- Mendley and Endnote.	2	CO 3
	1.8	Elements of a review research article.	2	CO 4

2	2.1	Process of research.	3	CO 4
	2.2	Selecting and defining research problem.	2	CO 4
	2.3	Research design.	2	CO 4
	2.4	Research database and search engines. Web of science, Scopus, ORCID ID.	2	CO 4
	2.5	Steps in writing a Research proposal in Geology.	3	CO 3
3	3.1	Field work and geotagging sample sites. Apps for conducting systematic fieldwork. Sampling methods for specific geologic researches. Sample size and its determination - Types of sampling distributions - Sampling error.	4	CO 5
	3.2	Statistical analysis-. Analysis of numerical data - Measures of central tendency, dispersion, testing significance of variations, analysing correlation of variables. Regression analysis, Principal Component Analysis and Factor Analysis, and Cluster Analysis and its use in geological research.	4	CO 5
	3.3	Analysis and data interpretation. Software for statistical analysis. Validity of data.	3	CO 3
	3.4	Software for graphical representation of data. Data interpolation techniques.	3	CO 3
	3.5	Software for spatial data processing. Elements of digital cartography.	2	CO 3
	4.1	Academic writing and effective communication. Rules of scientific writing, form, content and language, layout, typography and illustrations, nomenclature, reference and citation styles, contexts for writing - paper, thesis, reports etc.	3	CO 5
	4.2	Scholarly publishing - IMRAD concept. Structure of a thesis and research article.	3	CO 5
	4.3	Choice of journal and reviewing process.	2	CO 5

4		Stages in the realization of a research article.		
	4.4	Research metrics-Journal level, Article level and Author level, Plagiarism and research ethics.	3	CO 5
	4.5	Introduction to IPR, Concepts of IPR, Types of IPR. Patents- Concept, Objectives and benefits, features, Patent process – steps and procedures.	4	CO 5
5	Teacher specific contents			

Teaching and Learning Approach	**CLASS ROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminars/Viva, and Class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **F. End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

- Panneerselvam. Research Methodology. Prentice Hall of India, New Delhi, 2012.
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- Day, R. A. How to Write and Publish a Scientific Paper. Cambridge University Press, 1989.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**NATURAL HAZARDS AND DISASTER MANAGEMENT**					
Type of Course	**DCE**					
Course Code	**MG7DCE GEO400**					
Course Level	**400-499**					
Course Summary	The course deals with the natural hazards, their causes, impacts, and strategies for mitigation and management. It makes awareness on the significance of disaster management with respect to the type of natural disasters.					
Semester	**7**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic knowledge on natural hazards, natural disasters and disaster management					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the Fundamental concepts for natural hazards	U	PO 1
2	Differentiate the causes and management of various disasters such as earthquakes, volcanic eruptions, and tsunamis	U	PO 1
3	Realize the causes, mechanisms, and consequences of floods and landslides; and the strategies for their assessment, mitigation, and management.	An	PO 1 PO 3

4	Recognize various hazards that affect coastal areas, including their causes, impacts, and mitigation strategies.	An	PO 1 PO 6
5	Understand major disasters of India, disaster management cycle, and disaster management policies in national, state & local government levels.	U	PO 1 PO 6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Natural hazards: hazardous natural processes and energy sources	3	CO 1
	1.2	Distinction among hazard, risk, disaster, and catastrophe. Magnitude and frequency of hazardous events	3	CO 1
	1.3	Fundamental concepts for understanding natural processes as hazards	3	CO 1
	1.4	Climate change and related hazards	3	CO 1
2	2.1	Earthquake: magnitude and intensity; seismic belts of the world	4	CO 2
	2.2	Reduction of earthquake hazard, Earthquake risk, prediction, preparedness, impact and post-earthquake recovery	3	CO 2
	2.3	Mitigation strategies: Engineering solutions for earthquake hazards	3	CO 2
	2.4	Tsunamis: Causes of tsunamis, tsunami risk minimization	3	CO 2
	2.5	Volcanic eruptions, distribution of volcanoes, Minimizing the impacts of volcanic hazards.	3	CO 2
3	3.1	Landslides: Causes, types, and Identification of past landslides	4	CO 3
	3.2	Landslide hazard zonation mapping, and landslide-warning systems	3	CO 3
	3.3	Landslide disasters, and mitigation process.	3	CO 3

	3.4	River flooding: Types, magnitude and frequency of floods	4	CO 3
	3.5	Extent of flood hazards, flood zonation mapping, and flood management	2	CO 3
4	4.1	Coastal hazards: coastal processes; sea-level change; perception and mitigation of coastal hazards	2	CO 4
	4.2	Cyclones: development, classification and nomenclature. Cyclone-prone regions, effects of cyclones, forecast and warning	2	CO 4
	4.3	Major natural disasters in India	3	CO 5
	4.4	Disaster management Act and policies, National Disaster Management Policy. State Disaster Management Policy. Role of Local self-government in disaster management	3	CO 5
	4.5	The Disaster Management Cycle: Mitigation, Preparedness, Response and Recovery phases	3	CO 5
	4.6	Community based mitigation. Preparedness and Mitigation measures with special reference to Kerala,	3	CO 5
5	Teacher specific contents			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminar/Viva and Class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **G. End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

- Abbott, P. L. Natural Disasters. 8th ed., McGraw-Hill, 2009, New York.
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Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Geology**				
Course Name	**CRYSTALLOGRAPHY**				
Type of Course	**DCE**				
Course Code	**MG7DCE GEO401**				
Course Level	**400-499**				
Course Summary	The course deals with the scientific study of crystals and their structure. It covers various symmetry elements of various crystal systems, their spherical projection, and defects in crystals.				
Semester	**7**	Credits		**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others
		4		0	**60**
Pre-requisites, if any	Basic knowledge of Material science				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand crystal symmetry and significance of crystallography	U	PO 1 PO 2
2	Differentiate the symmetry elements of crystals of different systems	U	PO 1 PO 2 PO 10
3	Distinguish the crystal defects and twinning	U	PO 1 PO 2
4	Realize the crystal projection: spherical projections of crystals	U	PO 1 PO 2 PO 10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create

(C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Crystals: morphological features, Euler's formula.	2	CO1
	1.2	Concept of Lattices: Point lattice, plane lattice, space lattice. Bravais lattices. Unit cell. Crystal systems	2	CO1
	1.3	Crystallographic axes, Crystal symmetry, Point symmetry, reflection, rotation, inversion, roto-inversion. Concepts of non-translational symmetry, screw axis and glide plane.	4	CO1
	1.4	Crystal notations: parameter system of Weiss and Miller indices	2	CO1
	1.5	Laws of crystallography: Axial ratio, Law of constancy of symmetry, Law of constancy of interfacial angles, Law of rational indices. Crystal angles and their measurement using goniometer	2	CO1
2	2.1	Study and demonstration of symmetry elements and forms of Hexoctahedral, Diploidal, Hextetrahedral and Gyroidal classes of Isometric system	5	CO2
	2.2	Study of Ditetragonal dipyramidal class: Symmetry and Forms; Tetragonal Sphenoidal class Symmetry and Forms	4	CO2
	2.3	Study of symmetry elements and forms of Dihexagonal dipyramidal, Hexagonal	4	CO2

		pyramidal, Hexagonal trapezohedral, Ditrigonal scalenohedral classes		
	2.4	Study of symmetry elements and forms, Trigonal trapezohedral classes of Hexagonal and Trigonal systems	4	CO2
3	3.1	Study of symmetry elements and forms of Orthorhombic dipyramidal and Orthorhombic pyramidal classes of Orthorhombic system	3	CO2
	3.2	Study of symmetry elements and forms of Prismatic class of Monoclinic system	3	CO2
	3.3	Study of symmetry elements and forms Pinacoidal class of Triclinic system	2	CO2
	3.4	Hermann-Mauguin notations; derivation of point groups (basic concept only)	2	CO2
4	4.1	Crystal defects: point, line, plane, and volume defects; Twinning in crystals: composition plane, twinning plane, and twinning axis.	4	CO3
	4.2	Laws of twinning in different crystal systems.	3	CO3
	4.3	Classification of twins: Based on origin; primary, secondary and diffusion twins	3	CO3
	4.4	Based on compositional plane: simple, multiple, and repeated (polysynthetic twins); Based on twin plane: contact and penetration twins.	3	CO3
	4.5	Stereographic projections of crystals: Introduction	4	CO4
	4.6	Stereographic projections of forms and symmetry of Holohedral classes of Isometric, Tetragonal, Hexagonal, Orthorhombic,	4	CO4

		Monoclinic and Triclinic systems.		
5	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURE** Lectures, demonstrations using wooden models, Assignments, Hands own training.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

- Dana. A Textbook of Mineralogy. Asia Publishing House, 2006.
- Kerr, P. F. Optical Mineralogy, M C Graw Hill Education, 2014
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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**ORE GENESIS**					
Type of Course	**DCE**					
Course Code	**MG7DCE GEO402**					
Course Level	**400-499**					
Course Summary	The course deals with the physico-chemical processes governing ore formation. It covers diverse geological processes and geothermometric methods in Earth's crust for comprehensive ore genesis; distinguishing magmatic, hydrothermal and sedimentary deposits.					
Semester	**7**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic knowledge in mineralogy, and economic geology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the physico-chemical processes, sources, and migration routes of ore formation.	U	PO 1 PO 2
2	Differentiate magmatic deposits occur in ultramafic rocks in various settings and forms.	U	PO 1 PO 2
3	Distinguish the types of hydrothermal deposits, based on their formation, properties of fluids, P-T-X conditions, and tectonic influences.	U	PO 1 PO 2 PO 4

4	Understand the diverse geological processes, and characteristics associated with sedimentary, mechanical, residual, infiltration, supergene enrichment, metamorphic, and non-metallic deposits in Earth's crust.	U	PO 1 PO 2 PO 4 PO 10
5	Understand the geothermometric methods for the study of ore genesis, based on indicator minerals, trace elements, and stable isotopes, along with the fluid inclusion and Laser Raman techniques.	U	PO 1 PO 2 PO 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Physico-chemical environment of ore formation: source, migration, and traps in ore formation.	4	CO 1
	1.2	Magmatic deposits in ultramafic rocks: chromite - podiform and stratiform; diamonds in Kimberlites; PGE deposit	4	CO 2
	1.3	Deposits associated with mafic rocks: Cu-Ni-Fe sulphide deposits	4	CO 2
	1.4	Deposits associated with felsic rocks: REE deposits.	3	CO 2
	1.5	Pegmatitic deposits.	3	CO 2
2	2.1	Hydrothermal deposits: types, formation and properties of hydrothermal fluids, conditions favouring hydrothermal deposit formation- P-T-X condition and tectonic environment.	3	CO 3
	2.2	Magmatic hydrothermal deposits: Prophyry; Greisen; Skarn deposits.	4	CO 3

	2.3	Seawater hydrothermal deposits: VHMS; SEDEX; MVT.	4	CO 3
	2.4	Hydrothermal Unconformity-type U; Epithermal Ag-Au; lode Au deposits	4	CO 3
3	3.1	Sedimentary deposits: Syn sedimentary-QPC type U; phosphatic nodules; nodular Fe-Mn. BIF	4	CO 4
	3.2	Deposits formed by mechanical concentration: Placer deposits and types	2	CO 4
	3.3	Deposits formed by residual concentration: Bauxite; laterite	2	CO 4
	3.4	Infiltration: sandstone-type U; Supergene enrichment: Gossan.	4	CO 4
	3.5	Metamorphic deposits: Graphite: Aluminium refractory minerals.	3	CO 4
	3.6	Metamorphosed deposits: Gondite; Non-metallic deposits: Asbestos, Talc, Clay, and Tourmaline	2	CO 4
4	4.1	Introduction to Geothermometric studies using indicator mineral, trace element and stable isotope of ore.	3	CO 5
	4.2	Fluid inclusion studies in relation to ore genesis. Application of Laser Raman techniques in fluid inclusion studies.	3	CO 5
	4.3	Global metallogenic epochs and provinces with special references	4	CO 5
5	Teacher specific content			

Teaching and Learning Approach	**CLASSROOM PROCEDURE** Lectures, Demonstrations, Assignments, Seminars/Viva, and Class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

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Semester-VIII

Mahatma Gandhi University
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Programme	**BSc (Hons) Geology**					
Course Name	**HYDROGEOLOGY**					
Type of Course	**DCC**					
Course Code	**MG8DCCGEO400**					
Course Level	**400-499**					
Course Summary	The course deals with the comprehensive understanding of groundwater system, groundwater flow, storage, and the quality of groundwater for house hold and irrigation purposes. Also, the course addresses groundwater fluctuations, and various types of recharge methods with its significance in water resources management and environmental sustainability.					
Semester	**8**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		**75**
Pre-requisites, if any	Knowledge in Petrology, Geological structures, Geoinformatics and Geomorphology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the fundamentals of hydrological cycle with its components, and distribution of groundwater	U	PO 6 PO 7
2	Realize the physical and chemical properties of water, saline water intrusion and water quality for house hold and irrigation purposes	An	PO 1 PO 6,
3	Examine the groundwater level fluctuations, and	An	PO 1

	prepare reduced water level contour maps		PO 6
4	Recognize groundwater exploration techniques and type of wells	U	PO 1 PO 6
5	Differentiate the artificial recharge methods, and its significance in groundwater replenishment	U	PO 1 PO 6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Hydrogeology definition, occurrence of groundwater: Aquifer, Aquiclude, Aquifuge and Aquitard, Global distribution of groundwater	3	CO 1
	1.2	Introduction to hydrologic cycle; Processes of Hydrologic cycle: Precipitation, Run-off, Infiltration, Evaporation, Transpiration-Evapotranspiration, and Condensation	3	CO 1
	1.3	Vertical distribution of Groundwater; Zone of aeration, zone of saturation, water table	2	CO 1
	1.4	Geological formations as aquifers; confined and unconfined aquifers; Porosity, void ratio, effective porosity and representative porosity range; Primary and secondary porosities; Specific retention, specific yield	3	CO 1
	1.5	Concept of Darcy's law, Permeability, Intrinsic permeability, Hydraulic conductivity, Transmissivity	3	CO 1
	1.6	Groundwater conditions of Kerala, major aquifers of Kerala	2	CO 1
2	2.1	Physical and chemical properties of water, Water quality; water quality parameters and their standards proposed by WHO and BIS. Physical, Chemical and biological parameters	3	CO 2
	2.2	Groundwater composition, quality criteria for domestic irrigation and industrial uses	3	CO 2

	2.3	Groundwater contamination from mining, quarrying and waste disposal, and its remedial measures	3	CO 2
	2.4	Salt water intrusion of coastal aquifers: Occurrence of salt water intrusion, the Ghyben - Herzberg concept, the dynamic concept,	2	CO 2
	2.5	Control of saline water intrusion, Development of Groundwater in intrusion areas.	3	CO 2
	2.6	Geogenic pollution - Problems of arsenic fluoride and nitrate	2	CO 2
3	3.1	Groundwater fluctuations: Secular, Seasonal and Short-term fluctuations due to stream flow, Evapotranspiration, Meteorological phenomena	2	CO 3
	3.2	Water table contour maps, water table fluctuations and causative factors over exploitation	3	CO3
	3.3	Surface methods of groundwater exploration, geological and geophysical methods - resistivity and seismic methods	2	CO 4
	3.4	Types of wells - open well, bore well, filter point well and tube well	2	CO 4
	3.5	Artificial Recharge of Groundwater: Concept, Recharge methods, Surface methods - Basin method, Stream channel method, Ditch and Furrow method, Irrigation method	2	CO 5
	3.6	Subsurface methods – infiltration basins, percolation ponds, Recharge Wells or Injection Wells, Artificial Recharge Trenches, Subsurface Dams	2	CO 5
Practical contents **4**	4.1	Preparation of reduced water level contour map	15	CO 3
	4.2	Graphical interpretation of chemical data	15	CO 2
5	Teacher specific content			

Teaching and Learning Approach	**CLASS ROOM PROCEDURES** Lectures, Demonstration, Assignment, Seminar / Viva, Class tests and practical
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12 **Practical: 35 Marks** Examination: 25, Viva:10

References

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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**EXPLORATION GEOLOGY**					
Type of Course	**DCC**					
Course Code	**MG8DCC GEO401**					
Course Level	**400-499**					
Course Summary	This course explores the principles and techniques of Exploration Geology, covering geological prospecting, stages of exploration, ore reserve estimation, and diverse survey methods. Learn about gathering and studying data from exploration, drilling, surveys, and interpreting ore reserves to understand resource evaluation in natural resource exploration.					
Semester	**8**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		**75**
Pre-requisites, if any	Knowledge in Petrology, Structural Geology and Environmental Geology.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the fundamental principles of exploration geology, including the stages of exploration, ore reserve estimation methods, and criteria for exploration guidance	U	PO 1 PO 3
2	Realize the significance of resource and reserve classification systems, such as McKelvey and UNFC, in the context of exploration geology	U	PO 2
3	Understand the sampling techniques, drilling design	U	PO 2

	principles, and various rock sampling methods to collect and analyze exploration data		
4	Analyze geochemical anomalies, dispersion patterns, and factors controlling element mobility to interpret and identify potential mineral deposits during geochemical exploration.	An	PO 2 PO 3
5	Recognize various geophysical survey techniques, including resistivity, magnetic, gravity, seismic, and radiometric surveys, to design effective exploration programs and prospect for mineral resources.	A	PO 2 PO 3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Overview of Exploration Geology. Principles of geological prospecting and mineral exploration	2	CO 1
	1.2	Stages of exploration: Reconnaissance & Prospecting, General, Detailed, and Mine Exploration	3	CO 1
	1.3	Ore reserve estimation, geostatistical method: concept, and conventional method.	3	CO 1
	1.4	Resource and reserve: McKelvey and UNFC classification.	1	CO 2
	1.5	Collection of exploration data and sampling techniques: Pitting, trenching and underground workings	2	CO 3
	1.6	Drilling: Design of drilling programme; types of drilling: coring and non-coring; vertical and inclined drilling	2	CO 3
	1.7	Rock sampling methods: channel sampling, chip sampling, bulk sampling and bore hole sampling; Borehole logging: introduction	2	CO 3
	2.1	Principles of Geochemical exploration;	2	CO 4

		Threshold values and geochemical anomalies		
2	2.2	Geochemical mobility of elements; Factors controlling mobility of elements in the surficial and deep-seated environments	2	CO 4
	2.3	Dispersion pattern: Primary and Secondary; Indicator and Pathfinder elements	2	CO 4
	2.4	Geochemical survey and sampling: lithological & pedological	3	CO 4
	2.5	Introduction to Atmospheric and hydrogeochemical surveys; Geobotanical survey techniques; Biogeochemical survey.	2	CO 4
3	3.1	Concept of geophysical exploration.	3	CO 5
	3.2	Electrical prospecting: Resistivity Survey	3	CO 5
	3.3	Magnetic survey: Principles and Prospecting	3	CO 5
	3.4	Gravity survey: Principles and prospecting	3	CO 5
	3.5	Seismic Survey: Principles and Prospecting	4	CO 5
	3.6	Radiometric survey: Principles and prospecting	3	CO 5
Practical contents **4**	4.1	Ore reserve estimation: grade and tonnage calculation	10	CO 1
	4.2	Interpretation of borehole data	10	CO 3
	4.3	Geological section preparation	10	CO 3
5	Teacher Specific Content			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminars/Viva, class tests, and Practical
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12 **Practical: 35 Marks** Examination: 25, Viva:10

References

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Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**GEOCHEMICAL ANALYTICAL TECHNIQUES**					
Type of Course	**DCE**					
Course Code	**MG8DCEGEO400**					
Course Level	**400-499**					
Course Summary	This course familiarizes the different analytical techniques used in different fields of geology. The course provides in-depth knowledge in diverse analytical methods so that appropriate techniques can be chosen to solve diverse problems.					
Semester	8	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		**75**
Pre-requisites, if any	Basic knowledge of mineralogy and petrology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand and apply analytical techniques in geology, including wet chemical analysis and spectroscopy, for quantitative and qualitative	A	PO 1

	analysis of major, minor, and trace elements.		
2	Understand the basic principles, instruments, merits, and demerits of spectrophotometry, flame photometry, AAS, XRF spectroscopy, ICP AES, and LIBS in geological applications.	U	PO 1
3	Gain comprehensive knowledge of analytical techniques in geology, including atomic absorption spectroscopy, XRD, ICPMS, EPMA, and SHRIMP, covering principles, instruments, and associated merits and demerits	U	PO 1
4	Representation of analytical data through bivariate and triangular plots, normalized plots, discrimination diagrams and determination of cations and anions using Spectrometer, Flame photometer, AAS and volumetric methods	A	PO 1 PO 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (75)	CO No.
1	1.1	Introduction: Major, minor trace elements; Quantitative & qualitative analyses	3	CO 1
	1.2	Basic analytical techniques: Wet chemical analysis, instrumental techniques	3	CO 1
	1.3	Emission and absorption spectroscopy	3	CO 1
	1.4	Wave length dispersive & energy dispersive spectroscopy	3	CO 1
	1.5	Mass spectroscopy: Basic principle, instrument, merit, and demerit.	3	CO 1
2	2.1	Spectrophotometer: Basic principle, instrument, merit, and demerit.	3	CO 2

	2.2	Flame photometer: Basic principle, instrument, merit, and demerit.	3	CO 2
	2.3	X-ray fluorescence (XRF) spectroscopy: Basic principle, instrument, merit, and demerit.	3	CO 2
	2.4	Inductively couple plasma: Atomic emission spectroscopy-ICP AES-Basic principle, instrument, merit, and demerit.	3	CO 2
	2.5	LIBS (Laser induced breakdown spectroscopy): Basic principle, instrument, merit, and demerit.	3	CO 2
3	3.1	Atomic absorption spectroscopy: Basic principle, instrument, merit, and demerit.	3	CO 3
	3.2	XRD: Basic principle, instrument, merit, and demerit.	3	CO 3
	3.3	ICPMS: Basic principle, instrument, merit, and demerit.	3	CO 3
	3.4	EPMA: Basic principle, instrument, merit, and demerit.	3	CO 3
	3.5	SHRIMP: Basic principle, instrument, merit, and demerit.	3	CO 3
	3.6	Modelling using geochemical data: (Brief introduction only)	1	CO 4
4 Practical	4.1	Representing analytical data: Data validation	2	CO 4
	4.2	Bivariate plot and triangular plots	2	CO 4
	4.3	Normalized plots and their uses	3	CO 4
	4.4	Discrimination diagrams and their application in petrology	3	CO 4
	4.5	Determination of cations and anions using Spectrometer, Flame photometer and AAS	20	CO 4
5	Teacher Specific Content			

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lectures, Demonstrations, Assignments, Seminars/Viva, class tests
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 Marks** Assignments, Viva/Seminar, Class Tests **Practical: 15 Marks** Lab Report, Viva, Lab involvement **B. End Semester Evaluation (ESE)** **Theory: 50 Marks** Short Answer in 60 words (7 out of 8): 7x2=14 Short Notes in 250 words (3 out of 5): 3x8 = 24 Essays in 400 words (1 out of 2):1x12=12 **Practical: 35 Marks** Examination: 25, Viva:10

References

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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**HYDRO RESOURCES OF INDIA**					
Type of Course	**DCE**					
Course Code	**MG8DCEGEO401**					
Course Level	**400-499**					
Course Summary	The Course seals with the geography of major rivers, their flow patterns, hydrological cycles, and the potential for hydroelectricity generation. The course may delve into the socio-economic and environmental aspects of harnessing hydro resources, including issues related to water management, irrigation, flood control, and ecological impact assessment.					
Semester	**8**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic knowledge about rivers and water resources					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the major Indian rivers and its tributaries: Dive deep into some of the important facts about the major rivers of India	U	PO 6
2	Differentiate the Major surface water resources in Kerala	U	PO 2 PO 6
3	Understand the Major Rivers systems in Kerala	U	PO 6
4	Distinguish the value and functioning of wetland ecosystems and different aspects of Wetland	U	PO 2 PO 7

	management planning that will aid governance		PO 6
5	Analyse the major impacts of droughts and floods; its causes and effects; Structural and non-structural measures to control it	An	PO 6 PO 7
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Rivers of India: General introduction	2	CO 1
	1.2	Classification of different types of river basins	2	CO 1
	1.3	Major River systems of India: the Ganges, the Indus (General introduction, Major Tributaries)	4	CO 1
	1.4	The Brahmaputhra and the Godavari (General introduction, Major Tributaries)	4	CO 1
	1.5	Conflicts over trans-boundary water resources	1	CO 1
2	2.1	Surface water resources of Kerala: Rivers, Backwaters, Lakes, Estuaries	4	CO 2
	2.2	Rivers of Kerala: General Introduction	2	CO 3
	2.3	Major Rivers of Kerala: East and West Flowing Rivers (General Introduction)	2	CO 3
	2.4	East Flowing Rivers	3	CO 3
	2.5	West Flowing Rivers	3	CO 3
3	3.1	Wetlands: Definition, Benefits of wetland, Major threats to wetland	3	CO 4
	3.2	General classification of wetlands: (Lacustrine, Riverine, Palustrine, Marine and Estuarine); Major Wetlands in India (Marine / Coastal, Inland, Man-made)	4	CO 4
	3.3	Wetlands in Kerala: Vembanad – Kole, Ashtamudi Lake, Sasthamcotta Lake	4	CO 4
	3.4	Ramsar Convention; Montreux Record.	2	CO 4
	3.5	Ramsar sites of India and Kerala	3	CO 4
4	4.1	Floods and droughts: Introduction	2	CO 5
	4.2	Flood frequency analysis; design flood; Flood routing, Flood control	3	CO 5
	4.3	Structural measures: reservoirs, levees, flood	4	CO 5

		walls, flood ways and channel improvement (Brief description)		
	4.4	Non-structural measures: evacuation, flood proofing, land management, flood plain management	4	CO 5
	4.5	Droughts; Types: meteorological, agricultural and hydrological droughts	4	CO 5
5		Teacher specific content		

Teaching and Learning Approach	**CLASS ROOM PROCEDURES** Lecture, Demonstration, Assignment, Seminar / Viva, and Class test
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

References

- Trujillo P. Alan and Thurman V. Harold. Essentials of Oceanography. 13th Edition, Pearson Publications. Prentice hall 2011.
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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Geology**					
Course Name	**ECOHYDROLOGY**					
Type of Course	**DCE**					
Course Code	**MG8DCE GEO402**					
Course Level	**400-499**					
Course Summary	The course explores the dynamic interactions between ecological and hydrological processes in terrestrial ecosystems. The course offers understanding of the principles and applications of Ecohydrology, including the effects of vegetation on water flow, nutrient cycling, and ecosystem health. Also give an understanding about Global climate systems.					
Semester	**8**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		**60**
Pre-requisites, if any	Basic knowledge about ecosystem and water resources					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understanding the ecosystem, climatic conditions and hydro geological conditions in relation with ecosystem.	U	PO 1 PO 2
2	Recognize the ecosystem dynamics and their relation to hydrological cycle.	U	PO 1 PO 2
3	Apply the knowledge of biodiversity and wetland ecosystem in water quality maintenance.	A	PO 2 PO 6

4	Analyses the role of people's participation in various water resource conservation and providing a scene of responsibility towards society.	An	PO 2 PO 6
5	Analyse the recent trends in climate change and its effect on ecosystem; interaction of ecosystem and human health.	An	PO 1 PO 6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs (60)	CO No.
1	1.1	Foundation of Ecohydrology: Definition and scope	3	CO 1
	1.2	Historical development and importance of Ecohydrology	3	CO 1
	1.3	Interdisciplinary nature of Ecohydrology	2	CO 1
	1.4	Biotic and abiotic factors in Ecohydrology	2	CO 1
	1.5	Vegetation-water-Soil interactions	2	CO 1
2	2.1	Introduction to hydrological cycle: processes of hydrological cycle	3	CO 2
	2.2	Factors affecting: Evapotranspiration, infiltration, runoff, Surface flow and groundwater flow	4	CO 2
	2.3	Ecohydrological cycle	3	CO 2
	2.4	Definition and classification of Ecosystem	3	CO 2
	2.5	Ecosystem services related to water (provisional, regulating, supporting, cultural)	4	CO 4
3	3.1	Type of Wetlands; Wetland ecosystem, water quality, Wetland Ecology and riparian zones	5	CO 3
	3.2	Wetland- ecosystem management	3	CO 3
	3.3	Role of biodiversity in water ecosystem services	3	CO 4
	3.4	Ecosystem based water management	2	CO 3
	3.5	Ecosystem dynamic and biogeochemical cycle	2	CO 3
4	4.1	Basic concepts and definition of climate	2	

		change		CO 5
	4.2	Global climate systems and Ecohydrology in a changing climate	5	CO 5
	4.3	Ecological consequences of climate change	3	CO 5
	4.4	Role of vegetation in modifying microclimate	3	CO 4
	4.5	Human health impacts on Ecohydrological systems	3	CO 5
5		Teacher specific content		

Teaching and Learning Approach	**CLASSROOM PROCEDURES** Lecture, Demonstration, Seminar/viva, Assignment, Class test
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 Marks** Assignments, Viva/Seminar, Class Tests **B End Semester Evaluation (ESE)** **Theory: 70 Marks** Short Answer in 60 words (5 out of 6): 5x2=10 Short Notes in 250 words (6 out of 8): 6x8 = 48 Essays in 400 words (1 out of 2):1x12=12

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Project (MG8PRJGEO400)

A. Individual Project (For Honours with Research)

A comprehensive assessment pattern for the **'individual project'** of the 'Honours with Research Degree' in Geology is given below.

Components:

1. Project proposal and approval
2. Half term progress report submission
3. Supervisor Feedback with attendance
4. Synopsis presentation
5. Submission of project report (hard copy)
6. Open defence and evaluation of the project

	Criteria for the Project Evaluation (H R)	**Percentage**
1	Scope of the study	10
2	Half term progress report	10
3	Supervisor feedback with attendance	10
4	Content and presentation of the project report	60
5	Open defence performance	10
	Total	**100**

Internship Evaluation (MG4INTGEO200)

An internship is a structured program that provides practical work experience to the students in a specific field, from an institution or organization with professional excellence. The primary goal of an internship is to offer participants the opportunity to apply theoretical knowledge gained in academic settings to real-world situations, thereby integrating their knowledge with skills and experiments to affirm their professional development.

Evaluation criterion

1. Performance Reviews: Regular performance reviews conducted by supervisors or mentors can assess interns' progress, strengths, and areas for improvement.

2. Project Assessments: Evaluate interns based on the completion and quality of assigned projects or tasks. Assessments can consider factors such as creativity, problem-solving abilities, attention to detail, and adherence to deadlines.

3. Skills Assessments: Administer pre- and post-internship skills assessments to measure interns' skill development over the course of their internship. Assessments can cover technical skills relevant to the internship role, as well as soft skills such as teamwork, leadership, and time management.

4. Supervisor Feedback: Solicit feedback from supervisors or mentors on interns' performance, contributions, and overall professionalism. Supervisor feedback can help interns understand expectations, receive constructive criticism, and identify opportunities for growth.

5. Presentation: Require interns to deliver presentations or compile portfolios showcasing their work and accomplishments during the internship. Presentation or portfolio reviews provide interns with an opportunity to demonstrate their skills, achievements, and contributions to stakeholders.

Internship evaluation	
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA): 15 marks** Performance reviews:10 marks Supervisor feedback :5 marks **B. End Internship Evaluation (EIE) : 35 Marks** Project Assessments:20 marks Skill Assessments:10 marks Presentation:5 marks

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