KANNUR UNIVERSITY

(Abstract)

Scheme and Syllabus of B.Sc. Geology Programme in tune with KU-FYUGP Regulations 2024 with effect from 2024 Admission onwards- Approved- Implemented- Orders Issued

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FYUGP Spl.cell

ACAD/FYSC-III/18781/2024 Dated: 24.09.2024

Read:-1. U.O. No. FYUGPSC/FYSC-I/5074/2024, dated: 18/04/2024

2. The FYUGP Syllabus in B.Sc. Geology submitted by Chairperson, Board of Studies in Geology(Cd) on 14.06.2024

3. The Minutes of the Meeting of the Scrutiny Committee held on 14.06.2024

4. Orders of the Vice Chancellor on 24.06.2024.

5. E-mail of the Chairperson, Board of Studies in Geology (Cd), dated 25.06.2024

6. The Minutes of the Meeting of the Academic Council, held on 25.06.2024

ORDER

1.The Regulations of the Kannur University Four Year UG Programmes (KU-FYUGP Regulations 2024) for affiliated Colleges was implemented with effect from 2024 admission onwards, vide paper read as(1) above.

2. Subsequently, the Chairperson, Board of Studies in Geology (Cd) vide paper read as (2) above, submitted the Syllabus of the B.Sc. Geology programme in tune with KUFYUGP Regulations 2024 with effect from 2024 Admission onwards.

3.Thereafter, the Scrutiny Committee, which included the Dean, Faculty of Science vide paper read as (3) above, scrutinized the Syllabus and recommended suggestions.

4.Subsequently, the Vice Chancellor ordered to place the Syllabus before the Academic Council for consideration, as per the paper read (4) above.

5.Thereafter, vide paper read as (5) above, the Chairperson, Board of Studies in Geology(Cd) forwarded the modified Syllabus of the B.Sc. Geology programme for approval.

6. Accordingly, the Syllabus of the B.Sc. Geology programme in tune with KU-FYUGP Regulations 2024 was approved by the meeting of the Academic Council held on 25-06-2024 and granted permission to publish the same, as and when it is ready, after making the necessary modifications, as per paper read as (6) above.

7.Considering the matter in detail, the Vice Chancellor approved the Minutes of the aforesaid meeting of the Academic Council and the Syllabus of the B.Sc. Geology programme, prepared in tune with KU-FYUGP Regulations, 2024.

8.The approved Syllabus of the B.Sc. Geology programme is appended with this U.O.and uploaded in the University website.

Orders are issued accordingly.

Sd/-

ANIL CHANDRAN R

DEPUTY REGISTRAR (ACADEMIC)

For REGISTRAR

To: The Principals of Arts and Science Colleges

Copy To: 1. The Examination Branch (through PA to CE)
2. The Chairperson, Board of Studies in Geology(Cd)
3. PS to VC/PA to R
4. DR/AR (Academic)
5. The IT Cell (For uploading in the website)
6. SF/DF/FC

Forwarded / By Order

SECTION OFFICER

KANNUR UNIVERSITY

B.Sc. GEOLOGY HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS

w.e.f. 2024 admission onwards

(KUFYUGP Regulations 2024)

Prepared by Collaborative efforts of Adhoc Committees and Board of Studies

Preface

Geology, the scientific study of the Earth, its materials, and the processes that shape it, is a cornerstone of our understanding of the natural world. This field encompasses a wide range of topics, including the study of minerals, rocks, fossils, and the dynamic processes that have shaped the Earth's surface and interior over time. A comprehensive understanding of geology is crucial not only for scientific research but also for practical applications in areas such as resource management, environmental protection, and natural hazard mitigation. Offering geology as an optional subject in the Bachelor of Science degree can be highly advantageous, particularly in today's rapidly evolving scientific and technological landscape. In addition to traditional roles in academia and research, graduates in geology are well-equipped to pursue careers in environmental consulting, natural resource management, geotechnical engineering, and various positions within the energy sector.

Students can prepare for careers as geologists, environmental consultants, research scientists, or educators in the field of Earth sciences. Other potential roles for geology graduates include hydrogeologists, petroleum geologists, mining geologists, environmental analysts, GIS specialists, and natural hazard assessors. Additionally, the skills gained from studying geology, such as critical thinking, problem-solving, and data analysis, are highly valued in a wide range of professions. An undergraduate course in geology provides a solid foundation for advanced studies in Earth sciences and opens pathways to research opportunities. Graduates in geology are employable in teaching, research, industry, and governmental agencies. They can also pursue postgraduate courses and research opportunities. The multidisciplinary nature of geology allows it to intersect with fields such as environmental science, engineering, archaeology, and planetary science.

Graduates of this program will acquire strong analytical skills, understand the formation and classification of minerals and rocks, interpret geological maps, analyze geological data, assess natural resources, understand the processes driving natural hazards, and apply geological principles to environmental and engineering problems.

With the introduction of the Four-Year Undergraduate Programme in Kerala, we have also initiated the preparation of a syllabus for the Bachelor's degree in Geology. It has been a challenging task to incorporate all aspects of geology with proper gradation. I extend my heartfelt gratitude to all the members of the Board of Studies and the Ad hoc committee for their contributions.

This version aims to present the content clearly and professionally, tailored specifically to the field of geology.

Chairperson
Board of Studies in Geology (combined)
Kannur University

BOARD OF STUDIES IN GEOLOGY (COMBINED)

Chairperson Dr. Gopinathan Nair A, Assistant Professor, Department of Geology, Government College Kasaragod.

Members

1. Dr. Ananthapadmanabha A L, Associate Professor, Department of Geology, Government College Kasaragod
2. Sri. Anilkumar S S, Associate professor, Retired from Govt. College of Engineering, Kannur.
3. Sri. Asif Iqbal Kakkassery, Assistant Professor, Department of Geology, Government College Kasaragod
4. Dr. Soumya G S, Assistant Professor, Department of Geology, Government College Kasaragod
5. Dr. Anoop S, Assistant Professor, Department of Geology, University College, Thiruvananthapuram

6 Sri. Sajesh P V, Senior Geologist, Marine and Costal Survey Division, Geological Survey of India.

7. Sri. Harikrishnan, Professor, Dept. of Geology, NSS college of Engineering, Palakkad.
8. Dr. Sreela S R, Assistant Professor, Sree Narayana College, Sivagiri, Varkala, Kolam.
9. Dr. Brijesh V K, Assistant Professor, Department of Geology, M E S College, Ponnani
10. Dr Sijin Kumar A V, Associate Professor and Dean, Department of Geology, School of Earth Science Systems, Central University of Kerala.

FYUGP GEOLOGY AD HOC COMMITTEE

Convenor Dr. Gopinathan Nair A, Assistant Professor, Department of Geology, Government College Kasaragod.

Members

1. Dr. Ananthapadmanabha A L, Associate Professor, Department of Geology, Government College Kasaragod.
2. Sri.Asif Iqbal Kakkassery, Assistant Professor, Department of Geology, Government College Kasaragod.
3. Dr. Soumya G S, Assistant Professor, Department of Geology, Government College Kasaragod
4. Sri. Suraj P R, Assistant Professor, Department of Geology, Government College Kasaragod
5. Sri. Sajesh P V, Senior Geologist, Marine and Costal Survey Division, Geological Survey of India, Manglore.

6 Dr. A N Manoharan, Assistant Professor, Department of Geology, Government College Kasaragod

7. Dr Sijin Kumar A V, Associate Professor and Dean, Department of Geology, School of Earth Science Systems, Central University of Kerala

8. Dr. Sandeep K, Assistant Professor, Department of Geology, School of Earth Science Systems, Central University of Kerala.

9. Dr. Brijesh V K, Assistant Professor, Department of Geology, M E S College, Ponnani

1. INTRODUCTION

The implementation of the Four-Year Undergraduate Programme (FYUGP) has been driven by the pressing need to address contemporary challenges ensuring responsive changes to the evolving needs of students, industry, and society at large. Recognizing the curriculum as the cornerstone of any education system, it requires regular refinement to align with evolving socio-economic factors. Higher education must provide students with practical and technical skills relevant to their fields of interest, necessitating the development of a job-oriented curriculum. Despite significant increases in access and expansion of higher education over the years, concerns persist regarding the quality and relevance of educational outcomes, particularly in terms of employability skills. As the world becomes increasingly interconnected, our education system must evolve to instill 21st-century skills, enabling students not only to survive but to thrive in this dynamic environment. Moreover, there is a growing need for higher education institutions to embrace social responsibility and contribute to the development of a knowledge society capable of driving sustainable development through innovation. With the central objective of fostering a robust knowledge society to support a knowledge economy, the Government of Kerala has initiated steps to reform higher education. Accordingly, three commissions were established to suggest reforms in higher education policy, legal and regulatory mechanisms, and evaluation and examination systems. It is within this context that a comprehensive reform of the undergraduate curriculum has been proposed, leading to the restructuring of the Four-Year Undergraduate Programme (FYUGP).

Kannur University Four-Year Undergraduate Programme (KU-FYUGP) – Regulations and Curriculum Framework

Apart from ensuring quality education, the proposed KU-FYUGP is intended to make curriculum and courses more student-centric and industry-centric. The transformative initiative introduces holistic and multidisciplinary undergraduate education that would help develop all capacities of human beings - intellectual, aesthetic, social, physical, emotional, ethical, and moral - in an integrated manner; soft skills, such as complex problem solving, critical thinking, creative thinking, communication skills; and rigorous specialization in a chosen field (s) of learning. It proposes the adoption of flexible curricular structures to enable creative combinations of disciplinary areas for study in multidisciplinary contexts that would also allow flexibility in course options that would be on offer to students, in addition to rigorous specialization in a subject or subjects. It provides self-paced learning and options for multiple entry, exit and re-entry points. The curriculum and syllabus of the restructured KU-

FYUGP emphasises an outcome-based approach, centred around the needs and capabilities of students. This approach, rooted in Outcome Based Education (OBE), focuses on defining what students should be able to do, setting predetermined achievement outcomes. It surpasses traditional structured tasks, requiring students to actively engage in learning processes and demonstrate their skills through more challenging tasks and higher-order thinking. In this instructional model, learning takes precedence in education, with teaching serving as a facilitator and nurturer. Teaching encompasses not only imparting knowledge but also involves constructing curriculum, syllabi, learning materials, and assessment methods. The curriculum framework aims to stimulate constructive dialogue about the design of undergraduate degree programs and the learning approaches of students. The core educational principle of the framework advocates for students to predominantly learn through research and critical inquiry rather than passively receiving established knowledge. It recognizes knowledge not merely as the articulation of understanding but also as the capacity to generate new knowledge. To enhance students' ability to create new knowledge, the curriculum offers flexibility to design courses that integrate knowledge from various disciplines. Moreover, the restructured KU-FYUGP empowers teachers by enabling them to be autonomous and creative in designing courses and syllabi. Teachers who teach are also involved in course design and syllabi development, ensuring alignment with collectively developed curricula. This approach promotes teacher autonomy and creativity in the educational process.

Graduate Attributes:

Kannur University is fundamentally dedicated to nurturing well-rounded individuals with a comprehensive set of graduate attributes. Graduates from Kannur University emerge equipped with a multidisciplinary approach, allowing them to integrate knowledge across various domains for a holistic understanding of complex issues. With a strong emphasis on critical thinking and effective problem-solving skills, Kannur University's graduates demonstrate intellectual curiosity and the ability to tackle challenges creatively. Proficient in communication and social interaction, they engage adeptly in diverse settings, fostering collaboration and effective interpersonal connections. Moreover, the graduates embody effective citizenship and leadership, showcasing a sense of responsibility, community engagement, and leadership qualities. With a global perspective, ethical grounding, and a commitment to environmental sustainability, our students are well-prepared for active participation in an interconnected world. Embracing self-directed and lifelong learning, they continually adapt to evolving challenges, embodying the university's commitment to producing resilient, knowledgeable, and socially responsible individuals.

The BSc (Hons) Geology FYUG program at Kannur University offers a comprehensive curriculum designed to provide students with a robust foundation in geology and its practical applications. This program includes a range of courses categorized as major and foundational courses necessary for a deep understanding of the Earth's structures, materials, and processes. Students explore topics such as landforms, subsurface processes, rocks, minerals, groundwater resources, and the Earth's interior. The program also emphasizes the importance of historical geology, which helps students appreciate how Earth's past informs its present and future, particularly in understanding natural hazards like landslides, earthquakes, floods, and volcanic eruptions. Additionally, the curriculum addresses contemporary issues such as climate change, preparing students to engage with ongoing environmental challenges. Graduates from this program are well-prepared for careers in various sectors including natural resource companies, environmental consulting, government agencies, and academic and research institutions. The Geology graduation in KUFYUG program not only equips students with essential geological knowledge but also provides them with practical skills through fieldwork, making them competitive for both national and international opportunities.

The B.Sc. Geology honoursunder KUFYUG program is designed to offer a diverse and comprehensive educational experience, tailored to meet the varied interests and career goals of its students. The syllabus encompasses a wide range of department-specific major courses, minor courses, elective courses, and foundational courses. This structure allows students pursuing a graduate program to choose from five distinct pathways specified in the KUFUGP regulations, ensuring a personalized and focused academic journey.

The courses are thoughtfully curated to cover essential aspects of geology, including detailed studies on landforms, geological processes, and resource management. These are complemented by elective courses that enable students to specialize further in areas such as environmental geology, paleontology, or hydrogeology, depending on their interests and career aspirations. The inclusion of minor courses from other departments enhances interdisciplinary learning and broadens the academic scope beyond traditional geological studies. This flexible and rich curriculum not only equips students with deep geological knowledge but also prepares them for diverse roles within government agencies, private sector, research institutions, and beyond. Graduates of the Geology program at Kannur University are well-prepared to tackle global challenges such as climate change, resource management, and natural hazard mitigation, making significant contributions to both local and international communities.

Program Outcomes (POs):

Program Outcomes (POs) serve as a foundational framework defining the skills, knowledge, and attributes that students at Kannur University are expected to acquire upon completion of a specific academic program. Tailored to the unique goals of each program, POs articulate the overarching learning objectives that guide curriculum design and assessment. These outcomes encompass a diverse range of competencies, including critical thinking, problem-solving, effective communication, and discipline-specific expertise. POs play a crucial role in shaping educational experiences, ensuring alignment with academic standards and industry expectations. By articulating clear and measurable expectations, POs contribute to the continuous improvement of academic programs and provide a roadmap for students to develop into well-rounded, competent professionals within their chosen fields.

At the end of the graduate programme at Calicut University, a student would aciive following program outcomes:

PO1	**Critical Thinking and Problem-Solving:**Apply critical thinking skills to analyze information and develop effective problem-solving strategies for tackling complex challenges.
PO2	**Effective Communication and Social Interaction:**Proficiently express ideas and engage in collaborative practices, fostering effective interpersonal connections.
PO3	**Holistic Understanding:** Demonstrate a multidisciplinary approach by integrating knowledge across various domains for a comprehensive understanding of complex issues.
PO4	**Citizenship and Leadership:** Exhibit a sense of responsibility, actively contribute to the community, and showcase leadership qualities to shape a just and inclusive society.
PO5	**Global Perspective:** Develop a broad awareness of global issues and an understanding of diverse perspectives, preparing for active participation in a globalized world.
PO6	**Ethics, Integrity and Environmental Sustainability:** Uphold high ethical standards in academic and professional endeavors, demonstrating integrity and ethical decision-making. Also acquire an understanding of environmental issues and sustainable practices, promoting responsibility towards ecological well-being.

PO7	**Lifelong Learning and Adaptability:** Cultivate a commitment to continuous self- directed learning, adapting to evolving challenges, and acquiring knowledge throughout life.

Program Specific Outcomes (PSOs):

At the end of the BSc Geology Honours programme at Kannur University, a student would:

PSO1	Develop a strong foundation in geological principles, theories, and methodologies to analyze and interpret Earth's dynamic processes and history.
PSO2	Acquire practical skills in fieldwork, laboratory techniques, and data analysis to conduct geological investigations and research effectively.
PSO3	Gain comprehensive knowledge of Earth's structure, composition, age and geological resources to address environmental challenges and sustainable resource management.
PSO4	Cultivate critical thinking and problem-solving abilities to evaluate geological hazards, assess risks, and propose mitigation strategies for societal resilience.
PSO5	Foster communication and collaboration skills to effectively convey geological concepts, findings, and recommendations to diverse stakeholders and communities.
PSO6	Explore interdisciplinary connections between geology and other scientific disciplines including planetary sciences to address complex global issues, such as climate change, natural disasters, and energy sustainability.
PSO7	Engage in lifelong learning and professional development opportunities to stay abreast of advancements in geology and contribute to the advancement of scientific knowledge and societal well-being.

Distribution of major courses, minor courses, foundation courses, projects and internship in Geology for various pathways in KUFYUGP												
Semester	**Course type**	**Course Code**	**Course Tittle**	**Credits**	**Hours/ week**	**Totalhours/ week**	**Mark Distribution**					
							Theory		**Practical**		**Total**
							CCA	**ESE**	**CCA**	**ESE**	
	100 level courses											
1	Major	KU1DSC GEL101	Exploring planet earth	4	5	75	25	50	10	15	100
	Minor	KU1DSC GEL102	Understanding the Earth.	4	5	75	25	50	10	15	100
	Minor	KU1DSC GEL103	Natural hazards	4	4	60	30	70	0	0	100
	MDC	KU1MDC GEL101	Fundamentals of Geology	3	3	45	25	50	0	0	75
	MDC	KU1MDC GEL102	Earth system studies	3	3	45	25	50	0	0	75
2	Major	KU2DSC GEL101	Dynamic earth	4	5	75	25	50	10	15	100
	Minor	KU2DSC GEL102	Landforms of our planet	4	5	75	25	50	10	15	100
	Minor	KU2DSC GEL103	Our ocean	4	5	75	25	50	10	15	100
	MDC	KU2MDC GEL102	Introduction to Geomorphology	3	3	45	25	50	0	0	75
	VAC (for thosewho opt double major)	KU2VAC GEL101	Introduction to Environmental Geology	3	3	45	25	50	0	0	75
	200 level courses											
3	Major	KU3DSC GEL201	Crystals and Minerals	4	5	75	25	50	10	15	100
	Major	KU3DSCG EL202*	Rock Structures	4	6	90	15	35	20	30	100

	Minor	KU3DSC GEL203	Basic Structural Geology	4	5	75	25	50	10	15	100
	Minor	KU3DSC GEL204	Introduction to Rocks	4	4	60	30	70	0	0	100
	MDC (for double	KU3MDC GEL201	Geology and mineral resources of Kerala	3	3	45	25	50	0	0	75
	VAC	KU3VAC GEL201	Climate change	3	3	45	25	50	0	0	75
	VAC	KU3VACG EL202	Introduction to Environmental Geology	3	3	45	25	50	0	0	75
*This course includes fieldwork, which corresponds to 2 credits. The fieldwork/study tour within South India will last for 4 to 6 working days. Students will be deputed to the fieldwork/study tour for 4 to 6 consecutive days during the third semester.											
4	Major	KU4DSC GEL201	Crystallography and Optical Mineralogy	4	5	75	25	50	10	15	100
	Major	KU4DSC GEL202	Structural Geology	4	5	75	25	50	10	15	100
	Major	KU4DSC GEL203	Igneous Petrology	4	5	75	25	50	10	15	100
	SEC	KU4SEC GEL201	Fundamentals of Mapping	3	4	60	15	35	10	15	75
	SEC	KU4SEC GEL202	Introduction to Remote sensing and GIS	3	3	45	25	50	0	0	75
	VAC	KU4VAC GEL201	Water resource management	3	3	45	25	50	0	0	75
	VAC	KU4VAC GEL202	Introduction to hydrogeology	3	3	45	25	50	0	0	75
	300 level courses										
5	Major	KU5DSC GEL301	Sedimentary and Metamorphic petrology	4	5	75	25	50	10	15	100
	Major	KU5DSCG EL302*	Field Geology	4	7	105	10	15	30	45	100
	Major	KU5DSC GEL303	Stratigraphy	4	4	60	30	70	0	0	100

	Major (Elective)	KU5DSEGEL301/ KU5DSEGEL302	Major 11: Precambrian Geology of India/Marine Geology	4	4	60	30	70	0	0	100
	Major (Elective)	KU5DSEGEL303/ KU5DSEGEL304	Major 12 (Elective): Environmental Geology/Fuel Geology	4	4	60	30	70	0	0	100
	SEC	KU4SEC GEL301	Groundwater exploration	3	3	45	25	50	0	0	75
* This course includes fieldwork, which corresponds to 3 credits. The fieldwork/study tour will last for 8 to 12 working days. Students will be deputed to the fieldwork/study tour for 8 to 12 consecutive days during the fifth semester.											
6	Major	KU6DSC GEL301	Ore Geology	4	5	75	25	50	10	15	100
	Major	KU6DSCGEL302	Invertebrate palaeontology	4	5	75	25	50	10	15	100
	Major	KU6DSC GEL303	Global Tectonics	4	4	60	30	70	0	0	100
	Major (Elective)	KU6DSE GEL301/ KU6DSE GEL302	Phanerozoic Stratigraphy of India/ Fuel resources of India	4	4	60	30	70	0	0	100
	Major (Elective)	KU6DSE GEL303/ KU6DSE GEL304	Planetary Geology/ Mineral deposits of India	4	4	60	30	70	0	0	100
	SEC (for those who opt double major)	KU6SECGEL301	Geological field techniques	3	3	45	25	50	0	0	75
	Internship	KU6INTG ELGOL		2	-	-	-	-	-	-	50
		400 level courses									
7	Major	KU7DSCGEL401	Applied Geomorphology	4	5	75	25	50	10	15	100
	Major	KU7DSCGEL402	Geochemistry & Isotope Geology	4	5	75	25	50	10	15	100

	Major	KU7DSCG EL403	Advanced Igneous and Metamorphic Petrology	4	5	75	25	50	10	15	100
	Major (Elective)	KU7DSEG EL401/ KU7DSEG EL402	Sedimentology /Analytical Geochemistry	4	5	75	25	50	10	15	100
	Major (Elective)	KU7DSEG EL403/ KU7DSEG EL404	Applied Micropaleontology /Remote Sensing and Geoinformatics	4	5	75	25	50	10	15	100
8	Major	KU8DSCG EL401	Applied Structural Geology	4	4	60	30	70	0	0	100
	Major	KU8DSCG EL402	Climatology and Quaternary Geology	4	4	60	30	70	0	0	100
	Major	KU8DSCG EL403	Applied Hydrogeology	4	4	60	30	70	0	0	100
	Major	KU8DSCG EL404	Research methodology in Geoscience	4	4	60	30	70	0	0	100
	Research Project	KU8PRJGE L499	Research Project (in the Honours with Research programme)	12	13	360#	30		70		100
	Major/ Minor	KU8DSCG EL405	Geo-exploration	4	4	60	30	70	0	0	100
	Major/ Minor	KU8DSCG EL406	Engineering Geology	4	4	60	30	70	0	0	100
In the eighth semester, students can study three courses online via MOOC.											
# The teacher should have 9 hours per week of engagement, corresponding to the three core courses, in guiding the project(s) in the Honours with Research program. Each student should have 24 hours per week of engagement in the project work. The total hours are based on the student's engagement.											

Minimum Credit Requirements of the Different Pathways in Three-Year Programme in KU-FYUGP

Sl No.	Academic Pathways	Major (17Courses)	Minor/Other Disciplines (6courses)	Foundation Courses AEC:4 MDC:3 SEC:3 VAC:3	Internship	Total Credits	Example
		Each course has 4credits		Each course has 3 credits			
I	Single Major (A)	68	24 (6courses)	39 (13 courses)	2	133	Major: Geology + six courses in different disciplines in different combinations
II	Major (A) with Multiple Disciplines (B, C)	68	12+12 (3+3=6 courses)	39 (13 courses)	2	133	Major: Geology + Chemistry and Physics/Statistics/ Mathematics/ GIS / Remote Sensing
III	Major (A) with Minor (B)	68	24 (6 courses)	39 (13 courses)	2	133	Major: Geology Minor: Chemistry / Geoinformatics (GIS + Remote Sensing)
IV	Major (A) with Vocational Minor (B)	68	24 (6 courses)	39 (13 courses)	2	133	Major: Geology Minor: Geoinformatics (GIS + Remote Sensing)
V		A: 48	-	12+18+9	2	133	

	Double Major (A, B)	(12 courses) B: 44 (11 courses)	The 24 credits in the Minor stream are distributed between the two Majors. 2 MDC, 2 SEC, 2 VAC and the Internship should be in Major A. Total credits in Major A should be 48 + 20 = 68 (50% of 133) 1 MDC, 1 SEC and 1 VAC should be in Major B. Total credits in Major B should be 44 + 9 = 53 (40% of 133)		Geology and Chemistry double major
Exit with UG Degree / Proceed to Fourth Year with 133 Minimum Credits					

Credit requirement for Discipline-Specific Courses in the Fourth Year of KU-FYUGP

Semester	**Nature of the Discipline-Specific Course**	**No. of Courses**	**Required Credits**
VII	Five PG level courses (level 400 & above) in the Major discipline	5	20
VII	(i) Three PG level courses (level 400 & above) in the Major discipline (for Honours); or (ii) One 12-credit Research Project in the Major discipline (for Honours with Research) (iii) In the case of Honours students who go to another institution for doing the Project, the remaining Major course can be in the online mode or in the in-person mode from the institution where the Project is being done.	3	12

	(i) Three Minor Pathway Courses of level 300 & above / level 400 & above. or (ii) Three courses in Major discipline of level 400 & above. or (iii) Two courses in Minor discipline + One course in Major / any other discipline. or (iv) Three courses in any other discipline of level 300 & above / level 400 & above. or (v) Two courses in Major / Minor / any other discipline + One course in research methodology (vi) Two of these courses can be in the online mode. These online courses can be taken either in semester VII or in semester VIII, but their credits shall be added to the student's account only in semester VIII. (vii) For those students who go to another institution for doing the Project, all these three courses can be in the online mode or in the in-person mode from the institution where the Project is being done.	3	12
	Total in the fourth year of KU-FYUGP	11	44

B.Sc. GEOLOGY HONOURS PROGRAMME
COURSE STRUCTURE FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

T: Theory; P: Practical CCA: Comprehensive Continuous Assessment; ESE: End Semester Evaluation

Level	Semester	Course Code	Course Tittle	Credits	Hours/ week	Total hours	Mark Distribution				
							T		P		Total
							CCA	ESE	CCA	ESE	
100-199	I	KU1DSCGEL101	Major 1: Exploring planet earth	4	5	75	25	50	10	15	100
			Minor Course 1*	4	5	75	25	50	10	15	100
			Minor Course 2*	4	4/5	60/75	30	70	0	0	100

			Ability Enhancement Course 1– English	3	3/4						
			Ability Enhancement Course 2 – Additional Language	3	3						
			Multi-Disciplinary Course 1 – Other than Major	3	3	45	25	50	0	0	75
	Total			21	22-25						**575**
	*Students have the flexibility to select minor courses from a variety of disciplines based on the pathway they are pursuing.										
	II	KU2DSCGEL101	Major 2: Dynamic earth	4	5	75	25	50	10	15	100
			Minor Course 3*	4	4/5	75	25	50	10	15	100
			Minor Course 4*	4	4/5	60/75	30	70	0	0	100
			Ability Enhancement Course 3– English	3	3/4						
			Ability Enhancement Course 4 – Additional Language	3	3						
			Multi-Disciplinary Course 2 – Other than the Major	3	3	45	25	50	0	0	75
	Total			21	22-25						**575**
	*Students have the flexibility to select minor courses from a variety of disciplines based on the pathway they are pursuing.										
	III	KU3DSCGEL201	Major 3: Crystals and minerals	4	5	75	25	50	10	15	100
		KU3DSCGEL202 *	Major 4: Rock structures	4	6	90	15	35	20	30	100
			Minor Course 4**	4	4/5	60/75	25	50	10	15	100
			Minor Course 5**	4	4/5	60/75	30	70	0	0	100
			Multi-Disciplinary Course 3	3	3	45	25	50	0	0	75

			Value-Added Course-1	3	3	45	25	50	0	0	75
	Total			22	24-26						**550**
	*This course includes fieldwork that corresponds to 2 credits. Fieldwork/study tour within South India will last 4 to 6 working days. Students will be deputed to fieldwork/study tour for 4 to 6 consecutive days during the third semester. **Students have the flexibility to select minor courses from a variety of disciplines based on the pathway they are pursuing.										
	IV	KU4DSCGEL201	Major 5: Crystallography and optical mineralogy	4	5	75	25	50	10	15	100
		KU4DSCGEL202	Major 6: Structural geology	4	5	75	25	50	10	15	100
		KU4DSCGEL202	Major 7: Igneous petrology	4	5	75	25	50	10	15	100
			Skill Enhancement Course-1	3	3/4	45	25	50	0	0	75
			Value-Added Course-2	3	3	45	25	50	0	0	75
			Value-Added Course-3	3	3	45	25	50	0	0	75
	Total			21	24/25						**525**
	V	KU5DSCGEL301	Major 8: Sedimentary and Metamorphic petrology	4	5	75	25	50	10	15	100
		KU5DSCGEL302 *	Major 9: Field Geology	4	7	105	10	15	30	45	100
		KU5DSCGEL303	Major 10: Stratigraphy	4	4	60	30	70	0	0	100
		KU5DSEGEL301/ KU5DSEGEL302	Major 11 (Elective): Precambrian Geology of India/Marine Geology	4	4	60	30	70	0	0	100
		KU5DSEGEL303/ KU5DSEGEL304	Major 12 (Elective): Environmental Geology/Fuel Geology	4	4	60	30	70	0	0	100
			Skill Enhancement Course-2	3	3	45	25	50	0	0	75
	Total			23	27						**575**

	*This course includes fieldwork that corresponds to 3 credits. Fieldwork/study tour will last 8 to 12 working days. Students will be deputed to fieldwork/study tour for 8 to 12 consecutive days during the fifth semester.										
	VI	KU6DSCGEL301	Major13: Ore Geology	4	5	75	25	50	10	15	100
		KU6DSCGEL302	Major 14: Invertebrate Palaeontology and Palaeobotany.	4	5	75	25	50	10	15	100
		KU6DSCGEL303	Major 15: Global Tectonics	4	4	60	30	70	0	0	100
		KU6DSEGEL301/ KU6DSEGEL302	Major 16 (Elective): Phanerozoic Geology of India/ Fuel resources of India	4	4	60	30	70	0	0	100
		KU6DSEGEL303/ KU6DSEGEL304	Major 17 (Elective): Planetary Geology/ Mineral deposits of India	4	4	60	30	70	0	0	100
			Skill Enhancement Course-3	3	3	45	25	50	0	0	75
		KU6INTGE399	Internship in Major*	2	-	-	0	0	20	30	50
	Total			25	25						
	*Credit for internship to be awarded only at the end of Semester VI										
	Total Credits for Three Years			**133**							
	VII	KU7DSCGEL401	Major 18: Applied Geomorphology	4	5	75	25	50	10	15	100
		KU7DSCGEL402	Major 19: Geochemistry & Isotope Geology	4	5	75	25	50	10	15	100
		KU7DSCGEL403	Major20: Advanced Igneous and Metamorphic Petrology	4	5	75	25	50	10	15	100
		KU7DSEGEL401/ KU7DSEGEL402	Major 21: (Elective) Sedimentology/ Analytical Geochemistry	4	5	75	25	50	10	15	100
		KU7DSEGEL403/		4	5	75	25	50	10	15	100

		KU7DSEGEL404	Major 22: (Elective): Applied Micropaleontology / Remote Sensing and Geoinformatics				25	50	10	15	100
							25	50	10	15	100
	Total			20	25						500
	VIII	KU8DSCGEL401	Major 23: Applied Structural Geology	4	4	60	30	0	70	0	100
		KU8DSCGEL402	Major 24: Climatology and Quaternary Geology	4	4	60	30	0	70	0	100
		KU8DSCGEL403	Major 25: Applied Hydrogeology	4	4	60	30	0	70	0	100
		Or									
		KU8PRJGEL499	Research Project (in Honors with Research programme)	12	13	360**	30		70		100
		students have to earn 12 more credits either by doing all three major courses offered by the department (listed below) or Three Minor Pathway Courses of level 300 & above / level 400 & above or Two courses in Minor discipline + One course in Major / any other discipline or Two courses in Major / Minor / any other discipline + One course in research methodology. Three of these courses can be in the online mode. Research methodology course in geoscience is compulsory for the students who opted to do project.									
		KU8DSCGEL404/ MOOC/ONLINE	Major: Research methodology in Geoscience	4	4	60	30	0	70	0	100
		KU8DSCGEL405/ MOOC/ONLINE	Major/Minor: Geo-exploration	4	4	60	30	0	70	0	100
		KU8DSCGEL406/ MOOC/ONLINE	Major/ Minor: Engineering Geology	4	4	60	30	0	70	0	100
	** The teacher should have 9 hours per week of engagement, corresponding to the three core courses, in guiding the project(s) in the Honours with Research program. Each student should have 24 hours per week of engagement in the project work. The total hours are based on the student's engagement										

COURSE STRUCTURE FOR PATHWAY 5: DOUBLE MAJOR

(A and B are the disciplines that offer major courses)

Semester	Course Code	Course Tittle	Credits	Hours/week	Total hours	Mark Distribution				
						T		P		Total
						CCA	ESE	CCA	ESE	
I	KU1DSCGEL101	Major 1: Exploring planet earth	4	5	75	25	50	10	15	100
	KU1DSCGEL102/KU1DSCGEL103	Understanding the Earth/Natural hazards	4	4/5	60/75	75/100		25/0		100
		A major or minor course offered by discipline	4	4/5	60/75	75/100		25/0		100
		Ability Enhancement Course 1– English	3	3/4	45	75/50		0/25		75
		Ability Enhancement Course 2 – Additional Language	3	3	45	75		0		75
	KU1MDCGEL101/KU1MDCGEL102	Fundamentals of Geology/ Earth system studies	3	3	45	75		0		75
	Or									
	Multi-Disciplinary Course 1 – from other Major									
Total			21	22-25						525
II	KU2DSCGEL101	Major 2: Dynamic earth	4	5	75	25	50	10	15	100
		A major or minor course offered by other discipline	4	4/5	60/75	75/100		25/0		100

		A major or minor course offered by other discipline	4	4/5	60/75	75/100		25/0		100
		Ability Enhancement Course 3– English	3	3/4	45	75/50		0/25		75
		Ability Enhancement Course 4 – Additional Language	3	3	45	75		0		75
	KU2MDCGEL102	Introduction to Geomorphology	3	3	45	75		0		75
	Or									
	Multi-Disciplinary Course 2– from other discipline									
	KU2VACGEL101	Introduction to Environmental Geology				75		0		75
	Or									
	Value-Added Course-1 offered by other discipline		3	3	45					
Total			24	25-28						600
III	KU3DSCGEL201	Major 3: Crystals and minerals	4	5	75	25.	50	10	15	100
	KU3DSCGEL202*	Major 4: Rock structures	4	6	90	15	35	20	30	100
		A major or minor course offered by other discipline	4	4/5	60/75	75/100		25/0		100
		A major or minor course offered by other discipline	4	4/5	60/75	75/100		25/0		100
	KU3MDCGEL201	Geology and mineral resources of Kerala	3	3	45	75		0		75

	Or									
	Multi-Disciplinary Course 3- from other Major (B)									
	KU3VACGEL201/KU3VACGEL202	Climate change/Introduction to Environmental Geology	3	3	45	75		0		75
	Or									
	Value-Added Course-1 offered by other discipline (B)									
Total			22	24-27						600
* This course includes fieldwork that corresponds to 2 credits. The fieldwork or study tour within South India will last for 4 to 6 working days. Students will be assigned to the fieldwork or study tour for 4 to 6 consecutive days during the third semester.										
IV	KU4DSCGEL202	Major 6: Structural geology	4	5	75	25.	50	10	15	100
	KU4DSCGEL202	Major 7: Igneous petrology	4	5	75	25.	50	10	15	100
		A major or minor course offered by other discipline	4	4/5	60/75	75/100		25/0		100
		A major or minor course offered by other discipline	4	5	75	25.	50	10	15	100
	KU4SECGEL201/ KU4SECGEL202	Fundamentals of Mapping/ Introduction to Remote sensing and GIS	3	4/3	60/45	15/25	35/50	10/0	15/0	75
	Or									
	Skill Enhancement Course-1 offered by other discipline									
	KU4VACGEL201	Water resource management	3	3	45	30		70		100

	Or									
	Value-Added Course-2 offered by other discipline									
	KU4VACGEL202	Introduction to Hydrogeology	3	3	45	30		70		100
	Or									
	Value-Added Course-3 offered by other discipline									
Total			22	24-27						600
V	KU5DSCGEL301	Major 8: Sedimentary and Metamorphic petrology	4	5	75	25	50	10	15	100
	KU5DSCGEL302*	Major 9: Field Geology	4	7	105	10	15	30	45	100
	KU5DSCGEL304	Major 10: Precambrian Geology of India	4	4	60	30	70	0	0	100
		A major or minor course offered by other discipline	4	4	60	30	70	0	0	100
		A major or minor course offered by other discipline	4	4	60	30	70	0	0	100
	KU4SECGEL301	Groundwater exploration	3	3	45	75		0		75
	Or									
	Skill Enhancement Course-2 offered by other discipline									
Total			23	27						575
* This course includes fieldwork that corresponds to 3 credits. The fieldwork or study tour will last for 8 to 12 working days. Students will be assigned to the fieldwork or study tour for 8 to 12 consecutive days during the fifth semester.										
VI	KU6DSCGEL302	Major 14: Invertebrate Palaeontology and Palaeobotany.	4	5	75	25	50	10	15	100
	KU6DSCGEL303	Major 15: Global Tectonics	4	4	60	30	70	0	0	100

		A major or minor course offered by other discipline								
		A major or minor course offered by other discipline								
		A major or minor course offered by other discipline								
	KU6SECGEL301	Geological field techniques								
	Or									
	Skill Enhancement Course-3 offered by other discipline (B)		3	3	45	75		0		75
	KU6INTGE399	Internship in Major A*	2	-	-					
Total			25	25						
*Credit for internship to be awarded only at the end of Semester VI										
Total Credits for Three Years			**133**							

In this structure 12 courses each from discipline A and B are given. STUDENTS are allowed to **OPT OUT** one DSC in **discipline B**. Students should opt any **SIX** foundation courses in discipline A and any **THREE** foundation courses in discipline B. (3 foundation courses from each category are compulsory according to the regulation).

EXIT WITH UG DEGREE / PROCEED TO FOURTH YEAR WITH MINIMUM 133 CREDITS
On completion of 3 year UG Student will get 68 credits in major 1 (48 + 18+2 = 68 (50% of 133)) and 53 credits in Major 2 (44 + 9 = 53 (40% of 133))

The Double Major pathway is not extended to the fourth year. In the fourth year, the student can continue to earn the required credits in either Major A (Geology) or Major B to qualify for a UG Degree (Honours) / UG Degree (Honours with Research) in A (Geology) or B. If he/she opts to continue with Major B in the fourth year, he/she should earn an additional 15 credits of 300-399 level in B through in-person or online courses. (For a student who opt geology as discipline B in double major pathway, to continue with geology in 4th year, he/she has enroll for online courses and earn additional 15 credits). The course structure in semesters 7 and 8 is the same as for pathways 1 – 4.

MINOR COURSES IN GEOLOGY

Students enrolled in any discipline of the KUFYUGP program at an institution with a geology department have opportunity to learn the following minor courses in geology. Each course carries four credits in accordance with KUFYUGP regulations. Details regarding semesterwise credits, marks, and course distribution for these minor courses are provided in the accompanying table.

I. Single Major Pathway: Students pursuing a single major are required to earn 24 credits by completing any six discipline-specific courses from disciplines other than their major. Those opting for this pathway may choose from the minor courses listed above.

II. Major with Multiple Disciplines Pathway: Students enrolled in a program with majors across multiple disciplines must accumulate 24 credits, distributed equally with 12 credits from each of two different disciplines. For those selecting geology as one of their minors, it is possible to choose any three of the minor courses previously listed.

III. Major with Minor Pathway: Students who choose to pursue a major with a minor are required to complete all 24 credits from six discipline-specific courses offered within their chosen minor discipline. For students interested in geology as a minor, all six listed courses must be completed.

IV. Major with Vocational Minor: Currently, the option to pursue a major with a vocational minor is not available within the geology department.

Semester	Course type	Course Code	Course Tittle	Credits	Hours/week	Mark Distribution				
						T		P		Total
						CCA	ESE	CCA	ESE	
I	Minor	KU1DSCGEL102	Understanding the Earth.	4	5	25	50	10	15	100
	Minor	KU1DSCGEL103	Natural hazards	4	4	30	70	0	0	100
II	Minor	KU2DSCGEL102	Landforms of our planet	4	5	25	50	10	15	100
	Minor	KU2DSCGEL103	Our Ocean	4	5	25	50	10	15	100
III	Minor	KU3DSCGEL203	Basic Structural Geology	4	5	25	50	10	15	100
	Minor	KU3DSCGEL204	Introduction to Rocks	4	4	30	70	0	0	100

DISTRIBUTION OF GENERAL FOUNDATION COURSES IN GEOLOGY

Semester	Course type	Course Code	Course Tittle	Credits	Hours /week	Mark Distribution				
						T		P		Total
						CCA	ESE	CCA	ESE	
I	Multi-Disciplinary Cours (MDC) 1	KU1MDCGEL101	Fundamentals of Geology	3	3	25	50	0	0	75
	Multi-Disciplinary Cours (MDC) 1	KU1MDCGEL102	Earth system studies	3	3	25	50	0	0	75
II	Multi-Disciplinary Cours (MDC) 2	KU2MDCGEL102	Introduction to Geomorphology	3	3	25	50	0	0	75
	Value-Added Course (VAC) (preferable for double major pathway)	KU2VACGEL101	Introduction to Environmental Geology	3	3	25	50	0	0	75
III	Multi-Disciplinary Cours (MDC) 3 (preferable for double major pathway)	KU3MDCGEL201	Geology and mineral resources of Kerala	3	3	25	50	0	0	5
	Value-Added Course 1 (VAC)	KU3VACGEL201	Climate change	3	3	25	50	0	0	75
IV	Skill Enhancement Cours (SEC) 1	KU4SECGEL201	Fundamentals of Mapping	3	4	15	35	10	15	75
	Skill Enhancement Cours (SEC) 1	KU4SECGEL202	Introduction to Remote sensing and GIS	3	3	25	50	0	0	75
	Value-Added Course 2 (VAC)	KU4VACGEL201	Water resource management	3	3	25	50	0	0	75
	Value-Added Course 3(VAC)	KU4VACGEL202	Introduction to Hydrogeology	3	3	25	50	0	0	75
V	Skill Enhancement Cours (SEC) 2	KU4SECGEL301	Groundwater exploration	3	3	25	50	0	0	75

VI	Skill Enhancement Cours (SEC) 3	KU6SECGEL301	Geological field techniques	3	3	25	50	0	0	75

It is mandatory for all students who enroll in an FYUG degree programme to acquire 39 credits from general foundation courses, which are classified into four different sub-categories (approximately 30% credit is decided for the three-year programme). Ability Enhancement Courses (AEC) and Multi-Disciplinary Course (MDC) with Kerala specific content in third semester will be offered by language departments.

EVALUATION SCHEME

The evaluation scheme for each course contains two parts: comprehensive continuous Assessment (CCA) and End Semester Evaluation (ESE). Each of the Major and Minor courses is of 4-credits and foundation courses are of 3-credits. All the courses are evaluated as per the table given below

Course	Credit		Mark		L		P		
	L	P	L	P	CCA	ESE	CCA	ESE	Total marks
4 Credit	4	0	100	0	30	70	0	0	100
	3	1	75	25	25	50	10	15	100
	2	2	50	50	15	35	20	30	100
	1	3	25	75	10	15	30	45	100
	0	4	0	100	0	0	40	60	100
	Credit		Mark		L		P		
	L	P	L	P	CCA	ESE	CCA	ESE	Total marks
3 Credit	3	0	75	0	25	50	0	0	75
	2	1	50	25	15	35	10	15	75
	1	2	25	50	10	15	20	30	75
	0	3	0	75	0	0	30	45	75

L – Lecture/Theory , P – Practical/Practicum components, CCA – Continuous Comprehensive Assessment, ESE – End Semester Evaluation

INTERNSHIP

All students should undergo Internship of 2-credits during the first six semesters in a firm, industry or organization, or training in labs with faculty and researchers of their own institution or other Higher Educational Institutions (HEIs) or research institutions. Internship can be for enhancing the employability of the student or for developing the research aptitude.

Internship can involve hands-on training on a particular skill/ equipment/ software. It can be a short project on a specific problem or area. Attending seminars or workshops related to an area of learning or skill can be a component of Internship. A faculty member/ scientist/ instructor of the respective institution, where the student does the Internship, should be the supervisor of the Internship.

GUIDELINES FOR INTERNSHIP

The following guidelines are designed to ensure that the internship experience is both structured and beneficial, contributing significantly to the student's educational and professional development in the field of Geology.

1. **Scope of Internship:** Internships may be conducted in Geology or related disciplines to ensure relevant professional experience.
2. **Duration Requirement:** Students are required to engage in the Internship for a minimum of 60 hours to meet the program's experiential learning requirements.
3. **Scheduling:** Internships can be completed during summer vacations or other official holidays, providing flexibility in fulfilling the hours required.
4. **Location and Requirements:** For the BSc. Geology Honours program, completing an institute or industry visit is mandatory. Internships can be conducted at geological organizations, research institutes, laboratories, or significant geological sites. A comprehensive report including photographs and analytical insights must be submitted upon completion.
5. **Documentation:** Students must maintain a detailed personal logbook throughout their internship. This logbook should chronologically document the internship activities, including experimental conditions, results, theoretical notes, rough calculations, and file names. All entries must be dated. The Internship supervisor is required to periodically review and countersign the logbook to verify progress.
6. **Submission of Documentation:** At the conclusion of the internship, both the logbook and a typed final report must be submitted for assessment.
7. **Approval Process:** The location and organization where the internship is conducted must receive prior approval from the Department Council at the college where the student is enrolled in the UG Honours program.

EVALUATION OF INTERNSHIP

- The evaluation of Internship shall be done internally through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honours programme.
- The credits and marks for the Internship will be awarded only at the end of semester 6.

Sl No	Components of Evaluation of Internship		Marks	Weightage
1	Continuous evaluation of internship through interim presentations and reports by the committee internally constituted by Department Council	Interim Presentation and Viva-voce	10	40%
		Punctuality and Log Book	10	
2	Evaluation of the day-to-day records, the report of internship supervisor, and final report submitted for the end semester viva-voce examination before the committee internally constituted by the Department Council		10	20%
3	End-semester viva-voce examination conducted committee constituted to by be the internally by Department Council	Quality of the work	8	40%
		Presentation of the work	6	
		Viva-voce	6	
	Total		50	

PROJECT IN HONOURS PROGRAMME

- In Honours programme, the student has the option to do a Project of 12-credits or a Project of 8 credits and a major course instead of three Major courses in semester 8
- The Project can be done in the same institution or any other higher educational institution (HEI) or research centre/ training centre.
- A project in Honours programme can be a short research work or an extended internship or a skill-based training programme.
- A faculty member of the respective institution, where the student does the Project, should be the supervisor of the Project.

PROJECT IN HONOURS WITH RESEARCH PROGRAMME

- Students who secure 75% marks and above (equivalently, CGPA 7.5 and above) cumulatively in the first six semesters are eligible to get selected to Honours with Research stream in the fourth year.
- A relaxation of 5% in marks (equivalently, a relaxation of 0.5 grade in CGPA) is allowed for those belonging to SC/ ST/ OBC (non-creamy layer)/ Differently-Abled/ Economically

Weaker Section (EWS)/ other categories of candidates as per the decision of the UGC from time to time.

- In Honours with Research programme, the student has to do a mandatory Research Project of 12-credits instead of three Core Courses in Major in semester 8.
- The approved research centres of Kannur University or any other university/ HEI can offer the Honours with Research programme. The departments in the affiliated colleges under Kannur University, which are not the approved research centres of the University, should get prior approval from the University to offer the Honours with Research programme. Such departments should have minimum two faculty members with Ph.D., and they should also have the necessary infrastructure to offer Honours with Research programme.
- A faculty member of the University/ College with a Ph.D. degree can supervise the research project of the students who have enrolled for Honours with Research.
- One such faculty member can supervise maximum five students in Honours with Research stream.
- The maximum intake of the department for Honours with Research programme is fixed by the department based on the number of faculty members eligible for project supervision, and other academic, research, and infrastructural facilities available.
- If a greater number of eligible students are opting for the Honours with Research programme than the number of available seats, then the allotment shall be based on the existing rules of reservations and merits.

GUIDELINES FOR THE PROJECT IN HONOURS WITH RESEARCH PROGRAMME

1. Project can be in Geology or allied disciplines.
2. Project should be done individually.
3. Project work can be of fieldwork-based/experimental/ theoretical/computational in nature.
4. There should be minimum 360 hours (24X15) of engagement from the student in the Project work in Honours programme.
5. There should be minimum 13 hrs/week of engagement (the hours corresponding to the three Major courses in semester 8) from the teacher in the guidance of the Project(s) in honours with Research programme.
6. The various steps in project works are the following:
   - Wide review of a topic.
   - Investigation on a problem in systematic way using appropriate techniques.

- Necessary fieldwork and data collection
- Systematic recording of the work.
- Reporting the results with interpretation in a standard documented form.
- Presenting the results before the examiners.

7. During the Project the students should make regular and detailed entries in to a personal log book through the period of investigation. The log book will be a record of the progress of the Project and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Project supervisor should periodically examine and countersign the log book.
8. The log book and the typed report must be submitted at the end of the Project. A copy of the report should be kept for reference at the department. A soft copy of the report too should be submitted, to be sent to the external examiner in advance.
9. It is desirable, but not mandatory, to publish the results of the Project in a peer reviewed journal.
10. The project report shall have an undertaking from the student and a certificate from the research supervisor for originality of the work, stating that there is no plagiarism, and that the work has not been submitted for the award of any other degree/ diploma in the same institution or any other institution.
11. The project proposal, institution at which the project is being carried out, and the project supervisor should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours programme.

GUIDELINES FOR THE PROJECT IN HONOURS PROGRAMME

1. Project can be in Geology or allied disciplines.
2. Project should be done individually.
3. Project work can be of fieldwork-based/experimental/ theoretical/computational in nature.
4. There should be minimum 240 hours (16X15) of engagement from the student in the Project work in Honours programme.
5. There should be minimum 9 hrs/week of engagement (the hours corresponding to the two major courses in semester 8) from the teacher in the guidance of the Project(s) in honours with programme.
6. The various steps in project works are the following:

- Wide review of a topic.
- Investigation on a problem in systematic way using appropriate techniques.
- Necessary fieldwork and data collection
- Systematic recording of the work.
- Reporting the results with interpretation in a standard documented form.
- Presenting the results before the examiners.

7. During the Project the students should make regular and detailed entries in to a personal log book through the period of investigation. The log book will be a record of the progress of the Project and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Project supervisor should periodically examine and countersign the log book.
8. The log book and the typed report must be submitted at the end of the Project. A copy of the report should be kept for reference at the department. A soft copy of the report too should be submitted, to be sent to the external examiner in advance.
9. It is desirable, but not mandatory, to publish the results of the Project in a peer reviewed journal.
10. The project report shall have an undertaking from the student and a certificate from the research supervisor for originality of the work, stating that there is no plagiarism, and that the work has not been submitted for the award of any other degree/ diploma in the same institution or any other institution.
11. The project proposal, institution at which the project is being carried out, and the project supervisor should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours programme.

EVALUATION OF PROJECT

- The evaluation of Project will be conducted at the end of the eighth semester by both internal and external modes.
- The Project in Honours programme as well as that in Honours with Research programme will be evaluated for 100 marks.
- Out of this, 30 marks is from internal evaluation and 70 marks, from external evaluation.
- The internal evaluation of the Project work shall be done through continuous assessment mode by a committee internally constituted by the Department Council of the college where

the student has enrolled for the UG Honours programme. 30% of the weightage shall be given through this mode.

- The remaining 70% shall be awarded by the external examiner appointed by the University.
- The scheme of continuous evaluation and the end-semester viva-voce of the Project shall be as given below:

Components of Evaluation of Project	**Marks for the Project (Honours/ Honours with Research)**	**Weightage**
Continuous evaluation of project work through interim presentations and reports by the committee internally constituted by the Department Council	30	30%
End-semester viva-voce examination to be conducted by the external examiner appointed by the university	50	50%
Evaluation of the day-to-day records and project report submitted for the end-semester viva–voce examination conducted by the external examiner	20	20%
Total	100	

INTERNAL EVALUATION OF PROJECT

Sl No.	**Components of Evaluation of Project**	**Marks for the Project (Honours/ Honours with Research)**
1	Skill in doing project work	8
2	Interim Presentation and Viva-Voce	12
3	Punctuality and Log book	5
4	Scheme/ Organization of Project Report	5

Chairperson

Board of Studies in Geology (combined)

SEMESTER 1

DISCIPLINE SPECIFIC COURSES

KU1DSCGEL101: EXPLORING PLANET EARTH

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	Major	100 -199	KU1DSCGEL101	4	75

<table>
<tr><th colspan="3">Learning Approach (Hours/ Week)</th><th colspan="5">Marks Distribution</th><th rowspan="3">Duration of ESE (Hours)</th></tr>
<tr><th rowspan="2">Lecture</th><th rowspan="2">Practical/ Internship</th><th rowspan="2">Tutorial</th><th colspan="2">Theory</th><th colspan="2">Practical</th><th rowspan="2">Total</th></tr>
<tr><th>CCA</th><th>ESE</th><th>CCA</th><th>ESE</th></tr>
<tr><td>3</td><td>2</td><td>-</td><td>25</td><td>50</td><td>10</td><td>15</td><td>100</td><td>2 hours</td></tr>
</table>

Course Description: *The course ‘Exploring out planet ’is an introductory geology course that provides a foundational overview of the field, covering essential concepts such as Earth's structure, geological time scale, weathering processes, minerals, rocks, fossils, and landforms. Through theoretical learning and practical field work, students gain a comprehensive understanding of geological principles, preparing them for further studies or careers in geology.*

Course Prerequisite: A pass in plus two science / any other subject combination with geology at plus two level.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamental concepts of geology, including Earth's structure, geological time scale, and key geological processes.	R,U
2	Identify and describe various weathering processes and their significance in shaping Earth's surface features.	U,A
3	Classify minerals and rocks based on their composition and understand their role in Earth's geology.	A,E
4	Analyze the formation and significance of fossils in interpreting Earth's history and geological events	An,C

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓			✓			
CO 2		✓			✓		
CO 3			✓				
CO 4			✓			✓	

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**INTRODUCTION**	**8**
	1	A brief introduction to scope of geology and role of a geologist.	1
	2	Brief introduction to the various branches of earth sciences. Geology as an interdisciplinary science.	1
	3	Earth -Our cosmic address in the universe. Solar system and terrestrial planets. Earth parameters: size, shape, volume, mass, rotation and revolution.	2

	4	Age of the earth. Geological time scale. Theories for the origin of earth.	4

2	**EARTH'S LAYERS AND ATMOSPHERE**		**12**
	1	Internal structure of the earth. Detailed study of physical properties and composition of crust, mantle and core.	4
	2	Introduction to different Geospheres. Parts and component of lithosphere	2
	3	Parts and component of atmosphere.	4
	4	Parts and component of hydrosphere and biosphere.	2

3	**WEATHERING**		10
	1	Weathering – Types and importance physical weathering	2
	2	Types and importance of chemical and biological weathering.	2
	3	Soil and soil profile.	3
	4	Geological classification of soil	3

4	**MINERALS, ROCKS AND FOSSILS**		**10**
	1	Introduction to Minerals – Compositional classification of Minerals.	2
	2	General study of different rocks – Classification.	2
	3	Introduction to fossils- Type of fossils.	2
	4	Stratigraphic principles and history of earth	4

5	**Teacher Specific Module**	**5**

	Directions:Teachers are encouraged to incorporate teacher-specific content focusing on local climate phenomena and case studies showcasing factors influencing climate variability and change. Additionally, they should emphasize the dynamics of ocean circulation, including surface currents, deep-water circulation, and the role of thermohaline circulation in regional and global climate systems.	5
Module 6 (Practical)	1. Toposheet reading: Identifying the elements, component and features from the toposheet. 2. Drainage basin delineation- Drainage pattern identification. 3. Megascopic mineral identification through physical property only - Quartz, feldspar, biotite, tourmaline, gypsum, calcite, garnet, magnetite, fluorite, dolomite. 4. Megascopic identification of rocks – Granite, basalt, pegmatite, gabbro, slate, phyllite, schist, marble, BIF, charnockite, sandstone, conglomerate, breccia, limestone.	30

Essential Readings:

1. Thompson, G. R. and Turk, J. (1997) Introduction to Physical Geology. 2nd Edn. Thompson Brooks Publishers.

2.Carlson, D. and Plummer, C. (2010) Physical Geomorphology: Earth Revealed. 9th Edn., Mc-Graw Hill Co.

3. Parbin Singh (2012). General and Engineering Geology. S. K. Kataria and Sons

4. Holmes, A. (1981) Principles of Physical Geology. ELBS, Third Edition. Thomas Nelson

5. Skinner B.J. and Porter S.C. (1987) Physical Geology. John Wiley and Sons, New York

6. Raup, D.M. and Stanley, M.S. (1978) Principles of Palaeontology. CBS Publishers.

7. Black A M. The elements of Palaeontology.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,3,4
	2	1,3,4

	3	1,3,4
	4	1,3,4
2	1	3,4
	2	4,5
	3	1,4
	4	1,3
3	1	1,3,4
	2	1,3,4
	3	1,3
	4	1,4
4	1	3,4
	2	3,4
	3	6,7
	4	6,7

Suggested Readings:

1.Judson, S. and Kauffman, M.E. (1990) Physical Geology. Eighth Edition, Prentice Hall, New Jersey.
2.Mcalister, A.L. and Hay, E.A. (1975) Physical Geology, Principles and Perspectives. Prentice Hall Inc. London.
3. Montgomery C.W. (1993) Physical Geology. Wn. C. Brown Publishers, IOWA.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10

b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU1DSCGEL102 : UNDERSTANDING THE EARTH

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	Minor	100 -199	KU1DSCGEL102	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
3	2	--	25	50	10	15	100	2

Course Description: *This introductory course, understanding the earth, offers a broad overview of geology, covering topics such as Earth's origin, mineral classification, fossil records, seismic activity, and Earth's magnetism. Through theoretical learning and practical exercises, students gain essential knowledge and analytical skills to interpret geological phenomena and address environmental challenges. This foundational course prepares* *students for further studies or careers in geology and related fields.*

Course Prerequisite: A pass in plus two science / any other subject combination with geology at plus two level.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the origin of our planet Earth and different theories related to it.	U
2	Understand the concept of Geological Time Scale and its divisions.	*U*
3	Recognize major geological event in the Earth's history.	*U*
4	Identify and classify common rock and ore forming minerals.	*R*
5	Classification and identification of different rocks.	*U & R*
6	Understand fossils and fossil record of our planet and identify major extinction events in the earth's history.	*U*
7	Understand the physical properties of our planet including seismicity and magnetism and their origin and importance.	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓			✓		
CO 2	✓		✓		✓		
CO 3	✓		✓		✓		✓
CO 4	✓		✓		✓	✓	

CO 5	✓	✓	✓		✓		
CO 6	✓	✓	✓	✓		✓	✓
CO 7	✓	✓	✓	✓		✓	✓

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**EARTH'S HISTROY**	**10**
	1	Origin of earth and related theories	3
	2	Concept of Geological Time and Earth's History	3
	3	Geological Eras and Periods	2
	4	Major geological events during the past	2
2		**EARTH'S MATERILS**	**10**
	1	Introduction to rock and ore forming minerals.	2
	2	Introduction to rocks. Genetic classification of igneous rocks.	3
	3	Types of sedimentary rocks and their genetic classification.	2
	4	Metamorphic rocks and their genetic classification.	3
3		**FOSSILS AND EARTH'S EVENTS**	**12**
	1	Fossils record and history of planet.	3
	2	Fossilization and types of fossils.	3

	3	Extinction event in Earth history	3
	4	Brief study of K- T boundary extinction	3

4	**PHYSICAL PROPERTIES OF EARTH**		8
	1	Seismicity of earth and distribution of earthquakes	2
	2	Types and properties of seismic waves.	2
	3	Earth magnetism – Elements of earth's magnetic field.	2
	4	Origin and significance of earth's magnetism.	2

5	**Teacher Specific Module**	**5**
	Directions: Develop teacher-specific content for the course focusing on Plate Tectonic Theory, evidence, types of plate boundaries, geological features, tectonic processes including earthquakes, volcanism, and mountain building.	5
Module VI (Practical)	1. Toposheet reading: Identifying the elements, component and features from the toposheet. 2. Drainage basin delineation- Drainage pattern identification. 3. Megascopic mineral identification through physical property only - Quartz, feldspar, biotite, tourmaline, gypsum, calcite, garnet, magnetite, fluorite, dolomite. 4. Megascopic identification of rocks – Granite, basalt, pegmatite, gabbro, slate, phyllite, schist, marble, BIF, charnockite, sandstone, conglomerate, breccia, limestone.	30

Essential Readings:

1. Christiansen, Eric H., and W. Kenneth Hamblin. *Dynamic Earth: an introduction to physical geology*. Jones & Bartlett Publishers, 2014.
2. Skinner, Brian, and S. Porter. "Physical geology." (1987).

3. Plummer, Charles C., David McGeary, and Diane H. Carlson. *Physical geology*. Boston: McGraw-Hill, 2001.
4. McGeary, David, Charles C. Plummer, and Diane H. Carlson. "Physical geology: Earth revealed." *(No Title)* (2001).

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	1
	3	2
	4	1
2	1	3
	2	2
	3	3
	4	2
3	1	1
	2	2
	3	2
	4	4
4	1	4
	2	4
	3	2
	4	3

Suggested Readings:

1. Banger K.M., (2008). Principles of Engineering Geology, Standard publishers and Distributors, 451p
2. Parbin Singh (2012). General and Engineering Geology. S. K. Kataria and Sons
3. Raup, D.M. and Stanley, M.S. (1978) Principles of Palaeontology. CBS Publishers.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU1DSCGEL103: NATURAL HAZARDS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	Minor	100-199	**KU1DSCGEL103**	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	0	--	30	70	100	2 hours

Course Description: *The course offers an in-depth analysis of natural hazards, exploring the origins, mechanisms, and impacts of earthquakes, tsunamis, landslides, volcanic activity, and cyclones. It focuses on understanding these phenomena through scientific principles, assessing their socio-economic effects, and examining strategies for risk mitigation and disaster preparedness.*

Course Prerequisite: A pass in plus two science / any other subject combination with geology at plus two level**.**

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the geological, climatic, and environmental factors contributing to-various natural hazards including landslides, earthquakes, tsunamis, volcanic eruptions, and cyclones.	U
2	Develop the ability to conduct risk assessments for different natural hazards by analyzing their mechanisms, triggers, and impacts.	U, A
3	Students will learn to apply modern techniques and tools for monitoring natural hazards such as seismic instrumentation, tsunami warning systems, and volcano monitoring technologies.	E

4	Students will be equipped to design and evaluate emergency response plans and disaster preparedness strategies for communities at risk from natural hazards.	E
5	Students will integrate knowledge from various disciplines such as geology, environmental science, civil engineering, and urban planning to address complex issues related to natural hazards.	I

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), (I) Integrate**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓					
CO 2			✓				
CO 3	✓		✓	✓			
CO 4	✓					✓	
CO 5					✓	✓	✓

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**LANDSLIDES**	**10**
	1	Landslide as natural hazard- Definition. Geological and climatic factors of landslides.	2
	2	Mechanisms of slope failure. Types of mass movements.	3

	3	Mechanism and factors of landslides.	2
	4	Landslide Risk Assessment and Mitigation - Land-use planning.	3
2		**EARTHQUAKE AND TSUNAMI**	**15**
	1	Geological causes of earthquakes and their potential effects on the environment and human structures.	4
	2	Understand the tools and techniques used in seismic monitoring and measurement of the magnitude and intensity of earthquakes. Richter Scale and Mercalli Scale. Case studies of significant historical earthquakes and their impacts	4
	3	Define tsunamis and understand the conditions that trigger these devastating water movements.	4
	4	Overview of global and regional tsunami warning systems and their effectiveness in early detection and alert processes; Seismic zone map of India	3
3		**VOLCANOES**	**12**
	1	Classification of Volcanoes and Types of Volcanic Eruptions; Introduction to the basic types of volcanoes: shield, composite, cinder cone, and super volcanoes.	4
	2	Detailed exploration of eruption types, including effusive, explosive, phreatomagmatic, and phreatic eruptions. Case studies of notable eruptions and their characteristics.	2
	3	Pyroclastic Flows, Ash Clouds, and different type of Lava Flows	4
	4	Lahars and Volcanic Mudflows; Volcanic Gases and Their Environmental Impact	2
4		**CYCLONES**	**15**
	1	Definition and types of cyclones (tropical, temperate, and others); Introduction to Cyclonic and Anticyclonic Systems;	4
	2	The role of pressure systems, sea surface temperatures, air circulation patterns, and the Coriolis effect in the formation of these systems	3

	3	Differences between hurricanes, typhoons, and cyclones based on geographic location; Case studies of major cyclones and their aftermath; Short-term and long-term ecological impacts (e.g., damage to coral reefs, flooding, erosion)	4
	4	Mitigation and Adaptation Strategies-Engineering and architectural strategies for cyclone-resistant infrastructure; Policy measures and the role of government and non-governmental organizations in risk reduction	4

5	**Teacher Specific Module**	**8**
	To ensure the course on 'Natural Hazards' remains up-to-date and relevant, teachers are encouraged to develop and integrate specific topics that reflect recent developments and case studies in the field of natural disasters. Examples for such events might include the 2018 Kerala floods, the 2024 Dubai floods, and the 2024 Uttarakhand Forest fires. These events provide contemporary relevance and enhance the learning experience.	

Essential Readings:

1.Gupta, H.K. (2003). Disaster Management. Universities Press

2. Smith, K., & Petley, D. (2013). Environmental Hazards: Assessing Risk and Reducing Disaster (6th ed.). Routledge.

3.David H. Keefer (2000) Landslides: A Geological Perspective, CRC Press, 347p

4.John W. Lowe (2011), Understanding Landslides Springer, 295 pages.

5.Patrick L. Abbott (2018): Natural Hazards, Routledge, USA,528p

6.Earthquakes and Tsunamis by Lucy Jane Bledsoe (2016): Chelsea House Publications, Canada, 128p

7. Bruce A. Bolt (2009) – Earthquakes, W. H. Freeman and Company, New York, 504p

8. Peter J. Leone (2019)- Understanding Plate Tectonics ,Springer Nature Switzerland, 200p

9. Katie Preece (2017): Volcanoes: A Very Short Introduction Oxford University Press, United Kingdom, 150p.

10. Robert Decker and Barbara Decker (1990): Volcanoes: Unveiling the Earth's Fire, W. H. Freeman and Company, New York, 432p.

11. Joan Martí and Maria-Jose Lopez (2016) :Volcanoes and the Environment, Cambridge University Press, UK, 368p.

12. William C. Reaves (2017): Hurricanes: The Ultimate Unleashing of Nature, Chelsea House Publications, Canada, 128p.

13. Kerry Emanuel (2000): Tropical Cyclones: Climatology and Dynamics, Academic Press, Elsevier Inc., USA, 496p.

14. Michael S. Dossett (2020) :Weather Hazards: Avoiding, Preparing for, and Recovering from the Most Dangerous Weather Events, ABC-CLIO, USA, 360p.

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1,3,4
	2	3,4
	3	3,4
	4	3,4
2	1	7,8
	2	6,7
	3	6
	4	2,6
3	1	9,10
	2	10
	3	10,11
	4	10,11
4	1	12,13,14
	2	13,14
	3	12,13,14
	4	12,14

Suggested Readings:

1. Murthy, R.K. (2012) Disaster Management, Wisdom Press, New Delhi.
2. State of Environment Report Kerala 2007 Vol. 2 Natural Hazards, KSCSTE 2007
3. Website: www.http://nidm.gov.in
4. Website: www.http://cwc.gov.in

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

SEMESTER 1

FOUNDATION COURSES

KU1MDCGEL101: FUNDAMENTALS OF GEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	MDC	100 -109	KU1MDCGEL101	3	45

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
3	-	-	25	50	75	2 hours

Course Description: *This course provides an in-depth exploration of the fundamental concepts in geology, focusing on minerals, rocks, weathering processes, sedimentary formations, igneous activities, metamorphic transformations, and various geological structures. Through lectures, students will gain a comprehensive understanding of the Earth's dynamic processes and the forces that shape its surface.*

Course Prerequisite: A pass in plus two science / any other subject combination with geology at plus two level.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Students will acquire a deep understanding of the composition, properties, and classifications of minerals and rocks, enabling them to identify and interpret various geological formations accurately.	U
2	Understand processes that shape the Earth's surface and interior.	*U*
3	Understand mineral and rock identification, geological mapping, and the interpretation of geological structures in natural settings.	*U*
4	Knows timescales and dynamic history of the Earth, including its evolution, tectonic events, and environmental changes.	*R*
5	Classification and identification of different rocks.	*U & R*
6	Understand weathering and products of weathering.	*U*

7	Understand the structures of rocks, their origin and importance.	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓			✓		
CO 2	✓		✓		✓		
CO 3	✓		✓		✓		✓
CO 4	✓		✓		✓	✓	
CO 5	✓	✓	✓		✓		
CO 6	✓	✓	✓	✓		✓	✓
CO 7	✓	✓	✓	✓		✓	✓

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**MINERALS AND ROCKS**		**10**
	1	Minerals – Different mineral groups	3
	2	Rock forming minerals- Silicates	3

	3	Physical Properties of Minerals	2
	4	Chemical properties of minerals	2

2	**WEATHERING, SOIL AND SEDIMENTARY ROCKS**		**10**
	1	Weathering – Definition and types. Physical weathering.	3
	2	Chemical and biological weathering.	3
	3	Products of weathering – Soil and soil profile.	2
	4	Sedimentary rocks – Divisions of sediments and sedimentary rocks.	2

3	**IGNEOUS AND METAMORPHIC ROCKS**		**10**
	1	Igneous rocks: Types of Igneous rocks.	2
	2	Igneous forms- Types.	2
	3	Metamorphism – Types of metamorphism	3
	4	General classification of metamorphic rocks.	3

4	**ROCK STRUCTURES**		**10**
	1	Rock structures- stratification- strike and dip – outcrop , factors controlling width of outcrop. Rule of V	3
	2	Fold - geometry and terminology. Types of folds. Fault – terminology and classification. Criteria to recognize fold and fault in the field and map.	4
	3	Joints, foliation and lineation	2
	4	Unconformity and its significance.	1

5	**Teacher Specific Module**	**5**
	Directions: Create teacher-specific content focusing on principles of relative and absolute dating methods, geological time scale, and stratigraphic principles for the course.	

Essential Readings:

1 Plummer, Charles C., David McGeary, and Diane H. Carlson (2014.). *Physical geology*. Boston: McGraw-Hill, 2001.

2. Skinner, Brian, and S. Porter. (1987). Physical geology.

3. Christiansen, Eric H., and W. Kenneth Hamblin. *Dynamic Earth: an introduction to physical geology*. Jones & Bartlett Publishers,

4. Holmes, A. (1981) Principles of Physical Geology. ELBS, Third Edition. Thomas Nelson

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	1
	3	2
	4	1
2	1	3
	2	2
	3	3
	4	2
3	1	1
	2	2
	3	2
	4	4

<table>
<tr><td rowspan="4">4</td><td>1</td><td>4</td></tr>
<tr><td>2</td><td>4</td></tr>
<tr><td>3</td><td>2</td></tr>
<tr><td>4</td><td>3</td></tr>
</table>

Suggested Readings:

1. Parbin singh (2012). General and Engineering Geology. S. K. Kataria and Sons
2. Banger K.M., (2008). Principles of Engineering Geology, Standard publishers and Distributors, 451p

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**50**
Theory test paper		50
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
	Total	**75**

KU1MDCGEL102 : EARTH SYSTEM STUDIES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	MDC	100 -109	KU1MDCGEL102	3	45

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
3	-	-	25	50	75	2 hours

Course Description: *students will achieve a comprehensive understanding of the fundamental aspects of the Earth's structure, atmosphere, oceans, and geological processes. They will grasp the concept of plate tectonics and its role in shaping the Earth's surface through processes like seafloor spreading, continental drift, and the formation of various geological features such as mountains, volcanoes, and earthquakes. Overall, students will develop a holistic understanding of Earth's dynamic processes, enabling them to appreciate the interconnectedness of various Earth systems and their impacts on the environment and human society.*

Course Prerequisite: A pass in plus two science / any other subject combination with geology at plus two level.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understands the internal structure of earth	U
2	Understand processes lithospheric plate movements.	*U*
3	Understand structure and composition of atmosphere.	*U*
4	Knows clouds and their types.	*R*
5	Understands oceanic processes and geologic landforms.	*U & R*

6	Understand Coastal erosion and beach related land features and geological action of rivers.	*U*
7	Understand the occurrence, distribution and geological actions of groundwater	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓			✓		
CO 2	✓		✓		✓		
CO 3	✓		✓		✓		✓
CO 4	✓		✓		✓	✓	
CO 5	✓	✓	✓		✓		
CO 6	✓	✓	✓	✓		✓	✓
CO 7	✓	✓	✓	✓		✓	✓

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**STRUCTURE AND TECTONICS OF THE EARTH**		**10**
	1	Structure and composition of the earth – crust, mantle and core. Role of seismic waves in understanding earth's interior.	3

	2	Lithosphere and lithospheric plates, Continental drift theory of Wegner and supporting evidences.	3
	3	Plate Tectonics -basic concepts and hypothesis. Classification of plate boundaries- divergent, convergent, transform boundaries. Geological features associated with each type of plate boundary	2
	4	Seafloor spreading and paleomagnetism. Plate Movement Mechanisms.	2

2	**EARTH'S ATMOSPHERE**		**10**
	1	Overview of Earth's atmospheric layers- Troposphere, stratosphere, thermosphere, mesosphere and ionosphere Ozone layer: formation, distribution, and significance.	3
	2	Composition of the atmosphere- temperature gradients in the atmosphere. Cloud identification based on appearance and altitude - Stratus, cirrus, nimbus and cumulus, cumulonimbus clouds.	3
	3	Greenhouse gases and their role in climate change-Ozone layer and ozone depletion.	2
	4	Air pollution and its impact on the atmosphere	2

3	**OCEANIC FEATURES AND PROCESSES.**		**10**
	1	Hydrosphere – Ocean - Ocean basins: Topography and features	3
	2	Ocean currents and their geological impact.	2
	3	Submarine volcanism and hydrothermal vents- Mid-ocean ridges, trenches, and abyssal plains - Submarine landslides and their consequences	2
	4	Coastal erosion and deposition -Formation of beaches, spits, and barrier islands - Earthquakes and tsunamis in the ocean- - storm surges and hurricanes.	3

4	**GEOLOGICAL WORK OF STREAMS AND GROUNDWATER**		**10**
	1	Streams – types, drainage pattern.	2
	2	Stream as a geological agent – landforms	3
	3	Groundwater – Hydrological cycle, source and origin of groundwater, vertical distribution of groundwater, classification of rocks based on hydrologic characteristics. Artesian wells.	2
	4	Groundwater as a geological agent – land forms	3

5	**Teacher Specific Module**	
	Develop teacher-specific modules incorporating contemporary global events related to atmospheric circulation patterns such as global wind systems, jet streams, and monsoons. Additionally, integrate geological hazards like earthquakes, cyclones, and tsunamis along with their mitigation strategies into the course content.	

Essential Readings:

1. Thompson, G. R. and Turk, J. (1997) Introduction to Physical Geology. 2nd Edn. Thompson Brooks Publishers.

2. Carlson, D. and Plummer, C. (2010) Physical Geomorphology: Earth Revealed. 9th Edn., Mc-Graw Hill Co.

3.Parbin singh (2012). General and Engineering Geology. S. K. Kataria and Sons

4. Herbert Riehl 1978, Introduction to the Atmosphere, III edn. MacGraw Hill

5. Siddartha.K, Climatology (Atmosphere, Weather and Climate) Kithab Mahal

6. Shepard, F.P, 1963, Submarine Geology, II edn., Harper & Row.

7.Sverdrup, H.V. et al., 1961, The Oceans, Asia Publishing House.

8. Ahamed, E. (1972) Coastal Geomorphology of India. Orient Longman, New Delhi.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2

	2	1,2
	3	1, 2
	4	1,2
2	1	3,4
	2	4,5
	3	4,5
	4	4,5
3	1	6
	2	7
	3	1,6
	4	5,8
4	1	1,2
	2	2,3
	3	1,3
	4	1

Suggested Readings:

1. Banger K.M., (2008). Principles of Engineering Geology, Standard publishers and Distributors, 451p
2. Mahapatra, A text book of Geology

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**50**
Theory test paper		50
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10

c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
	Total	**75**

SEMESTER 2

DISCIPLINE SPECIFIC COURSES

KU2DSCGEL101: DYNAMIC EARTH

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	Major	100-199	**KU2DSCGEL101**	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
3	2	--	25	50	10	15	100	2 hours

Course Description: *This comprehensive course explores Earth's dynamic processes and landforms, covering both endogenic and exogenic phenomena. Topics include plate tectonics, earthquakes, volcanoes, wind, streams, lakes, groundwater, glaciers, soil, mass wasting, oceanography, coastal geomorphology, seafloor morphology, and mountain classification. Through this curriculum, students gain a holistic understanding of Earth's surface processes and landform evolution.*

Course Prerequisite: A pass in plus two science / any other subject combination with geology at plus two level.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand Earth's internal processes and their impact on surface features.	U
2	Analyze landform types and their evolution.	An

3	Demonstrate knowledge of hydrological processes and their geological effects.	U
4	Analyze glacier formation and their role in landscape shaping.	A
5	Explore coastal, seafloor, and mountain processes and their significance.	U, A

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2	✓		✓			✓	
CO 3	✓	✓	✓		✓		
CO 4	✓						
CO 5	✓	✓	✓				

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**ENDOGENIC PROCESSES**		**15**
	1	Endogenic processes of earth – Plate tectonic theory.	3
	2	Types of plate boundaries and associated processes. Tectonic landforms.	5

	3	Earthquakes – Seismic waves – Distribution of earthquakes and reason.	4
	4	Volcanos – Types of volcanos and their distribution.	3

2	**EXOGENIC PROCESSES**		**8**
	1	Exogenic process of earth. Wind and their geological work. Aeolian landforms.	2
	2	Stream as a geological agent – Role of river in the landform evolution.	2
	3	Lakes -Definition and scope of limnology- Classification of lakes based on origin, size, and physical characteristics. Groundwater - Hydrological cycle, source and origin of groundwater.	2
	4	Vertical distribution of groundwater, classification of rocks based on hydrologic characteristics. Artesian wells. Geological action of groundwater– land forms- Karst topography.	2

3	**GLACIER, SOIL AND MASS WASTING**		**7**
	1	Glacier – General introduction of ice age and their importance. Definition and classification of glaciers. Glacier formation and types	2
	2	Geological work of glacier. Glacial erosion mechanisms. Erosional and depositional landforms.	2
	3	Soil and soil profile. Role of climate in soil formation. Types and causes of soil erosion. Badlands topography	2
	4	Mass wasting processes- types of mass wasting. Factors controlling mass wasting.	1

4	**OCEANS AND MOUNTAINS**		**10**
	1	Ocean – Waves, tides and currents. Origin of waves and tides.	2

	2	Coastal geomorphology - Erosional and depositional landforms	2
	3	Seafloor morphology and topographic variations – Continental shelf, continental slope and rise. Submarine canyon formation.	3
	4	Mountains – types. Classification of mountains based on origin: tectonic, volcanic, and residual. Brief study of origin of Himalayan Mountain belt.	3

5	**Teacher Specific Module**	**5**
	Directions- Participate in the class room discussion by posting one question and responding to two peers about the topics discussed.	
6	**Practical**	30
	1. Dentification of plate boundaries from models, figures and maps 2. Landform identification from models – stream, glacier, wind, lake and ocean. 3. Use of toposheets for the identification of different landforms. 4. Slope calculation 5. Landslide identification from diagram and google earth image 6. Epicentre calculation from triangulation method	

Essential Readings:

1. Thompson, G. R. and Turk, J. (1997) Introduction to Physical Geology. 2nd Edn. Thompson Brooks Publishers.
2. Carlson, D. and Plummer, C. (2010) Physical Geomorphology: Earth Revealed. 9th Edn., Mc-Graw Hill Co.
3. Parbin Singh (2012). General and Engineering Geology. S. K. Kataria and Sons
4. Holmes, A. (1981) Principles of Physical Geology. ELBS, Third Edition. Thomas Nelson. Prentice Hall Inc. London.

5. Thornbury, W.D. (1968) Principles of Geomorphology, Wiley.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2
	2	1,3
	3	2,3
	4	1,3
2	1	1,4
	2	2,4
	3	4
	4	1,2,3
3	1	1,2
	2	1,2
	3	1,3
	4	3,5
4	1	1,2,4
	2	1,2,4
	3	2,3
	4	3,4

Suggested Readings:

1. Bloom, A.L. (1992) Geomorphology, Second Edition, Prentice Hall India Pvt. Ltd., New Delhi.
2. Gilluly, J., Waters A.C. and A.O. Woodford (1975) Principles of Geology. 4th Edition, W.H. Freeman and Co.
3. Judson, S. and Kauffman, M.E. (1990) Physical Geology. Eighth Edition, Prentice Hall, New Jersey.

4. Mcalister, A.L. and Hay, E.A. (1975) Physical Geology, Principles and Perspectives. Prentice Hall Inc. London.
5. Montgomery C.W. (1993) Physical Geology. Wn. C. Brown Publishers, IOWA.
6. Skinner B.J. and Porter S.C. (1987) Physical Geology. John Wiley and Sons, New York.
7.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU2DSCGEL102 – LANDFORMS OF OUR PLANET

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	Minor	100 - 199	KU2DSCGEL102	4	75

<table>
<tr><th colspan="3">Learning Approach (Hours/ Week)</th><th colspan="5">Marks Distribution</th><th rowspan="3">Duration of ESE (Hours)</th></tr>
<tr><th rowspan="2">Lecture</th><th rowspan="2">Practical/ Internship</th><th rowspan="2">Tutorial</th><th colspan="2">Theory</th><th colspan="2">Practical</th><th rowspan="2">Total</th></tr>
<tr><th>CCA</th><th>ESE</th><th>CCA</th><th>ESE</th></tr>
<tr><td>3</td><td>2</td><td>--</td><td>25</td><td>50</td><td>10</td><td>15</td><td>100</td><td>2 hours</td></tr>
</table>

Course Description:

This course explores the dynamic forces shaping Earth's surface through four modules. Module 1 discusses mountains and glaciers, covering their diverse features, types, and the geological processes behind their formation. Module 2 focuses on rivers and wind, discussing their roles as agents of erosion and deposition, along with the landforms they create. In Module 3, the course examines oceans, seas, and lakes, emphasizing ocean bathymetry, wave and current-driven landforms, and various lake types. Finally, Module 4 delves into groundwater, its types, and associated geological features, as well as the types and significance of volcanoes. Each module offers a comprehensive understanding of Earth's dynamic geology within a compact timeframe.

Course Prerequisite: A pass in plus two science / any other subject combination with geology at plus two level.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Remember and understand the diverse features and classifications of mountains, including tectonic and non-tectonic origins	U

2	Understand the formation and characteristics of glaciers, exploring various types and their role in past ice ages, and identify erosional and depositional landforms resulting from glacial activity.	U
3	Understand the river dynamics, including drainage patterns, geological processes, and the formation of erosional and depositional landforms associated with river systems.	R
4	Examine wind as a geological agent, understanding its role in shaping the Earth's surface and identifying erosional and depositional landforms formed by wind processes.	U & R
5	Explore the ocean and its geological features, including bathymetry, waves, currents, and associated landforms, as well as the types and characteristics of lakes and estuaries.	U
6	Identify the groundwater systems, including types and occurrence zones, and understand the geological processes associated with groundwater and formation related landforms. Additionally, classify types of volcanoes and understand their impact on the Earth's surface and climate.	U

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓				✓		
CO 2	✓	✓			✓		
CO 3	✓				✓	✓	
CO 4	✓	✓		✓	✓	✓	
CO 5	✓	✓	✓		✓	✓	✓
CO 6	✓		✓		✓	✓	✓

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**MOUNTAINS AND GLACIERS**		**10**
	1	Mountains – Features and different type of Mountains	2
	2	Tectonic and Non- tectonic mountains.	2
	3	Glacier - Types of glaciers – Ice age	3
	4	Erosional and depositional land forms of glaciers	3
2	**RIVER AND WIND**		**10**
	1	River and river profile – Drainage pattern of the river	3
	3	Erosional and depositional landforms of river.	3
	4	Wind as a geological agent.	2
	5	Erosional and depositional landforms of wind.	2
3	**OCEAN AND LAKES**		**10**
	1	Ocean and sea. - Ocean bathymetry	2
	2	Geological agents in ocean - Wave and currents	2
	3	Landforms of ocean	3
	4	Lakes and estuaries - types of lakes.	3

4	**GROUNDWATER AND VOLCANO**		**10**
	1	Groundwater – Types of groundwater	2
	2	Type of aquifers	2
	3.	Geological work of groundwater and related landforms	3
	4.	Volcanos- types and importance.	3

5	**Teacher Specific Module**	**5**
	Directions: Students are required construct models, figures, tables and diagrams, conduct lab and field experiments as per the requirement of the course guided by teacher in charge. Teacher can direct students to recent and real time learning activities related with earth based landforms.	
6 Practical	1. Dentification of plate boundaries from models, figures and maps 2. Landform identification from models – stream, glacier, wind, lake and ocean. 3. Use of toposheets for the identification of different landforms. 4. Slope calculation 5. Landslide identification from diagram and google earth image 6. Epicentre calculation from triangulation method	30

Essential Readings:

1 Tarbuck, Edward J., et al. *Earth: an introduction to physical geology*. Upper Saddle River: Pearson/Prentice Hall, 2005.

2. Plummer, Charles C., David McGeary, and Diane H. Carlson. *Physical Geology*. Boston: McGraw-Hill, 2001.

3.Huggett, Richard, and Emma Shuttleworth. *Fundamentals of geomorphology*. Routledge, 2022.

4. Gregory, Kenneth J., and John Lewin. *The basics of geomorphology: Key concepts*. Sage, 2014.
5. Christiansen, Eric H., and W. Kenneth Hamblin. *Dynamic Earth: an introduction to physical geology*. Jones & Bartlett Publishers, 2014.
6.Knauss, John A., and Newell Garfield. *Introduction to physical oceanography*. Waveland Press, 2016.
7.Todd, David Keith, and Larry W. Mays. *Groundwater hydrology*. John Wiley & Sons, 2004.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2
	2	1,2
	3	1,2
	4	1,2
2	1	2,3
	2	1,2
	3	2,3
	4	3,4
3	1	2,6
	2	2,6
	3	2,5,6
	4	2,5,6
4	1	2,7
	2	1,2,7
	3	2,7
	4	7

Suggested Readings:

1.Ahamed, E. (1972) Coastal Geomorphology of India. Orient Longman, New Delhi.

2. King, C.A.M. (1972) Beaches and Coasts. Arnold, London.

3. Thornbury, W.D. (1968) Principles of Geomorphology, Wiley.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU2DSCGEL103: OUR OCEAN

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	Minor	100-199	KU2DSCGEL103	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	0	--	30	70	100	2 hours

Course Description: *This course provides a comprehensive understanding of ocean science, covering the physiography and bathymetric features of the ocean floor, plate tectonics including mechanisms of seafloor spreading and plate motion, properties of seawater, factors influencing ocean circulation, coastal phenomena such as upwelling/downwelling and storms, ocean waves and tides, tsunami generation and early warning systems, marine resources including petroleum, methane hydrates, manganese nodules, and ferromanganese crusts, as well as marine pollution sources, impacts, and mitigation strategies.*

Course Prerequisite: A pass in plus two science / any other subject combination with geology at plus two level.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand ocean floor features and their significance.	U
2	Analyze plate tectonics and seafloor spreading mechanisms.	An

3	Demonstrate knowledge of ocean properties and circulation patterns.	U, A
4	Assess the impact of natural phenomena on coastal environments.	E
5	Identify marine pollution sources and mitigation strategies.	A

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2	✓	✓					
CO 3		✓				✓	
CO 4			✓			✓	
CO 5			✓			✓	✓

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**OCEAN FLOOR AND PLATE TECTONICS**	**15**
	1	Physiography and bathymetric features of Ocean floor. – Continental shelve, slope and abyssal plain.	3

	2	Introduction to plate tectonics - continental drift: Wegener's hypothesis. Role of the lithosphere in plate tectonics. Types of plate boundaries. Evidences for plate tectonics.	4
	3	Origin of oceanic basin. Mechanisms of seafloor spreading: mid-ocean ridges, rift zones, and transform faults. Evidence supporting seafloor spreading.	4
	4	Mechanisms of Plate Motion- Mantle convection, Ridge push and slab pull mechanisms. Wilson cycle.	4

2	**OCEAN WATER AND CIRCULATION**		**15**
	1	Temperature, salinity, and density of sea water, Layers of the ocean: surface, thermocline, deep ocean Physical and chemical characteristics of each layer. Dissolved gases in the ocean.	4
	2	Factors influencing ocean circulation: winds, temperature gradients, and density variations.	4
	3	Coastal upwelling and downwelling: mechanisms and impacts.	3
	4	Coastal storms and storm surges. Ocean currents	4

3	**OCEAN WAVES AND TIDES**		**15**
	1	Ocean waves – Component and origin.	3
	2	Geological work of ocean wave and coastal landforms.	5
	3	Tide – Origin and influencing factors. Tidal currents.	3
	4	Tsunami- definition and characteristics. Tsunami generation mechanisms- earthquakes, landslides and volcanic eruption. Tsunami early warning system.	4

4	**MARINE RESOURCES; MARINE POLLUTION**		**10**
	1	Marine resources- Petroleum and natural gases.	3

	2	Methane hydrates- occurrence and distribution.	3
	3	Manganese nodules and ferromanganese crust -occurrence and distribution	2
	4	Marine pollution – Types and sources of marine pollutants - Anthropogenic Sources. Impact of Marine Pollution. Mitigation	2

5	**Teacher Specific Module**	**5**
	Directions -Watch educational videos explaining the basics of marine sediments and their importance. Use oceanographic maps to study the global distribution of various marine sediments. Study the major surface currents (e.g., Gulf Stream, Kuroshio Current) from textbooks and atlases. Visit a local estuary *to* understand *the ecological importance of estuaries and their unique environments.*	

Essential Readings:

1. Bhatt, J.J. 1978 Oceanography - Exploring "the planet Ocean. *D. van Nostrand Company*
2. Duxbury, A.B. 1993 Fundamentals of Oceanography. *Wm. C. Brown Publishers* & Duxbury, AC.
3. Erickson, J., & Harris, L. S. (2013). Marine Geology. Jones & Bartlett Learning
4. Garrison, T. 1996 Oceanography-An invitation to Marine Science. *Wadsworth Publishing Company*
5. Gross, M.G. 1972 Oceanography - A view of the Earth. *Prentice-Hall*
6. Lal, D.S. (1996), Climatology and oceanography, Sharda Pustak Bhawan publishers , Allahabad.
7. Thompson, G. R. and Turk, J. (1997) Introduction to Physical Geology. 2nd Edn. Thompson Brooks Publishers.
8. Carlson, D. and Plummer, C. (2010) Physical Geomorphology: Earth Revealed. 9th Edn., Mc-Graw Hill Co.
9. Qasim, S.Z. & 1996 India's Exclusive Economic Zone. Omega Scientific Roonwal, G.S.(eds). Publishers
10. Roonwal, G.S. 1986 The Indian Ocean: Exploitable mineral and petroleum Resources. Narosa Publishing House

11. Thobias N Hofer (2008)- Marine Pollution:New Research, Nova Science publishers, Inc., New York.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2
	2	7,8
	3	7,8
	4	7,8
2	1	1,2,3
	2	4,6
	3	4,6
	4	4,5,6
3	1	1,2,4
	2	7,8
	3	6
	4	6
4	1	9,10
	2	9,10
	3	9,10
	4	11

Suggested Readings:

1. S. Davis, R.A. Jr. 1972 Principles of Oeanography. *Addison - Wesley Publishing Company*
2. Thurman, B.Y. 1978 Introductory Oceanography. *Charles E. Merill Publishing Company*

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

SEMESTER 2

FOUNDATION COURSES

KU2MDCGEL102: INTRODUCTION TO GEOMORPHOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	MDC	100-199	KU2MDCGEL102	3	45

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
3	0	-	25	50	75	2 hours

Course Description: *This course provides a comprehensive examination of Earth's dynamic surface processes, encompassing both internal (endogenic) and external (exogenic) forces. Students will explore topics such as continental drift, plate tectonics, earthquakes, volcanoes, wind erosion, stream activity, glaciation, mass wasting, coastal processes, oceanic features, mountain types, and geomorphological features on extraterrestrial bodies. Through theoretical discussions, practical applications, and case studies, students will deepen their understanding of Earth's surface dynamics and the broader field of geosciences.*

Course Prerequisite: A pass in plus two science / any other subject combination with geology at plus two level**.**

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the processes driving Earth's surface dynamics, including plate tectonics, seismic activity, and volcanic eruptions.	U

2	Identify and analyze landforms resulting from both endogenic and exogenic processes, such as mountains, valleys, and coastal features.	An
3	Evaluate the impact of glacial activity and mass wasting processes on landscape formation and modification.	E
4	Explain oceanic processes like waves, tides, and currents, and their role in shaping coastal landforms.	U
5	Recognize and discuss geomorphological features on extraterrestrial bodies, enhancing understanding of planetary geology.	An, E

*_**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**_

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓		✓				
CO 3				✓			
CO 4	✓						
CO 5	✓					✓	

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**ENDOGENIC PROCESSES**	**10**
	1	Endogenic processes. Continental drift and Plate tectonic theory.	2
	2	Land forms associated with plate boundaries.	2
	3	Earthquakes – Types of earthquakes, Types of seismic waves. Seismograph and seismogram. Global distribution of earthquake.	3
	4	Volcanos – Types of volcanos, Volcanic land forms and global distribution of volcano.	3

2		**EXOGENIC PROCESSES**	**10**
	1	Exogenic process of earth. Wind and their geological work.	2
	2	Landforms of aeolian origin	2
	3	Streams: Types, Drainage basins and drainage patterns	3
	4	Geological activity of stream; erosional and depositional landforms. Davisian cycle.	3

3		**GLACIERS; LANDSLIDES**	**10**
	1	Glacier –formation and morphology, types, erosion and transportation by glaciers	3
	2	Glacial landforms, Ice age.	3

	3	Mass wasting processes- Landslides- types of landslides.	3
	4	Causes and prevention of landslides.	1

4	**OCEAN FLOOR; MOUNTAINS AND EXTRATERRESTRIAL GEOMORPHOLOGY**		**10**
	1	Ocean – Ocean floor topography. Coastal processes: Waves, tides and currents.	3
	2	Erosional and depositional processes by ocean and resulting landforms. Tsunami.	3
	3	Mountains – Different types. Orogenic and anorogenic mountains.	2
	4	Geomorphological features in extra-terrestrial bodies (Mars and Moon)	2

5	**Teacher Specific Module**	**5**
	Direction This module provides an in-depth introduction to the geomorphology of India, focusing on the processes that shape the landscape and the resulting landforms. Topics include tectonics, fluvial processes, coastal geomorphology and desert landscapes,	

Essential Readings:

1. David H. Keefer (2000) Landslides: A Geological Perspective, CRC Press, 347p
2. Gilluly, J., Waters A.C. and A.O. Woodford (1975) Principles of Geology. 4th Edition, W.H. Freeman and Co.
3. Judson, S. and Kauffman, M.E. (1990) Physical Geology. Eighth Edition, Prentice Hall, New Jersey.
4. Mcalister, A.L. and Hay, E.A. (1975) Physical Geology, Principles and Perspectives. Prentice Hall Inc. London.

5. Montgomery C.W. (1993) Physical Geology. Wn. C. Brown Publishers, IOWA.
6. Skinner B.J. and Porter S.C. (1987) Physical Geology. John Wiley and Sons, New York.
7. Bhatt, J.J. 1978 Oceanography - Exploring "the planet Ocean. D. van Nostrand Company
8. Michael H. Carr (2006): Mars: A Very Short Introduction, Oxford University Press, United Kingdom,184p.
9. Ian Crawford (2008) :The Moon: A Very Short Introduction, Oxford University Press, United Kingdom,184p

Reference Distribution:

Module	Unit	Reference No.
1	1	2,3
	2	2,5
	3	3,6
	4	5,6
2	1	3,4
	2	5
	3	4,5
	4	3,5
3	1	3,4
	2	4,5
	3	1
	4	1
4	1	5,6,7
	2	6,7

	3	6,7
	4	8,9

Suggested Readings:

1. Kale, V.S., & Gupta, A. (2001). Introduction to Geomorphology. Orient Longman.
2. Bloom, A.L. (1992) Geomorphology, Second Edition, Prentice Hall India Pvt. Ltd., New Delhi.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**50**
Theory test paper		50
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
	Total	**75**

SEMESTER 3

DISCIPLINE SPECIFIC COURSES

KU3DSCGEL201 – CRYSTALS AND MINERALS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	Major	200-299	**KU3DSCGEL201**	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
3	2	--	25	50	10	15	100	2 hours

Course Description:

This course provides students with an understanding of various aspects of crystals, including their atomic structure, lattice arrangements, and morphological features. It covers concepts such as crystallographic axes, symmetry elements, and interfacial angles, shedding light on the intricate world of crystalline solids. Meanwhile, mineralogy delves into the physical properties and macroscopic identification of minerals, facilitating a comprehensive grasp of their descriptive characteristics and classification. Together, these modules establish a foundational understanding of the science behind crystals and minerals, which is essential for various fields within geology.

Course Prerequisite:

The learner must have completed the basic courses in 100 – 199 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Gain an understanding of basic facts morphology of mineral crystals	*U*
2	Explore Parameters, Weiss notation, Miller Indices. Law of rational indices.	*U & An*

3	Analyse the various symmetry elements of crystals comprising Rotational, Reflectional, Inversion	*U & An*
4	Understands Interfacial angle – Contact goniometer and reflection goniometer, Law of constancy of interfacial angle, Zone and zone law.	*U & A*
5	Classify Crystals into possible Systems and classes with special emphasis on holohedral, hemihedral, hemimorphic and enantiomorphic crystal forms.	*U*
6	Understands the physical properties and megascopic identification of minerals. .	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓			✓		✓	✓
CO 3	✓			✓			✓
CO 4		✓			✓	✓	
CO 5	✓	✓		✓			

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**CRYSTALS**		**12**
	1	Crystals – basic facts. Atomic Structure and Arrangement. Crystal Lattice and Unit Cells. Morphology of crystals.	4

	2	Crystallographic Axes and Directions -Parameters, Weiss notation, Miller Indices. Law of rational indices.	4
	3	Symmetry Elements in Crystals - Rotational, Reflectional, Inversion. Zone and zone law. Interfacial angle – Contact goniometer and reflection goniometer. Law of constancy of interfacial angle.	4
	4	Holohedral, hemihedral, hemimorphic and enantiomorphic crystal forms. Overview of Crystal Systems and classes.	4

2	**MINERALS**		**10**
	1	Minerals – definition, the structure of minerals, types of bonding.	3
	2	Isomorphism, polymorphism, solid solution and exsolution	3
	3	Identification of minerals. Physical properties- Habit, colour, streak, lustre, fracture, cleavage, hardness and specific gravity. Scale of hardness, determination of specific gravity.	2
	4	Electrical, magnetic, thermal and chemical properties of minerals.	2

3	**CLASSIFICATION OF MINERALS**		**8**
	1	An outline of classification of minerals- native elements, sulphides and their analogues, halides, silicates, aluminosilicates and their analogues, carbonates, borates, nitrates, phosphates, sulphates, oxides and hydroxides.	2
	2	Native metals – Gold, silver, platinum and copper Non-metals – Diamond, graphite and sulphur	2
	3	Sulphides and their analogues. Structure and classification of silicates.	2
	4	Structure and classification of silicate minerals with detailed physical, and chemical properties of the following mineral families: Olivine, Garnet, Alumino silicate, Epidote. ,	2

4	**MINERAL GROUPS**		**10**
	1	Structure and classification of silicate minerals with detailed physical, and chemical properties of the following mineral families Pyroxene, Amphibole, Mica,	3

	2	Structure and classification of silicate minerals with detailed physical, and chemical properties of the following mineral families Feldspars, Feldspathoids, Quartz	2
	3	Structure and classification of silicate minerals with detailed physical, and chemical properties of the following mineral families Zeolite group, Beryl, Cordierite and Tourmaline.	3
	4	Clay minerals: Kaolinite, Montmorillonite, and Illite.	2

5	**Teacher Specific Module**	**5**
	Directions: Use diagrams to visualize how axial ratios vary among the six crystal systems. Examine precipitation from solutions, emphasizing conditions like evaporation and changes in pH or temperature that lead to mineral formation. Understand metamorphism as the transformation of existing minerals under heat and pressure. Investigate how factors like water, oxygen, and biological activity contribute to mineral alteration, forming secondary minerals.	
6 **Practical**	**Identification of crystal forms** – Base, prism, pyramid, Pinacoids and domes. Finding interfacial angle. Finding Miller indices of crystal faces. Drawing of symmetry elements of cubic crystal **Hands-on identification following minerals using physical properties:** Quartz, Smoky Quartz, Milky Quartz, Rosy Quartz, Amethyst, Chalcedony, Agate, Flint, Jasper, Chert, Opal, Orthoclase, Microcline, Plagioclase, Nepheline, Leucite, Sodalite, Enstatite, Bronzite, Hypersthene, Diopside, Augite, Spodumene, Acmite, Rhodonite, Wollastonite, Anthophyllite, Tremolite, Actinolite, Hornblende, Olivine, Serpentine, Muscovite, Biotite, Vermiculite, Phlogopite, Chlorite, Epidote, Garnet, Natrolite, Stilbite, Apophyllite, Talc, Steatite, Andalusite, Kyanite, Sillimanite, Staurolite, Cordierite, Apatite, Beryl, Topaz, Calcite, Dolomite, Tourmaline, Zircon, Fluorite, Magnesite, Gypsum, Corundum	30

Essential Readings:

1. Dana, E.S. (1955). A text book of mineralogy – Asia publishing House, Wiley.

2. Read, H.H. (1984) Rutley's elements of Mineralogy. CBS Publishers, Delhi.

3. Mason, B. and Berry, L.G- Elements of Mineralogy – W.H. Freeman & Co.

4.Berry, Mason, Dietrich, (2000) Mineralogy, CBS Publication.

5. Nesse Williams, D. (2008) Introduction to Mineralogy. Oxford University Press.

6. Perkins Dexter (2006) Mineralogy. Pearson Prentice Hall.

7.Milovski, A.V.,and Konov O.V.,(1985). Mineralogy, Mir publishers, Moscow

Reference Distribution:

Module	Unit	Reference No.
1	1	1, 2
	2	1, 2
	3	1,2
	4	1,2
2	1	1,2,3,7
	2	1,2,3, 7
	3	1,4,5
	4	1, 4,6
3	1	4, 5
	2	4,5,6
	3	5, 6
	4	1,6
4	1	1,2,6
	2	1,2.6
	3	1,2,6
	4	1,6

Suggested Readings:

1. Bangar, K.M., (2008). Principles of Engineering Geology, Standard publishers distributors, New Delhi, 451p.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15

Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU3DSCGEL202– ROCK STRUCTURES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	Major	200-299	KU3DSCGEL202*	4	90

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship*	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
2	4	--	15	35	20	30	100	2 hours

*A 4-hour per week practical component is allotted for this course. This includes fieldwork at geologically important locations in South India for 4 to 6 working days. The remaining hours, after the fieldwork, will be dedicated to theory classes or laboratory work.

Course Description:
In this course, students learn about different types of igneous, sedimentary and metamorphic rock structures and their formation.

Course Prerequisite:
The learner must have successfully completed the courses of 100 to 199 level of B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the diverse range of igneous forms and structures, including both extrusive and intrusive formations.	U &A
2	Identify and analyse various igneous rock structures and to develop proficiency in recognizing and interpreting these structures, providing insights into the processes associated with igneous rocks.	An
3	Understands various textures of metamorphic rocks.	U
4	Understands various structures found in metamorphic rocks	U
5	Apply acquired knowledge to interpret geological landscapes and formations, enhancing skills in geological mapping and fieldwork.	Ap & An
6	Gain practical expertise in identifying and interpreting different rock structures in real-world geological settings.	An

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✔			✔		✔	

CO 2	✓	✓			✓		✓
CO 3	✓		✓				✓
CO 4	✓		✓			✓	
CO 5	✓			✓		✓	
CO 6	✓		✓				

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**IGNEOUS FORMS AND STRUCTURES**		**9**
	1	Formation of different igneous forms and classification. Extrusive forms - Lava flows, pyroclastic deposits, and volcanic ash	2
	2	Intrusive igneous forms – Concordant forms- sill, laccolith, lopolith and phacolith.	2
	3	Intrusive igneous forms – Discordant forms - dyke, cone sheets, batholiths, stocks, bosses, bysmalith, ring dykes and dyke swarms.	3
	4	Igneous rock structures - vesicular, amygdaloidal, blocky lava, ropy lava, pillow structure, flow structure, sheeted joints, mural jointing, columnar jointing, rift and grain	2

2	**SEDIMENTARY STRUCTURES**		**8**
	1	Classification of sedimentary structures	3
	2	Physical structures – Bedding and laminations, bedding plane markings and deformation structures.	2

	3	Chemical sedimentary structures – Solution, accretionary and composite structures.	2
	4	Biogenic structures – Petrification, stromatolites and miscellaneous structures	1

3	**METAMORPHIC TEXTURES AND STRUCTURES**		**7**
	1	Textures of metamorphic rocks – Crystalloblastic, porhyroblastic, granoblastic and palimpsest texture.	1
	2	Cataclastic, Maculose and slaty structure	2
	3	Schistose, Gneissose, Granulose and Hornfelsic structure.	2
	4	Structural aspects of the following rocks -Slate, phyllite, schist, gneiss, amphibolite and marble.	2

4	**DEFORMATION STRUCTURES**		**7**
	1	Rock deformation – Stress and strain diagram - Hook’s law. Lithostatic stress.	2
	2	Structure related to ductile and brittle deformation.	2
	3	Shear zones and lineaments.	2
	4	Rock structures in tectonic settings	1

5	**Teacher Specific Module**	5
	Directions: This module focuses on the study of rock structures, examining their formation, classification, and the processes that influence their development. Students will gain an understanding of interpretation of rock structures in various geological settings. Students are required figures and diagrams, conduct field visits as per the requirement.	

VI	• Fieldwork/study tour within South India will last 4 to 6 working days. • Students will be deputed to fieldwork/study tour for 4 to 6 consecutive days in geologically important area. • During this tenure the students will learn the basic of mineral and rock identification from the field • Understand and implement the basics of mapping. • Understand and apply the geological field instruments.	

Essential Readings:

1. Tyrrell, George Walter. *The principles of petrology: an introduction to the science of rocks*. Springer Science & Business Media, 2012.
2. Tucker, Maurice E., and Stuart J. Jones. *Sedimentary petrology*. John Wiley & Sons, 2023.
3. Pyle, David. Blatt, H. & Tracy, RJ 1996. Petrology. Igneous, Sedimentary, and Metamorphic, WH Freeman & Co. *Geological Magazine* 134.1 (1997): 121-142.
4. Winter, John D. *Principles of igneous and metamorphic petrology*. Vol. 2. Harlow, UK: Pearson education, 2014.
5. Park, R. *Foundation of structural geology*. Routledge, 2013.
6. Marshak, S., & Mitra, G. (1988). Basic methods in structural geology (1st ed.). Prentice Hall. 446 p
7. Twiss, R. J., & Moores, E. M. (1992). Structural geology (2nd ed.). W. W. Norton & Company., 528 p

Reference Distribution:

Module	Unit	Reference No.
1	1	1, 4
	2	1, 4
	3	1, 4

	4	1, 4
2	1	2, 3
	2	1,2
	2	1, 2
	4	1,2,3
3	1	1,5
	2	1,5
	3	1,5
	4	1,5
4	1	5
	2	5
	3	6,7
	4	6,7

Suggested Readings:

1. Turner.F.J and Verhoogen.J (1960) Igneous and Metamorphic Petrology – McGraw Hill
2. Ehler G.E. and Blatt H. (1999) Petrology- Igneous, Sedimentary and Metamorphic. CBS Publishers and Distributors, New Del

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**65**
a)	Theory test paper	35
b)	Practical test paper	30
Continuous Evaluation (Theory)		**15**
a)	Written test	5

b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	5
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**20**
a)	Test paper/Practical test	15
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU3DSCGEL203 – BASIC STRUCTURAL GEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	Minor	200-299	**KU3DSCGEL203**	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
3	2	--	25	50	10	15	100	2 hours

Course Description: *This course provides a comprehensive understanding of structural geology, focusing on the processes that shape the Earth's crust and the methods used to analyze and interpret geological structures. Through a combination of lectures, laboratory exercises, and field trips, students will learn about the deformation of rocks, the formation of geological structures such as folds and faults.*

Course Prerequisite:

The learner must have completed the basic courses in 100 – 199 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	. To understand the basic principles of structural geology,	*U*
2	To identify and interpret stratigraphic layers, attitudes of rocks, and their significance in understanding geological history and tectonic evolution	*U & An*
3	To develop practical skills in the identification and measurement of rock structures in the field, geological maps, and cross-sections.	*U & An*
4	To understand the working of geological compass and their application in measuring the attitude of geological structures in the field.	*U & A*
5	To understand the fundamental principles of structural geology, including the processes of rock deformation and the classification of geological structures	*U*
6	To understand the various gravity formed structures and their recognition in the field.	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓			✓		✓	✓
CO 3	✓			✓			✓
CO 4		✓			✓	✓	
CO 5	✓	✓		✓			
CO 6	✓						✓

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**BASIC FACTS**		**15**
	1	Stratification, Attitudes of planar and linear structural elements: strike and dip, trend, plunge and pitch/ rake.	4
	2	Brief descriptions of the following terms: Scales of observation of structures. Penetrative and non-penetrative structural elements. primary and secondary structures. Diastrophic and non- diastrophic structures	3
	3	Topographic and geologic maps; map symbols and rock symbols.	4

	4	Methods for representing relief features: contours and contour lines.	4

2	**OUTCROPS AND GEOLOGICAL COMPASS**		**15**
	1	Outcrops- Factors controlling width of outcrops, true thickness and vertical thickness of beds.	2
	2	Outcrop patterns - Rule of V's. Outlier and inlier. Off lap and on lap.	4
	3	Structure and topography Effects of topography on structural features. Major topographic features of the earth – Continents and oceans, mountain ranges, ocean ridges and ocean trenches.	5
	4	Geological compass and their uses in the field – Brunton compass, clinometer compass and Sylva compass.	4

3	**ROCK DEFORMATION**		**15**
	1	Stress & strain – types and effects	3
	2	Stress and strain ellipsoids and their geological significance. Sources of stress in the Earth. Elastic rebound theory.	3
	3	Basic concepts of deformation, Stages of rock deformation – elastic, plastic and rupture deformation. Mechanism of plastic deformation.	5
	4	Hooke's Law. Factors controlling rock deformation. Strain markers in deformed rocks.	4

4	**GRAVITY CONTROLLED STRCTURES**		**15**
	1	Effect of gravity on topographic relief, effects on thrust sheet and nappes.	4
	2	Gravity induced spreading in large crustal masses, orogen collapse.	4

	3	Salt tectonics- types of salt structure	4
	4	Structures associated with salt diapirism.	3
5	**Teacher Specific Module**		**5**
	Directions: Learners are required to construct tables, diagram, figures and conduct experimental work associated with course under the guidance of teacher.		
6 Practical	Drawing block diagrams showing strike, true dip and apparent dip and major structures. Labelled diagrams of geological compasses. Diagrams indicating Rule of V. Structural map symbols and rock symbols. Problems – Three-point problems of strike and dip; Apparent dip and true dip. Problems related to width of outcrop on a horizontal surface.		10

Essential Readings:

1. Billings M.P. (1972) Structural Geology. Third Edition. Prentice Hall, New Delhi.

2. De Sitter (1964) Structural Geology. Second Edition, McGraw Hill Co.

3. Hill, S. (1961) Elements of Structural Geology, Asia Publishing House.

4. Lahee (1987) Field Geology. Sixth Edition, McGraw Hill Co.

5. Ben A. Van Der Pluijm, Marshak, S. (2004) Earth Structure- An introduction to Structural Geology and Tectonics. 2nd Edition

6. Haakon Fossen (2016)-Structural Geology, Cambridge University Press

7. Park, R.G., (1997). Foundations of structural geology, Third edition, Chapman and Hall, London

Reference Distribution:

Module	Unit	Reference No.
1	1	1,7
	2	1,2,7

	3	1,4
	4	1,3
2	1	1
	2	1
	3	1,4
	4	1,5
3	1	1,4
	2	2,4
	3	4
	4	4
4	1	7
	2	7
	3	6,7
	4	6,7

Suggested Readings:

1. Davis, H.D. and Reynolds, S.J. (1984) Structural Geology of rocks and regions. John Wiley and Sons, Inc
2.John Robberts - Introduction to Geological Maps and Structures, Pergamon Press.
3.Park R G (1997) Foundations of Structural Geology 3rd , Chapman & Hall

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU3DSCGEL204 – INTRODUCTION TO ROCKS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	Minor	200-299	**KU3DSCGEL204**	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	--	--	30	70	100	2 hours

Course Description:

This course provides a thorough exploration of various rocks and their classification, offering insights into the processes of the rock cycle and the composition of Earth's crust and mantle. This course investigates of igneous rocks, learner examine the formation of magma, Bowen's reaction series, and the diverse array of plutonic and volcanic rocks, including gabbro, basalt, and dolerite. Additionally, the course offers the knowledge of origins of sediments via physical, chemical, and biological weathering processes, allowing for the classification of sedimentary rocks based on genetic and clastic properties. Finally, metamorphism is defined, covering its types, zones, and grades, with a focus on common metamorphic rocks.

Course Prerequisite:

The learner must have completed the basic courses in 100 – 199 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Gain an understanding of rock classification, the rock cycle, and the petrology of Earth's crust and mantle.	*U*
2	Explore the processes of magmatism, Bowen's reaction series, and the formation of both plutonic and volcanic igneous rocks.	*U & An*
3	Analyze the occurrence and characteristics of specific igneous rocks such as gabbro, basalt, and dolerite.	*U & An*
4	Learn about the origins of sediments through physical, chemical, and biological weathering processes.	*U & A*
5	Classify sedimentary rocks based on their genesis.	*U*
6	Understands metamorphism, its types, agents, zones, and grades, while studying common metamorphic rocks like marble, slate, and phyllite.	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓			✓		✓	✓
CO 3	✓			✓			✓
CO 4		✓			✓	✓	
CO 5	✓	✓		✓			
CO 6	✓	✓					✓

COURSE CONTENTS

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**INTRODUCTION TO ROCKS**		**10**
	1	General classification of rocks – Rock cycle and its components.	3
	2	Petrology of crust and mantle.	2
	3	Igneous rocks – Magma and magmatism. Bowen's reaction series. Plutonic and volcanic activity and related rocks.	2

	4	Mode of occurrence of igneous rocks. Descriptive study of following igneous rocks - Gabbro, basalt and dolerite	3

2	**ORIGIN OF SEDIMENTS - WEATHERING**		**15**
	1	Role of sediments in the rock cycle Sources of Sediments -Terrestrial, Marine	4
	2	Role of weathering in sediment origine - Physical, Chemical, Biological weathering.	4
	3	Types of Sediments -Clastic, Chemical and Organic sediments Transportation and deposition of sediments.	3
	4	Classification of sedimentary rocks – Genetic classification	4

3	**SEDIMENTARY ROCKS**		**15**
	1	Clastic sediments – Udden- Wentworth scale for sediment classification.	3
	2	Rudaceous, arenaceous and argillaceous sedimentary rocks.	5
	3	Non clastic sediments and rocks – Chemical sedimentary rocks and their classification	4
	4	Bio-chemical sedimentary rocks - classification.	3

4	**METAMORPHIC ROCKS**		**15**
	1	Definition of metamorphism. Types and agents of metamorphism.	5
	2	Zones and grades of metamorphism.	3
	3	Study of following common metamorphic rocks – Marble, Slate, and Phyllite.	4
	4	Study of following common metamorphic rocks – Charnockite and Khondolite	3

5	**Teacher Specific Module**	**5**
	Directions: Learners are required to conduct experimental work associated with course under the guidance of teacher. Megascopic identification of common igneous rock, Megascopic identification of common sedimentary rocks, Megascopic identification of common metamorphic rocks	

Essential Readings:

1 Tarbuck, Edward J., et al. *Earth: an introduction to physical geology*. Upper Saddle River: Pearson/Prentice Hall, 2005.

2. Plummer, Charles C., David McGeary, and Diane H. Carlson. *Physical geology*. Boston: McGraw-Hill, 2001.

3. Tyrrell, George Walter. *The principles of petrology: an introduction to the science of rocks*. Springer Science & Business Media, 2012.

4. Boggs, Sam. *Petrology of sedimentary rocks*. Cambridge university press, 2009.

5. Nichols, Gary. *Sedimentology and stratigraphy*. John Wiley & Sons, 2009.

6 PROTHERO, DR & SCHWAB, F. 1996. Sedimentary Geology. An Introduction to Sedimentary Rocks and Stratigraphy. New York: WH Freeman.

7.Bull, Geologists. "Principles of Igneous and Metamorphic Petrology. John Winter." *Geology* 28:

Reference Distribution:

Module	Unit	Reference No.
1	1	1, 2
	2	1, 2
	3	3
	4	4
2	1	1,2
	2	3, 4

	3	4
	4	4
3	1	4, 5
	2	4,5,6
	3	5, 6
	4	6
4	1	3
	2	3,7
	3	3,7
	4	7

Suggested Readings:

1. Mibei, Geoffrey. (2014). "Introduction to types and classification of rocks." Geothermal Development Company.
2. Philpotts, Anthony Robert, and Jay J. Ague (2009).. Principles of igneous and metamorphic petrology. Cambridge University Press,

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

SEMESTER 3

FOUNDATION COURSES

KU3MDCGEL201– GEOLOGY AND MINERAL RESOURCES OF KERALA

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	MDC	300-399	**KU3MDCGEL301**	3	45

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
3	-	--	25	50	75	2 hours

Course Description: *The course offers a study of the physiography, drainage, geology, soil, and mineral resources of Kerala. It covers the ancient and recent geological formations of Kerala and their associated intrusive rocks, veins, and pegmatites.*

Course Prerequisite: The learner must have completed the basic courses in 300 – 399 level in B Sc Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive Understanding of Kerala’s Physiography.	*U*
2	Understand the major drainage systems of Kerala.	*U*
3	Understanding of the geological formations of Kerala, both ancient and recent.	*U*
4	Develop the ability to understand various soil types found in Kerala	*U*
5	Identify and evaluate the mineral resources of Kerala, including their economic value and distribution.	*R, A*

6	Understand the formation and significance of intrusive rocks, veins, and pegmatites.	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2	✓						
CO 3	✓						
CO 4		✓				✓	
CO 5	✓		✓				
CO 6	✓						

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**PHYSIOGRAPHY, WATER BODIES & SOIL**		**10**
	1	Physiographic divisions of Kerala – The highland, Foot hills, Midland and low lands. Brief study of major landforms of Kerala – Mountains, plains and plateaus.	2
	2	Brief study of rivers, backwaters and lagoons of Kerala	2
	3	Major landforms of Kerala – Mountains, plains and plateaus. Western ghats and Palghat gap; Plateaus- Munnar, Periyar, Wayanad and Nelliampathy plateaus.	3

	4	Soil types and their distribution	3

2	**STRATIGRAPHY**		**10**
	1	Stratigraphy of Kerala – Ancient Supracrustal, Wayanad Group, Vengad group,	3
	2	Charnockites and Khondalites	3
	3	Intrusives – Ezhimala pluton, Peralimala pluton, Angadimogar pluton, Ambalavayal granite	2
	4	Pegmatites, dolerites and quartz veins	2

3	**TERTIARY ROCKS**		**10**
	1	Tertiaries of Kerala – Vaikom formation,	*2*
	2	Quilon formation and Warkala formation	*3*
	3	Brief study of geological history of Kerala region.	*3*
	4	Mudbanks	*2*

4	**MINERAL RESOURCES.**		**10**
	1	Mineral resources – Bauxite, ball clays, China clays, Graphite, Iron ore	*3*
	2	Placer mineral deposits – Ilmenite, monazite, zircon, sillimanite	2
	3	Gem minerals, Lime shell, silica sand, mica, soap stone and limestone.	2
	4	Laterite – Nomenclature, classification and distribution.	3

5	**Teacher Specific Module**	**Hours**

	Directions: Groundwater conditions of Kerala covering topic like occurrence, aquifer types, groundwater recharge, rainwater harvesting , watershed, quality and groundwater problems of Kerala.	**5**

Essential Readings:

1. Soman, K (2002). Geology of Kerala, Geological Society of India, Banglore.
2. Roy Chacko P.T. (ed.), (2005). Mineral resources of Kerala. Department of Mining and Geology, Thiruvananthapuram.
3. Prasannakumar, V., (2007). Geomorphology of Kerala, International centre for Kerala studies University of Kerala, Karyavattom, 168p

Reference Distribution:

Module	Unit	Reference No.
1	1	1,3
	2	1,3
	3	1,3
	4	1,3
2	1	1,3
	2	1,3
	3	1,3
	4	1,3
3	1	1,3
	2	1,3
	3	1,3
	4	1,3
4	1	1,2
	2	1,2
	3	1,2
	4	1,2

Suggested readings:

1.Ramakrishnan M and.Vaidyanadhan R (2008) Geology of India, Geological Society of India Bangalore, India, 556p (Volume 1), 556 p(Volume 2)
2.Krishnan, M.S. Geology of India and Burma, CBS Publishers & Distributors, New Delhi, 536p.

Assessment Rubrics:

	Evaluation Type	Marks
End Semester Evaluation		**50**
Theory test paper		50
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
	Total	**75**

KU3VACGEL201: CLIMATE CHANGE

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	VAC	200-299	KU3VACGEL201	3	45

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
3	0	-	25	50	75	2 hours

Course Description: *This course provides a comprehensive overview of climate change, covering the scientific principles, societal impacts, and potential solutions to this global challenge. students will gain a deep understanding of the causes and consequences of climate change, as well as the interdisciplinary approaches required for effective mitigation and adaptation strategies.*

Course Prerequisite: The learner must have completed the basic courses in 100 – 199 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understanding of the scientific principles underlying climate change, including the greenhouse effect, carbon cycle, and anthropogenic drivers of global warming.	U
2	Evaluate the role of human activities - such as fossil fuel combustion, deforestation, and industrial processes - in driving climate change and altering Earth's climate system.	U

3	Examine potential mitigation strategies, including renewable energy adoption, carbon capture and storage technologies, and sustainable land management practices, and their effectiveness in reducing greenhouse gas emissions.	A
4	Analyze the role of policy, governance, and international cooperation in addressing climate change, including the examination of global agreements like the Paris Agreement and national-level climate policies.	An
5	Explore mitigation measures for addressing the impacts of climate change on infrastructure, agriculture, water resources, and public health, taking into account diverse social, economic, and environmental contexts.	E

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2		✓		✓			
CO 3				✓	✓		
CO 4					✓	✓	
CO 5			✓			✓	✓

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**CLIMATE AND CLIMATE CHANGE**	**10**
	1	Weather and Climate - Factors influencing climate.	2
	2	Introduction to the concept of climate change. Past climate patterns and variability.	3
	3	Natural causes of climate change - Solar Variability and Climate, Volcanic Eruptions and Climate	3
	4	Milankovitch theory and its role in shaping glacial-interglacial cycles	2
2		**ANTHROPOGENIC CAUSES**	**10**
	1	Anthropogenic causes of climate change - fossil fuel combustion, deforestation, and industrial processes.	3
	2	Greenhouse effect. Greenhouse gases. Ozone layer depletion.	2
	3	Global warming and sea level rise. -Evidence and indicators of global warming.	3
	4	Air pollution and climate change. Carbon capture and storage.	2
3		**MITIGATION MEASURES FOR CLIMATE CHANGE**	**10**

	1	Present status in addressing the climate change issues. World Summits and the agreements. International climate agreements: Paris Agreement, Kyoto Protocol.	3
	2	National climate policies and legislation. The Intergovernmental Panel on Climate Change (IPCC).	2
	3	Changes in the Earth's climate during the past- Paleoclimate Archives	3
	4	Carbon pricing and emissions trading.	2

4	**CLOUD; CLIMATE RELATED HAZARDS**		**10**
	1	Mitigation actions required to reduce the impact and vulnerability to climate change. Adaptation measures	2
	2	Climate change mitigation measures in India	2
	3	Cloud classification. Precipitation process. Artificial precipitation-	3
	4	Climate-related hazards: storms, floods, heatwaves, and wildfires	3

5	**Teacher Specific Module**	**5**
	Directions: Cordinator may include topics that help students to gain a deeper understanding of climate change impacts at various scales and explore solutions for a more sustainable future by referring to scientific journals such as Nature, Environmental Science & Technology, etc. United Nations Environment Programme (UNEP) offers resources on climate change impacts, including reports, data visualizations, and information on specific sectors like agriculture and water.	

Essential Readings:

1. Frederick K. Lutgens, Edward J. Tarbuck, and Dennis Tasa- The Atmosphere: An Introduction to Meteorology

2. Joanna D. Haigh and Peter Cargill - The Sun's Influence on Climate

3. John E. Zielinski and Lee R. Kump - Volcanism and Global Environmental Change

4.Herbert Riehl 1978, Introduction to the Atmosphere, III edn.. MacGraw Hill

5. Richard A. Muller and Gordon J. Mac Donald.- Ice Ages and Astronomical Causes: Data, Spectral Analysis and Mechanisms
6.Howard,J Critchfield,2002, General Climatology-Fourth Edition,Prentice Hall
7.Savindra Singh, 2005,Climatology, Prayag Pustak Bhavan.
8.Siddartha.K, Climatology(Atmosphere, Weather and Climate) Kithab Mahal,
9.William James Burroughs, 2001, Climate change, A multidisciplinary Approach, Cambridge University Press.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,9
	2	1
	3	2,3
	4	5
2	1	1,6,7
	2	1,6
	3	1,7
	4	1,6,7
3	1	1,7
	2	1,7
	3	1,7,8
	4	7,9
4	1	7,8
	2	7,8
	3	1,7,8
	4	7,8,9

Suggested Readings:

1.Andrew Dessler and Edward A. Parson- Introduction to Modern Climate Change

2.John E. Oliver -Principles of Climatology
3. Raymond S. Bradley (2015). Paleoclimatology: Reconstructing Climates of the Quaternary, Academic Press, Elsevier,628p.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**50**
Theory test paper		50
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
	Total	**75**

KU3VACCGEL202: INTRODUCTION TO ENVIRONMENTAL GEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	VAC	100 -199	KU3VACGEL202	3	45

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3	--	--	25	50	75	2 hours

Course Description: *This course provides a comprehensive examination of Earth Sciences, focusing on the Earth's structure, atmosphere, and hydrosphere. Students will explore seismic activities, atmospheric science, and oceanography, understanding how these elements shape global landscapes and climate. Through lectures, the course equips students* *with crucial insights to tackle key environmental and geological challenges.*

Course Prerequisite: A pass in plus two science / any other subject combination with geology at plus two level.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To gain the skills to assess the environmental impacts of geological hazards such as earthquakes, volcanoes, landslides, and floods.	U
2	To analyze how human activities such as mining, urbanization, and resource extraction impact geological systems and contribute to environmental issues like pollution and resource depletion.	U, A
3	To explore sustainable practices to minimize the impacts of anthropogenic activities on environment	E
4	Students will develop competencies in applying geotechnical methods for evaluating soil and rock properties in the context of construction, land use planning, and environmental restoration.	E
5	Integrate their knowledge of geology with approaches to managing natural resources sustainably and understanding geological influences on climate change.	I

*****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), (I) Integrate***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓			✓	

CO 2			✓				
CO 3			✓	✓			
CO 4	✓		✓			✓	
CO 5	✓		✓			✓	

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1		**GEOLOGY AND ITS INFLUENCE ON ENVIRONMENTAL SYSTEMS**	**14**
	1	Introduction to Geology and Environmental Systems. Overview of geological sciences and the importance of geology in environmental contexts.	4
	2	Relationship between geology and ecosystems.	3
	3	Basics of plate tectonics- plate boundaries, tectonic activity, and their impact on the environment. Tectonics influence climate, ocean patterns, and biodiversity.	4
	4	Importance of geological time in understanding Earth's environmental history.	3

2		**ENVIRONMENTAL IMPACTS**	**8**
	1	Causes, effects, and environmental impacts of volcanic eruptions and earthquakes.	3
	2	Environmental reasons that trigger of landslides, erosion and floods; Impact on landscapes and human settlements.	2

	3	Alternation of natural geological processes - urbanization, mining, and other human activities	2
	4	Strategies for sustainable management of Earth's resources.	1

3	**EARTH'S RESOURCES AND CHALLENGES**		**10**
	1	Importance of soil and groundwater in environmental geology.	2
	2	Environmental impacts of resource extraction and use.	3
	3	Geological aspects of waste disposal - landfills, tailings ponds. Pollution - types, sources, and control measures in geology.	3
	4	Overview of methods for remediating contaminated soil and water; Case studies on successful remediation projects.	2

4	**IMPACTS OF GEOLOGICAL PROCESSES**		**8**
	1	Basics of geotechnical investigation and its importance in construction and land use planning.	2
	2	Geological features of coastal and marine environments. Impact of geological processes on coastal stability and ecosystems.	2
	3	Influence of geological processes on climate and vice versa; Role of geology in understanding past climates and predicting future changes.	2
	4	Case studies on balancing ecological and geological factors in urban development.	2

5	**Teacher Specific Module**	**5**
	Ensure that new topics integrate real-world applications and current issues within Earth sciences to provide students with practical insights. Consider including case studies on natural disaster management, geoengineering projects, or the effects of human activities on geological processes.	

	Human-induced landslides, and mitigation measures. Floods and River Management- Flood hazards, and human impacts such as dam construction and river modification. Impact of climate change on geological processes, including glacial retreat and sea-level rise. Coastal erosion, storm surges, tsunamis, and human impact on coastal processes Role of communities in disaster risk reduction, preparedness, and response.	5

Essential Readings:

1.Smith, K., & Petley, D. (2013). Environmental Hazards: Assessing Risk and Reducing Disaster (6th ed.). Routledge.

2.Valdiya, K.S. (1987) Environmental Geology—Indian Context, Tata McGraw Hills.

3. Strahler, A.N. and Strahler, A.H. (1973) Environmental Geosciences, Wiley Eastern.

4.Donald. R. Coates (1981) Environmental Geology, John Wiley & Sons.

5.Peter. T. Elawan (1970) Environmental Geology, Harper & Row.

6.Keller, E.A. (1978) Environmental Geology, Bell & Howell, USA.

7. Bryante (1985) Natural Hazards, Cambridge University Press.

8.Das, R.C. and Behera, D.K. (2008) Environment Science Principles and Practice, Prentice Hall of India.

9. Davis, et. al., (1976), Environmental Geoscience, Wiley Eastern.

Reference Distribution:

Module	Unit	Reference No.
1	1	2
	2	2,3
	3	3,4

	4	3,9
2	1	1,7
	2	1,7
	3	1,7
	4	1,7
3	1	6,8
	2	6,8
	3	1,5,8
	4	8,9
4	1	2,4
	2	2,4
	3	2,9
	4	2,4

Suggested Readings:

1. Environmental flows- An introduction for Water resource Managers, Brij Gopal National Institute of Ecology, 2013
2. Coates, D.R. 1981, Environmental Geology, John Wiley & Sons.
3. Elawan, P.T., 1970, Environmental Geology, Harper & Row.
4. Gupta, H.K., (Editor), 2003, Disaster Management, Universities Press (India) Ltd., Hyderabad.
5. Lennis Barkub, G., 1980, Earthquakes and Urban Environment, V.1, 2 & 3, CRC Press Incorporated.

Assessment Rubrics:

Evaluation Type	Marks
End Semester Evaluation	**50**
Theory test paper	50

Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
	Total	**75**

SEMESTER 4

DISCIPLINE SPECIFIC COURSES

KU4DSCGEL201 – CRYSALLOGRAPHY AND OPTICAL MINERALOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	Major	200-299	**KU4DSCGEL201**	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
3	2	--	25	50	10	15	100	2 hours

Course Description: *This graduate course provides knowledge on Crystallography and Optical Mineralogy, exploring crystal systems, symmetry elements, and twinning in crystals. It covers mineral identification through optical properties using petrographic microscopes, emphasizing refractive indices, birefringence, and interference colors. Practical labs offer hands-on experience in analysing minerals in thin sections, integrating theoretical knowledge with practical skills.*

Course Prerequisite:

The learner must have completed the basic courses in 100 – 199 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understands various crystallographic systems, including isometric, tetragonal, hexagonal orthorhombic, monoclinic, and triclinic systems, along with their specific classes.	*U*

2	Analyze the symmetry elements and characteristics associated with different crystal systems, including normal, tetrahedral, pyritohedral, plagiohedral, tripyramidal, sphenoidal, trapezohedral, and hemimorphic classes.	*U & An*
3	Understand the definition, characteristics, and general rules of twinning in crystals, along with the various types of crystal twinning.	*U*
4	Understands and analyses minerals in thin sections through practical laboratory exercises, enhancing the integration of theoretical knowledge with practical applications.	*U & A*
5	Understanding of the properties of ordinary and polarized light, including the principles of light polarization, refractive index, critical angle, and total internal reflection.	*U*
6	Acquire the ability to identify and distinguish uniaxial and biaxial minerals through their optical properties using petrographic microscopes	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓			✓		✓	✓
CO 3	✓			✓			✓
CO 4		✓			✓	✓	
CO 5	✓	✓		✓			
CO 6	✓	✓					✓

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**CRYTAL SYSTEMS**		**15**
	1	Isometric system - normal, tetrahedral, pyritohedral and plagiohedral	4
	2	Tetragonal system - Normal, tripyramidal, pyrimadal hemimorphic and sphenoidal.	3
	3	Hexagonal system: Hexagonal Division - Normal, tripyramidal, trapezohedral classes.	4
	4	Hexagonal system – Rhombohedral Division - Rhombohedral, trirhombohedral, pyramidal hemimorphic, trapezohedral classes Orthorhombic system - Normal class.	4
2	**CRYTAL SYSTEMS; TWINNING**		**8**
	1	Monoclinic system - Normal class. Triclinic system - Normal class.	2
	2	Twinned crystals- Definition and Characteristics. General rules of twinning. Types of Crystal Twinning	2
	3	Classification of Twinning.	2
	4	Twinned crystals of six crystal systems. Morphologic imperfections in crystals.	2
3	**POLARIZED LIGHT**		**9**
	1	Ordinary and polarized light, polarization of light, refractive index, critical angle and total internal reflection. .	3
	2	Polarization by reflection, absorption, refraction, double refraction	2
	3	Construction of Nicol prisms.	2
	4	Petrological microscope: parts and functions.	2
4	**OPTICAL PROPERTIES OF MINERALS**		**8**

	1	Optical accessories: Mica plate, gypsum plate and quartz wedge.	2
	2	Optical properties of minerals: Colour, Pleochroism, pleochroic haloes, relief, Birefringence.	2
	3	Interference colour, extinction, twinning and zoning. Types of zoning.	2
	4	Mineral Classification Based on Optical Properties - Isotropic and anisotropic minerals, uniaxial and biaxial minerals. Sign of elongation.	2

5	**Teacher Specific Module**	**5**
	Directions: Learners are required to draw diagram, figures and conduct experimental work associated with course under the guidance of student coordinator.	
6 Practical	<u>**Crystallography**</u> **Drawing of symmetry elements of Normal classes of all systems.** **Identification and description of the following crystal models.** Isometric system: Galena, Garnet, Spinel, Magnetite, Fluorite, Sphalerite, Tetrahedrite, Pyrite and Cuprite. Tetragonal system: Zircon, Cassiterite, Rutile, Apophyllite, Wulfenite, Chalcopyrite. Hexagonal system: Beryl, Beta Quartz, Calcite, Tourmaline, Alpha Quartz. Orthorhombic System: Barite, Olivine, Topaz, Sulphur, Staurolite. Monoclinic system: Gypsum, Orthoclase, Augite, Hornblende. Triclinic: Axinite, Albite, Kyanite. Twin crystals: Spinel, Fluorite, Rutile, Calcite, Quartz, Staurolite, Aragonite, Gypsum, Augite, Orthoclase, Albite. **Microscopic study of the following minerals:** Quartz, Microcline, Orthoclase, Albite, Oligoclase, Labradorite, Nepheline, Leucite, Enstatite, Hypersthene, Augite, Diopside, Hornblende, Tremolite, Actinolite, Anthophyllite, Biotite, Muscovite, Olivine, Epidote, Garnet, Chlorite, Cordierite, Andalusite, Sillimanite, Kyanite, Staurolite, Calcite, Sphene, Apatite, Zircon.	30

Essential Readings:

1. Dana, E.S. (1962) A text book of Mineralogy (Revised by Ford). Asia Publishing House, Wiley.

2. Philips F.C. (1956) An Introduction to Crystallography. Longmans Green 20

3. Read, H.H. (1984) Rutley’s Elements of mineralogy. CBS Publishers, Delhi.

4. Hota R.N. (2011). Practical approach to crystallography and mineralogy, Geological Socety of India 202p.
5. Sharma, Ram & Sharma, Anurag & Editors A.K.,Jain, Series & Singh, Sandeep. (2013). Text-book Series in Geological Sciences for Graduate Students - Crystallography and Mineralogy.
6 Nesse Williams, D. (2003) Introduction to Optical Mineralogy. Oxford University Press.
7 Perkins Dexter (2006) Mineralogy. Pearson Prentice Hall.
8. Kerr P.F. (1977) Optical Mineralogy. Mcgraw-Hill
9 Perkins Dexter and Henke Kevin, R. (2007) Minerals in thin section. Pearson Education

Reference Distribution:

Module	Unit	Reference No.
1	1	1,3
	2	1,2
	3	1,5
	4	1,4
2	1	1,3
	2	1,3
	3	1,3
	4	1,3
3	1	1,6
	2	1,7
	3	1,7
	4	8,9
4	1	2,7
	2	6,8
	3	6,8
	4	1,6,8

Suggested Readings:

1.Deer. W.A., Howie. R.A and Zussman, J. (1966) An introduction of the Rock forming minerals. Longman.

2.Nesse Williams, D. (2008) Introduction to Mineralogy. Oxford University Press
3.Paui.F. Kerr (1959). Optical mineralogy, third edition, McGraw-Hill book company, Inc., New York.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU4DSCGEL202 –STRUCTURAL GEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	Major	200-299	**KU4DSCGEL202**	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
			Theory		Practical			
Lecture	Practical/ Internship	Tutorial	CCA	ESE	CCA	ESE	Total	
3	2	--	25	50	10	15	100	2 hours

Course Description: *This course provides a comprehensive understanding of structural geology, focusing on the processes that shape the Earth's crust and the methods used to analyze and interpret geological structures. students will learn about the deformation of rocks, the formation of geological structures such as folds and faults, and the recognition of structures in the field.*

Course Prerequisite:

The learner must have completed the basic courses in 100 – 199 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To understand the mechanical behavior of rocks and the processes involved in deformation.	*U*
2	To identify and interpret stratigraphic layers, attitudes of rocks, and their significance in understanding geological history and tectonic evolution	*U & An*
3	To develop practical skills in the identification and measurement of rock structures from field specimens, geological maps, and cross-sections.	*U & An*

4	To recognize different types of faults, their terminology, and their role in accommodating crustal deformation and seismic activity.	*U & A*
5	To understand the fundamental principles of structural geology, including the processes of rock deformation and the classification of geological structures	*U*
6	To classify and characterize joints and unconformities in the field, and understand their significance in geological mapping and resource exploration.	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓			✓		✓	✓
CO 3	✓			✓			✓
CO 4		✓			✓	✓	
CO 5	✓	✓		✓			
CO6		✓	✓		✓		

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**OUTCROPS, GEOLOGICAL MAPS AND DEFORMATION**		**10**

	1	Stratification, Attitudes of planar and linear structural elements: strike and dip, trend, plunge and pitch/ rake. Outcrops – Factors controlling width of outcrops., patterns of outcrop - Rule ov V’s. Outlier and inlier. overlap and off-lap.	4
	2	Topographic and geologic maps; map symbols and rock symbols. Methods for representing relief features: contours and contour lines.	3
	3	Stress and strain – Types. Hook’s law. Stress and Strain ellipsoid and their significance. Strain markers in deformed rocks.	4
	4	Rock deformation- Stages of rock deformation – elastic, plastic and rupture deformation. Mechanism of plastic deformation. Factors controlling rock deformation. Ductile and brittle deformation structures.	4

2	**CLASSIFICATION OF FOLDS AND FAULTS**		**10**
	1	Folds: terminology, geometry and elements of folded surfaces.	4
	2	Geometric and genetic classification of folds. Outline of Fleuty’s classification and Ramsay’s classification of folds.	3
	3	Relation between major folds and minor folds. Criteria for recognition of folds in the field and on maps.	4
	4	Faults: Terminology and classification.	4

3	**FAULT, FOLIATIONS AND LINEATIONS**		**10**
	1	Mechanism of faulting. Horst and graben structure. Thrust fault - autochthon, allochthon, window, klippe and nappe, .	3

	2	Effects of faults on outcrop of strata. Criteria for recognition of fault in the field.	4
	3	Foliations: classification and origin.	4
	4	Lineation: mechanism of formation and types	4

4		**JOINTS, UNCONFORMITIES, SALT TECTONICS AND PROJECTION**	**10**
	1	Joints: Joint sets and joint systems; classification and importance of joints.	4
	2	Unconformities: origin and types. Criteria for the recognition of unconformities in the field and on the map. Criteria for distinguishing from faults and intrusive contacts. Significance unconformities	4
	3	Salt tectonics- types of salt structure Structures associated with salt diapirism.	4
	4	Stereographic and equal area projection -Representation of planes and lines. Equal area net.	3

5	**Teacher Specific Module**	**5**
	Directions: Topics may include Various geological structures of world, structural mapping and interpretation of toposheets and geological maps.	
6 **Practical**	**Interpretation of geological maps and preparation of sections**. • Simple horizontal beds (2 maps) • Simple dipping beds (4 maps) • Simple dipping beds with intrusions (2 Maps) • Tracing the out crops (2 maps) • Folded beds (3 maps) • Maps with different types of faults (4 maps) • Simple dipping beds with unconformity (3 maps) • Combination of intrusions, unconformity, folds and faults (5 maps)	30

Essential Readings:

1. Billings M.P. (1972) Structural Geology. Third Edition. Prentice Hall, New Delhi.

2. De Sitter (1964) Structural Geology. Second Edition, McGraw Hill Co.

3. Hill, S. (1961) Elements of Structural Geology, Asia Publishing House.

4. Lahee (1987) Field Geology. Sixth Edition, McGraw Hill Co.

5. Ben A. Van Der Pluijm, Marshak, S. (2004) Earth Structure- An introduction to Structural Geology and Tectonics. 2nd Edition

6. Haakon Fossen (2016)-Structural Geology, Cambridge University Press

7..Park R G (1997) Foundations of Structural Geology 3rd , Chapman & Hall

Reference Distribution:

Module	Unit	Reference No.
1	1	1,4,7
	2	1,2,7
	3	1,4
	4	1,3
2	1	1,6
	2	1,6
	3	1,4,6
	4	1,6
3	1	1,4
	2	2,4
	3	4
	4	4
4	1	1,2,4
	2	2,4,5

	3	6,7
	4	6

Suggested Readings:

1. Davis, H.D. and Reynolds, S.J. (1984) Structural Geology of rocks and regions. John Wiley and Sons, Inc

2.John Robberts - Introduction to Geological Maps and Structures, Pergamon Press.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU4DSCGEL203 – IGNEOUS PETROLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	Major	200-299	**KU4DSCGEL203**	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
3	2	--	25	50	10	15	100	2 hours

Course Description:

This course offers a comprehensive understanding of igneous rocks. It explores the origins and occurrences of magma, Bowen's reaction series, and the phase rule's application in igneous systems. Discussions cover the diversity of igneous rocks, differentiation processes in the crust and upper mantle, igneous rock textures, classifications, and descriptive studies of various rock types. Through this logical approach, students gain insight into the complexities of igneous rocks and their significance in geology.

Course Prerequisite: The learner must have completed the basic courses in 100 – 199 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the origins of magma, including primary and parent magma, and comprehend Bowen's reaction series.	*U & An*

2	Apply the phase rule to igneous systems, analysing melting and crystallization behaviour in single and bi-component systems.	*A, An & E*
3	Explore the diversity of igneous rocks, including processes like fractional crystallization, magma mixing, and volatile transport, and grasp various igneous rock textures and their factors.	*U & An*
4	Apply different classification scheme for igneous rocks, including IUGS, TAS, Irvine-Baragar, and normative classifications.	*A & An*
5	Develop descriptive skills in petrology and petrography, distinguishing common igneous rocks like peridotite, basalt, granite, and diorite based on their composition and texture.	*U & An*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓			✓			
CO 2		✓		✓	✓	✓	✓
CO 3	✓		✓				
CO 4			✓				✓
CO 5	✓			✓			

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1		**MAGMA AND MAGMA SYSTEMS**	**10**
	1	Magma- Primary and parent magma. Magma series.	3
	2	Detailed analysis of Bowen's reaction series	2
	3	Introduction to phase rule and its application in igneous system. Melting and crystallization behavior of following systems - Albite – Anorthite and Diopside – Anorthite,	3
	4	Melting and crystallization following magmatic systems – Forsterite – Silica and Alkali feldspar system	2

2		**DIVERSITY OF IGNEOUS ROCKS AND IGNEOUS ROCK TEXTURE**	**10**
	1	Diversity of igneous rocks – Partial melting. Palingenesis and Anatexis.	2
	2	Magmatic differentiation process – Fractional crystallization, Volatile transport and Liquid immiscibility.	3
	3	Magmatic differentiation process – Magma mixing, Assimilation, Volatile transport and miscellaneous process	3
	4	Texture of igneous rocks – Factors. Description of Texture - Crystallinity, Granularity, Shape of crystals and Fabric. Study of different textures.	2

3		**CLASSIFICATION OF IGNEOUS ROCKS**	**10**
	1	Classification of igneous rocks- IUGS classification of plutonic volcanic and ultra-mafic rocks.	3
	2	TAS classification.	3
	3	Irivine - Baragar classification	2

	4	Normative classification	2

4	**DESCRIPTIVE STUDY OF IGENOUS ROCKS**		**10**
	1	Petrology, petrography and tectonic setting of following rocks – Peridotite and Pyroxenite.	*3*
	2	Petrology, petrography and tectonic setting of following rocks- Basalt and Gabbro	3
	3	Petrology, petrography and tectonic setting of following rocks- Dolerite and Anorthosite	2
	4	Petrology, petrography and tectonic setting of following rocks – Diorite, Granite and Syenite	2

5	**Teacher Specific Module**	**Hours**
	Directions: Coordinator may include topics that make learners have a grasp of basic geological concepts like minerals, rocks, plate tectonics, and the rock cycle.	**5**
6	**Practical -**	**Hours**
	1. Megascopic identification of following igneous rocks: Granite, Graphic granite, Pegmatite, Aplite, Granite Porphyry, Syenite, Syenite porphyry, Diorite, Gabbro, Anorthosite, Dunite, Pyroxenite, Dolerite, Basalt, Vesicular Basalt, Amygdaloidal basalt, Rhyolite, felsites, Obsidian, Pumice, Lamprophyre. 2. Microscopic identification of following igneous rocks Granite, Graphic granite, Pegmatite, Granite Porphyry, Syenite, Syenite porphyry, Diorite, Gabbro, Anorthosite, Dunite, Pyroxenite, Dolerite, Basalt, Vesicular Basalt, Rhyolite.	30

Essential Readings:

1. Philpotts, Anthony Robert, and Jay J. Ague. *Principles of igneous and metamorphic petrology*. Cambridge University Press, 2009.
2. John Winter- Principles of Igneous and Metamorphic Petrology.

3. Tyrrell, George Walter. *The principles of petrology: an introduction to the science of rocks*. Springer Science & Business Media, 2012.

4. Frost, B. Ronald, and Carol D. Frost. *Essentials of igneous and metamorphic petrology*. Cambridge University Press, 2019.

5. Le Bas, M. J., and Albert L. Streckeisen. "The IUGS systematics of igneous rocks." *Journal of the Geological Society* 148.5 (1991): 825-833.

6. Jerram, Dougal, and Nick Petford. *The field description of igneous rocks*. John Wiley & Sons, 2011.

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	2
	3	2
	4	2
2	1	1
	2	1,2
	3	1
	4	2
3	1	5
	2	5
	3	5
	4	3, 6
4	1	6
	2	6
	3	6
	4	6

Suggested Readings:

1 Cross, Whitman, et al. *Quantitative classification of igneous rocks: based on chemical and mineral characters, with a systematic nomenclature*. University of Chicago Press, 1902.

3. Yoder Jr, H. S. (2015). *Evolution of the igneous rocks: Fiftieth anniversary perspectives*. Princeton University Press.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

SEMESTER 4

FOUNDATION COURSES

KU4SECGEL201 – FUNDAMENTALS OF MAPPING

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	SEC	200-299	**KU4SECGEL201**	3	60

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
2	2	--	15	35	10	15	100	2 hours

Course Description*: This course provides an introduction to the theory and practice of geologic mapping. Students will develop the knowledge and skills necessary for independent field data collection, analysis, and interpretation, culminating in the creation of a geologic map.*

Course Prerequisite:

The learner must have completed the basic courses in 100 – 199 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	.To understand field observation techniques for the comprehensive characterization of rock units, structures, and other geologic features.	*U*
2	Analyze and interpret field-collected geologic data, encompassing rock types, structures, and stratigraphic relationships.	*U & An*
3	Interpret existing geologic maps to extract critical geological information.	*U & An*

4	Apply structural geology principles to effectively map folds, faults, and other geologic structures.	*U & A*
5	To understand rock identification in the field	*U*
6	To create a new geological map of a terrain	*C*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓			✓		✓	✓
CO 3	✓			✓			✓
CO 4		✓			✓	✓	
CO 5	✓	✓		✓			
CO 6	✓	✓		✓			

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**INTRODUCTION**		**11**
	1	Overview of cartography and geological maps. Elements of a map: scale, projection and coordinate systems.	3
	2	Data sources for mapping: Remote sensing, field surveys.	3

	3	Requirements for Fieldwork - Safety protocols - Permits and permissions for field access.	2
	4	Measuring distance - Traversing methods, Determination of slope and gradients.	3

2	**TOOLS AND TECHNIQUES**		**12**
	1	Field mapping equipment and tools: compass, GPS, hammer, hand lens, field notebook -Field Notebook practices for comprehensive data recording. Base map	2
	2	Topographic maps -Relief features, water bodies and cultural features. Interpretation of contour lines.	3
	3	Survey of India maps - Grid systems and coordinates on maps. Layout and numbering of SOI maps.	3
	4	Location and position fixing techniques – Triangulation method, Global Positioning System.	2

3	**ROCKS AND STRUCTURES**		**12**
	1	Identifying rock types: igneous, sedimentary, and metamorphic	3
	2	Describing rock textures and mineralogy	3
	3	Identifying structures: Fold, Fault, Joints, Foliation and lineation.	3
	4	Measurement of Attitude of Planar and Linear Structures - strike and dip; trend and plunge.	3

4	**GEOLOGICAL MAP**		10
	1	Symbols for rock units and structures.	2
	2	Stratigraphic principles and correlation of rock units and geologic formations	3

	3	Markings of Contacts and boundaries on the map	3
	4	Completion of geological map- Data integration, plotting and legend creation.	2

5	**Teacher Specific Module**	5
	Directions: Case Studies of Geologic Map Interpretation for Diverse Settings	
6 Practical	Exercises with topographic and geological maps. Drawing and interpreting geological cross-sections.	10

Essential Readings:

1 Lahee, F.H., 1961, Field Geology, 6th edn., McGraw Hill Book Company, New York, 926p

2.Low, J.W., Geological Field Methods, Harper & Brothers

3.Compton, R.R., 1968, Manual of Field Geology, Wiley Eastern Pvt. Ltd..

4.Stow, D.A.V., 2005, Sedimentary Rocks in the Field--A Color Guide, Manson Publishing, 320p.

5.Mathur, S.M.,(2001). Guide to field Geology, Prentice-Hall of India Pvt. Ltd.203p.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,3
	2	1,3
	3	5
	4	1,5
2	1	1,5
	2	3,5
	3	5
	4	3,5
3	1	4,5
	2	4,5

	3	1,3,5
	4	1,3
4	1	5
	2	3,5
	3	1,5
	4	2,3,5

Suggested Readings:

1.John M. Bird, Principles of Geological Mapping
2.Paul A. Rosen and Rama Rao, Field Methods in Remote Sensing

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**50**
a)	Theory test paper	35
b)	Practical test paper	15
Continuous Evaluation (Theory)		**15**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	5
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**75**

KU4SECGEL202: INTRODUCTION TO REMOTE SENSING AND GIS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	SEC	200-299	KU4SECGEL202	3	45

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
3	0	-	25	50	75	2 hours

Course Description: *" Introduction to remote sensing and GIS" provides a comprehensive study on remote sensing techniques, types, platforms, sensors, Electromagnetic radiation and their interaction with atmosphere, satellite classification, types orbits, satellite series and Indian satellite mission. The course offers introduction to advance remote sensing such as SLAR and SAR interferometry. The course delves into the map projection, surveying and survey instruments and procedures, global navigation satellite system and Indian navigation satellite system. It also examines geographic data, types of spatial data, sources of spatial data, data errors, database concepts and management, types of GIS, spatial analysis concepts and tools, and spatial and non-spatial data query. This foundational course equips students with essential knowledge of remote sensing and geographical information system for spatial data industrial sectors.*

Course Prerequisite: The learner must have completed the basic courses in 100 – 199 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learnin g

		Domains
1	Understand the basic concepts of remote sensing and GIS.	U
2	Through detailed studies of various tools and algorithms of remote sensing and GIS students can manage and analyse the various spatial and non-spatial data pertaining to the geology and earth system science.	U
3	Students will understand various sources of spatial and non-spatial data, instruments and techniques for acquisition data.	U
4	Students will be able to evaluate the spatial data integrity, types and sources, and methods rectification of data errors.	E
5	Students will be able to evaluate the advancement in remote sensing and GIS technology and software available.	E
6	Analysis of various thematic digital data layers, spatial and non-spatial data query and generation of spatial data models.	A

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

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	
CO 1	✓		✓					
CO 2		✓		✓				
CO 3				✓	✓			
CO 4					✓	✓		

CO 5			✓			✓	✓

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**REMOTE SENSING: INTRODUCTION AND TERMINOLOGY**	**10**
	1	Definition, Principles and methods of remote sensing - Active and Passive remote sensing - Remote Sensing platforms.	2
	2	Electromagnetic radiation- Spectrum- Blackbody radiation – Planck's law – Stefan – Boltzmann law-Whiskbroom scanner, Push-broom scanner.	2
	3	EMR Interactions: Interaction with atmosphere scattering of EMR - Rayleigh, Mie, Non Selective and Raman Scattering. Back scattering Speckle EMR Interaction with water and Ozone Atmospheric windows and its significance.	3
	4	EMR interaction with the earth surface materials - Radiance, Irradiance, Absorbance, Transmittance, Reflectance- Specular- and diffuse surface- Spectral signature – and curves EMR interaction with soil, water and vegetation. Resolution - Spectral, Spatial, Radiometric, and Temporal.	3

2		**REMOTE SENSING SATELLITES**	**10**
	1	Satellites classification based on orbit- Sun synchronous and eosynchronous. Based on purpose- Earth resources satellites, Communication satellite, Weather satellites and Spy satellites. .	2
	2	Multi High resolution and Hyperspectral Remote Sensing. Thermal and Microwave sensors, Sensor's characteristics.	3

	3	Satellites and their Specifications: LANDSAT, SPOT, ENVISAT, World- View, Quick bird, GeoEye, Sentinel-1/2, ASTER, RADARSAT and IKONOS. SLAR and SAR - Interferometry.	3
	4	Brief study of Indian Satellite missions.	2

3	**MAP PROJECTION**		**10**
	1	Basic geodesy - Geoid/Datum/Ellipsoid - Coordinate systems - Scale factor - Distortion on map – projections - Classification of map projections - Polyconic, LCC, Mercator. UTM projections - Map projection transformation.	3
	2	Surveying – Total Station – EDM – LIDAR.	2
	3	GNSS: Satellite constellation - GPS signals and data - GPS receivers - Single point positioning - Measuring distance and timing - GPS accuracy - Error corrections - Differential GPS - Glonass and Galileo systems -	3
	4	Applications of GPS - Carrying out a GPS survey. Indian Navigation Satellite system – NavIC (IRNSS).	2

4	**GEOSPATIAL DATA**		**10**
	1	Spatial and non-spatial data - Vector and raster data models - Vector and raster data structures - Data compression - Choice between raster and vector.	3
	2	Data transformations - Data sources & data input - Linking spatial and non-spatial data - Errors and quality control - Data storage - Data formats - Database concepts	2
	3	Database management in GIS- Web GIS - 3DGIS - Object Oriented GIS - Mobile GIS.	2
	4	Spatial Analysis – Geo-statistical analysis - Proximity analysis (buffering) - Overlay analysis – density analysis - Network analysis - Multi-criteria analysis - Site suitability analysis - Nearest neighbour analysis - Thiessen polygons - Surface mapping - Interpolation (including TIN) - Digital elevation model (DEM) - Terrain reclassification – Slope, aspect, angle of incidence. - Visibility (viewshed) analysis - Spatial and non-spatial query.	3

5	**Teacher Specific Module**	**5**
	Directions: Familiarize with the key concepts, principles, and terminology of remote sensing and GIS. Gain knowledge of technology and applications of remote sensing and GIS. Understand the applications of remote sensing and GIS for geo-environmental studies .	

Essential Readings:

1. Curran, P.J., 1988, Principles of Remote Sensing, 2nd edn., ELBS, Longmans.
2. Drury, S.A., 1987, A Guide to Remote Sensing Interpretation - Image of Earth, Oxford Univ. Press.
3. Lillesand, T.M., Kiefer, R.W. & Chapman, J.W., 2004, Remote Sensing and Image Interpretation, John Wiley &Sons.
4. Miller, V.C. & Miller, C.F., 1961, Photogeology, McGraw Hill Book Co. Inc., New York.
5. Narayan, L.R.A., 1999, Remote Sensing and its Application, Universities Press (India) Ltd., Hyderabad.
6. Pandey, S.N., 1987, Principles and Applications of Photogeology, Wiley Eastern Ltd., New Delhi.
7. Siegel, B.S., & Gillespie, A.K., 1980, Remote Sensing in Geology, John Wiley & Sons.
8. Burrough, P.A. & McDonnell, R.A., Principles of Geographical Information System, Oxford Pub.
9. Chang, Kang-Tsung., 2002, Introduction to Geographic Information Systems, Tata McGraw Hill Pub. Co. Ltd.
10. Clarke, K.C., Getting Started with Geographic Information System, Prentice Hall.
11. ESRI, Understanding Geographic Information System, The Arc-info Method, Wiley Publishers.
12. Gibson, P. J. & Power, C. H., 2000, Introductory Remote Sensing--Digital Image Processing and Applications.
13. Tarrytown, Geographic Information System for Geoscientists Modelling with GIS, Pergamon Press.
14. NRSC, Remote Sensing Applications.
15. Doc No: ISRO-ISAC-TR-1445, Indian Remote Sensing Missions & Payloads- A Glance.
16. Venkataramaiah., 2011, Text book on surveying (2nd Edn).
17. Garg P.K., 2023, Introduction to Surveying and Geomatics Engineering.
18. Basak N N., 2017, Surveying & Levelling|2nd Edition
19. Kaplan Elliott, Understanding GPS/GNSS: Principles and Applications.
20. Shivam Pandey, 2020, Basic Concept of Remote Sensing, GPS and GIS.

Reference Distribution:

Module	Unit	Reference No.
1	1	1, 3, 6
	2	1,3
	3	1,3, 6
	4	1,3,5
2	1	1,2,3,4,12.
	2	1,2,3,4,12.
	3	1,3,4
	4	14, 15
3	1	8,9,10, 11, 13
	2	16,17,18
	3	18,19,20
	4	18,19,20
4	1	8,9,10,11,13
	2	8,9,10
	3	8,9,10,11,13
	4	9,10,13

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**50**
Theory test paper		50
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10

c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
	Total	**75**

KU4VACGEL201: WATER RESOURCE MANAGEMENT

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	VAC	200-299	KU4VACGEL201	3	45

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
3	0	-	25	50	75	2 hours

Course Description: " Water resource management" course provides a comprehensive study on surface and subsurface water resource, hydrological cycle, ground water, ground water properties of rocks, types of aquifers, wells and its types, groundwater provinces of India, groundwater development potential of Kerala. The course deals with water quality standards, physical, chemical and biological parameters, sea water intrusion, pollution and remedial measures. It also examines the water resource development and management, water conservation practices, well design and management. This foundational course equips students with essential knowledge of watershed management, rainwater harvesting, artificial recharge and groundwater exploration.

Course Prerequisite: The learner must have completed the basic courses in 100 – 199 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Definition of various technical terms associated with water resource management.	R
2	Understand the basic concepts of water resource management.	U
3	Evaluate the components of hydrological cycle, aquifer parameters, water quality parameters and standards.	E
4	Students will be able to evaluate the causes water pollution, water borne diseases and remedial measures.	E
5	Students will be able to analyse the various water resource conservation practices, well design, artificial recharge, rain water harvesting and groundwater exploration.	A

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2		✓		✓			
CO 3				✓	✓		
CO 4					✓	✓	
CO 5			✓			✓	✓

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**WATER RESOURCE**		**10**
	1	Ground water and surface water. rivers ,lakes, ponds and wetlands. Reservoir: Types, Investigations, Site selection, Zones of storage, Safe yield, Reservoir capacity, Reservoir sedimentation and control.	2
	2	Hydrological cycle: components and processes. Significances of hydrological cycle. Climate and water availability, Water balances, Precipitation: Forms, Classification, Variability, Measurement, Data analysis, Evaporation and its measurement, Evapotranspiration and its measurement, Penman Monteith method. Infiltration: Factors affection infiltration, Horton's equation and Green Ampt method.	2
	3	Drainage pattern, development, controlling factors, hydrological significances. Hyetograph and Hydrograph Analysis: Hyetograph, Runoff: Hydrograph concepts assumptions and limitations of unit hydrograph, Derivation of unit hydrograph S hydrograph, Flow duration curve.	3
	4	River basins. Delineation of basin boundaries, water dividers. Major water resource regions, basin, catchment, sub-catchment, watershed, sub-watershed, mini-watershed and micro watershed.	3

2	**GROUNDWATER**		**10**
	1	Occurrence and movement of groundwater, Darcy's law, governing ground water flow equations, Factors governing ground water flow, Types of aquifers, porosity, specific yield, specific retention, storage coefficient, permeability, hydraulic conductivity, hydraulic transmissibility, Conjunctive use and its necessity..	2

	2	Type of wells - dug wells, tube wells bore wells and surangas.	3
	3	Groundwater provinces of India.	3
	4	Groundwater development potential of Kerala.	2

3	**WATER QUALITY**		**10**
	1	Water quality standards proposed by World Health Organization and Beuro of Indian Standards.	3
	2	Physical, chemical and biological parameters	2
	3	Sea water intrusion: causes, process and remedial measures-	3
	4	Water pollution -its causes and mitigation, water borne diseases and remedial measures.	2

4	**WATER RESOURCE DEVELOPMENT AND MANAGEMENT**		**10**
	1	Concept and practices of water resource development and management.	3
	2	Water conservation practices. Well design and well development.	2
	3	Watershed management- rain water harvesting-artificial recharge.	2
	4	Groundwater exploration. Classification and methods of groundwater exploration.	3

5	**Teacher Specific Module**	**5**

	Directions: Familiarize with the key concepts, principles, and terminology of water resources management. Gain knowledge of water conservation practices. Understand the significances of watershed management, groundwater recharge and groundwater exploration. Tools and technologies for water resources development and management.	

Essential Readings:

1. Cech Thomas V. (2003). Principles of water resources: History, development, management and policy. John Wiley& Sons.
2. Todd, D.K. (2004) Ground Water Hydrology, John Wiley & Sons, 636p.
3. Karanth, K.R. (1987) Groundwater Assessment, Development and Management. Tata McGraw Hill, New Delhi, 720p. •
4. Mays, L.W. Water resource engineering, John Wiley& Sons
5. Linsley R.K and Franzini J.B (1979) Water resource engineering, McGraw-Hill
6. Mays L.W. (1996) Water resources hand book, McGraw-Hill.
7. Jain S.K. and SnghV.P.,Water resources system planning and Management Elsevier
8. Walton, W.C. Ground Water Resources evaluation, McGraw-Hill.

Reference Distribution:

Module	Unit	Reference No.
1	1	1, 3, 6
	2	1,3
	3	1,3, 6
	4	1,3.
2	1	2, 3, 8
	2	2, 3, 8
	3	2, 3, 8
	4	2, 3, 8
3	1	2, 3
	2	2, 3, 8

	3	2, 3
	4	2, 3, 8
4	1	1, 4, 5, 6
	2	1, 4, 5
	3	1, 4, 5, 6
	4	1, 4, 5, 6

Suggested reading.

1.CGWB- Annual reports.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**50**
Theory test paper		50
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
	Total	**75**

KU4VACGEL202: INTRODUCTION TO HYDROGEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	VAC	200-299	KU3MDCGEL201	3	45

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
3	--	--	25	50	75	2 hours

Course Description: *The course offers an introduction to the subject of hydrogeology. It deals with the scope and opportunities, surface and sub-surface water resources, hydrological cycle, origin and types of groundwater, vertical distribution of groundwater and aquifer and its properties.*

Course Prerequisite: The learner must have completed the basic courses in 100 – 199 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the basic concepts of hydrogeology, including surface and subsurface occurrences of water resources, origin and types of groundwater, hydrological cycle, vertical distribution, groundwater harvesting structures and waterborne diseases.	R,U
2	Identify the water bearing formation, its subsurface distribution.	U,A
3	Classify rocks based on its water bearing properties. Evaluate the hydrological conductivity and aquifer properties.	A,E
4	Analyze the Darcy's law, validity and practical implications of Darcy's law.	An,C
5	Understand the management of water quality, waterborne diseases, and sustainable groundwater practices, including appropriate groundwater recharge techniques.	U,A

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓			✓			
CO 2		✓			✓		
CO 3			✓				
CO 4			✓			✓	
CO 5	✓			✓			✓

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**INTRODUCTION**	**10**
	1	Water resources-. Need and importance of water resources- Scope and opportunities.	2
	2	Surface and sub surface water resources. Groundwater and Surface water Interaction	3
	3	Origin of groundwater - Meteoritic, Juvenile, connate	2

	4	Hydrological cycle- a) Importance and components of hydrological cycle. b) Various processes in hydrological cycle	3

2	**AQUIFER PARAMETERS**		**10**
	1	Vertical distribution of groundwater - Zone of aeration, capillary zone, zone of saturation and water table.	2
	2	Porosity- Definition and Types; Factors Affecting Porosity Permeability -Definition, Factors Affecting Permeability Relationship between Porosity and Permeability	3
	3	Classification of rocks based on water bearing property – Aquifer, aquiclude, aquifuge and aquitard. Types of aquifers – confined and unconfined; perched aquifers; Piezometric surface. Artesian well	3
	4	Basic concepts of the following Hydraulic conductivity - Definition and units, factors affecting hydraulic conductivity Transmissivity- Definition and Units. Specific yield and Specific retention, Storage coefficient	2

3	**DARCY'S LAW AND WATER WELL**		**10**
	1	Darcy's law - Experimental verification of Darcy's law. Validity of Darcy's law, Reynolds number, Practical applications of Darcy's law.	3
	2	Groundwater quality parameters – Physical, chemical and biological parameters.	3
	3	Types of wells- open, borewell, tube well. Horizontal wells.	2
	4	Well development and management.	2

4	**GROUNDWATER QUALITY, POLLUTION AND RECHARGE**		**10**
	1	Water quality standard proposed by WHO and Bureau of Indian Standards (BIS)	3
	2	Water borne diseases - Types and causes.	2
	3	Groundwater pollution – Causes and preventive measures	2
	4	Groundwater recharge – Natural and artificial methods.	3

5	**Teacher Specific Module**	**5**
	Directions: Students have to conduct experiments and field visit under the supervision of teacher to understand the Role of aquifer parameters in groundwater flow and storage Measurement and Determination of porosity and permeability in the lab and field.	

Essential Readings:

1. Todd, D.K., (2006), Groundwater Hydrology, second edition., John Wiley & Sons.
2. Karanth, K.R., (1986), Groundwater and Wells, Science Pub., Jodhpur
3. Fetter, C.W. ,(1990), Applied Hydrology, Merril Publishing Co. U.S.A., 592p
4. BIS, [Bureau of Indian Standards], (2003). Indian standard drinking water specifications IS 10500:1991, Bureau of Indian Standards, New Delhi.
5. WHO, (2006) Guidelines for drinking water quality. Vol. 1,Recomendations, World Health Organization, Geneva.
6. Mark W. LeChevallier and Kwok-Keung Au (2004): American Water Works Association (AWWA), USA.
7. Abhijit Mukherjee and Tushar Mukhopadhyay (2017) . Groundwater Contamination and Remediation, CRC Press (Taylor & Francis Group).
8. The U.S. Environmental Protection Agency (EPA): https://www.epa.gov/sites/default/files/2015-08/documents/mgwc-gwc1.pdf.
9. D.K. Todd and Larry W. Mays (2005). Groundwater Resources Development and Management, Prentice Hall PTR
10. Leonard F. Konikow and Donald R. Leahy (2015). Geological Society of America.
11. Willis D. Weight Hydrogeology (2008). Field Manual, The McGraw-Hill Companies, Inc.

Reference Distribution:

Module	Unit	Reference No.
1.	1	1,2
	2	1,11
	3	2,3
	4	1,3
2	1	1
	2	1
	3	1
	4	1,3
3	1	1,2
	2	1,2
	3	1,2
	4	1,2
4	1	4,5
	2	6
	3	7,8
	4	9,10

Suggested Readings:

1. Tolman, C.F., Ground water, McGraw Hill.
2. Walton, W.C., 1970, Groundwater Resource Evaluation, McGraw Hill Inc.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**50**
Theory test paper		50
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
	Total	**75**

SEMESTER 5

DISCIPLINE SPECIFIC COURSES

KU5DSCGEL301– SEDIMENTARY AND METAMORPHIC PETROLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	Major	300- 399	KU5DSCGEL301	4	75

<table>
<tr><th colspan="3">Learning Approach (Hours/ Week)</th><th colspan="5">Marks Distribution</th><th rowspan="3">Duration of ESE (Hours)</th></tr>
<tr><th rowspan="2">Lecture</th><th rowspan="2">Practical/ Internship</th><th rowspan="2">Tutorial</th><th colspan="2">Theory</th><th colspan="2">Practical</th><th rowspan="2">Total</th></tr>
<tr><th>CCA</th><th>ESE</th><th>CCA</th><th>ESE</th></tr>
<tr><td>3</td><td>2</td><td>--</td><td>25</td><td>50</td><td>10</td><td>15</td><td>100</td><td>2 hours</td></tr>
</table>

Course Description:

This course discusses various fundamental aspects of sedimentary rocks. It explores clastic and non-clastic texture and components of sedimentary rocks. Details the different type of clastic sediments and sedimentary rocks including breccia, conglomerate, sandstone, shale, and mudstone and discusses textural and mineralogical maturity. The course explores nature of non-clastic sediments and rocks and their genesis. The course focus on different diagenetic processes such as compaction, cementation, anthogenesis, and recrystallization. This course also provides practical understanding of sedimentary rock identification in microscopic and megascopic level.

Course Prerequisite: The learner must have successfully completed the courses 200 to 299 level of B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Recognize and interpret different sedimentary textures and distinguish between clastic and non-clastic components.	U, A & An
2	Identify and classify different clastic and non-clastic sedimentary rocks	U & An
3	Recognize and comprehend the geological implications of diagenetic processes altering sediments into sedimentary rocks.	An & E

4	Understands types, factors controlling metamorphism and different metamorphic textures and structures.	U
5	Understands the concept of metamorphic grade and metamorphic facies and how to apply this knowledge in the field conditions.	U, A
6	Understands the petrography and petrogenetic aspects and identification of different types of metamorphic rocks.	U

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				✓
CO 2	✓	✓			✓		✓
CO 3	✓		✓	✓		✓	
CO 4	✓	✓					
CO 5		✓					✓
CO 6	✓		✓				

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**SEDIMENATRY TEXTURE AND CLASTIC ROCKS**		**10**
	1	Sedimentary texture- Clastic and non- texture components and type.	3
	2	Detailed study of clastic sedimentary rocks - Rudaceous rocks – Classification Breccia and conglomerate.	3
	3	Arenaceous rocks – Classification of Sandstone. Argillaceous – shale and mudstone.	2
	4	Textural and mineralogical maturity of clastic sediments	2

2	**NON- CLASTIC ROCKS, TEXTURE AND DIAGENESIS**		**10**
	1	Chemical sedimentary rocks – Limestone and Dolomites	3
	2	Chemical sedimentary rocks – Evaporites – Carbonates & Non carbonates	2
	3	Bio chemical rocks – Phosphorites	3
	4	Diagenesis – Major digenetic process – Compaction, Cementation, Authigenesis and Recrystallization	2

3	**METAMORPHISM- CONTROL FACTORS, TYPES, TEXTURES AND STRUCTURES.**		**10**
	1	Metamorphism and metamorphic rocks. Factors controlling Metamorphism.	3
	2	Types of metamorphism, Pressure-Temperature limits, Prograde and retrograde metamorphism.	2
	3	Metamorphic textures.	3
	4	Metamorphic structures	2

4	**METAMORPHIC FACIES AND GRADES; ROCK TYPES.**		**10**
	1	Concept of metamorphic facies -Greenschist, Amphibolite, Granulite, Eclogite and Blueschist facies and contact metamorphic facies	3
	2	Metamorphic Grade. Index minerals, Concept of depth zones. Barrowian zones and mineral paragenesis.	3
	3	Petrography and petrogenetic aspects of the following rock types: Slate, phyllite, schist, gneiss and amphibolite.	2
	4	Petrography and petrogenetic aspects of the following rock types marble, granulite (charnockite and khondalite), mylonite, and Banded Magnetite Quartzite/Banded Hematite Quartzite.	2

5	**Teacher Specific Module**	**5**
	Directions: Origin of Sedimentary rocks including disintegration & decomposition of rocks., Transportation and Deposition. Effects of metamorphism on different types of rocks: argillaceous rocks, calcareous rocks, arenaceous rock and basic igneous rocks.	
	Space to fill the selected area/ activity	

6	**Practical**	
	Megascopic identification of following hand specimen*: Sandstone, Shale, Conglomerate, Breccia, Grit, Limestone, Coralline limestone* ***Microscopic identification of following:*** *: Sandstone, Shale, Conglomerate, Breccia, limestone* ***Megascopic and microscopic identification of following hand specimen: Slate, Phyllite, Schist, Gneiss, Amphibolite, Marble, Eclogite, Charnockite and Khondalite.***	**30**

Essential Readings:

1. Tyrrell, George Walter. *The principles of petrology: an introduction to the science of rocks*. Springer Science & Business Media, 2012.
2. Boggs, Sam. *Petrology of sedimentary rocks*. Cambridge university press, 2009.
3. Nichols, Gary. *Sedimentology and stratigraphy*. John Wiley & Sons, 2009.
4. PROTHERO, DR & SCHWAB, F. 1996. Sedimentary Geology. An Introduction to Sedimentary Rocks and Stratigraphy. New York: WH Freeman.
5. Pettijohn, F.J.,Sedimentary rock, Prentice Hall., 5th Edition.
6. Harker, A. (1952) Metamorphism. Mc-Graw Hill Co.
7. Hyndman, D.W. (1972) Petrology of igneous and Metamorphic Rocks. Mc-Graw Hill.
8. Moorehouse, W.W. (1959) The study of rocks in thin sections. Harper and Row, New York.
9. Rao, B.B. (1986) Metamorphic Petrology. Oxford-IBH Publ. Co.
10. Williams, H., Turner, J.F. and Gilbert, C.M. (1985) Petrography-An Introduction to the study rocks in thin sections. Second Edn. CBS Publishers, Delhi.
11. Winter, J.D. (2001) An introduction to Igneous and Metamorphic Petrology. Prentice Hall, New Jersey.
12. Turner.F.J and Verhoogen.J (1960) Igneous and Metamorphic Petrology – McGraw Hill
13. Ehler G.E. and Blatt H. (1999) Petrology- Igneous, Sedimentary and Metamorphic. CBS Publishers and Distributors, New

Reference Distribution:

Module	Unit	Reference No.
1	1	4,5
	2	4,5
	3	4,5
	4	4,5,3
2	1	1,2
	2	1,2
	3	1,2,4
	4	1,2,3
3	1	6,7
	2	1,9
	3	1,8,10
	4	1,8,11
4	1	12,13
	2	12,13
	3	1,9,11
	4	1,9,11

Suggested Readings:

1.Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
2. Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Scientific and Technical, London.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**

a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU5DSCGEL302: FIELD GEOLOGY*

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	Major	300-399	**KU5DSCGEL302**	4	105

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
1	6	1	10	15	30	45	100	2 hours

Course Description: *Field Geology course is designed to provide students with hands-on experience in geological field methods and techniques. This course emphasizes practical skills in observing, recording, and interpreting geological features in their natural environment. Students will engage in extensive fieldwork, including mapping, sampling, and analyzing geological structures and formations.*

Course Prerequisite: The learner must have completed the basic courses in 200 – 299 level in B Sc Geology programme.

*This course includes fieldwork that corresponds to 3 credits. Fieldwork/study tour will last 8 to 12 working days. Students will be deputed to fieldwork/study tour for 8 to 12 consecutive days during the fifth semester.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understands field observation and description of geological features.	U
2	Develop proficiency in using geological field tools and instruments.	U, A
3	Measurement and interpretation of geological structures such as folds, faults, and joints.	A
4	Analyze geological formations and structures to interpret their history and processes.	A
5	Synthesize field data to create comprehensive geological reports and maps.	C
6	Understand and apply geological mapping techniques.	U,A

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), (I) Integrate*

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓					

CO 2		✓					
CO 3		✓	✓				
CO 4				✓	✓		
CO 5						✓	✓
CO6		✓			✓		

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**INTRODUCTION**	**4**
	1	Importance of geological surveying- Objective and type of geological field work	1
	2	Fieldwork planning and execution. Consideration of safety protocols	1
	3	Base map preparation – from topographic, areal photo and satellite imageries	1
	4	Use of GIS in pre planning the field work	1
2		FIELD WORK	**4**
	1	Geological compasses and types – Brunton and clinometer	1

	2	Geological hammers, Pocket and hand lenses, Pocket magnet, Haversack essentials, Hardness scale and knife	1
	3	GPS and related instruments	1
	4	Digital survey equipments – Drone, UAVs and Total Station	1

3	DOCUMENTATION		**4**
	1	Field notebook – Importance, Field sketches, and photographs.	1
	2	Symbols of rock and structures	1
	3	Understanding and utilizing Survey of India maps - Grid systems and coordinates on maps	1
	4	Digital documentation tools	1

4	FIELD MEASUREMENTS AND GEOLOGICAL MAPPING		**4**
	1	Measurement for attitude of beds- dip, strike, rake, plunge etc.	1
	2	Importance of traverse. Planning geological traverse.	1
	3	Key features to consider in the identification of igneous, sedimentary and metamorphic rocks.	1
	4	Techniques in Geological Mapping -Mapping structures and lithologies.	1

6	**MODULE 6 (Practical/Field Work)**	
	Students will participate in an extended field camp or study tour lasting 8-12 working days during the fifth semester.	90

Essential Readings:

1. Field Geology Frederic H. Woodruff (2017)- 7th Edition, John Wiley & Sons, 484p

2. Gary Nichols (2017)- Doing Fieldwork in Geosciences, Wiley Blackwell, 240p
3. Robert S. Yeats (2008) Geomorphology: The Study of Land forms, 3rd Edition, Prentice Hall, 600 p.
4. American Geosciences Institute (AGI) and Geological Society of America (GSA) -(2008) Field Safety: A Guide for Geoscientists ,2nd Edition, Geological Society of America, 128 p.
5. Paul F. Howell and David W. Ager Geological Techniques, (2009)Waveland Press, 532 p
6.Mathur, S.M., (2001)- Guide to field Geology, Prentice- Hall of India Pvt. Ltd., New Delhi.
7. Peter Van der Veen and Emile Janissen (2006) Portable X-Ray Fluorescence Spectrometry in Geosciences, Springer, 448 p
8. Stanley B. Smith (2005) Field-Portable Instrumentation for Geochemical Exploration and Environmental Investigations, CRC Press, USA, 336 p
9.Compton, R.R., 1968, Manual of Field Geology, Wiley Eastern Pvt. Ltd.
10 Lahee, F.H., 1961, Field Geology, 6th edn., McGraw Hill Book Company, New York, 926p
11.Low, J.W., Geological Field Methods, Harper & Brothers
12. Stow, D.A.V., 2005, Sedimentary Rocks in the Field--A Color Guide, Manson Publishing, 320p.
13. Philip Kearey, Michael Brooks and Ian Hil (2002): An Introduction to Geophysical Exploration, Blackwell Science Ltd., USA,262p.
14. Domenico Daniel D (2004) Ground Penetrating Radar Theory and Applications, Elsevier, , 858 p.
15. David H. Griffiths (2018): Drones and Aerial Photography for Geological Mapping: A Beginner's Guide, Elsevier,224p
16. Gretchen E. Prabu (2009)-GIS for Geoscientists: Applications in Environmental and Earth Sciences, Elsevier, 416p

Reference Distribution:

Module	Unit	Reference No.
1	1	1,3
	2	4,6
	3	2,5
	4	2,7,8
2	1	9

	2	6,9
	3	6,9
	4	13,14,15
3	1	10
	2	10,11
	3	10,11
	4	10,12
4	1	1,9,11
	2	1,9,11
	3	15,16
	4	16

Suggested Readings:

1. Richard Foster Reed Jr. (2005) . Geological Maps, 4th Edition, Waveland Press, 704 p
2. Richard J. Howarth and Arthur C. Ward (2016) Legend Sheet Design in Geological Maps, Cambridge University Press, 184 p

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**60**
a)	Theory test paper	15
b)	Practical test paper	45
Continuous Evaluation (Theory)		**10**
a)	Written test	05
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	-

c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
	Continuous Evaluation (Practical)	**30**
a)	Test paper/Practical test	25
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU5DSCGEL303: STRATIGRAPHY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	Major	100	KU5DSCGEL303	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	--	--	30	70	100	2 hours

Course Description: *Stratigraphy is the branch of geology concerned with the study of rock layers (strata) and layering (stratification). This course provides an introduction to the principles of stratigraphy, the methods used to study strata, and the interpretation of the stratigraphic record to understand the Earth's history.*

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understanding of the basic principles of stratigraphy, including the laws of superposition, original horizontality, lateral continuity, and cross-cutting relationships.	U

2	To identify, classify, and correlate lithostratigraphic, biostratigraphic, and chronostratigraphic units, applying these concepts to real-world geological problems.	U, A
3	To interpret past depositional environments, reconstruct paleoenvironments, and understand the sedimentary processes through the analysis of stratigraphic records and sedimentary structures.	U, C
4	Students will gain basic understanding in advanced stratigraphic methods, such as sequence stratigraphy, magnetostratigraphy, and chemostratigraphy, and understand their applications in basin analysis and geological dating.	U
5	Students will be able to apply stratigraphic knowledge to practical scenarios, such as hydrocarbon exploration, paleoenvironmental studies, and understanding the interactions between stratigraphy and tectonics, demonstrating the ability to solve complex geological problems using stratigraphic data.	

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), (I) Integrate*

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓			✓	
CO 2			✓				
CO 3			✓	✓			
CO 4	✓		✓			✓	
CO 5	✓		✓			✓	

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**BASICS OF STRATIGRAPHY**		**15**
	1	Definition and scope of stratigraphy; Historical development of stratigraphic concepts.	4
	2	Principles of Stratigraphy: Principle of uniformitarianism; Law of Superposition; Principle of Original Horizontality; Principle of Lateral Continuity; Principle of Cross-Cutting Relationships	4
	3	Stratigraphic Units: Lithostratigraphy, biostratigraphy, chronostratigraphy; Correlation and classification of strata.	4
	4	Geological Time Scale: Development and significance of the geological time scale; Major eons, eras, periods, and epochs.	3

2	**STRATIGRAPHIC UNITS**		**14**
	1	Lithostratigraphy: Lithostratigraphic units: formations, members, and beds.	4
	2	Biostratigraphy: Principles of biostratigraphy and biostratigraphic units	4
	3	Index fossils and their significance; Biozones and biostratigraphic correlation.	3
	4	Sedimentary Environments: Depositional environments and their stratigraphic signatures	3

3	**SEQUENCE STRATIGRAPHY & CHRONOSTRATIGRAPHY**		**15**
	1	Interpretation of sedimentary structures and facies.	4

	2	Sequence Stratigraphy: Concepts of sequences, systems tracts, and sequence boundaries;	4
	3	Application of sequence stratigraphy in basin analysis.	4
	4	Chronostratigraphy: Concepts of chronostratigraphic units and geochronology.	3

4	**MAGNETOSTRATIGRAPHY**		**11**
	1	Magnetostratigraphy: Earth's magnetic field and magnetic reversals; Recording magnetic signals in rocks	3
	2	Correlation of magnetic stratigraphy with the global geomagnetic polarity time scale	3
	3	Stratigraphy in Paleoenvironmental Studies: Reconstruction of past environments and climate; Use of stratigraphy in understanding sea-level changes.	3
	4	Current Trends and Future Directions: Advances in stratigraphic techniques and technologies; Role of stratigraphy in understanding Earth's future changes.	2

5	**Teacher Specific Module**	**5**
	Course coordinator is free to design this module that may include field trip report on local stratigraphic sections and correlation exercise using lithostratigraphic and bio stratigraphic data.	

Essential Readings:

1. James D. Hedgpeth (2007) Stratigraphy: Principles and Methods (Fourth Edition), Springer, 786 p.
2. John David Edwards (1984)-Stratigraphic Principles in Practice (Second Edition), Chapman and Hall, 461p.
3. Paul B. Taylor (2009), Fossils: A Very Short Introduction, Oxford University Press, 184 p.

4. Edward C. Pogge (2019), Earth: An Introduction to Physical Geology, 11th Edition, Waveland Press, 728 p.
5. Felix M. Gradstein, James G. Ogg, Mark D. Schmitz & Gerald M. Ogg (2020)- Geological Timescale for 2020- Elsevier, 1284 p.
6. Dorrik A. V. Stow (2010)-Sedimentary Rocks in the Field, Third Edition, Wiley-Blackwell,348p.
7. Brian Mc.Gowran (2005).Microfossils and Geological Time, Second Edition, Cambridge University Press, 320 p.
8. Michael E. Taylor and David N. Wilson (2003).Stratigraphic Paleobiology, Second Edition, University of Chicago Press,651p.
9. James C. Nichols (2009). Sedimentary Environments: Processes, Facies, and Stratigraphy, Fourth Edition, Wiley-Blackwell,488p.
10. Gerald M. Friedman and John E. Sanders (1978).Atlas of Sedimentary Structures , Edition, Springer, , 359 p
11. Henry Posamentier, Walter R.G. Ross and Colin G. Stacker (2007). Sequence Stratigraphy, (Second Edition), Cambridge University Press, 227 p.
12. Roger G. Walker Facies (1998). Analysis and Sequence Stratigraphy by (Second Edition), Wiley-Blackwell, 279 p.
13. Donald W. A. Irwin (1991).Magnetostratigraphy and Orogenic Processes by Blackwell Science Ltd, 371 p.
14. Norbert Nowaczyk (2011). Principles of Magneto stratigraphy, Springer-Verlag, 368p.
15. Michael E. Mann (2009). Proxy Records in Paleoclimatology: Concepts, Methods, and Limitations, Wiley-Blackwell, 426 p.
16. Andrew D. Miall (2016) Stratigraphy: A Modern Synthesis, Springer,454p
17. Eduardo A.M. Koutsoukos (Edtn.), (2007)-Applied Stratigraphy, Springer,518p
18. Dunbar, C.O and Rogers, J. (1961) Principles of Stratigraphy. Wiley Publications.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2
	2	2 ,3,18
	3	1,2,6

	4	4,5
2	1	1,6
	2	7,8
	3	1,3
	4	9
3	1	5,10
	2	11,12
	3	11,12
	4	1,5
4	1	13,14
	2	13,14
	3	1,15
	4	16,17

Suggested Readings:

1. James Hutton -Principles of Stratigraphy Edited by Gary D. Rosenberg (2006), Geological Society of America Special Paper 427,381 p
2. Philip A. Allen and John Allen (2008). Basin Analysis: Principles and Applications (Second Edition), Wiley-Blackwell, 597 p.
3. Magnetostratigraphy: Concepts, Definitions, and Applications (Chapter 7 in "New Frontiers in Integrated Stratigraphy") Edited by Shuhei Nishimura (Elsevier, 2016, 490 pages)
4. Eric C. F. Bird (2010) Coastal and Estuarine Environments: Processes, Geomorphology, and Sediments by (Second Edition), Cambridge University Press, 384 p.

Assessment Rubrics:

Evaluation Type	Marks
End Semester Evaluation	**70**
Theory test paper	70

Continuous Evaluation (Theory)		30
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

KU5DSEGEL301 – PRE-CAMBRIAN GEOLOGY OF INDIA

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	Major (Elective)	300- 399	**KU5DSEGEL301**	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	--	--	30	70	100	2 hours

Course Description:

This course offers a comprehensive exploration of India's Precambrian geological landscape in this course. This course aims to provide a detailed understanding of the origins and complexities of the Indian subcontinent's geological setup. The course details the major cratons such as Dharwar, Singhbhum, Bastar, and Aravalli, highlighting their tectonic divisions, regional stratigraphy, and structural characteristics. This course also examine the mobile belts of the sub continent including the Pandiyan belt and Central Indian Tectonic Zone (CITZ), understanding their tectonic settings and stratigraphic evolution. Highlighting the significance of Proterozoic basins like Vindhyan and Cuddapah, this course analyzes their stratigraphy and economic importance.

Course Prerequisite:
The learner must have successfully completed the courses 200 to 299 level of B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the tectonic divisions of the Indian subcontinent, including major cratons, mobile belts, and Proterozoic sedimentary basins.	*R, U, An*
2	Analyse the supra-crustal rocks of the Dharwar craton, exploring their regional stratigraphy and structure.	*A &An*
3	Analyse the Archean geology of peninsular India, with detailed studies of regional stratigraphy and structure in Singhbhum, Bastar, Bundelkhand, and Aravalli cratons.	*An & E*
4	Examine the mobile belts of India, focusing on the stratigraphy, structure, and ages of the Pandiyan mobile belt and CITZ.	*An & E*
5	Understand major Proterozoic sedimentary basins especially Vindhyan and Cuddapah and analyse their stratigraphy in genetic point. Also understand their economic importance, and geological characteristics.	U & An

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓			✓			
CO 2	✓	✓			✓		
CO 3	✓		✓		✓		✓
CO 4	✓		✓			✓	
CO 5	✓			✓	✓		

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**PRECAMBRAIN GEOLOGICAL SETTINGS**		**14**

	1	Tectonic divisions of Indian subcontinent – General study	4
	2	Precambrian terrains – Major cratons – Age and distribution	4
	3	Mobile belts in Indian sub-continent – Distribution and age	3
	4	Proterozoic sedimentary basins of India – General study	3

2	**ARCHEAN GEOLOGY OF PENINSULAR INDIA**		**15**
	1	Regional stratigraphy, structure and tectonic components of Dharwar craton.	4
	2	Regional stratigraphy, structure and tectonic components of Singhbhum craton.	3
	3	Regional stratigraphy, structure and tectonic components of Bastar craton.	4
	4	Regional stratigraphy, structure and tectonic components of Aravalli craton.	4

3	**MOBILE BELTS OF INDIA**		**12**
	1	Structure and tectonic zones of Pandian mobile belt.	4
	2	Regional stratigraphy of Pandiyan mobile belt.	2
	3	Central Indian Tectonic Zone (CITZ) – Regional stratigraphy.	4
	4	Litho tectonic division and age of CITZ.	2

4	**PROTEROZOIC SEDIMENTARY BASINS OF INDIA**		**14**
	1	Vindhyan basin– Distribution	3
	2	Vindhyan basin & Vindhyan super group – stratigraphy and economic importance.	4
	3	Cuddapah basin – Distribution	4

	4	Cuddapah basin &Cuddapah super group - Stratigraphy and economic importance.	3

5	**Teacher Specific Module**	**5**
	Directions: Students are required construct models, figures, tables and diagrams, conduct lab and field experiments as per the requirement of the course	
	Space to fill the selected area/ activity	

Essential Readings:

1. Ramakrishnan, Moni, and Rajagopala Vaidyanadhan. *Geology of India*. Vol. 1. Bangalore: Geological Society of India, 2008.
2. Ravindra Kumar, Fundamentals of historical geology and stratigraphy of India.3rd edition 2000.
3. Shah, Som K. *Historical geology of India*. Scientific Publishers, 2018.

Reference Distribution:

Module	Unit	Reference No.
1	1	2
	2	2
	3	2
	4	2
2	1	1,2
	2	1,2
	3	1,2
	4	1,2
3	1	1,2
	2	1,3
	3	2,3
	4	2,3
4	1	1,2
	2	1,2
	3	1,2
	4	1,2

Suggested Readings:

1.Alan M. Goodwin (1996) Precambrian Geology: The Dynamic Evolution of the Continental Crust, Academic Press,327p
2.K. S. Valdiya (2015). Precambrian Geology of India. Springer, 924p.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

KU5DSEGEL302 – MARINE GEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	Major (Elective)	300 - 399	KU5DSEGEL302	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	--	--	30	70	100	2 hours

Course Description:

The Marine Science course encompasses the dynamic ocean floor, exploring Earth's heat engine, plate tectonics, ocean basin ages, and tectonic features such as mid-ocean ridges, hotspots, and subduction zones. It covers marine sediments' classification, origin, and distribution on the shelf and deep sea. The course delves into oceanic energy resources like oil and gas, and mineral resources including manganese nodules and phosphates. It also includes ocean exploration history, techniques, and tools, and examines deep-sea drilling programs and maritime laws.

Course Prerequisite:

The learner must have completed the courses B Sc Geology programme of 200 – 299 level.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Explain the mechanisms of plate tectonics and analyse the tectonic features of ocean floor and their implications for the dynamic nature of the ocean.	***U, An, E***
2	Classify marine sediments and evaluate the processes ocean floor sedimentation in different tectonic settings.	***An, E***
3	Identify and assess the origin, distribution, and economic significance of marine energy and mineral resources and understand the Law of the Sea Treaty and the concept of Exclusive Economic Zones (EEZ).	***U, A***
4	Trace the history and development of ocean exploration, from early to recent explorations and analyse various ocean sampling and surveying techniques.	***R, U, A***
5	Investigate the stratigraphy and geochronology of deep-sea sediments to reconstruct the geological history of the ocean floor.	***An, E***

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7

CO 1	✓	✓	✓	✓	✓	✓	✓
CO 2	✓		✓	✓	✓	✓	✓
CO 3	✓	✓	✓		✓		✓
CO 4	✓						✓
CO 5	✓	✓					✓

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	Hours
1	**DYNAMIC OCEAN FLOOR**		**15**
	1	Heat engine of the earth and mechanism of plate tectonism. Age of the ocean basin and Wilson cycle.	4
	2	Tectonic features and their origin – Mid Oceanic Ridge system (MORs). Hot spot volcanism and ocean islands	4
	3	Subduction related oceanic features – Island Arcs, Back arc and Fore arc basin and Aulacogens	4
	4	Transform and transcurrent faults. Deep sea trenches	3

2	**MARINE SEDIMENTS**		**14**
	1	Classification of marine sediments – Terrigenous, biogenic and chemical sediments	3
	2	Shelf sedimentation – Origin and distribution of clastic and non- clastic sediments. Chemical sediments	3
	3	Deep sea sedimentation – Origin, type and distribution. Carbonates and non -carbonate sedimentation and their controlling mechanism.	4
	4	Deep sea stratigraphy and geochronology	4

3	**MARINE RESOURCES**		**14**
	1	Energy resources of ocean – Oil, Natural Gas and Gas hydrates – Origin and distribution.	4
	2	Mineral resources of ocean – Black smokers and manganese nodules. Cobalt rich oceanic crust.	3
	3	Origin and distribution Phosphatic deposits, Sand and gravel	4
	4	Law of the sea treaty and Exclusive Economic Zone (EEZ)	3

4	**OCEAN EXPLORATION**		**12**
	1	Brief history of ocean exploration – surface exploration to deep sea drilling.	3
	2	Magnetic survey and satellite mapping – GPS	3
	3	Ocean sampling techniques- Grabs, Dredgers, Corers, Water Samplers. Ocean floor survey tools - Echo-sounding methods, Side scan Sonar, Current meters and SCUBA diving-submersibles.	4
	4	Ocean floor drilling- Various deep-sea drilling programmes- JOIDES, DSDP, ODP, IODP.	3

5	**Teacher Specific Module**	**5**
	Directions: This module focusing on the geological processes and features of the ocean floor. The course will cover the formation and evolution of ocean basins, sedimentology, marine resources, and the impact of tectonic activities. Advanced techniques in marine geological research and the environmental implications of marine geological processes will also be included..	5
	Space to fill the selected area/ activity	

Essential Readings:

1. Duxbury, A.B. 1993 Fundamentals of Oceanography. Wm. C. Brown Publishers & Duxbury, AC.

2. Erickson, J., & Harris, L. S. (2013). Marine Geology. Jones & Bartlett Learning

3. Garrison, T. 1996 Oceanography-An invitation to Marine Science. Wadsworth Publishing Company

4.Gross, M.G. 1972 Oceanography - A view of the Earth. Prentice-Hall

5.Qasim, S.Z. & 1996 India's Exclusive Economic Zone. Omega Scientific Roonwal, G.S.(eds). Publishers

Reference Distribution:

Module	Unit	Reference No.
1	1	1, 2
	2	1, 2 ,3
	3	2, 3
	4	2,3
2	1	1, 2 ,3
	2	2, 3
	3	2,3
	4	3,4
3	1	3,4
	2	3,4,5
	3	3,4
	4	5,6
4	1	1,2 3
	2	3,4,
	3	3,4
	4	1, 5

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

KU5DSEGEL303: ENVIRONMENTAL GEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	Major (Elective)	300-399	**KU5DSEGEL303**	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	--	--	30	70	100	2 hours

Course Description: *Course explores the scope and application of environmental geoscience, focusing on the sustainable management and conservation of natural resources, alternative energy sources, and the interaction between natural hazards and the environment. The course covers the contamination of groundwater and marine* *environments, treatment and control methods, and the role of geologists in waste disposal. Students will develop a comprehensive understanding of the principles and practices that underpin the field of environmental geology*.

Course Prerequisite: The learner must have completed the basic courses in 200 – 299 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the broad scope of environmental geoscience, including its significance, interdisciplinary nature, and role in addressing environmental issues.	U
2	Understand various alternative energy sources principles of sustainability and how they apply to the management and conservation of natural resources.	U, A
3	Understand the potential and challenges associated with the extraction and management of ocean floor mineral resources.	A
4	Understands the relationship between natural hazards and the environment and learn to create hazard zonation maps.	C
5	Understand the sources, impacts, and control measures for pollution and also will be able to evaluate waste management practices and determine suitable sites for waste disposal, including landfills and deep well disposal.	U, E
6	Understand and effectively apply Environmental Impact Assessment (EIA) principles and methods across various environmental programs and projects.	U, A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), (I) Integrate***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓			✓	

CO 2			✓			✓	
CO 3			✓	✓		✓	
CO 4		✓		✓	✓		✓
CO 5		✓	✓				
CO6		✓	✓			✓	✓

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**RESOURSES AND HAZARDS**	**12**
	1	Environmental Geology: Scope of environmental geoscience. Natural resources: - Renewable resources, non-renewable resources. Sustainable management of resources. Conservation and preservation.	3
	2	Alternative energy sources – bio mass energy, wind energy, solar energy, geothermal energy, tidal energy, wave energy, ocean thermal energy and other alternate emerging energy sources for the future.	3
	3	Mineral resources of the ocean floor - Conservation, management and concept of sustainable development.	3
	4	Natural hazards and environment; Hazard zonation maps.	3

2	**POLLUTION**	**14**

	1	Pollution: Problems of pollution of geospheres. Pollution and climatic changes. Greenhouse effect and Ozone Layer Depletion. .	3
	2	Radioactive pollution – Radioactivity, characteristics of radioactive waste. Classification – low level, intermediate level and high level. Disposal of high level radioactive waste.	4
	3	Waste generation due to mining, environmental impacts of mining activities on land surface, air and water environment. Impacts of mining on depositional environments -reservoirs, lakes, lagoons and estuaries. Mine site decommissioning.	4
	4	Impacts of sand mining – River and beach sands. Soil pollution- sources, effects and control.	3

3	**WATER POLLUTION AND WASTE MANAGEMENT**		**15**
	1	Groundwater pollution – Sources of groundwater pollution- heavy metals, radioactive materials, acid mine drainage, fluoride, pesticide, fertilizers and arsenic contaminations. Marine	4
	2	Collection and treatment, detoxification and biodegradation, health hazards due to ground water pollution, microbes, BOD and COD. Controls of ground water pollution.	4
	3	Pollution: Marine Pollution: Sources of marine pollution – industrial effluents, marine ship effluents, oil spillage, inflow of fertilizers and pesticides, nuclear waste. Major impacts of marine pollution.	4
	4	Waste Management: Re-use and recycling. Waste disposal :Role of geologist to find suitable sites for waste disposal. Landfills-Secure landfills and deep well disposal.	3

4	**ENVIRONMENTAL IMPACT ASSESSMENT**		**14**
	1	EIA: Introduction, Definition, aim, principles and concept. Relationship of EIA in sustainable development.	3

	2	Methods for preparing EIA: Socio-economic aspects, making inventories, sampling and data process, baseline study.	4
	3	Impact prediction: Positive and negative impact, primary and secondary impact, impact on physical, social and biotic environment.	3
	4	EIA for different environmental programmes: Industries, urban development, land use, Energy Projects-Hydel, Thermal, Nuclear, oil and gas. Environmental Impact Analysis of dams, buildings, highways and tunnels. EIA case studies.	4

5	**Teacher Specific Module**	**5**
	This module includes natural hazards and how to manage them. It cover earthquakes, cyclones, coastal threats (tsunamis, erosion, sea level rise), landslides (including identification of prone areas), floods, and droughts (causes and prevention).	

Essential Readings:

1. Coates, D.R. 1981, Environmental Geology, John Wiley & Sons.

2.Elawan, P.T., 1970, Environmental Geology, Harper & Row.

3.Gupta, H.K., (Editor), 2003, Disaster Management, Universities Press (India) Ltd., Hyderabad.

4. Dorothy Merritts, Edward A. Keller (2017):,Environmental Geology: Sustainability, Resources, Hazards ,10th Edition, Waveland Press, United States, 752p.

5.Dimitrios A. Dimitriadis (2013) Marine Mineral Deposits, Elsevier, Netherlands, , 400p

6. Ian L. Gibson (2019) Environmental Pollution and Climate Change, Elsevier, Netherlands, , 512 p

7 Robert T. Watson. (2002) Ozone Depletion: A Threat to Life, Cambridge University Press, United Kingdom, 240 p

8. Jose M. Torroja (2017): Nuclear Waste Disposal- Options and Issues, Springer, Switzerland, 288 p

9. Ronald E. Smith (2017)-Mining and the Environment: From Cradle to Grave,Springer, Switzerland, , 320 p
10. Philippe Sands (2015) -Sand, Rarer Than You Think, Bloomsbury Publishing, United Kingdom, 272 p
11. Mohammad Faisal and Seema Rani (2017):Groundwater Pollution , Apple Academic Press, United States, 224 p
12. Michael Ehrhardt (2017)-Marine Pollution: Causes, Effects and Control, Springer, Switzerland, , 368 p
13. David P. Ahlrott (2019)Engineering Geology: An Environmental Approach, 8th Edition, Pearson Education Limited, United Kingdom, , 640 p.
14. Denise Frooman (2002) :Handbook of Environmental Impact Assessment, 2nd Edition, Edward Elgar Publishing, United Kingdom, , 856 p.
15. Case Studies in Environmental Impact Assessment (2007) -Edited by Edna Andresen, Alistair Gillespie and Andrew Porter, Edward Elgar Publishing, United Kingdom, , 368 p
16. Monica A. Ortolano (2017): Environmental Impact Assessment for Infrastructure Projects, Edward Elgar Publishing, United Kingdom, 320 p.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2
	2	1,2
	3	5
	4	3
2	1	6,7
	2	8
	3	9
	4	10
3	1	11
	2	11
	3	12
	4	13

4	1	14
	2	14
	3	14
	4	15,16

Suggested Readings:

1. Richard Foster Reed Jr. (2005). Geological Maps, 4th Edition, Waveland Press, 704 p
2. Richard J. Howarth and Arthur C. Ward (2016) Legend Sheet Design in Geological Maps, Cambridge University Press, 184 p
3. Lennis Barkub, G., 1980, Earthquakes and Urban Environment, V.1, 2 & 3, CRC Press Incorporated.
4. Simmons, I.G., 1981, The Ecology of Natural Resources, Edward Arnold Ltd.
5. Strahler, A.N. & Strahler, A.H., 1973, Environmental Geoscience, Wiley Eastern

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

KU5DSEGEL304 – FUEL GEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	Major (Elective)	200- 299	**KU5DSEGEL304**	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4		-	30	70	100	2 hours

Course Description:

This course helps the learner to understand the origin, occurrence and distribution of unconventional energy resources of our planet. This course provides historical context, physical and chemical attributes, classification and formation of coal and petroleum deposits, along with Indian occurrences. The course discusses the geological nature and distribution of important nuclear fuels, like uranium and thorium with special reference to Indian context. Lastly, this course explore emerging unconventional fuels like shale gas, coal bed methane, and tar sands.

Course Prerequisite:

The learner must have successfully completed the courses 200 to 299 level of B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the historical context and usage of coal, including its classification and the geological conditions required for coal formation and deposition.	*U & An*
2	Analyze the physical and chemical properties of coal, including coal petrography, combustion properties, grade, and calorific value, and their significance in various applications.	*A & An*

3	Understand the distribution of coal resources in India. Distinguishing between Gondwana and Tertiary coal deposits and evaluate their importance in the energy sector in present and future.	*U*
4	Examine the formation and geological conditions necessary for petroleum deposits, including the types of traps and reservoirs, and analyse the global and Indian distribution of petroleum resources, focusing on petroleum bearing basins.	*An & E*
5	Explore unconventional fuels such as shale gas, tight oil, gas hydrates, coal bed methane (CBM), tar sands, geological hydrogen, oil sands, and heavy oil resources, including their definitions, formations, occurrences, and potential as alternative energy sources.	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				✓
CO 2		✓			✓		✓
CO 3			✓			✓	
CO 4				✓		✓	
CO 5	✓		✓				

MODULE	UNIT	DESCRIPTION	HOURS
1	**COAL**		**13**
	1	Coal -Historical perspective on coal usage. Classification of coals.	2

	2	Formation and geologic conditions for coal deposits.	4
	3	Physical and chemical properties of coal. Coal Petrography. Coal combustion properties – Grade and calorific value.	4
	4	Indian coal resources – Gondwana and Tertiary coal	3

2	**PETROLEUM**		**14**
	1	Petroleum - Formation and geological conditions for petroleum deposits.	4
	2	Types of petroleum traps and reservoirs.	4
	3	Global distribution of petroleum resources.	3
	4	Petroliferous basins of India.	3

3	**NUCLEAR FUELS**		**14**
	1	Nuclear fuels – Classification	4
	2	Uranium deposits – Types – QPC, Stratifrom, Unconformity, Intrusive and Sandstone types.	4
	3	Uranium provinces of India.	3
	4	Thorium deposit of India with special reference to beach placer deposits.	3

4	**UNCONVENTIONAL FUELS**		**14**
	1	Unconventional fuels –Introduction to Shale Gas	3
	2	Gas hydrates- Definition, formation, and occurrence.	4
	3	Overview of Coal Bed Methane (CBM) - formation CBM.	4
	4	Overview Geological hydrogen and Oil Sands	3

<table>
<tr><td rowspan="3">5</td><td>Teacher Specific Module</td><td>5</td></tr>
<tr><td>This module covers fossil fuel exploration, including geophysical techniques such as seismic surveys to locate resources and well drilling for extraction. It also addresses the study of the environmental impact caused by fuel extraction, including air and water pollution, as well as land degradation.</td><td></td></tr>
<tr><td>Space to fill the selected area/ activity</td><td>5</td></tr>
</table>

COURSE CONTENTS

Essential Readings:

1. Thomas, Larry. *Coal geology*. John Wiley & Sons, 2020.
2. Speight, James G. *The chemistry and technology of coal*. CRC press, 2012.
3. Taylor, G. H., Teichmüller, M., Davis, A. C. F. K., Diessel, C. F. K., Littke, R., & Robert, P. (1998). Organic petrology.
4. SAHU, GEETANJOY. "The Coal of India." (2015): 29-31.
5. Selley, Richard C. *Elements of petroleum geology*. Gulf Professional Publishing, 1998.
6. Chapman, Richard E. *Petroleum geology*. Elsevier, 2000.
7. Ahlbrandt, T. A. "Global petroleum reserves, resources and forecasts." *Oil in the 21st Century: Issues, Challenges and Opportunities. Oxford University Press, Oxford, UK* (2006): 128-177.
8. Rao, MB Ramachandra. "Petroliferous Basins of India." *Geological Society of India* 25.6 (1984): 385-389.
9. Bustillo Revuelta, Manuel, and Manuel Bustillo Revuelta. "Mineral deposits: types and geology." *Mineral Resources: From Exploration to Sustainability Assessment* (2018): 49-119.
10. Dahlkamp, Franz J. *Uranium ore deposits*. Springer Science & Business Media, 2013.
11. Sarangi, A. K., and P. Krishnamurthy. "Uranium metallogeny with special reference to Indian deposits." *Trans. Mining Geol. Metal. Inst. India* 104 (2008): 19-54.
12. Barthel, F. H., and H. Tulsidas. "Thorium occurrences, geological deposits and resources." (2014).
13. Zendehboudi, Sohrab, and Alireza Bahadori. *Shale oil and gas handbook: theory, technologies, and challenges*. Gulf Professional Publishing, 2016.

14. Ahmadi, M. A., and Alireza Bahadori. "Chapter Eight-Gas Hydrates." *Fluid phase behavior for conventional and unconventional oil and gas reservoirs*. Elsevier Inc, 2017. 405-444.
15. Thakur, Pramod, et al., eds. *Coal bed methane: theory and applications*. Elsevier, 2020.
16. Tarkowski, Radoslaw. "Underground hydrogen storage: Characteristics and prospects." *Renewable and Sustainable Energy Reviews* 105 (2019): 86-94.

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1
	2	1
	3	3
	4	4
2	1	5, 6
	2	5
	3	7
	4	8
3	1	9
	2	10
	3	11
	4	12
4	1	13
	2	14
	3	15
	4	16

Suggested Readings:

1. Alhajji, Anas, et al. *Global impact of unconventional energy resources*. Lexington books, 2018.

2.Ahmed, Usman, and D. Nathan Meehan, eds. *Unconventional oil and gas resources: exploitation and development*. CRC Press, 2016.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

KU5SECGEL301– GROUNDWATER EXPLORATION

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	SEC	300-399	**KU5SECGEL301**	3	45

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
3	-	--	25	50	75	2 hours

Course Description: *This course equips students with the knowledge and skills for effective groundwater exploration. It covers hydrogeological principles, exploration techniques, data analysis, and sustainable resource management.*
.
Course Prerequisite: The learner must have completed the basic courses in 200 – 399 level in B Sc Geology programme.
Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the hydrogeological cycle and aquifer characteristics.	*U*
2	Apply electrical resistivity methods for subsurface exploration.	*A*
3	Understands various field techniques and instrumentation used in electrical resistivity surveys and interpreting resistivity data to identify geological formations, water content, and estimate aquifer parameters like thickness and saturation.	*U*
4	Apply seismic refraction techniques for groundwater exploration	*A*
5	Understand the fundamentals of remote sensing and apply image interpretation techniques for groundwater exploration.	*U, A*

6	Analyze how gravity and magnetometry methods respond to variations in subsurface geology and water content.	

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2		✓				✓	
CO 3	✓	✓				✓	✓
CO 4		✓				✓	
CO 5	✓					✓	
CO 6	✓	✓				✓	

COURSE CONTENTS

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**INTRODUCTION TO GROUNDWATER**		**10**
	1	Hydrological Cycle and Groundwater Occurrence	2
	2	Aquifer Properties and Classification	3
	3	Groundwater Flow and Recharge Mechanisms	2
	4	Groundwater Quality and Contamination Issues	3
2	**ELECTRICAL RESISTIVITY SURVEYS**		**10**

	1	Ohm's Law, Conductivity, Resistivity, Factors affecting electrical resistivity in earth materials.	2
	2	Field Techniques and Instrumentation	2
	3	Wenner, Schlumberger, and Dipole electrode configurations. Apparent resistivity calculations	3
	4	Interpretation of Resistivity Data - Correlation of resistivity values with geological formations and water content, Estimation of aquifer parameters.	3

3	**SEISMIC REFRACTION, GRAVITY AND MAGNETOMETRY SURVEYS**		**10**
	1	Seismic Waves - Elastic properties of rocks and seismic wave propagation. Types of seismic waves.	3
	2	Snell's Law and refraction of seismic waves at layer interfaces. Seismic Refraction Equipment – Seismographs and geophones	2
	3	Survey Design - Spread geometry, shot points, and geophone deployment.	3
	4	Gravity and Magnetometry Methods	2

4	REMOTE SENSING IN GROUNDWATER EXPLORATION		**10**
	1	Introduction to Remote Sensing and Image Interpretation	2
	2	Groundwater Potential Mapping using Satellite Imagery	2
	3	Lineament Analysis and Fracture Detection	3
	4	Integration of Remote Sensing with GIS for Groundwater Management	3

5	**Teacher Specific Module**	**Hours**

	Directions: Case Studies and Applications of various groundwater exploration techniques.	**5**

Essential Readings:

1. Todd, D.K., 2006, Groundwater Hydrology, II edn., John Wiley & Sons.
2. Henry Robert Burger (1992). Introduction to Applied Geophysics, W. W. Norton & Company, New York, 672 p
3. Robert E. Sheriff and Lloyd L. Geldart (1995), Seismic Exploration Methods, Society of Exploration Geophysicists, Tulsa, 625 p
4. William E. Kellogg and Frederic A. Mott (2002) Exploration Geophysics, SEG Books,, Tulsa, , 886 p
5. James M. Campbell and John M. Jensen (2015) Introduction to Remote Sensing, Pearson Education Limited, Edinburgh, UK, , 672 p
6. Bhattacharya, B. N. and Mukherjee A. K (2018). Groundwater Exploration Using Remote Sensing Techniques, Springer International Publishing, Cham, Switzerland, 314 p
7. Scott J. Foster and Dale L. Foster 2009Remote Sensing in Hydrogeology, Springer-Verlag New York, Inc., Secaucus, 264 p

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1
	2	1
	3	1
	4	1
2	1	1,2
	2	1,2
	3	1,2
	4	1,2
3	1	1,2
	2	2,3
	3	2,3
	4	3,4

4	1	5
	2	5
	3	6,7
	4	6

Suggested Readings:

1. Yoram Israel Yorav (2009). Geophysics for Engineers and Geologists, by Academic Press, San Diego, CA, 640 p.

2. Ward, S. H., & French, W. M. (1980). Resistivity methods in geophysics., Geoexploration.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**50**
Theory test paper		50
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
	Total	**75**

SEMESTER 6

DISCIPLINE SPECIFIC COURSES

KU6DSCGEL301 – ORE GEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	Major	300-399	KU6DSCGEL301	4	75

<table>
<tr><th colspan="3">Learning Approach (Hours/ Week)</th><th colspan="5">Marks Distribution</th><th rowspan="3">Duration of ESE (Hours)</th></tr>
<tr><th rowspan="2">Lecture</th><th rowspan="2">Practical/ Internship</th><th rowspan="2">Tutorial</th><th colspan="2">Theory</th><th colspan="2">Practical</th><th rowspan="2">Total</th></tr>
<tr><th>CCA</th><th>ESE</th><th>CCA</th><th>ESE</th></tr>
<tr><td>3</td><td>2</td><td>--</td><td>25</td><td>50</td><td>10</td><td>15</td><td>100</td><td>2 hours</td></tr>
</table>

Course Description: *This course covers ore and gangue minerals, resource types and deposit origins, mineral transport and deposit types. It includes ore formation, exploration methods, and delves into India's mineral wealth, including Kerala's deposits. Finally, it explores sustainable mining practices for a responsible future.*

Course Prerequisite: The learner must have completed the basic courses in 200 – 299 level in B Sc Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understands ore minerals and gangue minerals, the concepts of tenor and grade of ores, and differentiate between resources and reserves.	*U*
2	Understanding of the mineralising solutions, classification of mineral deposits and controls that govern ore localization ore.	*U*

3	Understanding of the different magmatic and hydrothermal processes that lead to the formation of various types of mineral deposits and evaluate the geological settings and processes that control the formation and localization of mineral deposits.	*U,E*
4	Understand and differentiate between various types of mineral deposits formed by residual, mechanical, volcanic, evaporitic, and sedimentary processes.	*U*
5	Understands geophysical and geochemical exploration methods, enables to apply these techniques in the field for the discovery and assessment of mineral resources.	*U,A*
6	Understands the mode of occurrence, distribution, and economic uses of important mineral deposits in India, with a special focus on the economically significant mineral deposits of Kerala.	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓		✓				
CO 3	✓		✓				✓
CO 4	✓	✓					
CO 5	✓	✓				✓	
CO 6			✓				

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**ORE MINERLS -AN OVERVIEW**		**10**
	1	Ore minerals and gangue minerals, tenor and grade of ores. Resources and reserves. Hypogene and supergene ore deposits, epigenetic and syngenetic mineral deposits.	3
	2	Mineralizing solutions and its migration. Stratabound and stratiform ore deposits.	2
	3	Physical, chemical, structural and stratigraphic controls of ore localization	2
	4	Outline of Lindgren's and Bateman's classification of mineral deposits.	3

2	**ORE FORMING PROCESS**		**10**
	1	Magmatic processes of formation of mineral deposits - Early and late magmatic mineral deposits.	3
	2	Hydrothermal deposits - cavity filling and replacement deposits.	3
	3	Contact metasomatic deposits, Sublimation and Pegmatitic mineral deposits	2
	4	Oxidation and supergene sulphide enrichment deposits.	2

3	**ORE FORMING PROCESS & EXPLORATION METHODS**		**10**
	1	Residual and mechanically concentrated deposits, placer deposits, metamorphic deposits.	3
	2	Volcanic exhalative deposits, evaporites, sedimentary deposits	2

	3	Brief study of ore exploration methods- Geophysical and Geochemical Explorations.	3
	4	Metallogenetic epochs and provinces. Bushveld Igneous Complex.	2

4	**DISTRIBUTION & DEVELOPMENT OF ORE MINERALS**		**10**
	1	Minerals used as abrasives, refractories, fertilizers, ceramics and gemstones.	2
	2	Mode of occurrence, distribution and economic uses of the important mineral deposits in India	3
	3	Economically significant mineral deposits of Kerala.	2
	4	Sustainable development of mineral resources- mineral resources and their global distribution, benefits and drawbacks of mining, sustainable mining practices.	3

5	**Teacher specific module**	**Hours**
	Directions: Study of gem stones, Inclusions and other features of gemstones, enhancement and treatments, and major gemstones of India.	**5**

6	**PRACTICAL**	**Hours**

	Megascopic identification of important ore minerals: Ore minerals of Iron (Hematite, Magnetite, Siderite, Banded Hematite Quartzite and Banded Magnetite Quartzite) Manganese (Pyrolusite, Psilomelane, Wad) Aluminium (Bauxite) Lead and Zinc (Galena, Sphalerite) Copper (Chalcopyrite, Malachite, Azurite, Bornite and native copper) Chromium minerals (Chromite) Micas (Muscovite and Biotite), Talc Refractories (Graphite, Kyanite, Sillimanite, Barite) Asbestos minerals (Chrysotile and Serpentine) Sulphur minerals (Sulphur, Pyrite, Orpiment, Realgar) Abrasives (Quartz, Corundum, Garnet) Gemstones (Tourmaline, Garnet, Topaz and Beryl) Fertilizer minerals (Gypsum, Anhydrite, Calcite, Dolomite) Coal (Peat, Lignite, Bituminous coal, Anthracite) Petroleum (Crude oil) Radioactive minerals (Monazite, Ilmenite, Rutile) Clay minerals (Kaolinite, Ball clay)	30

Essential Readings:

1. Gokhale and Rao (1978) Ore deposits of India. Thomson Press (India)

2. Jensen, m and Bateman, A.M. (1981) Economic Mineral Deposits. John Wiley & Sons Inc

3. Krishnaswamy, S. (1988) Indian Mineral Resources. 3rd Edition. South Asia Books

4. Roy Chacko P.T. (ed.), (2005) Mineral resources of Kerala. Department of Mining and Geology.

5. Sinha, R.K (1982) Industrial minerals. Oxford and IBH Publishing Co.

6. Umeshwar Prasad (2000) Economic Geology- Economic Mineral Deposits. 2nd Edition. CBS Publishers and Distributors.

7. Evans, A.M. (1993). Ore Geology and Industrial minerals. An Introduction. (Third Edition). Blackwell Publishing.

8. Sarkar, S.C. and Gupta, A. (2014) Crustal Evolution and Metallogeny in India. Cambridge Publications

9. Mihir Deb and Sanjib Chandra Sarkar (2017) Minerals and Allied Natural Resources and their Sustainable Development: Principles, Perspectives with Emphasis on the Indian Scenario. Springer publications.

10. Vasudevan Rajaram, Heather L. Rowe, and C.S.D. Murthy (2005). Sustainable Mining Practices: A Global Perspective, CRC Press, USA , 336p

11. Karlheinz Spitz and John Trudinger (2008). Mining and the Environment: From Ore to Metal, CRC Press, USA.

12. Charles J. Moon, Michael K.G. Whateley, and Anthony M. Evans (2006) Introduction to Mineral Exploration, Wiley-Blackwell, 496p
13. John Ridley (2013) Ore Deposit Geology. Cambridge University Press, 398p
14. Soman ,K (2002)- Geology of Kerala, Geological Society of India, Banglore,335p

Reference Distribution:

Module	Unit	Reference No.
1	1	2,6
	2	2,6,7
	3	2,6,7
	4	2,6,7
2	1	2,6
	2	2,6
	3	2,6
	4	2,6
3	1	2,6
	2	2,6
	3	12
	4	8,13
4	1	1,3,5
	2	1,3,5
	3	4,14
	4	9,10,11

Suggested Readings:

1. Krauskopf (1994) Introduction to Geochemistry. 3rd Edition. McGraw-Hill Publications.
2. Park, C.F. and Mac Diarmid, R.A. (1964) Ore deposits. W. H. Freeman Publications.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU6DSCGEL302: INVERTEBRATE PALAEONTOLOGY AND PALAEOBOTANY.

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
6	Major	300-399	KU6DSCGEL302	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
3	2	--	25	50	10	15	100	2 hours

Course Description: *This paleontology course covers the fundamentals of fossil science, including types of fossils, taxonomic hierarchy, and their uses. Students explore the morphology, classification, and significance of major fossil groups such as Protozoa, Arthropoda, Mollusca, and plants. Special attention is given to Indian fossil flora, including Gondwana flora, providing students with a comprehensive understanding of paleontological principles and their applications in reconstructing Earth's history.*

Course Prerequisite:

The learner must have completed the basic courses in 200 – 299 level in B Sc Geology programme**.**

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Students will be able to identify various types of fossils and gather knowledge about taxonomic hierarchy and binomial nomenclature.	U
2	Students will understand the significance of fossils in paleontological research, including their use in stratigraphy, biostratigraphy, and understanding past environments and ecosystems.	U

3	Students will analyze the morphology and classification of major fossil groups, correlating their distribution to understand evolutionary trends.	An
4	Students will study Cretaceous fossils of Tamilnadu, Tertiary fossils of Kerala and Gondwana fossil flora, enhancing their understanding of the region's paleontological history.	U
5	Students will apply paleontological principles to interpret fossil records and reconstruct Earth's history.	A

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2	✓						
CO 3	✓	✓					
CO 4	✓						
CO 5					✓		

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**INTRODUCTION TO PALEONTOLOGY**		**15**
	1	Fossils and fossilization.	3

	2	Types of fossils: body fossils, trace fossils, index and zone fossils, transported fossils, leaked fossils and pseudo fossils.	2
	3	Taxonomic hierarchy, binomial nomenclature. Uses of fossils	3
	4	Pre-Cambrian fossils – stromatolites, blue green algae.	2

2	**INVERTEBRATE FOSSILS**		**10**
	1	Morphology, classification, stratigraphic distribution and importance of Phylum Protozoa – Order Foraminifera.	3
	2	Morphology, classification, stratigraphic distribution and importance of Phylum Arthropoda – Class Trilobites.	2
	3	Morphology, classification, stratigraphic distribution and importance of Phylum Brachiopoda.	2
	4	Morphology, classification, stratigraphic distribution and importance of Phylum Cidaria – Class Anthozoa.	3

3	**INVERTEBRATE FOSSILS**		**10**
	1	Morphology, classification, stratigraphic distribution and importance of Phylum Mollusca: Class - Pelecypoda, Gastropoda and Cephalopoda.	5
	2	Morphology, classification, stratigraphic distribution and importance of Phylum Echinodermata: Class - Echinoidea, Crinoidea, Blastoidea.	4
	3	Morphology, classification, stratigraphic distribution and importance of Phylum Hemicordata, graptolite.	4
	4	A short account of fossils in Cretaceous sediments of Trichinapoly, Tamilnadu and Tertiary sediments of Kerala.	2

4	**PALAEOBOTANY**		**10**
	1	Plant fossils, classification of plants.	3
	2	Modes of preservation of plant fossils, significance of plant fossils	2

	3	Overview of the Gondwana supercontinent and distribution of Gondwana flora.	3
	4	A short account of the following fossil flora from India: Glossopteris, Gangamopteris, Vertebraria, Thinnfeldia, Ptilophyllum, Calamites, Lepidodendron, and Sigillaria.	2

5	**Teacher Specific Module**	**5**
	Directions: High-resolution imaging technologies, such as synchrotron radiation and micro-CT scanning, for the visualization of fossilized structures, (3D reconstructions) and non-destructive analysis of internal features. Isotopic analysis for understanding of paleoecology and paleoclimate, giving evidences about ancient atmospheric conditions.	
6	**Practical**	
	Morphological studies of the following fossils Protozoa: Lagena, Nodosaria, Textularia, Nummulites, Globigerina. Coelentrata: Calceola, Zaphrentis, Halysites, Favosites, Montlivaltia. Arthropoda : Calymene, Phacops, Olenus, Olenellus and Paradoxides. Brachiopoda: Spirifer, Productus, Terebratula, Rhynchonella, Athyris, Orthis, Lingula Mollusca: Gasteropoda, Natica, Turbo, Trochus, Turritella, Cerethium, Conus, Murex, Cypraea, Physa Cephalopoda: Nautilus, Goniatites, Orthoceras, Phylloceras, Baculites, Schloenbachia, Ceratites, Acanthoceras Pelecypoda: Arca, Trigonia, Nucula, Spondylus, Pecten, Inoceramus, Ostrea, Gryphaea, Alectryonia. Echinodermata: Pentacrinus, Cidaris, Hemicidaris, Echinus, Micraster, Holaster, Encrinus. Plant fossils: Glossopteris, Gangamopteris, Ptilophyllum, Lepidodendron, Sigillaria, Calamites, Elatocladus.	30

Essential Readings:

1. Woods, H. (1961) Invertebrate Palaeontolgy. Cambridge University Press.
2. Romer, A.S. (1966) Vertebrate Palaeontology, 3rd edition. Chicago Univ. Press.
3. Arnold Ca. (1947) An introduction to Palaeobotany. Mc-Graw Hill.
4. Haq, B. U. and Boersma, A. (1978) Introduction to Marine Micropalaeontology. Elsevier, Netherlands.

5. Raup, D.M. and Stanley, M.S. (1978) Principles of Palaeontology. CBS Publishers.
6. Moore, R.C., Lalicker, C.G., and Fischer, A.G. (1952) Invertebrate Fossils. Mc-Graw Hill.
7. Shrock, R.R. and Twenhofel, W.H. (1953). Principles of Invertebrate Palaeontology, 2nd edition. Mc-Graw Hill.
8. Palaeontolgy – An introduction (1985). Pergamon; First Edition.
9. M.A. Semikhatov, J.A. Fedonkin (1982) Algal Fossils and Stromatolites Moscow, Nauka,296p
10. Walter M. R., (1976) Stromatolites, Elsevier Scientific Publishing Company, Netherlands,790p.
11. Christopher J. Cleal, Barry A. Thomas (2019) Introduction to Plant Fossils, Cambridge University Press, UK.296p.
12. Venkatachala , M. S., Rao ,K. S. P. (1974). Indian Gondwana Flora: Palaeobotanical Monograph Birbal Sahni Institute of Palaeobotany, 250p.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2,3,5
	2	1,2,3
	3	1,7
	4	4, 9,10
2	1	1,6,7
	2	1,6,7
	3	1,6,7
	4	1,6,7
3	1	1,6,7
	2	1,6,7
	3	1,6,7
	4	1,6,7

4	1	6 ,11
	2	6,11
	3	11,12
	4	11,12

Suggested Readings:

1. Ray A K. Fossils in earth science
2. Black A M. The elements of Palaeontology.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU6DSCGEL303: GLOBAL TECTONICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	Major	300-399	**KU6DSCGEL303**	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	0	--	30	70	100	2 hours

Course Description*: This geotectonics course provides a comprehensive study of Earth's dynamic processes in four modules. It covers the historical evolution of plate tectonics, mechanisms of plate movement, plate convergence, and intra-plate volcanic activity. Through case studies like the San Andreas Fault and the Ring of Fire, students gain a practical understanding of theoretical concepts.*

Course Prerequisite:

The learner must have completed the basic courses in 200 – 299 level in B Sc Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the historical evolution of plate tectonic theory and its framework, including concepts like continental drift and sea floor spreading.	U
2	Analyze mechanisms of plate movement and Earth's interior composition.	An
3	Apply theoretical knowledge to real-world examples, understanding plate tectonics through case studies like the San Andreas Fault and the East African Rift Valley.	A
4	Interpret geological phenomena such as plate convergence, orogeny, and intra-plate volcanism, including their associated landforms and processes.	E

5	Synthesize knowledge of the Wilson cycle and ancient supercontinents to understand Earth's dynamic geological history	C

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2		✓	✓				
CO 3					✓		
CO 4			✓		✓		
CO 5					✓	✓	

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**PLATE TECTONIC THEORY**		**13**
	1	Continental drift hypothesis - Supporting evidences, Objections to continental drift.	3
	2	Evolution of Plate tectonic theory. Framework of Plate tectonics - Sea floor spreading, palaeomagnetism and polar wandering. Objections to plate tectonics.	4

	3	Earth's interior - Seismic structure of the Earth.	3
	4	Mineralogical and petrological structure of Earth. Heat flow distribution within the Earth.	3

2	**MECHANISM OF PLATE MOVEMENT**		**14**
	1	The physical and chemical composition of earth interior layers.	4
	2	Mantle convection currents. Mantle drags and Edge force mechanism.	4
	3	Plate margin – Tripple Junction – Mechanism and types. Transform and Transcurrent boundaries. San Andreas Fault.	3
	4	Divergent plate margin - Mechanism of plate movement, types and landforms. East African Rift Valley.	3

3	**PLATE CONVERGENCE & RELATED LAND FORMS**		**14**
	1	Plate convergence: Oceanic – Oceanic and Continental – Oceanic convergence. Mechanism and related types. Ring of Fires.	3
	2	Plate convergence- Orogeny and related landforms.	4
	3	Evolution of Himalaya.	3
	4	Concept of isostacy – Pratt's hypothesis, Airy's hypothesis	4

4	**TECTONIC PROCESSES**		**14**
	1	Intra plate volcanism – Mantle plume and hotspot. Hotspot magmatism in India.	4
	2	Large Igneous Provinces- Bushveld Igneous Complex.	3
	3	Configuration of ancient supercontinents of Earth. – Columbia, Rodinia, Gondwana and Pangea. Break up of Gondwana land. The Wilson cycle.	4

	4	Tectonic evolution of Indian Platform.	3

5	**Teacher Specific Module**	**5**
	Directions: Plate Tectonics on Other Planets, microplates	
	Space to fill the selected area/ activity	5

Essential Readings:

1. Thompson, G. R. and Turk, J. (1997) Introduction to Physical Geology. 2nd Edn. Thompson Brooks Publishers.
2. Carlson, D. H., and Plummer, C. C. (2010) Physical Geomorphology: Earth Revealed. 9th Edn., Mc-Graw Hill Co.
3. Kearey, P., Klepeis, K. A., & Vine, F. J. (2009). Principles of Plate Tectonics. Wiley-Blackwell.
4. Grotzinger, J., & Jordan, T. H. (2010). Understanding Earth. 6th Edn., W. H. Freeman and Company.
5. Mathur, S.M., (2003). Physical geology of India, National Book Trust, India, 222p.
6. Patwardhan ,A.M. (2011) The Dynamic Earth: System and Processes, PHI Learning Pvt. Ltd.,360p
7. Plummer, C. C., Carlson, D. H., & Hammersley, L. (2018). Physical Geology. 16th Edn., McGraw-Hill Education.
8. Wilson, M. J. (1989). Igneous Petrogenesis. Unwin Hyman.
9. Philip Kearey, Keith A. Klepeis, and Frederick J. Vine (2009). Global Tectonics, 3rd Edition, Wiley-Blackwell,496p.
10. John J.W. Rogers and M. Santosh (2004). Continents and Supercontinents, Oxford University Press,304p.
11. Richard E. Ernst (2014)Large Igneous Provinces , Cambridge University Press,770p

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2
	2	3,4
	3	3,4
	4	3,4 ,6

2	1	6
	2	1,2,3,7
	3	1,2,3,7
	4	1,2,3,7
3	1	1,2,7
	2	1,2,7
	3	5
	4	1,2 ,5
4	1	2,5
	2	8 ,11
	3	9,10
	4	9,10

Suggested Readings:

1. Oreskes, N. (2003). Plate Tectonics: An Insider's History of the Modern Theory of the Earth. Westview Press.
2. Van der Pluijm, B. A., & Marshak, S. (2004). Earth Structure: An Introduction to Structural Geology and Tectonics. W. W. Norton & Company.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10

b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

KU6DSEGEL301 – PHANEROZOIC STRATIGRAPHY OF INDIA

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	Major (Elective)	300 - 399	**KU6DSEGEL301**	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	--	--	30	70	100	2 hours

Course Description:

This course provides a detailed understanding of the geological past of the Indian subcontinent, focusing on the Paleozoic, Mesozoic, and Cenozoic eras. It thoroughly explores the distribution, stratigraphy, and significance of Paleozoic successions in Spiti and Kashmir. Additionally, the course offers detailed discussions of important Mesozoic and Cenozoic formations. Furthermore, it delves into the geological importance of the Deccan Traps, which have played a significant role in shaping the Indian subcontinent.

Course Prerequisite:

The learners must have successfully completed the courses 200 to 299 level of B.Sc. Geology programme and have studied Precambrian Geology of India having the academic level 300-399.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains

1	Understand the distribution of Phanerozoic rocks in India, including the sedimentary basins of Peninsular India and Tethyan basins.	*U*
2	Gain detailed knowledge of the Paleozoic succession in India, with special focus on Spiti and Kashmir.	*An & E*
3	Analyze the Mesozoic succession in India, especially in Spiti, Kutch, Trichinapoly, and the Narmada Valley.	*An & E*
4	Explore the Gondwana supergroup, including its distribution, lithology, structural features, and coal resources.	*An & E*
5	Investigate the Cenozoic succession in India, with a detailed study of Tertiary formations in Kerala, Tamil Nadu, Siwalik Supergroup and Karewa Formation.	*An & E*
6	Analyse the origin of Deccan Traps and to understand its lithology, distribution, and classification and economic importance.	*An & E*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓		✓		
CO 2	✓		✓				✓
CO 3	✓	✓	✓				✓
CO 4	✓	✓		✓		✓	
CO 5	✓		✓				✓
CO 6	✓			✓	✓	✓	

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**PALEOZOIC ROCKS IN INIDA**		**13**
	1	Sedimentary basins of India – Tectonic division	3
	2	General study of distribution of Phanerozoic rocks in India.	4
	3	Tethyan basins and its importance	3
	4	Detailed study of following Paleozoic succession of India. Paleozoic of Spiti region.	4
2	**MESOZOIC ROCKS IN INIDA**		**14**
	1	Detailed study of Mesozoic succession of Spiti region. Cretaceous of Trichinapoly and Narmada Valley.	4
	2	Detailed study of Jurassic succession of Kutch	3
	3	Detailed study of succession of Cretaceous succession of Trichinapoly and Narmada Valley.	3
	4	Gondwana supergroup – its distribution, lithology, classification, structural features and coal resources. Gondwana of east coastal region.	4
3	**CENOZOIC ROCKS IN INIDA**		**14**
	1	Detailed study of. Tertiaries succession of Kerala.	4
	2	Detailed study of. Tertiaries succession of Tamil Nadu.	4
	3	Detailed study of. Siwalik Supergroup.	3
	4	Karewa Formation.	3
4	**DECCAN VOLCANIC PROVINCE**		**14**
	1	Deccan Volcanic Province – Origin and tectonic setting.	4
	2	Deccan Traps – Lava flow characteristics.	3
	3	Deccan Traps – Stratigraphy and distribution.	4
	4	Deccan Traps – economic importance	3
5	**Teacher Specific Module**		**5**

	Directions: Recent studies and developments in phnerozoic stratigraphy. Evolution of life through phanerozoic.	
	Space to fill the selected area/ activity	

Essential Readings:

1. Ramakrishnan, Moni, and Rajagopala Vaidyanadhan. *Geology of India*. Vol. 1. Bangalore: Geological Society of India, 2008.
2. Fundamentals of Historical Geology and Stratigraphy of India. *Geological Society of India*. 3rd Edition.
3. Shah, Som K. *Historical geology of India*. Scientific Publishers, 2018.
4. Rajan, S., Anju Tiwary, and Dhananjai Pandey. "The Deccan Volcanic Province: Thoughts about its genesis." *www. mantleplumes. org/Deccan2. html* (2005).

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2
	2	1,2
	3	1,2
	4	1,2
2	1	1,2
	2	1,2,3
	3	1,2
	4	1,2
3	1	1,2,3
	2	1,2,3
	3	1,2,3
	4	1,2,3
4	1	1,4
	2	1,4
	3	1,4
	4	1,4

Suggested Readings:

1.Ramakrishnan M and.Vaidyanadhan R (2008) Geology of India, Geological Society of India Bangalore, India, 556p (Volume 1), 556 p(Volume 2)

2.Krishnan, M.S. Geology of India and Burma, CBS Publishers & Distributors, New Delhi, 536p.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

KU6DSEGEL302 -FUEL RESOURSES OF INDIA

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	Major (Elective)	300 - 399	**KU6DSEGEL302**	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	--	--	30	70	100	2 hours

Course Description: *This course dives into conventional fuels like coal, oil & gas, and unconventional sources like coal bed methane. Learn about geological formations, exploration methods, and resource distribution across India. Analyze the economic importance of fuels, and discuss sustainable development strategies for responsible resource management.*
Course Prerequisite: The learner must have completed the basic courses in 300 – 399 level in B Sc Geology programme.
Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Analyze and evaluate various fuel resources.	An
2	Understands various exploration methods used to locate fuel resources, and various drilling and mining techniques.	U
3	Understands the different ranks of coal and the processes involved in coal formation.	U
4	Understand the formation and distribution of coal in India.	U
5	Evaluate the geological processes leading to formation of petroleum and petroleum deposits in India.	E
6	Understands a range of conventional and unconventional fuel resources, along with nuclear fuels and renewable alternatives.	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓	✓				✓	
CO 3	✓						
CO 4	✓	✓		✓			
CO 5	✓		✓	✓			
CO 6		✓				✓	

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**INTRODUCTION TO FUEL RESOURCES**		**14**
	1	Fuel resources - Definition and types, Importance of fuel resources	3
	2	Distribution of fuel resources in different geological settings. Major geological periods and Geological provinces of India rich in fuel resources	3
	3	Exploration methods for fuel resources Drilling and mining techniques	4
	4	Economic significance of fuel resources- Sustainable development and fuel resource management	4
2	**COAL RESOURCES OF INDIA**		**15**
	1	Types and ranks of coal.	4
	2	Coal formation processes and coalification	4
	3	Stratigraphy and distribution of coal seams Major coal-bearing formations in India	3
	4	Major Indian coalfields: Jharia, Raniganj, Talcher	4
3	**PETROLEUM RESOURCES OF INDIA**		**14**
	1	Origin and accumulation of petroleum	*4*
	2	Types of petroleum traps and reservoirs	*4*
	3	Source rocks, migration, and maturation	*3*
	4	Major petroleum-bearing basins in India	*3*

4	**OIL FILDS, COAL BED METHANE & NUCLEAR FUELS.**		**12**
	1	Major oil and gas fields: Bombay High, Krishna-Godavari Basin	*3*
	2	Coal bed methane: formation and extraction.	3
	3	Nuclear Fuel Resources -Geology of uranium and thorium deposits	3
	4	Renewable and Alternative Fuel resourses.	3

5	**Teacher Specific Module**	**Hours**
	Directions: Methods of petroleum exploration *Drilling and production techniques - Enhanced oil recovery methods* *Major natural gas fields in India*	**5**

Essential Readings:

1. Selley, R.C, (1998) Fossil Fuel Resources, Academic Press, 492p.
2. Larry Thomas (2012). Coal Geology, Wiley-Blackwell, 444p.
3. Ramakrishnan, M. Vaidyanadhan R (2008). The Geological Evolution of India and Sri Lanka, Geological Society of India, 366p.
4. North, F.K (1985). Petroleum Geology, Allen & Unwin, 607p.
5. Charles J. Moon, Michael K.G. Whateley, Anthony M. Evans (2006) Introduction to Mineral Exploration, 496p.
6. Gangopadhyay, D (2008). Indian Coal: Production and Projections, Oxford & IBH Publishing Co. Pvt. Ltd. 240p.
7. Romeo M. Flores (2014). Coal and Coalbed Gas: Fueling the Future, Elsevier,720p.
8. Sharma,N.L. and Ram,K.S.V. (1966), Introduction to the geology of Coal and Indian Coal fields, Oriental Publishers, Jaipur, 148p.
9. Sharma,N.L. and Ram,K.S.V. (1964), Introduction to India’s economic Minerals, Dhanbad Publications, 258p.

10. Mukhopadhya, D.,(2004). Fundamentals Of Renewable Energy SystemsNew Age International Private Limited, 262p.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2
	2	1,2
	3	1,2,3
	4	5
2	1	2,6
	2	2,6
	3	2,6,8
	4	2,6,8
3	1	4
	2	4
	3	4
	4	9
4	1	9
	2	7
	3	9
	4	10

Suggested Readings:

1. Despande, B.G., 1992, The World of Petroleum, Wiley Eastern Ltd.

2.Tisso, B.P. & Welta, D.H., 1978, Petroleum Formation and Occurrence, Springer-Verlag.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

KU6DSEGEL303: PLANETARY GEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	Major (Elective)	300-399	KU6DSEGEL303	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	--	--	30	70	100	2 hours

Course Description: *This course provides an in-depth understanding of the geological processes and features of planetary bodies in our solar system. It covers the comparative planetology, the study of planetary surfaces, interiors, and atmospheres, and the tools and techniques used in planetary exploration. The course is structured into four modules.*

Course Prerequisite:

The learner must have completed the basic courses in 200 – 299 level in B Sc Geology programme.
Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Students will be able to describe the processes involved in the formation of the solar system and the differentiation and thermal evolution of planetary bodies.	U
2	Students will gain the ability to identify and compare geological features on different planetary bodies, such as craters, volcanoes, and tectonic structures, and understand the surface processes that create them.	U, A
3	Students will be able to explain the internal structure and composition of planets and moons, and assess the geodynamic processes, including heat flow and magnetic field generation.	U
4	Students will be capable of analyzing the composition, structure, and dynamics of planetary atmospheres, and evaluate the climatic and weather patterns, as well as the factors influencing atmospheric evolution.	A
5	Students will develop the skills to critically review current research in planetary geosciences, propose hypotheses for the search for extraterrestrial life, and design concepts for future planetary exploration missions.	U

******Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), (I) Integrate***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✔		✔			✔	
CO 2			✔				
CO 3			✔	✔			
CO 4	✔		✔			✔	

CO 5	✓		✓			✓	

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**MODULE 1**		**15**
	1	Introduction to the Solar System: Overview of planets, moons, asteroids, and comets, Basic characteristics and classification of planetary bodies.	4
	2	Planetary Formation and Evolution: Theories of solar system formation, Differentiation and thermal evolution of planetary bodies.	4
	3	Basics of plate tectonics, including plate boundaries, tectonic activity, and their impact on the environment. How tectonics influence climate, ocean patterns, and biodiversity.	4
	4	Importance of geological time in understanding Earth's and other planet's environmental history.	3

2	**MODULE 2**		**14**
	1	Surface Processes: Impact cratering; Volcanism and tectonics; Weathering and erosion.	4
	2	Geologic Features: Surface composition and mineralogy; Topographic features (mountains, valleys, plains).	4
	3	Planetary Interiors: Structure and composition of planetary interiors; Heat flow and geodynamics.	3
	4	Magnetic Fields and Gravity: Planetary magnetism; Gravity measurements and their implications.	3

3	**MODULE 3**	**15**

	1	Atmospheric Composition and Structure: Composition of planetary atmospheres; Atmospheric layers and dynamics.	4
	2	Weather and Climate:Atmospheric circulation and weather patterns; Climate systems of different planets.	3
	3	Planetary Atmosphere Evolution: Formation and loss of atmospheres; Greenhouse effect and climate change on other planets.	3
	4	Atmospheric Exploration Techniques: Remote sensing of atmospheres; Data from landers and atmospheric probes.	2

4	**MODULE 4**		**11**
	1	Astrobiology and the Search for Life: Habitability criteria; Evidence of past or present life on Mars, Europa, Enceladus.	3
	2	Planetary Resources and Exploration: Potential for resource utilization; Future manned and unmanned missions.	3
	3	Exoplanets and Comparative Planetology: Methods of exoplanet detection; Comparisons between solar system planets and exoplanets.	3
	4	Emerging Technologies in Planetary Exploration: Advances in remote sensing, robotics, and AI;New frontiers in planetary exploration.	2

5	**Teacher Specific Module**	**5**
	Course coordinator is free to design current trends and future directions in planetary geosciences.	

Essential Readings:

1. The Solar System by Michael A. Seeds
2. Planetary Geology by Claudio Vita-Finzi
3. Geology of the Solar System by William M. Kaula
4. Planetary Climates by Andrew P. Ingersoll
5. Astrobiology: A Very Short Introduction by David C. Catling

Reference Distribution:

Module	Unit	Reference No.
1	1	1, 3
	2	1,2,3
	3	2,3

	4	2,3
2	1	2,3
	2	2,3
	3	2,3
	4	1,2,3
3	1	3,4
	2	3,4
	3	1,3,4
	4	3,4
4	1	5
	2	2,4
	3	2,4
	4	2,4

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

KU6DSEGEL304: MINERAL DEPOSITS OF INDIA

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	Major (Elective)	300-399	**KU6DSEGEL304**	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	0	--	30	70	100	2 hours

Course Description: *This course provides an overview of the fundamentals of mineral resources and metallogeny in India, including key terminologies, mineral classification, and the metallogenetic epochs and provinces. It covers the distribution and economic significance of major metallic (iron, manganese, gold, copper) and industrial minerals (fire clay, graphite, barite, limestone). Additionally, it addresses mineral economics, national policies, conservation laws, and the potential of marine and atomic mineral resources. The course emphasizes understanding the distribution of rare earth elements (REEs) and beach sand minerals in India.*

Course Prerequisite: The learner must have completed the basic courses in 200 – 299 level in B Sc Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Students will understand basic terminologies, classifications, and the concept of metallogenetic epochs and provinces in India.	U
2	Students will identify and describe key metallic mineral deposits in India, including their geological settings and distribution.	R,U,A
3	Students will learn about non-metallic and industrial minerals used in various industries and their distribution in India.	R,U,A
4	Students will understand the economic aspects of mineral resources, including strategic minerals, and India's National Mineral Policy and mineral conservation.	U,An
5	Students will learn about the distribution and significance of atomic minerals, REEs, and beach sand minerals in India.	U,An

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓	✓	✓				
CO 3	✓	✓	✓				
CO 4	✓	✓	✓	✓	✓	✓	
CO 5	✓	✓	✓				

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**FUNDAMENTALS OF MINERAL RESOURCES AND METALLOGENY IN INDIA**		**12**
	1	Introduction to mineral resources. Basic terminologies- Mineral resource, ore bodies, gangue, reserve, resource, host rock, tenor, ore grade.	3
	2	Classification – metallic and non-metallic minerals.	3
	3	Metallogenetic epochs of Indian mineral deposits	3
	4	Metallogenetic provinces of Indian mineral deposits	3

2	**METALLIC MINERAL DEPOSITS AND THEIR DISTRIBUTION**		**15**
	1	Detailed study of following metallic mineral deposits and their distribution in India: Iron, Manganese, chromite	4
	2	Gold, copper	4
	3	Aluminium, lead-zinc	4
	4	Platinum group elements	3

3	**INDUSTRIAL MINERALS AND THEIR DISTRIBUTION**		**14**
	1	Detailed study of following non-metallic/industrial mineral deposits- Minerals used in refractory industry (fire clay, graphite, dolomite, magnesite), fertilizer industry (potassium, phosphate),	3
	2	Minerals used in drilling industry (barite), abrasive industry (corundum, garnet)	4
	3	Minerals used in cement industry (limestone, gypsum), ceramic and glass industry (clay, quartz and silica sand)	4
	4	Minerals used in cosmetic industry (talc), building stones, precious stones.	3

4	**MINERAL ECONOMICS OF INDIA**		**14**
	1	Mineral Economics: Strategic, critical and essential minerals; India's status in mineral production. National Mineral Policy.	4
	2	Mineral Conservation Laws; Exclusive economic zone, marine mineral resources and laws of the sea.	4
	3	Detailed study of major atomic minerals and their distribution in India.	3
	4	REE distribution in India, Beach sand minerals in India.	3

5	**Teacher Specific Module**	**5**
	Directions: Study of fossil fuels of India	
	Space to fill the selected area/ activity	5

Essential Readings:

1. Chatterjee, K. K. (2008). Introduction to Mineral Economics. New Age International. 379p.
2. Evans, A. M. (1981). An Introduction to Ore Geology. Elsevier.
3. Evans, A. M. (1993). Ore Geology and Industrial Minerals: An Introduction (Third Edition). Blackwell Publishing.
4. Geological Survey of India (2012). Geology and Mineral Resources of India, Miscellaneous Publication 30, Part XXII. Geological Survey of India.

5. Jensen, M., & Bateman, A. M. (1981). Economic Mineral Deposits. John Wiley & Sons Inc.
6. Krishnaswamy, S. (1988). Indian Mineral Resources (3rd Edition). South Asia Books.
7. Prasad, U. (2011). Economic Geology: Economic Mineral Deposits. CBS Publishers, New Delhi. 319p.
8. Ray, S. C., & Sinha, I. N. (2016). Mines and Mineral Economics. Phi Learning Pvt Ltd. 241p.

Websites:

Geological Survey of India (GSI) website (www.gsi.gov.in) for reports and publications.

Ministry of Mines, Government of India (https://mines.gov.in)

Reference Distribution:

Module	Unit	Reference No.
1	1	7
	2	7
	3	4, 7
	4	4,7
2	1	2,4,5,6,7
	2	2,4,5,6,7
	3	2,4,5,6,7
	4	2,4,5,6,7
3	1	2,3,4,5,6,7
	2	2,3,4,5,6,7
	3	2,3,4,5,6,7
	4	2,3,4,5,6,7
4	1	4

	2	4
	3	1,4,6,8
	4	1,4,6,8

Suggested Readings:

1. Gokhale and Rao (1978) Ore deposits of India. Thomson Press (India)
2. John Ridley (2013) Ore Deposit Geology. Cambridge University Press, 398p
3. Pohl, W. L. (2011). Economic Geology: Principles and Practice. John Wiley & Sons Inc.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

FOUNDATION COURSES

KU6SECGEL301– GEOLOGICAL FIELD TECHNIQUES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	SEC	300-399	**KU6SECGEL301**	3	45

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
3	-	--	25	50	75	2 hours

Course Description: *This course equips students with essential geological field techniques, focusing on mapping, rock and mineral and structure identification, , and geophysical and geochemical surveys. Students develop skills in data collection and interpretation, and learn to produce detailed geological maps and reports.*

Course Prerequisite: The learner must have completed the basic courses in 200 – 299 level in B Sc Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Develop the ability to create detailed geological maps using field observations and topographic maps.	*U, C*
2	Identifying and describing various rocks and minerals in the field.	*U*
3	Understands how to measure, record, and analyze geological structures such as faults, folds, and joints in the field.	*U, AN*
4	Understands the identification of Sedimentary, Igneous, and Metamorphic rocks in the field.	*U*
5	Understands the basic processes and techniques of mineral exploration, oceanic exploration and methods of sample collection.	*U*
6	Understands the methods of electrical resistivity survey for groundwater exploration.	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓			✓		
CO 2		✓			✓		
CO 3		✓					✓
CO 4		✓					
CO 5			✓			✓	
CO 6		✓				✓	

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**TITLE**		**10**
	1	Scope and importance of Field Geology, Reconnaissance survey. Field safety measures.	2
	2	Geologic maps and mapping -Basic equipment required for mapping. Base map- Topographic map. Orientation of the map	3
	3	Field equipment- Geological compass, hand lens, hammer, chisel, pen knife, hand lens, pocket magnet, field note book.	2
	4	Basic procedures in the field: Taking a compass bearing, taping and pacing, locating the position in the map, Use of GPS.	3

2	**BASIC FIELD TECHNIQUES**		**10**
	1	Observations in the field, interpretation of the outcrop, taking field notes, drawing and photographing outcrops,	3

	2	Techniques of measurements of attitudes of planar and linear features - Strike, dip, plunge and pitch.	3
	3	Identification of igneous, sedimentary and metamorphic rocks.	2
	4	Collection of fossils and rock samples-their identification and naming.	2

3	**RECORDING ROCKS STRUCTURES IN THE FIELD.**		**10**
	1	Field and mapping techniques in sedimentary terrain.	*3*
	2	Field and mapping techniques in igneous terrain.	*2*
	3	Field and mapping techniques in metamorphic terrain.	*3*
	4	Identification of structures in the field- Faults, folds, foliations, lineations, joints and shear zones.	*2*

4	**GEOLOGIGAL EXPLORATION**		**10**
	1	Mineral exploration- Surface and subsurface methods	*3*
	2	Sampling techniques in mineral exploration.	2
	3	Electrical resistivity survey for groundwater exploration	2
	4	Brief outline of Ocean floor exploration.	3

5	**Teacher Specific Module**	**Hours**
	Directions: Geochemical and hydrogeological field Techniques, Soil and stream sediment sampling, Sampling and analyzing groundwater quality, Techniques for excavating and preserving fossils.	**5**

Essential Readings:

1. Compton, R.R., (1968), Manual of Field Geology, Wiley Eastern Pvt. Ltd.

2. Lahee, F.H., 1961, Field Geology, 6th edn., McGraw Hill Book Company, New York, 926p

3. Mathur, S.M., (2001)- Guide to field Geology, Prentice- Hall of India Pvt. Ltd., New Delhi.

4. Paul F. Howell and David W. Ager (2009) Geological Techniques, Waveland Press, 532 p

5. Frederic H. Woodruff (2017)-. Field Geology 7th Edition, John Wiley & Sons, 484p

6. Robert, S (2010) Mineral Exploration and Mining Essentials, Pakawau Geo Management Inc., Canada, 312p.

7. Charles Moon, Michael Whateley, Anthony Evans (2006). Introduction to Mineral Exploration, Blackwell Publishing, Oxford, UK, 496p.
8. Reinhard Kirsch (2006). Groundwater Geophysics: A Tool for Hydrogeology, Springer,548p.
9. Jon Erickson (1996). Marine Geology: Exploring the New Frontiers of the Ocean,

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1,2,3
	2	1,2,3
	3	1,2,3
	4	1,2,3
2	1	1,2,5
	2	1,2,5
	3	1,2,5
	4	1,2,5
3	1	1,4,5
	2	1,4,5
	3	1,4,5
	4	1,4,5
4	1	6,7,8
	2	6,7,8
	3	6,7,8
	4	9

Suggested Readings:

1. Low, J.W., Geological Field Methods, Harper & Brothers
2. Philip Kearey, Michael Brooks and Ian Hil (2002): An Introduction to Geophysical Exploration, Blackwell Science Ltd., USA,262p.

Assessment Rubrics:

Evaluation Type	**Marks**
End Semester Evaluation	**50**
Theory test paper	50
Continuous Evaluation (Theory)	**25**

a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
	Total	**75**

SEMESTER 7

DISCIPLINE SPECIFIC COURSES

KU7DSCGEL401 – APPLIED GEOMORPHOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	Major	400-499	KU7DSCGEL401	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
3	2	--	25	50	10	15	100	2 hours

Course Description: *Applied Geomorphology explores the practical applications of geomorphological principles in environmental management, natural hazard assessment, and land-use planning. This course offers students with an understanding of the processes shaping the Earth's surface and the skills to apply this knowledge to real-world situations.*
Course Prerequisite: The learner must have completed the basic courses in 300 – 399 level in B Sc Geology programme.
Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To understand the fundamental concepts and processes of geomorphology.	U
2	To develop skills in geomorphological mapping, remote sensing, and GIS applications.	C
3	To apply geomorphological knowledge in environmental and hazard management.	A
4	To analyze the impact of geomorphological processes on human activities and the impact of coastal geomorphological processes on coastal zone management.	An
5	To understand the role of geomorphology in watershed management and land-use planning for sustainable development.	U
6	To analyze the geomorphological characteristics of key regions in India, including the Himalayas, Indo-Gangetic Plains, and Peninsular region.	A

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2	✓	✓				✓	✓
CO 3	✓			✓			
CO 4			✓	✓			
CO 5	✓			✓		✓	
CO 6		✓					

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
	LANDFORM EVOLUTION		10
	1	Geomorphic principles. Theory of Uniformitarianism. Influence of structure, process, time, and climate on landforms.	2
1	2	Energy flow in geomorphic systems. Fluvial Geomorphology. - Mass wasting and hillslope evolution	3
	3	Structural control on fluvial erosion. Landform evolution by fluvial processes.	3
	4	Different models in the Evolution of landscape: Davis, Penck, King, Gilbert and Hack--Peneplain and Pediplain concepts.	2

	ANALYSIS OF LANDFORMS		10
	1	Applied geomorphology: Techniques of geomorphic analysis of landforms, slopes, drainage and processes, morphometry, terrain classification.	3
2	2	Karst processes and landforms; Geomorphology of arid regions.	3
	3	Shoreline processes and associated landforms - coastal dynamics. Coastal processes and landforms; Human impacts on coastal geomorphology.	2
	4	Glacial processes and landforms; Periglacial environments.	2

3	**APPLICATIONS OF GEOMORPHOLOGY**		10
	1	Remote sensing and GIS as tools in geomorphic applications.	2
	2	Geomorphology and hydrology- Application of geomorphic knowledge in groundwater investigations. Hydrology of laterite terrains.	3
	3	Geomorphology and mineral exploration - surface expression of ore bodies, weathering residues, epigenetic minerals and unconformities, placer deposits, oil exploration.	2
	4	Geomorphology and engineering works- road construction, dam site selection, location of sand and gravel pits.	3

4	**COASTAL ZONE, HAZARD AND WATERSHED MANAGEMENT; GEOMORPHIC PROVINCES OF INDIA**		10
	1	Definition of coastal zone—coastal processes: erosion, transportation and deposition by waves, tides and currents. Geomorphology and coastal zone management.	3
	2	Geomorphology and hazard management.	3
	3	Geomorphology in soil conservation, watershed management, and land-use planning.	2
	4	Geomorphic provinces of India - Himalayas, Indo-Gangetic Plains, Peninsular region.	2

5	**Teacher specific module**	**Hours**
	Instructions; Geomorphological Hazards-Landslides, floods, and coastal erosion; Hazard assessment and mitigation. Analysis of the Indus River in the context of Himalayan tectonics. GIS-based analysis of river networks in relation to geological structures.	**5**

6	**Practical**	**Hours**

	Analyzing river systems using topographic maps and aerial photographs. Coastal geomorphological mapping and shoreline change analysis. Identifying karst features; Analyzing desert landscapes. GIS-based geomorphological analysis and mapping. Using topographic maps and remote sensing data to identify structural features influencing river courses. GIS-based analysis of river networks in relation to geological structures.	30

Essential Readings:

1. Small, R.J. The Study of Landforms – A Textbook of Geomorphology, Cambridge University Press, 1970

2. R.J. Huggest (2007) Fundamentals of Geomorphology. Routledge Publishers

3. Sharma, H.S. (1990) Indian Geomorphology, Concept Pub. Co., New Delhi

4. D.W. Burbank & R.S. Anderson (2001), Tectonic Geomorphology, Blackwell Science Publishers.

5. W.D. Thornbury (1969) Principles of Geomorphology. Willey Eastern Ltd. New Delhi.

6. Allision, R. Applied Geomorphology: Theory and Practices, Wiley Europe, 2002

7. Goudie, A. Geomorphological Techniques, George Allen and Unwin, London, 1982

8. Hails, J.R. Applied Geomorphology, Elsevier, Amsterdam, 1977

9. King, C.A.M. Techniques in Geomorphology, Edward Arnold, 1967.

10. Knighton, D., (1998) Fluvial Forms and Processes, Edward Arnold, Hodder Education, UK

11.Vitek., J. D. and Giardino, J. R. Edtion. (1992): Geomorphology and Environmental Management, Allen & Unwin, Auatralia,368p

12. Abrahams A.D and. Parsons A.J Edition (1994) Geomorphology of Desert Environments. Chapman & Hall, U.K. 674 p.

13. Embleton and King (1968). Glacial Geomorphology, Edward Arnold, Hodder Education, UK

14. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). Remote Sensing and Image Interpretation, John Wiley & Sons, Inc, USA, 736p.

15. Robin Davidson-Arnott (2010). Introduction to Coastal Processes and Geomorphology, Cambridge University Press.

16. Bird, E. (2008). Coastal Geomorphology: An Introduction, John Wiley & Sons.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2, 5
	2	5,6,10
	3	6,8
	4	4,10
2	1	6,7,8
	2	12
	3	15,16
	4	13
3	1	14
	2	6,7,9
	3	6,7,9
	4	6,7,9
4	1	6,7,9
	2	6,7,9
	3	11
	4	3

Suggested Readings:

1. A.L. Bloom (1992) Geomorphology – A systematic analysis of ate Cenozoic landforms. PHI, New Delhi.
2. A.S. Goudie (2004), Encyclopaedia of Geomorphology (Vol. 1&2). Routledge Publishers.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10

b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU7DSCGEL402: GEOCHEMISTRY AND ISOTOPE GEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
7	Major	400-499	KU7DSCGEL402	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
3	2	--	25	50	10	15	100	2 hours

Course Description: *This geochemistry course provides an extensive overview of fundamental principles and applications in Earth sciences. Topics include origins and cosmic abundance of elements, geochemical classifications, thermodynamics, crystal chemistry, distribution and behavior of major, trace, and Rare Earth Elements (REE), as well as the geochemistry of Earth's crust, mantle, and core. Additionally, students will study radioactive systematics and dating methods, stable isotope* *studies, and their significance in petrology and isotope hydrogeology. Through theoretical discussions, practical work, and case studies, students will develop analytical skills to interpret geological phenomena and apply geochemical principles across disciplines.*

Course Prerequisite:

The learner must have completed the basic courses in 300 – 399 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Achieve comprehension of fundamental geochemical principles, including origins and cosmic abundance of elements, geochemical classifications, thermodynamics, and crystal chemistry.	U
2	Demonstrate the ability to analyze elemental distribution and behavior in geological environments, such as igneous, sedimentary, and metamorphic settings, and interpret their implications for petrogenesis.	An
3	Apply various radioactive systematics and dating methods, including Rb-Sr, K-Ar, Sm-Nd, U-Th-Pb, 14C, and fission track methods, to determine geochronological ages and infer petrogenesis.	A
4	Interpret stable isotope studies, including Delta notation, and understand the significance of stable isotopes of Carbon, Oxygen, and Sulphur in petrology and isotope hydrogeology.	U, A
5	Utilization of Analytical Skills in Geochemical Data Interpretation: Utilize analytical skills to interpret geochemical data, including oxidation-reduction reactions, oxygen fugacity, Eh-pH diagrams, and the geochemical cycle, for effective interpretation of geological phenomena.	A

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓						
CO 2		✓	✓				
CO 3				✓			
CO 4	✓				✓	✓	
CO 5		✓	✓	✓	✓		✓

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**GEOCHEMISTRY FUNDAMENTALS**	10
	1	Geochemistry: Origin and cosmic abundance of elements, Oddo-Harkin Law.	3
	2	Geochemical Classification of elements: siderophile, chalcophile, lithophile, atmophile.	2
	3	Thermodynamics and crystal chemistry	3
	4	Isomorphism, atomic substitution and polymorphism.	2
2		**ELEMENTAL DISTRIBUTION AND BEHAVIOUR**	10
	1	Distribution and behaviour of major, trace and Rare Earth Elements (REE) in igneous, sedimentary and metamorphic environments and their application in petrogenesis.	3
	2	Geochemistry of crust, mantle and core of the earth. Meteorites - classification and significance.	2
	3	Oxidation-Reduction reactions, Oxygen fugacity, Eh-pH diagrams.	3
	4	Geochemical Cycle. Mobility of elements.	2
3		**RADIOACTIVE SYSTEMATICS AND DATING METHODS**	10

	1	Isotopes, isobars and isotones. Stable and radioactive isotopes. Radioactivity and radioactive decay schemes. Study of different radioactive systematics and their application to geochronolory and petrogenesis. Isotope notation, epsilon notation. Rb-Sr systematics - mineral and whole rock isochrones.	2
	2	K-Ar systematics: model age and isochron age, the problem of Ar loss, metamorphic veil and rate of cooling intrusive. Sm-Nd systematics: isochron ages, isotopic evolution of Nd, CHUR model, epsilon parameter.	3
	3	U-Th-Pb, ^{207}Pb-^{206}Pb systematics. U-Pb Concordia-discordia method, Zircon dating- analysis of single zircon.	3
	4	^{14}C and fission track methods of dating.	2

4	**STABLE ISOTOPE STUDIES**		10
	1	Isotopic fractionation- Causes and mechanisms, Fractionation factor, Delta notation and its significance.	3
	2	Significance of stable isotope of Carbon in petrology	2
	3	Significance of stable isotopes of Oxygen and Sulphur in petrology	3
	4	Isotope hydrogeology - $\delta 18O$ and $\delta 2H$-, Global meteoric water line, altitude and latitudinal effects on rain water. Isotopes as tracers in water cycle and groundwater studies.	2

5	**Teacher Specific Module**	**5**
	Directions: The topics may be related to aspects of geochemistry like Analytical Techniques in Geochemistry, Environmental Geochemistry, Petroleum and Coal geochemistry, Geochemical interaction between water and rock.	
6	**Practical**	

	Mineralogical calculations using chemical analysis data of minerals - Garnet, Pyroxene, Feldspar, Olivine, Feldspathoid.	30

Essential Readings:

1. Albarede F. (2003) Geochemistry- An introduction, Cambridge university press.
2. Brian Mason, 1966, Principles of Geochemistry, Wiley.
3. Brownlow, A.N., 1979, Geochemistry, Prentice Hall.
4. Faure G. (1986) Principles of isotope geology1, John Wiley & Sons
5. Gill, R. (1989) Chemical fundamentals of geology, Unwin Hyman, London
6. Krauskopf, E.B. (1979) Introduction to geochemistry, McGraw Hill Book Company, New Delhi.
7. Mason, B. and Moore, C.B. (1985) Principles of geochemistry, Wiley Eastern Ltd, Bangalore
8. Paul Henderson, Inorganic Geochemistry, Pergamon Press.
9. Rankama, K. & Sahama, T.H.C., 1950, Geochemistry, University of Chicago Press.
10. Misra, K. C. (2012). Introduction to Geochemistry: Principles and Applications. John Wiley & Sons, Ltd., Publication, UK.
11. Gunter Faure and Teresa M. Mensing (2005). Isotopes: Principles and Applications, John Wiley & Sons, USA,897p.
12. Jochen Hoefs (2018) Stable Isotope Geochemistry, Springer, Germany, 389p.
13. Zachary Sharp (2017). Principles of Stable Isotope Geochemistry, Pearson Education,USA.304p.
14. Joel Gat (2010).Isotope Hydrology: A Study of the Water Cycle, Imperial College Press, UK, 198p.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2,3

	2	2,5,7
	3	6,7
	4	8,9
2	1	2,7,9
	2	1,7,9
	3	2,7,9
	4	9,10
3	1	4,11
	2	4,11
	3	4,11
	4	4,11
4	1	12,13
	2	12,13
	3	12,13
	4	14

Suggested Readings:

1. Rankama, K., 1963, Progress in Isotope Geology, Interscience.
2. Rollinson, H.R. (1993) Using geochemical data: Evaluation, presentation, interpretation. Longman scientific and Technical, New York.

Assessment Rubrics:

Evaluation Type	Marks
End Semester Evaluation	**65**

a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU7DSCGEL403 – ADVANCED IGNEOUS AND METAMORPHIC PETROLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	Major	400 - 499	**KU4DSCGEL202**	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
			Theory		Practical			
Lecture	Practical/ Internship	Tutorial	CCA	ESE	CCA	ESE	Total	
3	2	--	25	50	10	15	100	2 hours

Course Description:

This course explores mantle petrology, covering its composition and structures, including its homogeneous and heterogeneous aspects. Analyse the generation basaltic magma in different settings and learn about the significance of ophiolite suites understanding mantle composition. This course discusses different variation diagram and their use in magma evolution modelling. Additionally, learner will study the phase rule and its application of important three-component igneous system.

Course Prerequisite: The learner must have completed the basic courses in 300-– 399 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding of mantle petrology, distinguishing between homogeneous and heterogeneous mantle compositions and explore mantle melting mechanisms and the generation of basaltic magma across diverse tectonic settings.	*An & E*
2	Detailed study of ophiolite suite and petrogenic importance. Utilize variation diagrams, bivariate, and triangular plots for modelling magma evolution. Analyze isotopic, rare earth element (REE), and trace element patterns to differentiate between enriched and depleted mantle compositions.	*E & C*
3	Develop proficiency in applying phase rule principles to igneous systems, focusing on the Forsterite-Anorthite-Silica, Diopside-Albite-Anorthite, and Diopside-Forsterite-Silica systems. Enhance skills in interpreting phase equilibria and understanding the thermodynamic behaviour of three-component igneous systems.	*E & C*
4	Analyze and interpret various metamorphic textures and structures, understanding their genetic significance in geological processes.	*An & E*
5	Apply the phase rule to metamorphic systems to predict phase changes and equilibrium conditions under different temperature and pressure regimes.	*A, E& C*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7

CO 1	✓	✓	✓				✓
CO 2	✓				✓	✓	✓
CO 3	✓	✓		✓	✓		
CO 4	✓	✓			✓	✓	✓
CO 5	✓	✓	✓			✓	✓

COURSE CONTENTS

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**MANTLE PETROLOGY**		**10**
	1	Mantle petrology. Homogeneous and heterogeneous mantle.	2
	2	Mantle melting mechanism and generation of basaltic magma in different tectonic settings. - Oceanic Intraplate volcansin; Mid Oceanic Ridge (MOR) volcanism. Island arc and Continental arc igneous activity and Continental flood basalt.	3
	3	Ophiolite suite and its importance. Variation diagrams and its use in magma evolution modelling - Bivariate and triangular plots.	3
	4	Isotopic REE and Trace pattern of Enriched and depleted mantle. Tectonic discrimination diagram and it's applications.	2

2	**PHASE RULE AND THREE COMPONENT IGNEOUS SYSTEM**		10
	1	Phase rule and its application in igneous system - Anorthite - Fosterile - Diopside.	3
	2	Detailed study of Forsterile - Anorthite – Silica system.	2
	3	Detailed study of Diopside - Albite – Anorthite system.	2
	4	Detailed study of Diopside - Forsterite - Silica and Onhoclase - Anorthite – Albite system.	3

3	**CONCEPTS IN METAMORPHIC PETROLOGY**		10

	1	Genetic significance of metamorphic textures and structures	2
	2	Phase rule and its application in metamorphic systems	3
	3	Mineral Paragenesis and Chemographic diagrams: Composition plotting: ACF, AKF and AFM diagrams.	2
	4	UHP and UHT Metamorphism, P-T-t Paths	3

4	**METAMORPHIC REACTIONS**		10
	1	Metamorphic Reactions, Geothermobarometry	3
	2	Metamorphism of pelitic sediments	2
	3	Metamorphism of calcareous and ultramafic rocks	2
	4	Metamorphic fluids and metasomatism	3

5	**Teacher Specific Module**	**Hours**
	Directions: The topics cover the following aspects, especially case studies of igneous rock suites, analytical techniques in petrology, and the preparation of thin sections.	5
	Space to fill the selected area/ activity	

6	**Practical – Igneous Petrology**		**Hours**
		Megascopic and Microscopic identification of the following rocks with special stress to genetic significance - Granite, Syenite, Diorite, Pegmatite, Lamprophyre, Gabbro. Dolerite, Basalt, Dunite. Peridotite, Pyroxenite. Anonhosite and Kimberlite.	30
		Calculation of Niggli values and Peacock's Alkali Lime lndex - 2 Exercises. Norm calculation – 2 Excercises	
		AFM diagrams for classification of igneous rocks-3 Nos.	
		Tectonic discrimination diagrams : 1. Ti-Zr-Y Diagram, 2. K2O-SiO2 Diagram, 3. Ti- Si_Sr diagram, 4. Na - Nb - Sr diagram, 5. La/Yb-Nb/Yb Diagram	
		Graphical representation: Variation Diagrams--Harker. Larsen, Allen and Nickold and Niggli -2 each.	

	Practical-Metamorphic Petrology		
		Megascopic and Microscopic identification of the following rocks with special reference to genetic significance – Slate, phyllite, schist, gneiss, marble, quartzite, amphibolite, pyroxene granulite, charnockite, khondalite, eclogite.	
		Graphical representation of metamorphic rnineral paragenesis-5 Exercises.	
	3	ACF and AKF diagrams of the following facies -l each - Greenschist. Amphibolite, Granulite. Eclogite, Albite-Epidole-Hornfels. Homblende-hornfels. Pyroxene-hornfels and Sanidinite facies.	

Essential Readings:

1. Philpotts, Anthony Robert, and Jay J. Ague. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press,
2. John D. Winter.(2010). Principles of Igneous and Metamorphic Petrology. Pearson, USA,720p
3. Tyrrell, George Walter. (2012).The principles of petrology: an introduction to the science of rocks. Springer Science & Business Media,
4. Frost, B. Ronald, and Carol D. Frost (2019). Essentials of igneous and metamorphic petrology. Cambridge University Press,
5. Jerram, Dougal, and Nick Petford (2011). The field description of igneous rocks. John Wiley & Sons,

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1,3
	2	2
	3	2,4
	4	2
2	1	1
	2	1,2
	3	1
	4	2,5
3	1	2
	2	2

	3	2
	4	2
4	1	2
	2	2
	3	2
	4	2
6	1	2
	2	2
	3	2
	4	2

Suggested Readings:

1.Myron G. Best (2013). Igneous and Metamorphic Petrology, Wiley-Blackwell, USA, 752p.
2.Anthony Hall (1997), Igneous Petrology, Longman, London, UK,551p**.**

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU7DSEGEL401– SEDIMENTOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	Major (Elective)	400-499	KU7DSEGEL401	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
3	2	--	25	50	10	15	100	2 hours

Course Description: *This course provides an in-depth study of sedimentology, focusing on sedimentary processes, sedimentary structures, depositional environments, and the interpretation of sedimentary rocks. Students will gain a comprehensive understanding of the principles and applications of sedimentology in several geological settings.*

Course Prerequisite: The learner must have completed the basic courses in 300 – 399 level in B Sc Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To understand and apply the principles of sediment transport, distinguishing between suspended load and bed load, and utilize the Hjulstrom diagram to predict sediment behaviour in fluid flows.	U, A
2	To identify and interpret sedimentary structures and textures.	U
3	To analyze different depositional environments and their sedimentary records.	An

4	To evaluate and classify various sedimentary rocks, such as sandstone, conglomerate, breccia, carbonates, evaporites, chert, phosphates, and iron/manganese-bearing rocks, using established classification schemes and understanding their formation processes.	U
5	Understand the fundamental principles of sequence stratigraphy and to identify and interpret stratigraphic sequences and their boundaries.	U
6	Understands various settings of sedimentary basins and apply these to the study of palaeoslope and basin analysis.	A

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓					
CO 2		✓					
CO 3			✓	✓			
CO 4	✓						✓
CO 5	✓		✓				
CO 6		✓			✓	✓	

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**FLUID FLOW, TEXTURES & STRUCUTRES**		10
	1	Sediment movement by fluid flow--Fundamentals of fluid flow. Flow in pipes and channels competence and capacity. Turbulence,– Froude Number, Reynold’s Number. – Hjulstrom diagram. Processes- of sediment transport-suspended load and bed load.	2

	2	Clastic sedimentary textures: grain size, shape and fabric. Frequency distribution and statistical parameters.	3
	3	Sedimentary structures: Stratification, Flow regimes and processes of sediment transport, Ripples and dunes -Structures related to current ripples and wave ripples. Antidunes. Structures formed by scour, wave, tide and wind. Penecontemporaneous deformation structures.	2
	4	Structures of chemical origin-concretions and nodules. Biogenic structures-Biostratification, Bioturbation and Biodeposition structures. Stromatolites – Morphology and classification.	3

2	**PROVENANCE, FACIES & DIAGENESIS**		10
	1	Provenance studies: Mobility of oxides, mineral stability, mineralogical and textural maturity, minerals of sedimentary rocks and source rocks. Importance of heavy mineral suits.	3
	2	Study of following specific depositional environment and facies. Continental environment – Fluvial, Eolian, Lacustrine and Glacial systems. Evaporate environment.	3
	3	Mixed environment – Delta, beach and estuarine system. Siliciclastic marine environment – Shelf and deep-water system. Carbonate environment- Shelf system. Turbidity currents and deposits.	2
	4	Diagenesis of clastic rocks – Compaction, Cementation, Authigenesis, Recrystallization and Replacement Diagenetic structures. Non clastic diagenesis and environment.	2

3	**DESCRIPTIVE SEDIMENTARY PETROLOGY**		10
	1	Sandstone- origine and classification (Revised version of Dott'scheme), conglomerate and breccia.	3

	2	Carbonate sedimentary rock – components of limestone and classification (R L Folk's scheme).	2
	3	Dolomites and mechanism of dolomitization.	2
	4	Evaporites, Chert, phosphates and Iron and manganese bearing rocks.	3

4	**SEDIMENTARY BASINS & SEQUENCE STRATIGRAPHY**		10
	1	Paleoslope and palaeo current studies, basin analysis	2
	2	Tectonics and sedimentation -Geosynclinal and plate tectonic concept of basins.	2
	3	Basin classification and description. Sedimentary basins of India.	3
	4	Sequence stratigraphy- Basic concepts, terminology, types of system tracts. Applications of sequence stratigraphy.	3

5	**Teacher specific module**	**Hours**
	Instructions: Study of Sieving techniques, settling techniques for size analysis of sediments, Recent advances in sedimentological research and technology, Palaeo-environment analysis using structure.	**5**

6	**Practical**	**Hours**

	Textural analysis of sediments: Sieve analysis, settling analysis, thin sections, size analysis, measurement and calculation of Shape parameters, plotting and interpretation of such data. Size analysis using G- Stat software Heavy mineral separation. Study of thin sections and hand specimens of Limestone, Sandstone, Shale, Conglomerate, Breccia, Grit and Arkoses. Preparation of grain mounts - 5 Nos. Study of grain mounts of Magnetite, Ilmenite, Monazite, Garnet, Sillimanite, Zircon, Rutile, Leucoxene and Chromite.	10

Essential Readings:

1. Blatt, H., Middleton, G. V., & Murray, R. C. (1980). Origin of Sedimentary Rocks. Prentice Hall.
2. Boggs, S. (2011). Principles of Sedimentology and Stratigraphy. Pearson.
3. Tucker, M. E. (2011). Sedimentary Rocks in the Field: A Practical Guide. John Wiley & Sons
4. Tucker, M. E., & Wright, V. P. (2009). Carbonate Sedimentology. John Wiley & Sons.
5. Nichols, G. (2009). Sedimentology and Stratigraphy. John Wiley & Sons.
6. Sukhthankar, R.K., (2004). Applied sedimentology, CBS publishers and distributors, New Delhi,170p.
7. Folk, R.L., (1968), Petrology of Sedimentary Rocks, Hemphill's University Station, Texas
8. Pettijohn, F.J., (1957), Sedimentary Rocks. Harper & Row.
9. Sengupta, S.M., (2007). Introduction to sedimentology, CBS publishers and distributors, New Delhi,339p.
10. Singh, S. K. (2010). Sedimentary Basins of India. Tata McGraw-Hill Education.
11. Biswas, S. K. (1987). Regional Tectonic Framework, Structure and Evolution of the Western Marginal Basins of India. Journal Tectonophysics, 135(4), pp307-327

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	5,6,9
	2	6,8,9
	3	2,3,9
	4	2,3,9

2	1	7,8,9
	2	8,9
	3	4,8,9
	4	1,6
3	1	1,4,9
	2	1,4,9
	3	6,9
	4	6,9
4	1	2,9
	2	2,9
	3	9
	4	9,10,11

Suggested Readings:

1. Krumbein, W.C. & Pettijohn, F.J., 1938, Manual of Sedimentary Petrology. Appleton Century Co.
2. Miall, A.D., 1990, Principles of Sedimentary Basin Analysis, 2nd edn., Springer-Verlag.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05

c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU7DSEGEL402: ANALYTICAL GEOCHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	Major (Elective)	400-499	KU7DSEGEL402	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
			Theory		Practical			
Lecture	Practical/ Internship	Tutorial	CCA	ESE	CCA	ESE	Total	
3	2	--	25	50	10	15	100	2 hours

Course Description: *The analytical geochemistry course covers essential concepts and techniques for studying geological materials. Topics include sample preparation, spectroscopic analysis, titrimetry, and a range of analytical instruments such as XRF, AAS, ICP-AES, and ICP-MS for whole rock and sediment analysis. Mineral analysis techniques like XRD, EMPA, SEM-EDS, and SIMS are also explored. This course provides students with practical skills and theoretical knowledge necessary for geochemical research and exploration.*

Course Prerequisite:
The learner must have completed the basic courses in 300 – 399 level in B Sc Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Mastery of fundamental concepts and terminology in analytical geochemistry, enabling students to understand and apply precision, accuracy, detection limits, and sampling strategies in geological analysis.	U

2	Proficiency in sample preparation techniques such as crushing, grinding, and digestion, empowering students to effectively process geological samples for analysis.	A
3	Competence in utilizing a variety of spectroscopic and titrimetric techniques, including spectrophotometry and titrimetry, for elemental analysis of geological materials.	A
4	Ability to operate and interpret data from a range of analytical instruments, including XRF, AAS, ICP-AES, and ICP-MS, for whole rock and sediment analysis, facilitating comprehensive geological characterization.	An
5	Understanding and application of mineral analysis techniques such as XRD, EMPA, SEM-EDS, and SIMS, allowing students to identify and characterize minerals present in geological samples with precision and accuracy.	U, Ap

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓		✓			
CO 2	✓	✓					
CO 3	✓	✓					
CO 4	✓	✓			✓	✓	✓
CO 5	✓	✓			✓	✓	✓

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**INTRODUCTION**		**10**
	1	Concepts in analytical geochemistry.	3
	2	Terms and definitions in analytical geochemistry. Precision and accuracy, detection limits, sampling strategies, sample contamination, effects, calibrations, rock reference materials.	3
	3	Geochemical cycle and geochemical dispersion	2
	4	Sampling strategies for different geological materials.	2

2	**PREPARATION OF SAMPLE**		**10**
	1	Sample preparation: crushing, coning and quartering, grinding, sieving.	2
	2	Sample digestion techniques: Fusion techniques and acid digestion.	3
	3	Spectrophotometry – concept, instrument and procedure.	2
	4	Titrimetry.- concept, types and processes.	3

3	**ANALYSIS OF ROCKS & SEDIMENTS**	**10**

	1	Whole rock and sediment analysis techniques: X-Ray Fluorescence (XRF)	3
	2	Atomic Absorption Spectrometry (AAS)	3
	3	Induced Coupled Plasma Atomic Emission Spectroscopy (ICP-AES)	2
	4	Induced Coupled Plasma-Mass Spectrometry (ICP-MS),	2

4	**ANALYSIS OF MINERALS**		**10**
	1	Mineral Analysis: X-ray diffraction methods (XRD).	3
	2	Electron Microprobe Analysis (EMPA)	2
	3	Scanning Electron Microscopy-Energy Dispersive System (SEM-EDS)	3
	4	Secondary Ion Mass Spectroscopy (SIMS)	2

5	**Teacher Specific Module**	**5**
	Directions: The topics covered include Thermal Analysis Techniques such as Differential Thermal Analysis (DTA) and Thermogravimetric Analysis (TGA); Recent Advances and Emerging Techniques, including Nano geochemistry, Laser Ablation Techniques, and Synchrotron-based Techniques; and Applications of Analytical Geochemistry in mineralogy, petrology, and hydrogeology.	
	Space to fill the selected area/ activity	5
6	**Practical**	30
	Geochemical data analysis and interpretation using modern software.	

Essential Readings:

1. Skoog D.A; F. J. Holler, T.A. Nieman (1998). Principles of Instrumental Analysis, 5th edition. Orlando, FL: Harcourt Brace College Publishers.

2. Rollinson, H.R., (1993). Using Geochemical Data: Evaluation, Presentation, Interpretation. Longman, Harlow, 352p.

3.Putnis Andrew (1992), An Introduction to Mineral Sciences, 1 st Edn., Cambridge University Press, UK. ISBN: 0521429471, 978-0521429474.

4.Goldstein, J., Newbury, D. E., Joy, D. C., Lyman, C. E., Echlin, P., Lifshin, E., Sawyer, L., & Michael, J. R. (2003). Scanning Electron Microscopy and X-ray Microanalysis, 3rd Edn. Springer Science & Business Media

5.Faure G (1998) Principles and applications of geochemistry, 2nd edn. Prentice Hall, Upper Saddle River, NJ

6.Reed, S. J. B. (1997). Electron Microprobe Analysis, 2nd Edn. Cambridge University Press.

7. Paul W. J. M. Boumans (1987). Inductively Coupled Plasma Emission Spectroscopy, Part 1: Methodology, Instrumentation, and Performance, Wiley-Interscience, USA,640p.

8. Howard E. Taylor (2001).Inductively Coupled Plasma-Mass Spectrometry: Practices and Techniques, Academic Press, USA,294p.

9. Peter Williams (1983). Introduction to Secondary Ion Mass Spectrometry (SIMS), Research Studies Press, UK, 216p.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2
	2	1,2
	3	1,2
	4	1,2
2	1	2,3,5
	2	2,3,5
	3	2,3,5

	4	2,3,5
3	1	4,5,6
	2	4,5,6
	3	7
	4	8
4	1	3
	2	6
	3	4
	4	9

Suggested Readings:

1. Albarede F. (2003) Geochemistry- An introduction, Cambridge university press.
2. Mason,B,(1966), Principles of Geochemistry, Wiley

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05

c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU7DSEGEL403 – APPLIED MICROPALAEONTOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	Major (Elective)	400-499	KU7DSEGEL403	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Theory	
			CCA	ESE	CCA	ESE		
3	2	--	25	50	10	15	100	2 hours

Course Description: *students will be able to: will gain a comprehensive understanding of major microfossil groups, their morphology, and how they can be utilized to reconstruct past environments, decipher paleoclimates, and petroleum exploration.*

Course Prerequisite: The learner must have completed the basic courses in 300 – 399 level in B Sc Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To understand palaeontological principles, terms, definitions and classifications, the applications of micro fossils in understanding Earth history.	*U,R & A*
2	Perform sampling, processing and extraction of microfossils from sediments. Identification of various microfossil groups and their application in geological studies.	*U,R & A*

3	Application of micro fossils to constrain the age of the enclosing rock, identify and describe the principal microfossil groups, describe the methods of sample collection and laboratory preparation of microfossils.	*A& E*
4	To develop research capability and practical competency in the field of palaeontology.	*R & A*
5	Students will master complex and specialized knowledge, concepts and ideas in micro-palaeontology which includes identification and description of the unicellular organisms and microscopic remains of plants, spores and pollens.	*E & A*
6	Summarise the value of microfossils in paleoenvironmental reconstruction, assess the importance of microfossils in hydrocarbon sub-surface exploration	*A, E & C*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓					✓	
CO 2		✓				✓	
CO 3		✓	✓				
CO 4		✓	✓		✓		✓
CO 5	✓			✓	✓		
CO 6			✓			✓	

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**MICROPALAEONTOLOGY: SCOPE AND SUBDIVISIONS**		**10**
	1	Introduction to micropaleontology and microscopic examination.	3
	2	Microfossils - types, extraction of microfossils from sediments and sedimentary rocks.	2

	3	Zoo planktons, phytoplanktons and benthic microorganisms with examples	2
	4	Pioneers of micropaleontology and the development of the subjects	3

2	**CLASSIFICATION OF MICROFOSSILS**		**10**
	1	Classification of microfossils based on shell/skeleton composition	3
	2	Calcareous, Siliceous, organo walled, phosphatic microfossils	2
	3	Siliceous microfossils: Radiolaria, Diatoms, morphology, classification and importance.	3
	4	Organo walled microfossils- Acritarchs	2

3	**CALCAREOUS MICROFOSSILS**		**10**
	1	Foraminifera: their palaeoecology and application in paleoclimate, paleoceanography and biostratigraphy	3
	2	Calcareous phyto planktons: cocolithophores	2
	3	Ostracodes: their palaeoecology and application in paleoclimate, paleoceanography and biostratigraphy	2
	4	Stromatolites and their importance. Pteropods	3

4	**APPLICATIONS OF MICROFOSSILS**		**10**
	1	Application of microfossils in petroleum exploration	3
	2	Application of microfossils in biostratigraphy	2
	3	Application of microfossils in paleoclimatic and paleoceanographic studies	2
	4	Application of microfossils in evolutionary biology	3

5	**Teacher specific module**	**Hours**
	Directions: Study of Palynology including general morphology of spores and pollen. Evolution of plant life. Applications of palynology in paleoclimate,plant life evolution etc.	**5**

6	**Practical**	**Hours**
	Sample processing techniques and separation of microfossils from matrix and marine sediments. Identification of the following types of microfossils (calcareous and siliceous): Planktonic foraminifera, Benthic foraminifera, Ostracods, Pteropods and Radiolaria. Identification and separation of important species of planktonic foraminifera	30

Essential Readings:

1. Raup D.M. and Stanley .S (1985) Principles of Palaeontology, 481p.
2. Brasier. M.D (1980) Microfossils, George Allen and Unwin Ltd, 193p.
3. Glaessner,M.F. Principles of Micropalaeontolgy, Hafner Publishing Company, 296p.
4. Barghoorn, E.S. (1971) The Oldest Fossils, Scientific American, V. 224, No.5, 30-42.
5. Jones, D.J. (1956) Introduction to Microfossils, Harper & Bros. Pub.
6. Cushman, A. J. (1959) Foraminifera, Harward University Press, 605p.
7. Glaessner, M.F. (1953) Principles of Micro Palaeontology, McGraw Hill.
8. Moore, R.C., Lalicker, C.G. and Fischer, A.G. (1952) Invertebrate Fossils, McGraw Hill.
9. Tiwari, S.K. (2004) A Text Book of Stratigraphy, Micropalaeontology and Palaeobotany, Kalyani Pub., N.D

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1,2

	2	1,2
	3	1,2
	4	2,4
2	1	3, 5
	2	2,3
	3	2,3
	4	2,3
3	1	6
	2	3,2
	3	5
	4	5,6
4	1	6.7
	2	7
	3	5
	4	9

Suggested Readings:

1. B.U. Haq and A. Boersma (1998). Introduction to Marine Micropaleontology, second edition, Elsevier Science.

2. Catherine P. Hughes (2013). Principles of Applied Micropalaeontology, Cambridge University Press. 273 p

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10

c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU7DSEGEL404: REMOTE SENSING AND GEOINFOMATICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	Major (Elective)	400-499	KU7DSEGEL404	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Total	
			CCA	ESE	CCA	ESE		
3	2	-	25	50	10	15	100	2 hours

Course Description: Gain knowledge and comprehension of the advanced Satellite of Remote Sensing, Hyperspectral Remote Sensing, LIDAR Remote Sensing and their different application in terrestrial and vegetation mapping. Acquire skills in handling instruments, tools, techniques and modelling while using Remote Sensing Technology. The course introduce Geoinformatics as an advance tool consists of various advance science and technologies used for mapping and managing earth resources. Introduce the science and technologies involved in Geoinformatics. Explain the earth and mapping principles. Impart knowledge on traditional, conventional and advance surveying technologies. The course deals with basics about the Geodata & WebGIS and apply Geoinformatics in various fields

Course Prerequisite: The learner must have completed the basic courses in 300 – 399 level in B Sc Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the advanced concepts of remote sensing and geoinformatics.	U
2	Acquire skills in handling instruments, tools, techniques and modelling while using Remote Sensing Technology.	A
3	Students will learn geoinformatics as an advance tool consists of various advance science and technologies used for mapping and managing earth resources.	A
4	Students will be able to evaluate the traditional, conventional and advance surveying technologies.	E
5	Applications of geodata, web GIS and geoinformatics in various field.	A

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2		✓		✓			
CO 3				✓	✓		
CO 4					✓	✓	
CO 5			✓			✓	✓

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**ADVANCED REMOTE SENSING**	**10**
	1	Satellite and its classification. Sun synchronous orbit and geostationary orbit, Remote sensing.	2
	2	Satellites in operation: LANDSAT, SPOT, IRS, INSAT, GEOSAT, IKONOS, QUICK BIRD, NOAA, TERRA their sensor characteristics and application..	2
	3	Hyper spectral Remote Sensing Hyper spectral image analysis: Atmospheric correction, Analysis technique of hyper spectral remote sensing, Biophysical modelling, Image transmission & compression. Spectroscopy, Image cube, Hyperian/HYSI, Spectral matching, Digital Spectral Data, Libraries, Application of Hyper spectral data, MODIS	3
	4	Fundamental of LIDAR remote sensing, LIDAR Data Processing, LIDAR Data Management And Applications,(Topographic mapping,flood inundation analysis, line-of-sight analysis, Forestry, various types of LIDAR sensors-, Terrestrial And Bathymetric Laser Scanner.	3

2		**GROUND TRUITH VERIFICATION.**	**10**
	1	Ground truth data collection - use of radiometers, and spectrophotometers. Spectral Reflectance, Physical basis of spectral signatures of the objects and Spectral, Signature for Vegetation, Soil, Water and Snow.	2
	2	Thermal Image and Interpretation, Interpretation of SAR data (from Satellite) for Landuse studies.	2
	3	Rocks types, forms, Minerals and their field characteristics.	2
	4	Image interpretation for delineation of lithology (Rocks) and minerals, Geological structures - Folds, Faults and Joints and their field characteristics, Various important land forms, Image characteristics of geological structures and major land forms.	4

3	**SCOPE OF GEOINFORMATICS**		**10**
	1	Meaning and Scope of Geoinformatics – Science and Technologies involved.	2
	2	Cartography- Geodesy- Geology- Geographical Information System Photogrammetry - Information & Communication Technologies- Global Positioning System.	2
	3	Digital Image Processing - Map as decision tool.	2
	4	Basic principles of surveying – Classification and applications- Scales – Conventional signs - Survey instruments, their care and adjustment - traversing, trilateration and triangulation - conventional, electronic (total station) - Aerial and Satellite based survey techniques (Photogrammetry, RADAR, LiDAR) - Survey by GPS. .	4

4	**GEODATA VISUALIZATION AND ANALYSIS**		**10**
	1	Two – three – fourth dimension viewing – viewing by animation - Visualization by hyper map - virtual images – web GIS..	3
	2	Spatial database: Survey of India – NRSC - BHUVAN - NATMO – Geological Survey of India - Census of India –National Informatics Centre - Cadastral maps – open street map – foreign sources of data.	2
	3	Attribute database: Census of India- statistical – National Informatics Centre.	2
	4	Application of Geoinformatics: Rural Development, Geosciences, Agriculture, Forestry, Soil Studies, Meteorology, Environmental studies, and Civil Engineering.	3

5	**Teacher Specific Module**	**5**
	Directions: Familiarize with the advanced concepts, principles, and terminology of remote sensing and GIS. Gain knowledge of technology and applications of remote sensing and geoinformatics. Understand the applications of remote sensing and geoinformatics for geo-environmental studies .	

	Advanced applications of remote sensing and geoinformatics.	
6	**Practical**	
	Aerial Photography: Simple calculations based on aerial photos—photo scale, estimation of total number of photos required to cover a given area and determination of heights of objects. Interpretation of aerial photos with special reference to topography, drainage, structure and geology using Pocket Stereoscope and Mirror Stereoscope. Interpretation of satellite imageries: Identification and mapping of drainage patterns, lineaments, litho contacts, geological structures and preparation of geological maps. Identification of land use patterns and environmental features. Land use/cover classification.	30

Essential Readings:

1. Remote Sensing and Image interpretation: Thomas Lille sand & R.W. Keifer, John Wiley and Sons (3rd Ed.).
2. Text Book of Remote Sensing & Cartography Kalyani Publication, D. Nandi, T.Chattrejee.
3. Remote Sensing: Principles and Interpretation: F. Sabins, Freeman Publication.
4. Remote Sensing of the Environment by J.R. Jensen, Pearson Publication
5. Lidar: Range-Resolved Optical Remote Sensing of the Atmosphere, edited by Claus Weitkamp.
6. Manual of Airborne Topographic Lidar by Michael S. Renslow.
7. Lidar T echniques and Remote Sensing in the Atmosphere: Understanding the Use of Laser Light in the Atmosphere by Francis Emmanuel Mensah.
8. Peter A. Burrough and Rachael A. Mc. Donnell, Principles of Geographical Information System, Oxford University Press Inc., New York, 2004.
9. Ian Heywood, Sarah Cornelivs and Steve Carver, An Introduction to Geographical Information System, Pearson Education Pvt .Ltd., New Delhi, 2007.
10. Arthur H. Robinson et al. Elements of Cartography, V Edition, John Wiley & Sons, New Delhi, 2002.
11. Misra, R.P.and Ramesh, A, Fundamentals of Cartography, Concept Publishing Company, New Delhi, 2002.
12. Lillesand M. Thomas and Ralph W. Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons, New York, 2007.
13. LO. C.P., and Albert K. W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall of India, New Delhi, 2006.

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1,2,3,4,12
	2	1,2,3,4,12
	3	3,4,12
	4	5,6,7
2	1	3,4,12
	2	1,2,3,4
	3	1,2,3,4,12
	4	1,2,3,4,12
3	1	8,9,13
	2	10,11
	3	1,2,3,4,12
	4	8,9,10,11,13
4	1	8,9,10,11,13
	2	8,9,10,11,13
	3	8,9,10,11,13
	4	8,9,10,13

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10

c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

SEMESTER 8

DISCIPLINE SPECIFIC COURSES

KU8DSCGEL401 – APPLIED STRUCTURAL GEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	Major	400-499	KU8DSCGEL401	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	Theory		Practical		Theory	
			CCA	ESE	CCA	ESE		
3	2	--	25	50	10	15	100	2 hours

Course Description: *Students will learn to analyze geological structures, interpret geological maps, and apply advanced techniques in structural analysis*.

Course Prerequisite: The learner must have completed the basic courses in 300 – 399 level in B Sc Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To analyze and interpret the behavior of rocks and minerals under various deformation conditions, applying concepts such as elastic, plastic, and viscous deformation.	*An*
2	To develop proficiency in using analytical techniques such as the Mohr circle for stress analysis and various methods for strain analysis.	*U*

3	Understands classification and genesis of various fold types, able to identify and analyze superposed folds and interference patterns, as well as apply concepts like Pumpelley's rule to determine major fold structures using minor/drag folds.	*U,An*
4	Understanding of the genetic classification of faults and mechanisms of faulting.	*U*
5	To classify and interpret various structural features, analyze their formation processes, and use these structures to deduce tectonic histories.	*U,A*
6	Develops proficiency in structural and fabric analysis techniques, including the use of stereographic and equal area projection.	*U,A*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓	✓				
CO 2		✓				✓	
CO 3		✓					✓
CO 4	✓						
CO 5		✓			✓		
CO 6		✓		✓			

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**ROCK DEFORMATION**		**10**
	1	Rock Deformation: Basic concept of rheology.	3
	2	Concept of Stress and Strain. Stress-strain relationship of Elastic, Plastic and viscous materials.	3

	3	Stress-strain ellipsoid. Mohr circle. Various states of stress and their representation by Mohr circles.	2
	4	Techniques of strain analysis. Determination of paleo stress. Behaviour of minerals and rocks and minerals under deformation conditions. Deformation in single crystals.	2

2	**FOLD AND FAULT**		**10**
	1	Folds: Classification of folds based on genesis and style. Cylindroidal, non-cylindroidal and conical folds.	3
	2	Superposed folds and interference patterns. Minor/Drag folds and their use in determining the major fold structures- Pumpelley's rule.	2
	3	Fold classification by Donath and Parker, Mechanics of folding. Fault-related folding.	3
	4	Faults: genetic classification—causes and mechanism of faulting.	2

3	**FRACTURES, TECTONITES AND SHEAR ZONES**		**10**
	1	Fractures: terminology and classification—tension fractures, shear fractures. Fracture termination and interaction. Deformation bands and fractures in porous rocks	3
	2	Tectonites: Classification, tectonic fabric. Foliation: classification and origin-geometric relationship of cleavage to folding. Foliation as an aid in determining major structures.	3
	3	Lineation: types, significance in interpretation of tectonic history. Mechanics of development of boudins, foliations and lineations.	2
	4	Shear zones: Characteristics and types-brittle, ductile and brittle-ductile shear zones. Shear-sense indicators and shear fabrics. Shear zone rocks - Mylonites and fragmental rocks produced by shearing.	2

4	**STRUCTURAL ANALYSIS**		**10**
	1	Concept of Structural analysis: principles—structural co-ordinates of Sander.	3
	2	Fundamentals of Kinematic, dynamic and geometric analysis; geometric analysis of folds and lineation.	3
	3	Stereographic and Equal area projections. Pie and Beta diagrams. Rock fabrics: Microfabric and Petro fabric analysis. Symmetry concept in fabric analysis.	2
	4	Petro fabric diagrams. Universal stage and fabric analysis.	2

5	**Teacher specific module**	**Hours**
	Instructions; Orientation of structures. Graphical representation of orientation data: Histograms, Rose diagrams, spherical projections. Top and bottom criteria. Structural geology in hydrocarbon exploration and mining.	**5**
6	**Practical**	
	Interpretation of complex geological maps - 20 Nos. Trigonometric, graphical, and stereographic solutions to problems in structural geology. Fabric diagrams, Rose diagrams and Histograms. Geometric analysis of planar and linear structures. Interpretation of topography, structures, metamorphism, lithology, and geological history of maps of typical Precambrian terrains (5 examples).	30

Essential Readings:

1.Davis, G.H., 1984, Structural Geology of Rocks and Regions, John Wiley & Sons.

2.De Sitter, Structural Geology, II edn., McGraw Hill Co.

3. Hirth J. P. and Lothe J. (1982) Deformation and Fracture of Single Crystals, Wiley-Interscience,280p.
4. Twiss, R. J., & Moores, E. M. (2007). Structural Geology, W. H. Freeman and Company, 736 p
5. Hobbs, B.E., Means, W.D. & William, P.F., 1976, An Outline of Structural Geology, John Wiley.
6. Philips, F.C., 1960, Stereographic Projection in Structural Geology. 2nd edn., Arnold.
7. Ragan, D.M., 1969, Structural Geology, I edn., Wiley.
8. Ramsay, J. G., & Huber, M. I. (1987). "The Techniques of Modern Structural Geology, Volume 2: Folds and Fractures,
9. Turner, F.J. & Weiss, L.E., 1963, Structural Analysis of Metamorphic Tectonites, I edn., McGraw
10. Passchier, C. W., & Trouw, R. A. J. (2005). Microtectonics, , springer, 366p.
11. Whitten, E.H.T., 1969, Structural Geology of Folded rocks, 2nd edn., Rand McNelly.
12. Fossen, H. (2016). Structural Geology, Cambridge University Press, 528 p

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1,4,12
	2	1,2,5
	3	7,12
	4	3,12
2	1	1,8,11,12
	2	1,8,12
	3	1,8,12
	4	4,5,12
3	1	4,12
	2	4,12
	3	4,12
	4	4,12
4	1	8,9
	2	12
	3	6,10
	4	10

Suggested Readings:

1. Finkel, E.W. Jr.(Edr.), The Encyclopedia of Earth Sciences, Vol. XIII.
2. Hills, E.S., 1965, Elements of Structural Geology. I edn., Asia Publishing House.
3. Garg, S.K., 1999, Physical and Engineering Geology, Khanna Publishers, New Delhi.

4. Spencer E.P., 1969, Introduction to the Structure of the Earth, I edn, McGraw Hill.
5. Hill. Valdiya, K.S., Aspects of Tectonics, McGraw Hill, New Delhi.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50
b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU8DSCGEL402– CLIMATOLOGY AND QUARTERNARY GEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	Major	400-499	**KU8DSCGEL402**	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	-	--	30	70	100	2 hours

Course Description: *The course provides an overview of the physical processes responsible for determining global and regional climate, including radiative energy transfer, the atmospheric and surface energy balances, and the general atmospheric circulation. The course also deals with the components of the climatic system, precipitation and condensation mechanisms, climate change and its causes, and climate classification. The course also provides a comprehensive understanding of the climate and geological events during the Quaternary period (last 2.6 million years). The course provides an advanced understanding of the causes and consequences of long and short climatic changes during the Quaternary Period. The students will be exposed to different methods, proxies and archives for reconstructing Quaternary climate change*.

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Course Prerequisite: The learner must have completed the basic courses in 300 – 399 level in B.Sc. Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the Earth's atmosphere characteristics and the role of each atmosphere layer.	*R & U*
2	Analyse general atmospheric circulation, the relevant theories and how the ocean and atmospheric circulation patterns redistribute heat and energy across the Earth.	*A & An*
3	Describe and evaluate natural and anthropogenic causes of climate change	*A & E*
4	Understand various archives of Quaternary history.	*R & U*
5	Analyse the causes and mechanisms of Quaternary glacial and interglacial cycles and sea level changes.	*A & An*
6	Critically evaluate the advantages and disadvantages of different proxies and their usefulness in reconstructing Quaternary paleoclimate.	*E*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				

CO 2		✓		✓	✓		
CO 3					✓	✓	✓
CO 4	✓		✓				
CO 5	✓				✓	✓	
CO 6		✓				✓	✓

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**FUNDAMENTAL PRINCIPLES OF CLIMATOLOGY**		**14**
	1	Atmosphere- Its composition and structure	3
	2	Radiation laws and Radiation budget of Earth. Greenhouse effect and Global warming.	3
	3	Latitudinal and seasonal variations of insolation, temperature, pressure.	4
	4	Koppen's classification of climate. Causes and impacts of climate change	4

2	**CIRCULATION AND PROCESSES IN THE ATMOSPHERE**		**15**
	1	Factors affecting wind motion- Coriolis Effect and geostrophic winds. General circulation of the atmosphere: Hadley, Ferrel and Polar cells.	3
	2	Primary circulation- tropical easterlies, westerlies, polar easterlies, jet streams.	5
	3	Secondary circulation- monsoons and tropical cyclones Tertiary circulation system- periodic and non-periodic local winds	4

	4	Cloud classification. Precipitation mechanisms: Bergeron process, coalescence process. Types of precipitation, artificial precipitation.	3

3	**QUATERNARY GLACIATIONS AND RECORDS**		**14**
	1	Definition of Quaternary; concept and importance of Quaternary, Quaternary chronostratigraphic unit, standard sub-divisions of the Quaternary Period and their climatic significance.	4
	2	Quaternary Glaciations – causes, the pattern of glacial-interglacial cycles and associated eustatic changes	4
	3	Milankovitch orbital cycles. Ice core records of glaciations during the Pleistocene and Holocene	4
	4	Quaternary Stratigraphy of India– continental (fluvial, glacial, aeolian, palaeosols and duricrust) and marine records. Pleistocene faunal extinctions.	2

4	**TECHNIQUES FOR QUATERNARY STUDIES**		**12**
	1	Marine isotope stages in the Quaternary, biostratigraphy and magneto-stratigraphy	2
	2	Various Archives of Quaternary history: tree rings (dendrochronology), corals, speleothems (cave deposits), peat deposits. ice cores, lake sediments, marine sediments, glaciers, fluvial deposits.	4
	3	The 'proxy indicators' for the reconstruction of Quaternary environments--geological, geochemical (major and trace elements), biological (microfossils, pollen), sedimentological, isotopic (oxygen, carbon and nitrogen isotopes) and magnetic proxies.	4
	4	Quaternary dating methods – Radiocarbon dating, Fission track and thermoluminescence dating methods.	2

5	**Teacher Specific Module**	**Hours**

	Directions: Learners have an understanding of high and low frequency climatic variability	**5**
	North Atlantic oscillation (NAO), Indian Ocean Dipole (IOD), El Niño–Southern Oscillation (ENSO) Pacific decadal oscillation (PDO),	5

Essential Readings:

1 Critchfield, H. J. (2009) General climatology, PHI Learning, New Delhi.
2. Lal, D. S. (2011). Climatology, Sharda Pustak Bhavan.
3. Savindra Singh (2005). Climatology, Prayag Pustak Bhavan.
4. Siddhartha, K. (2016). Climatology-Atmosphere, weather and climate. Kitab Mahal, New Delhi.
5. Bradley, R. S. (1999): Paleoclimatology – Reconstructing Climates of the Quaternary, Elsevier, 613p.
6. Dawson A.G., (1992): Ice Age Earth: Late Quaternary Geology and Climate (Physical Environment), Routledge, 293p.
7. Lowe, J.J. and Walker, M. (1997). Reconstructing Quaternary Environments. Prentice Hall; 2nd edition.

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1,2
	2	2,3
	3	3,4
	4	2,3
2	1	1,2,3
	2	2,3,4
	3	2,3,4
	4	2,3,4
3	1	6
	2	5
	3	6,7
	4	6,7

4	1	5, 7
	2	5, 7
	3	5, 7
	4	5, 7

Suggested Readings:

1. Burroughs, W.J. (2001) Climate change, A multidisciplinary Approach, Cambridge University Press.

2. Sirocko, F., Claussen, M., Goni, M.F.S. and Litt, T. (Eds., (2008): The Climate of Past Interglacials, Elsevier, 638p.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

KU8DSCGEL403 – APPLIED HYDROGEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	Major	400-499	KU8DSCGEL403	4	75

Learning Approach (Hours/ Week)			Marks Distribution					Duration of ESE (Hours)
			Theory		Practical			
Lecture	Practical/ Internship	Tutorial	CCA	ESE	CCA	ESE	Total	
3	2	--	25	50	10	15	100	2 hours

Course Description:
This course that explores the principles and practices of hydrogeology with an emphasis on practical applications. This course aims to provide students with a deep understanding of the physical, chemical, and biological processes that govern the movement and quality of groundwater.
Course Prerequisite: The learner must have completed the basic courses in 300 – 399 level in B Sc Geology programme.
Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand and apply the fundamental principles of hydrogeology.	*U,A*
2	Characterize aquifer properties using various field and laboratory methods.	*U,A*
3	Analyze groundwater quality and propose appropriate remediation strategies.	*U*
4	Apply field methods and techniques for groundwater investigation.	*A*
5	Develop the skills to design water wells by evaluating grain size distribution and selecting appropriate screens and casings.	*A,E*
6	Identify and explain different types of wells and drilling methods	*U*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓	✓		✓			
CO 2		✓					✓
CO 3	✓				✓		
CO 4	✓	✓					
CO 5		✓					✓
CO 6		✓				✓	

COURSE CONTENTS

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**GROUNDWATER FLOW AND COASTAL AQUIFERS**		**10**
	1	Movement of ground water: forces causing ground water movements, fluid potentials, water table, piezometric surface.	3
	2	Theory of ground water flow: Darcy's law and its experimental verification--Range of validity of Darcy's law.	2
	3	Differential equation governing groundwater flow. Hydrogeological boundaries. Flow nets. Application of isotope studies and tracer techniques in ground water flow.	3
	4	Coastal aquifers and saline water intrusion—Ghyben-herzberg equation and its uses—slope, shape and movement of interface. Identification of saline zones and interfaces. Prevention and control of saline water intrusion	2

2	**GROUND WATER EXPLORATION & WELL LOGGING**		**10**
	1	Geological methods—lithological and structural mapping, fracture trace analysis. Hydrogeological methods—lithological classification with respect of hydrological properties.	3
	2	Geophysical methods: Electrical Resistivity methods—Wenner and Schlumberger methods. Seismic Refraction methods.	3

	3	Well logging: Spontaneous Potential Logging, Radiation logging, Gamma-gamma ray logging.	2
	4	Use of Aerial photos and satellite imageries in ground water prospecting.	2

3	**WELL HYDRAULICS**		**10**
	1	Aquifer tests, Pumping tests data analysis and recovery test.	3
	2	Drawdown, Steady Radial flow into a well in confined and unconfined aquifers –Theim's equation, Dupuit-Forhemeir equation.	3
	3	Unsteady Radial flow into wells—Theis, Chow's and Jacob's methods.	2
	4	Ground water recharge: natural and artificial recharges. Hydraulic budget.	2

4	**WATER WELL DESIGN, GROUNDWATER QUALITY**		**10**
	1	Well design: Types of wells, drilling methods: Cable-tool drilling, Hydraulic Rotary, Reverse Rotary and Down the Hole Hammer drilling.	3
	2	Water Well Design Criteria: Grain size distribution, screens and casings. Maintenance of production wells—Production well specifications and tests.	2
	3	Quality of ground water: Physical, chemical and bacterial measures of water quality. The general occurrence of various constituents in ground water. Quality of ground water standard for domestic, irrigation and industrial uses.	2
	4	Graphical representation of groundwater quality data--Collin's, Piper trilinear, Vector, Circular diagrams and Stiff's polygon.	3

5	**Teacher specific module**	**Hours**
	Directions: The study has to cover topics such as groundwater development and management, water conservation methods including rainwater harvesting, the National Water Policy, groundwater provinces of India, groundwater conditions of Kerala, and more.	**5**

	Practical	Hours
6	Solution of problems based on Darcy's Law. Preparation and interpretation of water table contour maps. Computation of aquifer parameters from pumping data. Collection of well inventory data. Graphical representation of hydro chemical data:- Piper Trilinear diagram, Vector diagram, Circular diagrams, Stiff's polygon. Calculation of various parameters based on chemical data. Electrical resistivity survey and interpretation of data. Determination of pH of ground water samples -- 10 Nos.	30

Essential Readings:

1. Todd, D.K., and Larry W. Mays (2005). John Wiley & Sons, New Jersey, 636p

2. Todd, D.K., (2006), Groundwater Hydrology, II edn., John Wiley & Sons.

3. Fetter, C.W. ,(2018), Applied Hydrogeology, (4th Edition), Waveland Press,691p

4. Kevin M. Hiscock and Victor F. Bense (2014) Hydrogeology: Principles and Practice (2nd Edition), Wiley-Blackwell, UK,552p

5. Patrick A. Domenico and Franklin W. Schwartz (1998). Physical and Chemical Hydrogeology, Wiley, New York,528p

6. Franklin W. Schwartz and Hubao Zhang 2003 Fundamentals of Groundwater; Wiley, New Jersey, USA,592p

7. Willis D. Weight (2008), Hydrogeology: Field Data Collection, Data Analysis, and Case Histories, McGraw-Hill Education, USA,751p.

8. Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman (2015), Remote Sensing and Image Interpretation, Wiley, New Jersey, USA, 779p

9. Yang Hong, Jonathan J. Gourley (2018) Remote Sensing and GIS for Hydrology and Water Resources, CRC Press, USA,367p.

10. G. P. Kruseman, N. A. de Ridder (1994). Analysis and Evaluation of Pumping Test Data, International Institute for Land Reclamation and Improvement (ILRI), Netherlands, 377p.

11. K.R. Rushton (2003).Groundwater Recharge: Principles and Methodologies, CRC press, 416p.

12. Fletcher G. Driscoll (1986). Groundwater and Wells. Johnson Screens, 1089p.

13. Raghunath, H.M.,(2003), Groundwater, III edn., New Age International Ltd.Wiley Eastern.

14. Karanth, K.R., (1986), Groundwater and Wells, Science Pub., Jodhpur.

Reference Distribution:

Module	Unit	Reference No.
1	1	1,3
	2	2,3
	3	4,5
	4	2,3,4
2	1	3,4
	2	6,7
	3	2,3
	4	8’9
3	1	2,3,10
	2	2,3,10
	3	2,3,10
	4	3,11
4	1	2,12,13
	2	2,12,13
	3	1,14
	4	2

Suggested Readings:

1. Davies, S.N. & Dewiest, (1969), Hydrogeology, John Wiley & Sons Inc

2. Walton, W.C., 1970, Groundwater Resource Evaluation, McGraw Hill Inc

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**65**
a)	Theory test paper	50

b)	Practical test paper	15
Continuous Evaluation (Theory)		**25**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	05
Continuous Evaluation (Practical)		**10**
a)	Test paper/Practical test	05
c)	Lab involvement/ Laboratory (report) or any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	05
	Total	**100**

KU8DSCGEL404 – RESEARCH METHODOLOGY IN GEOSCINCE

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	Major	400-499	**KU8DSCGEL404**	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	-	--	30	70	100	2 hours

Course Description:

This course, "Research Methodology in Earth Science," provides a comprehensive introduction to the principles and practices of scientific research in Earth Science. Covering essential topics such as research design, data collection, statistical analysis, and scientific communication, students will develop the skills necessary to conduct independent research. The course includes hands-on experience with fieldwork, laboratory techniques, GIS, and remote sensing, preparing students for careers in academia, industry, and environmental management.

Course Prerequisite:

The learner must have completed the courses B Sc Geology programme of 300 – 399 level.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Students will demonstrate a thorough understanding of the fundamental principles of research methodology, including the formulation of research questions, design of research projects, and ethical considerations in Earth Science research.	***U***
2	Students will acquire and apply a variety of data collection methods specific to Earth Science, including fieldwork, laboratory analysis, remote sensing, and GIS, ensuring accurate and reliable data for research purposes.	***A***
3	Students will develop skills in analysing and interpreting complex data sets using statistical methods, geospatial analysis, and modelling techniques, enabling them to draw meaningful conclusions and make informed decisions based on their research.	***An***
4	Students will enhance their ability to communicate research findings effectively through scientific writing and presentations, mastering the structure of research papers, poster presentations, and the use of visual aids.	***E***
5	Students will apply their research skills to address real-world challenges in Earth Science, such as environmental management and industry-specific applications, demonstrating the practical relevance and impact of their research.	***C***

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓	✓			✓
CO 2		✓	✓	✓		✓	✓
CO 3	✓	✓	✓	✓		✓	

CO 4					✓		✓
CO 5	✓	✓	✓	✓		✓	✓

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	Hours
1	**INTRODUCTION TO RESEARCH METHODOLOGY**		**12**
	1	Fundamentals of Research - Definition and objectives of research. Types of research: basic vs. applied, qualitative vs. quantitative. Ethical considerations in research.	3
	2	Research Design and Planning - Formulating research questions and hypotheses. Literature review: purpose, process, and sources. Research proposal components and preparation.	3
	3	Introduction to Earth Science Research - Overview of major research areas in Earth Science (geology, meteorology, oceanography, environmental science etc..).	3
	4	Key challenges and current trends in Earth Science research	3

2	**DATA COLLECTION**		**12**
	1	Fieldwork Techniques in Earth Science. Sampling methods: random, systematic, stratified. Field surveys: geological, hydrological, environmental etc. Use of GPS and remote sensing in data collection.	2
	2	Laboratory Techniques - Geochemical analysis: rock, soil, and water samples. Petrological and mineralogical analysis. Sedimentological analysis.	4

	3	Remote Sensing and GIS - Basics of remote sensing: platforms and sensors. Image processing and interpretation. Geographic Information Systems (GIS): data integration and spatial analysis.	4
	4	Instrumentation and Measurement Techniques - Geophysical instruments and their applications (seismometers, magnetometers, resistivity meter.). Logging.	2

3	**DATA ANALYSIS AND INTERPRETATION**		**13**
	1	Statistical Methods in Earth Science - Descriptive and inferential statistics. - Statistical software applications – SPSS and R. Data visualization techniques.	3
	2	Geospatial Data Analysis - Spatial data types and structures. Spatial analysis techniques: interpolation, kriging, spatial autocorrelation.	3
	3	Modelling in Earth Science - Conceptual and numerical models. Model calibration and validation.	4
	4	Advanced Data Analysis Techniques - Multivariate analysis. Time series analysis. Machine learning applications in Earth Science.	3

4	**RESEARCH COMMUNICATION AND APPLICATION**		**13**
	1	Scientific Writing and Publishing - Structure of a research paper: abstract, introduction, methodology, results, discussion, conclusion. Writing for journals and conference presentations. Peer review process.	3
	2	Presenting Research - Designing effective posters and presentations. Public speaking skills. Use of visual aids and technology.	3
	3	Application of Research in Earth Science. - Case studies in environmental management and policy. Industry applications: mining, oil and gas, environmental consulting. Future trends in Earth Science research.	4
	4	Research Project Presentations and Review - Students present their research proposals or projects. Peer feedback and discussion. Course review and final reflections.	3

5	**Teacher Specific Module**	**Hours**
	Directions: Students are encouraged to write review on research papers, They can participate in seminars, conferences etc..	5
	Space to fill the selected area/ activity	

Essential Readings:

1. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches Creswell, J.W. (2014). Sage Publications.*
2. *Research Methodology: A Step-by-Step Guide for Beginners.Kumar, R. (2019). Sage Publications.*
3. *Basic Research Opportunities in Earth Science. NRC (2001). The National Academies Press.*
4. *Fundamentals of Geographic Information Systems. Demers, M.N. (2017). Wiley.*
5. *Chemical Fundamentals of Geology and Environmental Geoscience.Gill, R. (2015). Wiley-Blackwell.*
6. *Introductory Digital Image Processing: A Remote Sensing Perspective.J.R. (2016). Pearson.*
7. *Fundamentals of Geophysics.Lowrie, W. (2007). Cambridge University Press.*
8. *Statistics and Data Analysis in Geology.Davis, J.C. (2002). Wiley.*
9. *Principles of Geographical Information Systems.Burrough, P.A., & McDonnell, R.A. (2015). Oxford University Press.*
10. *Machine Learning in Geosciences., Lary, D.J. (2018). Springer.*
11. *Day, R.A., & Gastel, B. (2011). How to Write and Publish a Scientific Paper. Cambridge University Press.*
12. *Alley, M. (2013). The Craft of Scientific Presentations: Critical Steps to Succeed and Critical Errors to Avoid. Springer.*

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1
	2	1,2
	3	2,3
	4	3

2	1	4
	2	5
	3	6
	4	7
3	1	8
	2	8, 9
	3	8, 9
	4	10
4	1	11
	2	11,12
	3	12
	4	12

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

KU8DSCGEL405 – GEOEXPLORATION

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	Major/ Minor	400-499	**KU8DSCGEL405**	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	-	--	30	70	100	2 hours

Course Description:

This course offers a comprehensive understanding of various exploration techniques. It covers the fundamentals of ore reserve classification and various sampling methods. It also includes theoretical understanding of geological, geochemical and geophysical exploration techniques. Through this course students can acquire information about various logging, drilling and surveying techniques related to mineral exploration.

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Course Prerequisite: The learner must have completed the basic courses in 300 – 399 level in B Sc Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamentals of mineral exploration and reserve classification	*R,U*
2	Understand various sampling and drilling methods. Apply the chemical properties of geological materials in exploration	*U,Ap*
3	Understand and analyse the gravity, magnetic and seismic characteristics of rocks and minerals in exploration	U, An

4	Apply and Analyse the electrical properties of minerals and rocks in the ore mineral exploration. Understand the fundamentals of radiometric survey and bore hole logging	*U, A, An*

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1		✓					
CO 2						✓	
CO 3		✓					
CO 4			✓				

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**Geological Exploration and ore reserve classification**		**14**
	1	Guides to Mineral Prospecting—Prospecting and Exploration—geological exploration. Exploratory grids, location and documentation.	4
	2	Exploratory workings: Pitting, Trenching, underground workings and boreholes—delineation of ore deposit based on exploration data.	4
	3	Exploration programme – Objectives, economic factors and gestation period in Reconnaissance and Detailed exploration. Regional exploration programme.	3
	4	Reserve estimation . Ore body modelling. Grade, tonnage, cut off grade and reserve classification. UNFC – Sampling and ore reserve calculation, plan methods and cross-section methods.	4

2	**Geochemical Exploration**		**15**
	1	Sampling techniques and evaluation of grade: Types of sampling methods--Rock sampling, soil sampling, water sampling , vegetation sampling and vapour sampling. Drilling: Design of a drilling programme--drilling methods—Percussion, Rotary and miscellaneous--Vertical and inclined drill holes--Logging of boreholes--Borehole Deviations.	4
	2	Geochemical Exploration techniques: Geochemical mobility of elements—factors controlling mobility of elements in the surficial environments. Gossans--Threshold values and geochemical anomalies. Primary dispersion pattern of deepseated ores. Diffusion and leakage anomalies.	4
	3	Geochemical Rock surveys. Geochemical Soil surveys: Hydromorphic anomalies in residual soils and transported overburden. Geochemical Drainage surveys. Anomalies in ground and surface waters.	3
	4	Uptake of mineral matters by plants—Bio-geochemical surveys and techniques—Geobotanical methods of mineral prospecting—Accumulator and Indicator plants—universal and local indicators.	4

3	**Gravity, Magnetic and Seismic Surveys**		**14**
	1	Geophysical prospecting: Gravity survey – principles. Bouguer anomaly, latitude, elevation and terrain corrections, survey methods, interpretation of gravity curves of bodies of different shapes.	*4*
	2	Magnetic survey – principles and earth's magnetic fields, survey methods, interpretation and applications.	*3*
	3	Seismic surveys – methods of generation, propagation and sensing of seismic waves, wave types, travel time graphs from different media and interfaces. Seismic velocities in geological materials.	*4*
	4	Seismic survey source, recorders, reflection and refraction surveys and interpretation of profiles.	*3*

4	**Electrical Surveys and Logging**		**12**
	1	Electrical surveys: electrical properties of rocks, theory of current flow in different media. Resistivity survey, application and interpretation of data.	*4*
	2	Self potential survey, application and interpretation of data. Induced polarization, application and interpretation of profiles.	3
	3	Radiometric survey – theory, survey, methods and interpretation of data.	2
	4	Borehole logging – electrical, radiometric, sonic and thermal logging of the boreholes. Drilling mud – its role and effects on logging.	3

5	**Teacher Specific Module**	**Hours**
	Directions: Advanced developments in geoexploration techniques and exploration in extraterrestrial bodies and planets.	**5**

Essential Readings:

1. Peters W. C. Exploration and mining geology. Wiley.

2. Rose A. W. Hawkes H. E. and Webb J. S. Geochemistry in mineral exploration Academic Press.

3. Arogyaswamy R. N. P. Courses in Mining Geology. Oxford and IBH, New Delhi.

4. Malyuga D. P. Biochemical methods of prospecting. Consultants Bureau N York.

5. Dobrin M. B. Introduction to geophysical prospecting. Pergamon Press.

6. Ginzburg D. H. Principles of geochemical prospecting. Pergamon

7. Ginzburg D. H. and Kind R. F. Applied geophysics for geologists and engineers. Pergamon.

8. Bagchi T. C. Elements of prospecting and exploration. Kalyan Publishers.

9. Reedman J. H. Techniques in Mineral exploration. Allied Scientific.

10. Umathay R. M. Textbook of Mining Geology.

11. Chandra D., Singh R. M. and Singh M. P. Textbook of coal (Indian context) Tara Book Agency,Varanasi, 2000.

12. Boyle R. W. Geochemical prospecting for thorium and uranium deposits. Elsevier.

13.Banerjee P. K. and Ghosh S. Elements of prospecting for non – fuel mineral deposits 1997.

14. Moon, Charles J., Whatley, Michael, K. G. and Evans, Anthony M., (ed.). Introduction to Mineral Exploration. 2 Edn. Blackwell, 2012.

15. Roger W. Marjoribanks. Geological Methods in Mineral Exploration and Mining. Chapman &Hall, 1997.

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1,8
	2	14,15
	3	8,10
	4	13,15
2	1	9,10
	2	4,6
	3	2,3
	4	3,6
3	1	3,7
	2	7,12
	3	8,9
	4	14,15
4	1	9,11
	2	13,14
	3	12,15
	4	3,15

Suggested Readings:

1. Charles J. Moon, Michael K.G. Whateley, and Anthony M. Evans (2006) Introduction to Mineral Exploration, Wiley-Blackwel,496p.

2. Telford, W. M. Geldart L. P., and. Sheriff,. R. E (1990). Applied Geophysics, Cambridge University Press, 792p.

Assessment Rubrics:

Evaluation Type	**Marks**
End Semester Evaluation	**70**
Theory test paper	70

Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

KU8DSCGEL406 – ENGINEERING GEOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	Major/ Minor	400-499	**KU8DSCGEL406**	4	60

Learning Approach (Hours/ Week)			Marks Distribution (Theory)			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CCA	ESE	Total	
4	-	--	30	70	100	2 hours

Course Description: *The course **provides an in-depth understanding of the application of geological principles in engineering practice. It covers the classification and characterization of rocks and soils, geological investigations for site selection, and the evaluation of geological hazards such as earthquakes and landslides. The course delves into rock mechanics, soil mechanics, and the design and analysis of foundations, dams, tunnels, and other infrastructure projects***

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Course Prerequisite: The learner must have completed the basic courses in 300 – 399 level in B Sc Geology programme.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Learn to evaluate the durability, strength, and other engineering properties of building stones, aiding in the selection of appropriate materials for construction projects.	*R, E*
2	Students will develop the ability to assess and classify rock bodies using various standardized systems enabling them to make informed decisions regarding the stability, support requirements, and overall feasibility of engineering projects.	*U*
3	To evaluate and address geological factors such as topography, structure, and lithology in the planning, design, and maintenance of critical infrastructure projects, including dams, reservoirs, tunnels, bridges, and highways.	*U, E*
4	Develop the capability to identify and mitigate potential geotechnical issues such as foundation and seepage problems in dams, seepage and silting in reservoirs, and stability concerns in bridge sites and road construction.	*U*
5	Understands the causes and factors for earthquakes and landslides, along with the knowledge to implement corrective and preventive measures, enhancing the flexibility and safety of civil engineering structures.	
6	Develop the skills to conduct seismic hazard and risk assessments and apply foundation treatment techniques such as grouting, rock bolting, and other support mechanisms, ensuring the stability and integrity of infrastructures in geologically active areas.	

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

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	✓		✓				
CO 2	✓	✓				✓	
CO 3	✓		✓			✓	
CO 4		✓	✓	✓		✓	
CO 5	✓			✓		✓	✓
CO 6		✓		✓		✓	

COURSE CONTENTS

MODULE	UNIT	DESCRIPTION	HOURS
1	**ROCK MECHANICS**		**14**
	1	Role of Geology in Civil Engineering.	2
	2	Elementary concepts of rock mechanics - Strength and Elastic properties.	4
	3	Engineering properties and characteristics of soils.	4
	4	Properties of building stones.	4

2	**EVALUATION SYSTEMS IN ENGINEERING GEOLOGY**		**14**
	1	Concept, Mechanism and Significance of Rock Quality Designation (RQD)	3
	2	Concept, Mechanism and Significance of Rock Structure Rating (RSR)	3
	3	Concept, Mechanism and Significance of Rock Mass Rating (RMR)	4

	4	Concept, Mechanism and Significance of Tunnelling Quality Index (Q).	4

3	**GEOLOGICAL CONSIDERATIONS FOR INFRASTRUCTURE DEVELOPMENT**		**15**
	1	Dams and reservoirs: Dams: Types of Dams. Geological considerations- topography, structure and lithology. Foundation and seepage problems in dams and their treatment. Reservoir: Reservoir problems- seepage and silting.	4
	2	Tunnels: terminology, definition, types- hard rock and soft rock tunnels. Geological considerations- topography, structure and lithology	4
	3	Bridge sites: Terminology, Bridge structure, types, bridge problems, and stability of bridges. Geology of bridge sites.	4
	4	Geological considerations in road and highway construction.	3

4	**MITIGATION OF NATURAL HAZARDS**		**12**
	1	Earthquakes: Causes, Factors and corrective/Preventive measures.	3
	2	Seismic hazards and risk assessment	3
	3	Landslides: Causes, Factors and corrective/Preventive measures	3
	4	Foundation treatment; Grouting, Rock Bolting and other support mechanisms.	3

5	**Teacher Specific Module**	**Hours**
	Directions: Geotechnical Instrumentation and Monitoring, Types of geotechnical instruments, Installation and maintenance of monitoring systems, Waste disposal and management, Remediation techniques for contaminated sites, Rock slope stability analysis, Design and support of rock slopes	**5**

Essential Readings:

1.Krynin, D.P. and Judd W.R. 1957. Principles of Engineering Geology and Geotechnique, McGraw Hill (CBS Publ).
2.Johnson, R.B. and De Graf, J.V. 1988. Principles of Engineering Geology, John Wiley.
3.Goodman, R.E., 1993. Engineering Geology: Rock in Engineering constructions. John Wiley & Sons, N.Y.
4.Waltham, T., 2009. Foundations of Engineering Geology (3rd Edn.) Taylor & Francis.
5.Bell: F.G-, 2006. Basic Environmental and Engineering Geology Whittles Publishing.
6.Bell, .F.G, 2007. Engineering Geology, Butterworth-Heineman
7. Robert E. Goodman (1989). Introduction to Rock Mechanics, Wiley, 562p.
8. John A. Franklin and Maurice B. Dusseault (2010). Rock Engineering, McGraw-Hill: 672p.
9. Bieniawski, Z.T. (1989). Engineering Rock Mass Classifications: A Complete Manual for Engineers and Geologists in Mining, Civil, and Petroleum Engineering, Wiley, 272p.
10. Nick Barton, R. Lien, and J. Lunde (1974). Engineering Classification of Rock Masses for the Design of Tunnel Support (paper), Norwegian Geotechnical Institute (NGI),

Reference Distribution:

Module	Unit	Reference No.
1	1	1,2
	2	2,6,7
	3	1,2
	4	3
2	1	7
	2	8
	3	9
	4	10
3	1	1,2,4,5
	2	1,2,4,5

	3	1,2,4,5
	4	1,2,4,5
4	1	1,2,4,5
	2	1,2,6
	3	1,2,6
	4	1,2,6

Suggested Readings:

1. Parbin Singh, Engineering and General Geology, Katson Pub. House, Ludhiana, India.

2. Kesavulu, N.C., 1993, A Text Book of Engineering Geology, Macmillan India Ltd., New Delhi.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Theory test paper		70
Continuous Evaluation (Theory)		**30**
a)	Written test	10
b)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator	10
c)	Any one method or combinations of methods suggested in KUFYUGP regulations as decided by the course coordinator **based on open ended module**	10
	Total	**100**

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