Regulations, Scheme of Evaluation, and Syllabus for

M.Sc. Integrated Programme

in

Geology (Core)

with

Chemistry and Physics (as allied core)

(2021 Admission onwards)

Under

Calicut University Regulations for

Choice Based Credit Semester System

Modified and updated by

Christ College Autonomous,

Irinjalakuda, Thrissur

For Postgraduate (Integrated 5 years programme) Curriculum 2021

(CC CUCBCSS INT-PG - 2021)

CHRIST COLLEGE AUTONOMOUS,

IRINJALAKUDA

Board of Studies in Geology (UG & PG)

January 2021

Christ College Autonomous, Irinjalakuda

Scheme of Postgraduate (M.Sc. Integrated, 5 years) Programme in Geology

Rules, Regulations, and Syllabus

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1. TITLE

These Regulations shall be called 'The University of Calicut Regulations for Integrated Programme under the Choice Based Credit and Semester System (CBCSS) in Affiliated Colleges', 2020.

2. SCOPE, APPLICATION & COMMENCEMENT

The regulations provided herein shall apply to M.Sc. Integrated course in Geology at Christ College Autonomous under Faculty of Science conducted by the Christ College autonomous for the admissions commencing from 2021, with effect from the academic year 2020-2021. Every programme conducted under the Choice Based Credit and Semester System in the College shall be monitored by the College Council.

3. ADMISSION

Registration and admission to the M.Sc. Integrated programme in Geology will be as per the rules and regulations of the University of Calicut. Minimum qualification for the admission is a pass in higher secondary degree (10+2 Science scheme/ equivalent) or qualifications announced by the University from time to time.

The applicants for M.Sc. Integrated Course will be ranked as follows:

Total marks obtained for Part III Optional at the Higher Secondary or equivalent level plus highest marks scored for any one of the subsidiaries among Physics/ Chemistry/Computer Science/Mathematics/Geology/Biology. In the case of a tie, preference shall be given as per the following order:

1) Candidates with Geology as optional subject
2) Marks for Geology
3) Marks for Chemistry
4) Marks for Physics
5) Marks for Mathematics
6) Marks for Computer Science
7) Alphabetical Order of the applicants

(U.O No. G&AIVJ4852/2021/Admn Dated 26-04-2021)

4. PROGRAMME STRUCTURE

Duration of the programme shall be ten semesters distributed in a period of five years. Each semester consists of a minimum of 18 weeks, (16 instructional weeks and two weeks for examination). The odd (1, 3, 5,7,9) semesters shall be from June to October and even (2, 4, 6,8,10) semesters shall be from November to March.

The programme shall include five types of courses, *viz,* Common Courses (Code IA), Core courses (Code IB), Allied Core courses (Code IC), Open Course (Code ID), Elective Courses (Code IE), Project (Code IF), Comprehensive Viva (Code IG), Practical/Lab (IH) and Audit courses (Code II).

- Comprehensive Field work/Study Tour, Mapping Camp, Viva-voce, and Project Work / Dissertation shall be treated as Core Courses.
- Common Courses (6 theory) with 22 credits (14 for common English courses + 8 for common languages other than English)
- Core courses (24 Theory, 11 Practical, 7 Elective theory, and 2 Projects and 2 Field Training and a field mapping camp) with a total credit of 153.
- Allied Core courses with Chemistry as compulsory course (2 theory courses) and 2 theory courses of Physics and 2 practical's with a total of 24 credits.
- Open Course (one from other department) with 3 credits; and
- Altogether, there shall be a total of 202 credits for Common, Core, Complementary, and Open courses.

Ability Enhancement course/Audit course: There shall be one Audit course each in the first four semesters of the Foundation Programme. These courses are not meant for class room study. The foundation Programmes should follow the Audit courses from I to IV semesters as per the CBCSS UG Regulations, University of Calicut. Changes made in the syllabus of the Audit courses by the respective boards will be applicable to Integrated Programmes also. The students can attain only pass (Grade P) for these courses. At the end of each semester there shall be examination conducted by the college from a pool of questions (Question Bank) set by the University. The students can also attain these credits through online courses like SWAYAM, MOOC etc (optional). The list of passed students must be sent to the University from the colleges at least before the fifth semester examination. The list of courses in each semester with credits are given below.

Course	Credit	Semester
Environment Studies	4	1
Disaster Management	4	2
*Human Rights/ Intellectual Property Rights/ Consumer Protection	4	3
*Gender Studies/Gerontology	4	4

*Colleges can opt any one of the courses.

There will be two Audit Courses (Ability Enhancement Course & Professional Competency Course) with 4 credits each in the Advanced Programme. These have to be done one each in the seventh and eighth semesters. The credits will not be counted for evaluating the overall SGPA & CGPA. The colleges shall conduct examination for these courses and have to intimate / upload the results of the same to the University on the stipulated date during the IX Semester. Students have to obtain only minimum pass requirements in the Audit Courses. The details of Audit courses are given below:

Semester	Course Title	Suggested Area	Details
VII	Ability Enhancement Course (AEC)	Internship / Seminar presentation / Publications / Case study analysis / Industrial or Practical Training /Community linkage programme / Book reviews etc.	
VIII	Professional Competency Course (PCC)	To test the skill level of students like testing the application level of different software's such as SPSS/R/ Econometrics/	

		Python/Any software relevant to the programme of study / Translations	

Ability Enhancement Course (AEC) GEL 1A 01

Scheme and Evaluation

1. Preparation of a research proposal. Identification. Detailed methodology. Time frame. National and international status of the research problem. Literature survey report. Evaluation: Relevance - 20%, Novelty - 20% Document - 35%, Presentation / Viva - 25%.

2. Developing e-content for any one module of any course of the student's choice. It might include reading material, questions with answers, glossary, PowerPoint and videos. Evaluation: Classroom presentation - 50% Developed contents - 40% Originality - 10%

3. Synthesis of any one geological problem using research literature. Evaluation: Presentation - 25%, Discussion - 25% Methodology - 25%, Result - 25%

Professional Competency Course (PCC) GEL 2A 02

1. Statistical data analysis and representation of the results using any one software. Evaluation: Four practical tests of 25% marks each.

2. Developing a new methodology / software / App, for problem solving in geological sciences, significant to the societal needs. Evaluation: The software / app by direct testing. Methodology - by discussion among the panel of teachers.

3. Writing a research paper following the guidelines of any standard research journal, using open-source data. Evaluation: Separate review by at least two teachers from the panel.

5. EVALUATION AND GRADING

There shall be University examinations at the end of each semester. 20% of marks are awarded through internal assessment. Mark system is followed instead of direct grading for each question. For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system as per the University guidelines

(a) Distribution of Credits:

Sl. No.	Course		Credits
1.	Common	English	14
2.	Common	Additional Language	8
3.	Core	Geology	153
4.	Allied Core Course I	Chemistry	12
5.	Allied Core Course II	Physics	12
6.	Open Course	One theory course offered by any other department	3

7.	Audit Course (Extra Credits)	One theory course	24
		Total	**226**

(b) Ten-point Indirect Grading System

Indirect grading System based on a 10-point scale is used to evaluate the performance of students. Each course is evaluated by assigning marks with a letter grade (O, A^+, A, B^+, B, C, P, F, I or Ab) to that course by the method of indirect grading. An aggregate of P grade (after external and internal put together) is required in each course for a pass and also for awarding a degree (A minimum of 20% marks in external evaluation is needed for a pass in a course. But no separate pass minimum is needed for internal evaluation). No separate grade/mark for internal and external will be displayed in the grade card; only an aggregate grade will be displayed. Also the aggregate mark of internal and external are not displayed in the grade card.

% of Marks (Both internal & External put together)	Grade	Interpretation	Grade Point Average (G)	Range of Grade points	Class
95 and above	O	Outstanding	10	9.50–10.00	First Class with distinction
85 to below 95	A^+	Excellent	9	8.50–9.49	
75 to below 85	A	Very Good	8	7.50–8.49	
65 to below 75	B^+	Good	7	6.50–7.49	First Class
55 to below 65	B	Satisfactory	6	5.50–6.49	
45 to below 55	C	Average	5	4.50–5.49	Second Class
35 to below 45	P	Pass	4	3.50–4.49	Third Class
Below 35	F	Failure	0	0	Fail
Incomplete	I	Incomplete	0	0	Fail
Absent	Ab	Absent	0	0	Fail

(c) Extra Credits:

The additional credit awarded to a student over and above the minimum credits required in a programme, for achievements in co-curricular activities and social activities conducted outside the regular class hours, as decided by the University. Extra credits will be awarded to students who participate in activities like NCC, NSS and Swatch Bharath. Those students who could not join in any of the above activities have to undergo Calicut University Social Service Programme (CUSSP). For calculating SGPA and/or CGPA, extra credits will not be considered.

(d) Attendance:

A student shall be permitted to appear for the semester examination, only if he/she secures not less than 75% attendance in each semester. Attendance shall be maintained by the Department concerned. Condonation of shortage of attendance to a maximum of 10% in the case of single condonation and 20% in the case of double condonation in a semester shall be granted by University remitting the required fee. Benefits of attendance may be

granted to students who attend the approved activities of the college/university with the prior concurrence of the Head of the institution. Participation in such activities may be treated as presence in lieu of their absence on production of participation/attendance certificate (within two weeks) in curricular/extracurricular activities (maximum 9 days in a semester). Students can avail of condonation of shortage of attendance in a maximum of four semesters during the entire programme (Either four single condonations or one double condonation and two single condonations during the entire programme). If a student fails to get 65% attendance, he/she can move to the next semester only if he/she acquires 50% attendance. In that case, a provisional registration is needed. Such students can appear for supplementary examination for such semesters after the completion of the programme. Less than 50% attendance requires Readmission. Readmission is permitted only once during the entire programme.

(e) Grace Marks:

Grace marks may be awarded to a student for meritorious achievements in co-curricular activities (in Sports/Arts/NSS/NCC/Student Entrepreneurship) carried out besides the regular hours. Such a benefit is applicable and limited to a maximum of 8 courses in an academic year spreading over two semesters. In addition, maximum of 6 marks per semester can be awarded to the students of UG Programmes, for participating in the College Fitness Education Programme (COFE).

(f) Improvement course:

Improvement of a particular semester can be done only once. The student shall avail of the improvement chance in the succeeding year after the successful completion of the semester concerned. The students can improve a maximum of two courses in a particular semester. The internal marks already obtained will be carried forward to determine the new grade/mark in the improvement examination. If the candidate fails to appear for the improvement examination after registration, or if there is no change in the results of the improved examination, the mark/grade obtained in the first appearance will be retained. Improvement and supplementary examinations cannot be done simultaneously.

After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given below. For the successful completion of a semester, a student should pass all courses. However, a student is permitted to move to the next semester irrespective of SGPA obtained.

SGPA of the student in that semester is calculated using the formula:

$$SGPA = \frac{Sum\ of\ the\ credit\ points\ of\ all\ courses\ in\ a\ semester}{Total\ credits\ in\ that\ semester}$$

The Cumulative Grade Point Average (CGPA) of the student is calculated at the end of a programme. The CGPA of a student determines the overall academic level of the student in a programme and is the criterion for ranking the students. CGPA can be calculated by the following formula:

$$CGPA = \frac{Total\ credit\ points\ obtained\ in\ six\ semesters}{Total\ credits\ acquired\ (120)}$$

CGPA determines the broad academic level of the student in a programme and is the index for ranking students (in terms of grade points). An overall letter grade (cumulative

grade) for the entire programme shall be awarded to a student depending on her/his CGPA.

6. COURSE STRUCTURE

Sem	Course Type	Course Code	Course Title	Hrs per week	Credits	Max Marks		
						Internal	**External**	**Total**
I	Theory	GLO1IB01	Earth and Environment	4	3	15	60	75
			Chemistry I	4	4	20	80	100
			English I	5	4	20	80	100
			English II	4	3	15	60	75
			Additional language I	4	4	20	80	100
	Practical	GLO1IH01(P)	Field Geology	2	0	-	-	
			Chemistry Practical	2	0	-	-	-
II	Theory	GLO2IB02	Geomorphology	4	3	15	60	75
			Physics I	4	4	20	80	100
			English III	5	4	20	80	100
			English IV	4	3	15	60	75
			Additional language II	4	4	20	80	100
	Practical	GLO2IH02(P)	Geomorphology	2	0	-	-	
			Physics Practical	2	0	-	-	-
III	Theory	GLO3IB03	Crystallography and Mineralogy	4	3	15	60	75
		A11	Biodiversity - Scope and Relevance	5	4	20	80	100
		A12	Research Methodology	5	4	20	80	100
			Physics II	4	4	20	80	100
	Practical	GLO3IH03(P)	Crystallography	3	0	-	-	-
			Physics Practical	4	4	20	80	100
IV	Theory	GLO4IB04	Optical and Descriptive Mineralogy	4	3	15	60	75
		A13	Intellectual Property Rights	5	4	20	80	100
		A14	Natural Resource Management	5	4	20	80	100
			Chemistry II	4	4	20	80	100
	Practical	GLO4IH04(P)	Crystallography, Mineralogy	3	3	15	60	75
			Chemistry Practical	4	4	20	80	100
V	Theory	GLO5IB05	Igneous Petrology	4	3	15	60	75
		GLO5IB06	Metamorphic Petrology	3	3	15	60	75
		GLO5IB07	Sedimentary Petrology	3	3	15	60	75
		GLO5IB08	Structural geology and Geotectonics	4	3	15	60	75

			Open Course	3	3	15	60	75
	Practical	GLO5IH05(P)	Petrology	4	4	20	80	100
		GLO5IH06(P)	Structural Geology	4	4	20	80	100
VI	Theory	GLO6IB09	Economic Geology	4	3	15	60	75
		GLO6IB10	Palaeontology	4	3	15	60	75
		GLO6IB11	Stratigraphy and Indian Geology	4	3	15	60	75
	Elective#	GLO6IE01(E01a)	Remote Sensing and GIS	3	3	15	60	75
		GLO6IE01(E01b)	Environmental Geology					
		GLO6IE01(E01c)	Engineering Geology and hydrogeology					
	Practical's	GLO6IH07(P)	Economic Geology and Palaeontology	4	3	15	60	75
	Field Trip	GLO6IG01(FT)	Geological Field work	3	2	15	60	75
	Project	GLO6IF01	Project Viva Voice	3	3	15	60	75
VII	Theory	GLO7IB12	Advanced Crystallography and Mineralogy	5	4	20	80	100
		GLO7IB13	Advanced Geomorphology	4	4	20	80	100
		GLO7IB14	Advanced Igneous & Metamorphic Petrology	5	4	20	80	100
		GLO7IB15	Advanced Stratigraphy	5	4	20	80	100
	Practical's	GLO7IH08(P)	Mineralogy, Crystallography, Geomorphology, Igneous & Metamorphic Petrology	4	3	15	60	75
	Field Trip	GLO7IG02 (FT)	Field Studies	2	0	-	-	
VIII	Theory	GLO8IB16	Advanced Structural Geology	6	4	20	80	100
		GLO8IB17	Exploration Geophysics and Field Techniques	6	4	20	80	100
		GLO8IB18	Advanced Economic Geology	6	4	20	80	100
		GLO8IH09(P)	Structural Geology, Geophysics and Economic Geology	5	3	15	60	75
	Field Trip	GLO8IG03(FT)	Field Studies	2	2	15	60	75
	Internship	GLO8IG04(IN)	Professional Training/Internship$	0	0	-	-	-
IX	Theory	GLO9IB19	Applied Sedimentology	5	4	20	80	100
		GLO9IB20	Hydrogeology	5	4	20	80	100
		GLO9IB21	Advanced Remote Sensing and Geographic Information System	4	4	20	80	100
	Elective#	GLO9IE02(E02a)	Advanced Environmental Geology	3	3	15	60	75

		GLO9IE02(E02b)	Precambrian Crustal Evolution					
		GLO9IE02(E02c)	Quaternary Geology & Paleoclimate					
		GLO9IE03(E03a)	Marine Geology and Oceanography	3	3	15	60	75
		GLO9IE03(E03b)	Disaster Management					
		GLO9IE03(E03c)	Applied River Science					
	Practical	GLO9IH10(P)	Sedimentology, Hydrogeology, Remote sensing and Geographic Information System	5	3	15	60	75
	Field Trip	GLO9IG05(FT)	Field Training and Mapping	10 – 15 days	0	-	-	-
X	Theory	GLO10IB22	Advanced Palaeontology	5	4	20	80	100
		GLO10IB23	Geochemistry and Isotope Geology	5	4	20	80	100
	Elective#	GLO10IE04(E04a)	Geotechnical Engineering	3	3	15	60	75
		GLO10IE04(E04b)	Tectonic Geomorphology					
		GLO10IE04(E04c)	Coal & Petroleum Geology					
		GLO10IE05(E05a)	Advanced Mapping Techniques and Exploration Geology	3	3	15	60	75
		GLO10IE05(E05b)	Element of Mining and Ore Dressing					
		GLO10IE05(E05c)	Climatology					
	Practical	GLO10IH11(P)	Advanced Palaeontology and Geochemistry	3	3	15	60	75
	Field Trip	GLO10IG06(FT)	Advanced Field Training and Mapping	2	2	15	60	75
	Project	GLO10IF02	Project	4	4	20	80	100
Total								

* Study tour, Study project and practical evaluation will be held at the end of even semester.

An institution can offer any one among these courses.

$ Report evaluation of the Internship may be done at the end of Xth Semester

7. COURSE EVALUATION:

The evaluation scheme for each course shall contain two parts:

(a) Internal assessment and (b) external evaluation

20% weight will be given to the internal assessment. The remaining 80% weight will be for the external evaluation. The colleges will send only the marks obtained for internal examination to the University.

7.1. Components of Internal Assessment

The internal assessment shall be based on a predetermined transparent system involving written tests, Classroom participation based on attendance in respect of theory courses and lab involvement/ records attendance in respect of Practical Courses. There shall not be any chance for improvement for internal marks.

Components with percentage of marks of Internal Evaluation of Theory Courses:

- Test paper 40%
- Assignment 20%
- Seminar 20%
- Class room participation based on attendance 20%.

For the test paper marks, at least one test paper should be conducted. If more test papers are conducted, the mark of the best one should be taken.

For practical courses

- Record 60%
- Lab involvement 40%.

Marks awarded for the record of practical works shall be purely based on the number of practical works carried out/specimens studied by the candidate.

If a fraction appears in internal marks, nearest whole number is to be taken.

(a) Split up of marks for Theory Test Paper

Range of Marks in Test paper	Out of 8 (Max. internal mark is 20)	Out of 6 (Max. internal mark is 15)
Less than 35%	1	1
35% – 45%	2	2
45% – 55%	3	3
55% – 65%	4	4
65% – 85%	6	5
85% – 100%	8	6

(b) Split up of marks for Class room participation (CRP)

Range of CRP	Out of 4 (Max. internal mark is 20)	Out of 3 (Max. internal mark is 15)
50% ≤ CRP < 75%	1	1
75% ≤ CRP < 85%	2	2
85% and above	4	3

7.2. Components of External Evaluation

External evaluation carries 80% of marks. All question papers for theory shall be set by the University. The external question papers may be of uniform pattern with 80/60 marks. The courses with 2/3 credits will have an external examination of 2 hours duration with 60 marks and courses with 4/5 credits will have an external examination of 2.5 hours duration with 80 marks.

The external examination in theory courses is to be conducted by the University with question papers set by external experts. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation and answer keys shall be provided by the University.

(a) Scheme of examination - Theory

Question paper type 1:

The external QP with 80 marks and Internal examination is of 20 marks. Duration of each external examination is 2.5 Hrs. The pattern of External Examination is as given in Annexure I. The students can answer all the questions in Sections A & B. But there shall be Ceiling in each section.

Question paper type 1:

The external QP with 60 marks and Internal examination is of 15 marks. Duration of each external examination is 2 Hrs. The pattern of External Examination is as given in Annexure II. The students can answer all the questions in Sections A & B. But there shall be Ceiling in each section.

(b) Scheme of examination - Practical

The external examination in practical courses shall be conducted by two examiners – one internal and an external, the latter appointed by the University. Only candidates with records of more than 75% of practical works prescribed in the syllabus and duly attested by the head of the department shall be allowed to appear for Practical examination.

(c) Core Course Project Work

Evaluation of the Project Report shall be done under Mark System. The evaluation of the project will be done at two stages:

a) Internal Assessment (supervising teachers will assess the project and award internal Marks)
b) External evaluation (external examiner appointed by the University)
c) Grade for the project will be awarded to candidates, combining the internal and external marks.

The internal to external components is to be taken in the ratio 1:4. Assessment of different components may be taken as below:

Components		Percentage of Marks
Internal	**External**	
Originality	Relevance of the Topic; Statement of Objectives	20
Methodology	Reference/Bibliography; Presentation; Quality of Analysis/Use of Statistical Tools.	20
Scheme/Organization of Report	Findings and recommendations	30
Viva–Voce	Viva–Voce	30

7.2.1. Study Tour/Field Work: Evaluation Scheme

Study tours for geological field work, including collection of minerals, rocks, and fossil specimens, training on the measurement and recording of structural attributes and geological information, are integral and mandatory component of the program. These study tours are to be scheduled as follows:

(1) Field work expanding for 8 to 12 days shall be conducted in the first four semesters with emphasis on Physical Geology, Geomorphology, Mineralogy, and Mineral Deposits within southern India. The field work in the first four semesters may be carried out either in a single stretch in any of the semesters or as two stretches initially at first or second semester and later one at the third or fourth semester.

(2) Extensive field work with emphasis on Stratigraphy, Structural Geology, Economic Geology, Palaeontology, and Petrology for 12 to 15 days in different parts of India shall be conducted in fifth and Eighth semester of the programme.

(3) Mapping camp, extending for 10 to 15 days in a particular location, anywhere in India with emphasis on structural and lithological mapping shall be carried out during ninth semester of the programme

The study tour should be organized in such a way that a major portion of the entire tour period is exclusively allocated for field-based studies, including visit to quarries, mines and locations of geological interest, and limited time slots may be reserved to visit Academic/Research institutions. During the field-based studies and training, the students shall be grouped with a maximum strength of 15 numbers in a group supervised by one faculty member for each group.

A detailed and collective report of these field works, certified by the teacher(s)-in-charge of the study tour(s) and also by the Head of the Department should be submitted in the Sixth Semester, and specimens collected during the field works should be displayed at the time of practical examination in Sixth Semester. The study tour report is compulsory for each student appearing for Sixth Semester practical examination.

(a) Internal Assessment

Sl. No.	Criteria	Marks
1.	Punctuality & Field Note	4
2.	Field work/Skill	4
3.	Specimen collection	6
4.	Viva-Voce	6
	Total	**20**

(b) External Evaluation

Sl. No.	Criteria	Marks
1.	Study Tour Report	20
2.	Specimen Display	20
3.	Presentation/Viva-Voce	40
	Total	**80**

PROGRAMME SPECIFIC OUTCOMES

Integrated M.Sc. Geology:

Integrated M.Sc. Geology is a 5-year long course focused on Earth Science. The program is aimed at providing training in Geosciences of the highest academic quality in a challenging and supportive learning environment. The program will demonstrate, help to solve and understand major concepts of various disciplines of Geology. Since field trips are a key aspect of our course, we have been offering fieldtrips every year including one-week long field works outside the state. The students will be trained to conduct geologic field mapping, statistical analyses of data collected through field studies/ experimentally generated, use of computer techniques and software, petrological microscopy, fossil identification, study groundwater resources and environmental issues of Earth. The students will get an intense learning experience enabling them to identify and differentiate different minerals, rocks and other geological structures in their natural environment.

After successful completion of Five-year Integrated M.Sc. program in Geology a student should be able to:

- Students will get an understanding about concept of geological time, different periods and important events in geology and dating of geological materials.
- Students will be able to identify geological structures like fold, fault, joints and unconformity.
- Students will be exposed to studies on natural hazards, assess its effects and various management and mitigation measures.
- Construct and interpret geologic cross sections from geological and topographic maps.
- Good understanding about plate tectonic process and explain its relationship to earth processes, features and landforms.
- Understand the basic concepts of basic tenants of Geology and apply this knowledge to analyze geological formations and structures for the benefit of mankind.
- Understand spatial and temporal relationships between Earth processes, landforms and products, and development and evolution of various spheres of Earth including Lithosphere, Hydrosphere, Atmosphere and Biosphere.
- Explain the causes and effects of global climate change, understand proxies to reconstruct past climate.
- Application of Earth Observation Science with the help of Remote sensing techniques, its visualization and interpretation using Geographic Information System tools and software.
- Think methodically, independently and draw a logical conclusion about Geological processes and its applications.
- Employ critical thinking and the scientific knowledge in solving geological issues by carrying out field studies, record field observations, design and use of laboratory analyses, interpret results and prepare scientific/ technical reports and its presentation.

- Lead the team to create awareness about the importance of Geoscience on the environment and society, importance of conservation and sustainability of its resources.

CORE COURSE: GEOLOGY
(THEORY)

GLO1IB01 – EARTH AND ENVIRONMENT

Credit: 3 **Total Hours: 64**

Course Outcome

Students will be able to understand about

CO1: Basic knowledge about the subject and Planet Earth
CO2: Basic knowledge about minerals and Rocks
CO3: Basic knowledge about structural features
CO4: Basic knowledge about Natural Hazards
CO5: Knowledge about earthquakes and Volcanoes

Unit 1

- Geology and its perspective
- Origin of Planets- Nebular hypothesis, Planetesimal hypothesis, Gaseous-Tidal Hypothesis; Binary star
- Earth in relation to solar system, size, shape, mass, density and its development.
- Age of the Earth – Determination of Earth's age, - Radioactive methods and non-radioactive methods.
- Plate Tectonics: The Discovery of Plate Tectonics, The Mosaic of Plates, Rates and History of Plate Motions, The Engine of Plate Tectonics.
- Geological Time scale: Eons; Eras; Periods; and Epochs

Unit 2

- Minerals: A brief introduction to minerals, The Atomic Structure of Minerals. Rock-Forming Minerals, Properties of Minerals.
- Rocks: Types of rocks - brief introduction to Igneous, sedimentary and metamorphic rocks; Concept of rock cycle, Rock and Fossil Record

Unit 3

- Brief Introduction about Folds, Faults, and other Records of Rock Deformation, Evolution of the Continents
- Elementary ideas about outcrops, dip, strike, outlier, inlier and overlap

Unit 4

- Natural Hazards: Volcanism, Earthquakes, Tsunamis, Landslide Issues relating to prediction, protection and mitigation. Landscape - Tectonic and Climate Interaction

Unit 5

- Volcanoes – Classification based on Lava Types; Styles of Eruptions – Landforms, Products - Global Distribution; Causes; Effects; Prediction
- Mountains and Classification, Isostasy – Airy Theory, Pratt Theory, Heiskanen's Theory
- Earthquakes – Properties of seismic waves; Magnitude and Intensity – Ritcher and Mercalli's Scales; Seismogram and Seismograph. Origin, distribution and prediction of earthquakes. Tsunami – Origin and effects.

Reference:-

1. Frank Press Raymond Siever: Understanding Earth (3rd ed). W.H. Freeman and Company. New York. 2000

2. Skinner B. J. and Porter S.C: The Dynamic Earth – An Introduction to Physical Geology 3rd edition. John Wiley & Sons, New York. 1995

3. P. McL. D. Duff : Holme's Principles of Physical Geology (4th ed). Chapman & Hall. London. 1996

4. Cox A. & Hart R.B.: Plate Tectonics How it works. Blackwell Scientific Publ. Co. Boston. 1986.

5. Philip A. Allen.: Earth Surface Processes Blackwell Sciences Ltd, Oxford. 1997

6. Murck B.W., Skinner B.J & Porter S.C.: Dangerous Earth – An Introduction to Geologic Hazards John Wiley & Sons New York. 1996

7. Condie, K.C.: Earth as an Evolving Planetary System, 3rd Edition, Academic Press, USA. 2015

8. Marshak, S.: Earth: Portrait of a Planet. W.W. Norton & Co., Inc., USA. 2001

9. Tarbuck, E.J. and Lutgens, F.K.: Earth: An Introduction to Physical Geology. 9th Edition, Pearson Education, Inc., New Jersey, USA. 2008

10. Wicander, R. and Monroe, J.: Essentials of Geology. 4th Edition, Thomson Learning Inc., USA. 2006

GLO2IB02: GEOMORPHOLOGY

Credit: 3 **Total Hours: 64**

Course Outcome

Students will be able to understand about

CO1: Basic Knowledge about weathering processes.
CO2: Basic Knowledge about geological action of different geological agents
CO3: Basic knowledge about Field Methodologies

Unit–1:

Introduction: Fundamental concepts; Cycle of erosion; Base level.
Weathering: Factors influencing weathering Types - Physical: Expansion, crystal growth, thermal expansion, organic activity, colloidal plucking. Chemical: Hydration, hydrolysis, oxidation, carbonation and solution.
Products of Weathering, Soil and Soil Profile
Mass wasting: Conditions favoring mass wasting: lithology, stratigraphy, structure, topography, climate, organism etc. Slow flowage: creep, solifluction Rapid flowage: Earthflow, Mudflow, Debris avalanche Landslides: slump, slide, fall.

Unit-2:

Running water as a geological agent: Development of a typical stream-Drainage system consequent and subsequent streams - Drainage basin- Drainage Pattern-Geological work of stream, erosional and depositional fluvial landforms, Concept of base level, Peneplanation, Monadnocks, Stream terrace, Rejuvenation, Knick Point, Entrenched meanders.
Geological work of wind. Erosional and depositional landforms. Loess, types of dunes, Pedi planation, playas and inselbergs. Formation of deserts.

Unit-3:

Glaciers- Formation of glaciers- Types- Movements-Erosional and depositional landforms, Glacier landforms, glacial ages.
Underground water: occurrence, zone of aeration & saturation, Water table, Perched water table, porosity, permeability, Aquifers- confined and unconfined, aquicludes, aquitard and aquifuge. Artesian wells, Geyser and springs. Erosional and depositional landscapes produced by action of ground water.
Origin of limestone caverns-Stalactite and stalagmites. Karst topography: Terra rosa, lapies, sinkholes, blind valley, caverns, stalactites and stalagmites, natural bridge, tunnel.

Unit 4

Oceans and Seas: Waves, tides and currents. Geological work of oceans. Classification of shore line and Coast, Shore line types
Description of continental margins, Continental Shelf-Continental slope submarine canyons- sea mount-Guyots, midocean ridges, trenches.
Coral reefs – types and origin.
Lakes and its types

Unit 5

Field methodologies in Geology– Topographic Maps and its uses – Instruments – Clinometer, Brunton compass, Map Symbols, Toposheets,
GPS, Aerial Photographs, Satellite imageries

References: -

1. Thornbury W.D. 1984, Principles of Geomorphology, First Willey Eastern Reprint, New Delhi.
2. Frank Press and Raymond Siever 1998, Earth (4th Edition) W.H. Freeman & Co., San Francisco.
3. Avery T. E and Berlin G. L, 1992, Fundamentals of remote sensing and Air photo interpretation. McMillion Publishing Co., New York.
4. Pitty A.F., 1971, Introduction to geomorphology, Methuen, London.
5. Pandey S. N. 1987 Principles and Applications of Photogeology, Wiley Eastern
6. Lo, C.P. and Yeung, A.K.W., 2007. Concepts and Techniques in Geographic Information Systems.
7. Tarbuck, E.J. and Lutgens, F.K., 2008. Earth: An Introduction to Physical Geology. 9th Edition, Pearson Education, Inc., New Jersey, USA.
8. Wicander, R. and Monroe, J., 2006. Essentials of Geology. 4th Edition, Thomson Learning Inc., USA.

GLO3IB03 - CRYSTALLOGRAPHY AND MINERALOGY

Credit: 3 **Total Hours: 64**

Course outcome:

Students will be able to understand about

CO1: Basics of mineralogy and crystallography helps in building the overall knowledge in Geology.
CO2: Identify face, form, Axis, symmetry and laws of crystallography.
CO3: To recognize and calculate Miller indices of crystallographic planes & directions.
CO4: Describe different symmetry class and morphological forms present in particular symmetry class.
CO5: Define mineral and describe physical properties and optical properties of given minerals.
CO6: Describe physical and optical properties of a given mineral group.
CO7: Polymorphism, pseudomorphism, isomorphism and solid solution.

Unit 1:

- Crystallography – A brief introduction to scope and its applications.
- Nature of crystals; crystalline and amorphous materials; polycrystalline materials; a brief introduction to Crystal systems.
- Morphological characters of crystal – faces, forms, edges solid angles Interfacial angle
- Symmetry elements – crystallographic axes, crystal notation, parameter system of Weiss and Miller indices, axial ratio.
- Laws of crystallography – law of constancy of symmetry, law of constancy of interfacial angles, law of rational indices.
- Classification of crystals into systems and classes – Holohedral, Hemihedral, Hemimorphic and Enantiomorphic forms in crystals.

Unit 2:

- Study of the symmetry elements and forms of the Normal, pyritohedral, tetrahedral and plagiohedral classes of cubic system with special reference to well-developed crystals of Galena, Spinel, Garnet, Flourite, Diamond, Pyrite, Tetrahedrite, Boracite and cuprite.
- Study of symmetry elements and forms of Normal, Hemimorphic, Tripyramidal, Sphenoidal and Trapezphedral classes of Tetragonal system.
- Study of the symmetry elements and forms of Normal, Hemimorphic, Tripyramidal, Trapezohedral, Rhombohedral, Rhombohedral Hemimorphic and Trapezohedral classes of Hexagonal system.

Unit 3:

- Study of the symmetry elements and forms of the Normal and Sphenoidal classes of the Orthorhombic system.
- Study of the symmetry elements and forms of the Normal classes of the Monoclinic and Triclinic systems.
- Twin crystals – Definitions – Effects of Twinning – laws of twinning –

composition plane, twinning plane and twinning axis, indices of twins – simple and repeated (polysynthetic twins), contact and penetration twins: secondary twins.

Unit 4:

- Definition of Mineral and Mineraloid – Scope and aim of Mineralogy.
- Crystal Coordination - the making of minerals
- Classification and structural diversity of silicate minerals

Unit 5:

- Compositional variation and coupled ionic substitution, Isomorphism, Polymorphism, Pseudomorphism, solid solution and ex- solution in minerals.
- Physical properties of minerals Form, colour, streak, luster, Hardness, Cleavage, Fracture, Specific Gravity, Tenacity, transparency, Electrical and Magnetic properties- pyro and piezo electricity, Ferri-, Para-, and Diamagnetism.

Reference: -

- Borchardt-Ott, W: Crystallography– An Introduction. Springer Heidelberg, 355p, 2011
- Dana F.S: A Text Book of Mineralogy. Asia publishing House, Wiley, 1955
- Klen C., Hurlbut C.S.: Manual of Minerology, John Wiley & Sons, 1985.
- Perkins D.:Mineralogy. Pearson Education (3Ed), 568 p,2015.

GLO4IB04 - OPTICAL AND DESCRIPTIVE MINERALOGY

Credit: 3 **Total Hours: 64**

Course Outcome:

Students will be able to understand about

CO1: The physics of how light interacts with minerals.
CO2: Petrological microscope, isotropic and anisotropic minerals;
CO3: Uniaxial and biaxial indicatrices
CO4: Optical properties in relation to indicatrices absorption and pleochroism, extinction, birefringence; Interference figures

Unit 1:

- Nature of light – Ordinary and polarized light; Refraction and reflection; Refractive index, Critical angle and Total internal reflection.
- Double refraction – Plane Polarization by Reflection; Plane polarization by Refraction; Nicol Prism; Plane polarization by absorption.
- Petrological microscope and its parts
- Isotropic and anisotropic minerals - Optical properties.

Unit 2:

- Characters of Uniaxial and biaxial minerals – Optic axis and optic axial angle; Acute and Obtuse Bisectrix; Optic sign of Uniaxial and Biaxial minerals; Uniaxial and Biaxial Indicatrix; Sign of elongation.
- Extinction – Types, angles, determination, and applications in mineral identification.
- Optical accessories and uses – Quartz wedge (Determination of order of Interference Colour), Gypsum plate and Mica plate (Determination of Fast and Slow vibration directions).

Unit 3:

- Structure, Chemistry, Optical and Physical properties, Modes of occurrence and uses of the following groups of minerals: Olivine, Garnet, Epidote , Aluminium silicates, Pyroxene, and Amphibole.

Unit 4:

- Structure, Chemistry, Optical and Physical properties, Modes of occurrence and uses of the following groups of minerals: Mica, Chlorite, Polymorph and varieties of Quartz, Feldspars, Feldspathoids and Spinel.

Unit 5:

- Chemistry, Optical and Physical properties, Modes of occurrences and industrial uses of the following minerals: Scapolite, Cordierite, Talc, Serpentine, Steatite, Calcite, Dolomite, Topaz, Staurolite, Beryl, Tourmaline, Fluorite, Apatite, Zircon, Rutile, Sphene, Zeolites and Corundum.

Reference :-

- Dyar M.D., Gunter, M.E.:Mineralogy and Optical Mineralogy. Min. Soc. America, 705p, 2007.
- Nesse W.D.: Introduction to Optical Mineralogy. Oxford University Press; 4

edition, 384p, 2012.

- Pichler H., Riegraf C.S.: Rock-forming Minerals in Thin Section. Springer, 220 p, 2011.
- Deer W.A., Howie R.A., Zussman J.: Introduction to the Rock-forming Minerals. Mineralogical Society of Great Britain & Ireland,510p, 2013

GLO5IB05 - IGNEOUS PETROLOGY

Credit: 3 **Total Hours: 64**

Course outcome:

Students will be able to understand about

CO1: Important structures and textures of igneous rocks.
CO2: Different classifications of igneous rocks.
CO3: Reasons for diversity in igneous rocks.
CO4: Crystallization behaviour and petrogenetic significance of magmas.
CO5: Different rock types their Mineralogy, classification and occurrence

Unit 1:

- Composition and constitution of magmas – Primary and Parental Magmas.
- Forms of Intrusive igneous rocks: Concordant forms - Sill, Laccolith, Lopolith and Phacolith, Discordant forms - Dykes, Cone Sheets, Volcanic neck, Ring dyke, Batholiths, Stocks, Bosses and bysmaliths.
- Forms of Extrusive igneous rocks: Lava flows, Pyroclastic deposits - Agglomerate, Lapilli, volcanic ash and volcanic froth.

Unit 2:

- Structures: vesicular and Amygdaloidal structures – block lava – Ropy lava – pillow structure – flow structure – sheet joints- mural jointing – columnar jointing – rift and grain.
- Textures: Definition and description - crystallinity: crystallites and microlites – Devitrification – Granularity – shapes of crystals, mutual relations – Equigranular textures: allotriomorphic hypidiomorphic, Panidiomorphic. inequigranular Textures: porphyritic and Intergrowth texture – Trachytic texture – Intergrowth texture structures orbicular structure Spherulitic structure – Perlitic fracture. , Directive textures, Overgrowth textures, Reaction textures - Micro Structures

Unit 3:

- Classification: bases of classification – Genetic classification – classification based on colour index – based on the proportion of Alkali to plagioclase feldspars-based on silica saturation – based on alumina saturation –
- A short account of CIPW classification, Normative minerals, salic and femic groups – Merits and defects of CIPW classification
- Tyrrel's tabular classification- IUGS classification.

Unit 4:

- Crystallization of Unicomponent magma
- Crystallization and petrogenetic significance of Binary magmas: Diopside – Anorthite Eutectic system, Albite – Anorthite Solid-Solution system, Forsterite – Silica incongruent melting system and Ab- Or system.
- Reaction principle and Bowen's reaction series - Causes for the diversity of Igneous rocks – Magmatic Differentiation: Fractional Crystallization, Liquid immiscibility, Assimilation

Unit 5:

- Study of Texture, Mineralogy, Classification, and Modes of occurrence of Granite, Granodiorite, Syenite, Diorite, Gabbro with their hypabyssal and volcanic equivalents.
- Petrographic characters and origin of Pegmatites, Lamprophyres, Alkaline rocks, Dunite, Peridotite and Anorthosites

Reference :-

- Frost, B.R., Frost, C.D., 2014. Essentials of Igneous and Metamorphic Petrology. Cambridge University Pres. 318 p.
- Raymond, L.A., 2002. Petrology: The Study of Igneous, Sedimentary and Metamorphic Rocks, 720p.
- Winter, J.D., 2009. Principles of Igneous and Metamorphic Petrology. Pearson, 720 p.

GLO5IB06 - METAMORPHIC PETROLOGY

Credit: 3 **Total Hours: 48**

Course outcome:

Students will be able to understand about

CO1: Identify and define basic concept, factors and types of metamorphism
CO2: Identify different structures and textures of metamorphic rocks
CO3: Different metamorphic grades and facies
C04: Apprehend petrography and origin of various metamorphic rocks

Unit 1:

- Metamorphism – Definition; limits of metamorphism (low and high T/P limits and influence of water and bulk compositions on metamorphic limits).
- Variables of metamorphism – temperature, lithostatic pressure, deviatoric stress, fluids.
- Types of metamorphism – classification based on the principal agents (thermal, dynamic, dynamo-thermal, hydrothermal); based on geological setting – contact, shock, high-strain, regional (burial, ocean-ridge, orogenic); based on plate tectonic setting – metamorphism at convergent, divergent, and transform plate margins.
- Fault-zone and impact metamorphism

Unit 2:

- Classification of metamorphic rocks: foliated and lineated; non-foliated and non-lineated; specific rock groups (Quartzite, Greenstone, Amphibolite, Serpentinite, Calc- silicate, Skarn)
- Metamorphic structures – fabric, layer, foliation, schistosity, cleavage, gneissosity, lineations.
- Metamorphic textures – augen, cataclastic, corona, decussate, epitaxial, flaser, granoblastic, lepidoblastic, megacrystic, nematoblastic, poikiloblastic, porphyroblastic, strain shadow, symplectite, and relict textures.
- Equilibrium mineral assemblages; Introduction to chemographic diagrams: ACF, AKF Diagrams

Unit 3:

- Metamorphic grades and isograds; mineral zones and Barrowian sequence;
- Metamorphic facies – zeolite, prehnite-pumpellyite, greenschist, epidote-amphibolite, amphibolite, granulite, blueschist, eclogite, and contact metamorphic facies
- Facies series and plate tectonics – paired metamorphic belts.

Unit 4:

- Metamorphic effects on – argillaceous (medium P-T Barrovian); calcareous (contact metamorphism); basic igneous (regional metamorphism) rocks
- Petrography and origin of slate, phyllite, chlorite schist, kyanite schist, biotite schist, biotite gneiss, hornblende gneiss, amphibolite, marble, charnockite, eclogite, and mylonite

Unit 5:

- Prograde and retrograde metamorphism
- Nature of metamorphic fluids and metasomatism

- Anatexis and migmatites; metamorphic differentiation

References:

- Barker, A.J., 1990. Introduction to Metamorphic Textures and Microstructures. Blackie, 162p.
- Bucher, K. and Grapes, R., 2011. Petrogenesis of Metamorphic Rocks. Springer-Verlag, Berlin-Heidelberg, 428p.
- Frost, C.D., Frost, B.R, 2013. Essentials of Igneous and Metamorphic Petrology, Cambridge University Press, 336p.
- Kretz, R., 1994. Metamorphic Crystallization. John Wiley & Sons, 507p.
- Miyashiro, A., 1978. Metamorphism and Metamorphic Belts. 3rd Edition. George Allen & Unwin, London, 492p.
- Vernon, R.H. and Clarke, G.L., 2008. Principles of Metamorphic Petrology. Cambridge University Press, 446p.
- Winter, J.D., 2011. Principles of Igneous and Metamorphic Petrology, Prentice-Hall, 728p.

GLO5IB07 - SEDIMENTARY PETROLOGY

Credit: 3 **Total Hours: 48**

Course outcome:

Students will be able to understand about

CO1: Broad classification of sedimentary rocks.
CO2: Sedimentary structures and textures.
CO3: Different rock types their Mineralogy, classification and origin

Unit 1

- Origin of sediments
- Weathering and sedimentary flux: Physical and chemical weathering,
- Soils and paleosols.

Unit 2:

- Sediment granulometry, Grain size scale, particle size distribution, Environmental connotation; particle shape and fabric

Unit 3:

- Sedimentary textures, structures and environment Fluid flow, sediment transport and sedimentary structures:
- Types of fluids, Laminar vs. turbulent flow, Particle entrainment, transport and deposition.
- Paleocurrent analysis- Paleocurrents for different sedimentary environments Sedimentary structure- Primary and syn-sedimentary structures

Unit 4:

- Varieties of sedimentary rocks
- Siliciclastic rocks: Conglomerates, sandstones and its classification, mudrocks.
- Carbonate rocks, controls of carbonate deposition, components and classification of limestone, dolomite and dolomitisation

Unit 5:

- Diagenesis Concepts of diagenesis Stages of diagenesis Compaction and cementation.

References

1. Prothero, D. R., & Schwab, F. 2004. Sedimentary geology. Macmillan.

2. Tucker, M. E. 2006 Sedimenary Petrology, Blackwell Publishing.

3. Collinson, J. D. & Thompson, D. B. 1988 Sedimentary structures, Unwin- Hyman, London.

4. Nichols, G. 2009. Sedimentology and Stratigraphy Second Edition. Wiley Blackwell

GLO5IB08 - STRUCTURAL GEOLOGY AND GEOTECTONICS

Credit: 3 **Total Hours: 64**

Course outcome:

Students will be able to understand about

CO1: Different types of rock deformation, associated pressure-temperature conditions, and stages of deformation.
CO2: Geometric and genetic classification of types of different structures and associated deformation mechanism.
CO3: Different tectonic deformation structures on Earth's surface

Unit-1

- Concept of force and stress. Normal stress and shear Stress. Stress components. Hydrostatic and deviatoric stresses.
- Concept of strain. Nature of strain. Pure shear and simple shear. Concept of strain ellipsoid. Behaviour of materials under stress.
- Concept of deformation. Elastic and plastic behaviour of rocks. Brittle and ductile deformation.

Unit -2

- Folds: Basic fold geometry, nomenclature and definitions.
- Classification of folds. Describing folds. Interference and superposition of folds. Folds and ductile deformation.
- Unconformity: Concept of unconformity, types of unconformity, criteria of recognition, significance of unconformity

Unit -3

- Faults: Fault geometry, nomenclature and definitions,
- Classification of faults, Features associated with fault plane, criteria for recognizing fault in field. Faulting and earthquakes.
- Concept of Shear zone.

Unit -4

- Joints: Nomenclature and definitions related to joints and the structures related to joints. Classification of joints.
- Linear structures: Lineations, cleavages and foliations. Morphology and description of lineations and cleavages, cleavages on different scales.
- Significance of linear structures.

Unit -5

- Introduction to plate-tectonics, Historical development of the concept of plate-tectonics
- Continental drift, Sea-floor spreading; Concept of lithosphere and lithospheric plates. Nature of plate boundaries. Hot-spots and mantle plumes.

- Geological structures associated with different plate boundaries, Continents and Oceans, Mountain ranges, Oceanic ridges and trenches, Stable and unstable tectonic zones.
- Tectonics of Indian plate. Brief study of origin of Himalayas.

References:

- Billings M P, Structural Geology, Pearson Education, 624pp
- Davis, G.H., Reynolds, S.J., 1996, Structural geology of rocks and regions, 2nd Edition, John Wiley & sons.
- Hamblin, W.K., Christiansen, E.H. 2003, Earth Dynamic Systems, 10th Edition, Prentice Hall.
- Turcotte, D.L., & Schubert, G., 2001, Geodynamics 2nd Edition, Cambridge University Press
- Pollard, D.D. & Fletcher, R.C. 2005, Fundamentals of Structural Geology, CambridgeUniversity Press
- Park, R. G., 1983, Foundations of structural Geology, Blackie Academic and Professional
- Ramsay, J.G. & Huber, M.I. 1984, The Techniques of Modern Structural Geology, Vol 1: Strain Analysis, Academic Press
- Ramsay, J.G. & Huber, M.I. 1987, The Techniques of Modern Structural Geology, Vol 2: Folds and Fractures, Academic Press.
- Moores, E.M., Twiss, R.J. 1995, Tectonics,W.H. Freeman
- Ragan, D. M. (2009) Structural Geology: an introduction to geometrical techniques (4th Ed). Cambridge University Press (For Practical)

GLO6IB09 – ECONOMIC GEOLOGY

Credit: 3 **Total Hours:64**

Course outcome:

Students will be able to understand about

CO1 - Classification of different mineral deposits in earth.
CO2 - How prevailing geological features controls ore deposition and also serve as tools to find hidden treasure
CO3 – Formation of mineral deposits.
CO4 - Mineral deposits of India
CO5 - The formation and different aspects related to Coal, crude oil and natural gas

Unit 1

- Historical development of economic Geology.
- Geochemical distribution of elements.
- Materials of mineral deposits – ore minerals, gangue minerals, tenor and grade of ores, ore shoots and bonanzas.
- Classification of mineral deposits. Outline of Lindgren's and Bateman's classification-Syngenetic and epigenetic deposits.
- Controls of ore localization – structural, stratigraphic, physical and chemical.
- Brief study of metallogenic epochs and provinces – geologic thermometers.

Unit 2

- Magmatic processes. – mode of formation – Early magmatic processes and deposits, disseminations, segregations and injections – Late magmatic processes and deposits – Residual liquid segregation and injection – immiscible liquid segregation and injection – sublimation.
- Contact Metasomatic processes – the process and effects – resulting mineral deposits.
- Hydrothermal processes – principles – Factors affecting deposition – wall rock alteration – minerals sequence – cavity filling deposits Fissure veins, shear – zone, stock-work, saddle reef, ladder vein, fold cracks, breccia filling, solution cavities, pore space and vesicular filling – replacement deposits- process and deposits – criteria of replacement.

Unit 3

- Sedimentary processes and cycles – principles involved in sedimentation – cycles of Iron and manganese
- Weathering processes – principles- Residual concentration process and deposits – mechanical concentration principles – eluvial, alluvial, beach and eolian placers.
- Oxidation and supergene sulphide enrichment – solution and deposition in the zone of oxidation – secondary sulphide enrichments – Gossans and capping.
- Metamorphic processes – Formation of Graphite, Asbestos, Talc, Soapstone and Sillimanite group of minerals.

Unit 4

- Diagnostic physical properties, chemical composition, uses, modes of occurrence and distribution in India of the following:

1) Economic Minerals- Gold, Silver, Copper, Lead, Zinc, Iron, Manganese, Chromium, Tin, Aluminium

2) Radioactive metals - Thorium, Uranium, Titanium.

3) Industrial Minerals- Asbestos, Barite, Graphite, Gypsum and Mica.

4) Abrasives- Diamond, Corundum, Emery garnet, Abrasive sand, Tripoli, Pumice, Sand feldspar, Limestone, Clay, Talc etc.

5) Refractories- fireclay, graphite, Dolomite and sillimanite group of minerals, diaspore, pyrophillite, zircon etc

6) Ceramic minerals- Clay, Feldspar, Wollastonite,

7) Gemstones.

UNIT 5

- Fossil fuels – coal and lignite – uses, classification, constitution, origin and distribution in India.
- Petroleum- composition, uses, theories of origin, oil traps, and important oil fields of India.
- A brief account of mineral deposits in Kerala.
- Significance of minerals in the National Economy. Strategic, critical and essential minerals.

References:

1. Gokhale and Rao. 1973. Ore deposits of India. Thomson Press (India), Publication Division, Delhi
2. Mead. L.Jensen and Alan M.Bateman. 1981. Economic Mineral Deposits. John Wiley and Sons, New York
3. Krishnaswamy, S. 1972. Indian Mineral Resources. Oxford & IBH Pub. Co. New Delhi
4. Park C. F and Macdiarmid. 1964. Ore deposits. W.H. Freeman and CO
6. Umeshwar Prasad. 2006. Economic geology. CBS Publishers, New Delhi

GLO6IB10 – PALAEONTOLOGY

Credit: 3 **Total Hours: 64**

Course outcome:

Students will be able to understand about

CO1: Different methods of fossil preservation and uses of fossils
CO2: Morphology, classification and importance of foraminifera
CO3: Morphology, classification of different Phylum – Coelenterate, Hemichordata, Mollusca, Gastropoda, Cephalopoda, Brachiopoda, Echinodermta and Arthropoda
CO4: Different plant fossils in India.

Unit 1:

- An outline of life through ages, its evolution and distribution
- Definition of Palaeontology – organic world – classification of animals– Habitats and habits of animals - Flora and Fauna – vertebrates and invertebrates
- Definition of fossils – nature and modes of preservation of fossils: Unaltered hard parts: Altered hard parts : Petrifaction, permineralisation, carbonisation, recrystallisation, silicification , mould, casts, tracks , trails, borings,
- Uses of fossils – stratigraphic indicators – climatic indicators- indicators of palaeogeography – indicators of evolution and migration of life forms – indicators of new deposits of coal and petroleum

Unit 2:

- Phylum protozoa – Order: Foraminifera: General morphology – chitinous test – septa, arrangement of chambers, suture, aperture, dimorphism – classification, geological history and stratigraphic importance.
- Phylum coelenterata – class Anthozoa – zoological features – General morphology: corallum, corallite , theca , chambers, septa, fossula, columella, septal developments, classification – tabulate corals – Rugose corals evolution geological distribution – stratigraphic importance.
- Sub phylum Hemichordata – class Graptozoa: order Dendroidea and Graptoloidea – general morphology , rhabdosome, stipe , theca , common canal , nema , virgula , sicula , angle of divergence, central disc, uniserial, biserial, classification, geological distribution and stratigraphic importance

Unit 3:

- Phylum mollusca: Class Pelecypoda:- General characters – umbo, Hinge line – ligament – lunule and escutcheon – adductor impressions, pallial line, pallial sinus, dental patterns, ornamentation, classification, geological history
- Class Gastropoda:- General morphology, shell forms, whorl, spire, spiral angle, suture, aperture, columella, umbilicus , peristome , aperture , (Holostomatus and siphonostomatus) – types of coiling – Dextral and sinistral – ornamentation , classification and geological history
- Class Cephalopoda:- General morphology , siphuncle, septa, septal necks, connecting ringes, chambers, suture lines, (Nautilitic , Goniotitic , Ceratitic and Ammonitic) – shell forms – ornamentation – classification evolution, geological history- morphology of a Belemnite shell.

Unit 4:

- Phylum Brachiopoda:- General morphology, umbo, hinge line , pedicle opening, delthyrium, deltidium pseudo deltidium – Brachial skeleton – morphometric details, ornamentation , classification , geological history.
- Phylum Echinodermata: - Class Echinoidea:- General morphology, periproct, apical system (Anus, ocular plates, Genetal plates, madriporic plates), corona (Ambulacra , inter ambulacra) – peristome – Regular and irregular echinoids – classification – geologicial history. Class crinoidea:- General morphology , calyx , dorsal cup, (Radicals , basals, intrabasals), arms, stem, classification, geological history. Class Blastoidea: - General morphology – calyx, dorsal cup (Basals, radials, deltoids, ambulacra). Brachioles, cicatrix, geological history

Unit 5:

- Phylum Arthropoda:- Class – Trilobita- General morphology : Cephalon: glabella, facial suture, free cheek, fixed cheek, genal angle , genal spine , cranadium; thorax – pygidium – classification – geological history.
- Brief account of Siwalik vertebrate fossils
- General classification of plant kingdom – plant fossils from India – A brief account of the following plant fossils :- Glossopteris , Gangamopteris , Ptilophyllum , Calamites , Lepididendron and Sigillaria

References:

1. Henry woods : Invertebrate palaeontolgy – Cambridge.
2. Romer , A.S.: Vertebrate palaeontology, Chicago press.
3. Arnold, C.A., An introduction to Palaeobotany., MC-Graw Hill.
4. B.U. Haq and A. Boersma (1978) Introduction to marine Micropalaeontology. Elsevier, Netherlands
5. Raup, D.M. and Stanely, M.S.: Principles of Palaeontology, CBS Publishers.
6. Moore , R.C., Laliker , C.G.& Fishcher, A.G.: Invertebrate Fossils , Harper brothers
7. Shrock. R.R. and Twenhofel , W.H – 1953 : Principles of invertebrate Palaeontology, Amold publication

GLO6IB11 - STRATIGRAPHY AND INDIAN GEOLOGY

Credit: 3 **Total Hours: 64**

Course outcome:

Students will be able to understand about

CO1: Various stratigraphic laws & physical and biological criteria of correlation
CO2- Students can able to understand different stratigraphic distribution of Indian.
CO3- Students will get a detailed understanding of stratigraphy and geology of Kerala

Unit 1

- Scope of the subject, its relationship with other disciplines.
- Principles of stratigraphy.
- Indian Time Scale
- Correlation, facies and unconformities.

Unit 2

- Facies and facial changes-litho and bio facies- break in stratigraphic records - diastems.
- Stratigraphic classification. Walters law
- BiostratigraphIc classification- Biozones, biohorizon, index fossil.
- Range zone- Taxon range zone concurrent range zone, interval zone, assemblage zone, Acme zone.
- Lithostratigraphic classification Group, Formation, Member, Bed.
- Chronostratigraphic classification- Eonothem, erathem, system, series, stage.

Unit 3

- Early Precambrian Stratigraphy: concept of craton, mobile belt, shield area, Sargur supracrustals; Tectonic frame work of south India; Dharwar Supergroup; Aravalli Supergroup
- Late Precambrian Stratigraphy: Delhi Supergroup, Cudappah Supergroup, Vindhyan Super group. Brief study of Singhbhum craton, Sausar and Sakoli group

Unit 4

- Cambrain of Salt Range and Paleozoic rocks of Kashmir Valley, Spiti Valley and Pensinsular India
- Gondwana Supergroup – their classification, lithology, fossils and distribution in India.
- Brief knowledge on distribution, lithology, fossil content and classification of Triassic of Spiti, Jurassic of Kutch and Cretaceous of Tiruchirappali.

Unit 5

- Deccan Traps – Intra and Inter trapeans – Origin, composition, distribution.
- Stratigraphy of Siwalik system, fauna and flora of Siwaliks
- Tertiary rocks of Assam, Karewa formation
- Tertiary rocks of Tamil Nadu

- Stratigraphy and Geology of Kerala

Reference:-

- Lemon,R.R .1990. Principles of stratigraphy.. Merrill Publ. New York
- Boggs,S.1987. Principles of Sedimentology and Stratigraphy, Merrill, New York.
- Krishnan, M.S. 1982. Geology of India and Burma. CBS publishers, New Delhi
- Vaidyanathan R and Ramakrishnan M. 2008. Geology of India, GSI Publications.
- Soman,K.(1997): Geology of Kerala, Geological society of India publications

GLO7IB12 - ADVANCED CRYSTALLOGRAPHY AND MINERALOGY

Credit: 4 **Total Hours: 80**

Course outcome:

Students will be able to understand about

CO1: Derivation of 32 crystal classes and stereographic projections
CO2: Use of Crystal notations (Schoenflies notation, Herman Maugin)
CO3: Conoscopic observations of minerals under petrological microsope
CO4: Understanding the mineralogical composition of Crust and Mantle

Unit 1

- Crystallography: Derivation and determination of point groups.
- Concept of space group. Crystalline state-Repetition theory. Translation periodicity of crystals. Basic rotational symmetries and possibility of simultaneous rotational symmetries in different directions of crystals-symmetrical plane and symmetrical lattices.
- Derivation of 32 crystal classes. Stereographic projection of crystals. Crystal notation-Schoenflies notation. Herman Mauguin symbols-comparison between Schoenflies and International notations. Calculation of crystal elements to test the knowledge of the application of tangent relation, anharmonic ratios, Napier;s theorem and equation of the normal.

Unit 2

- Conoscopic observations of minerals under petrological microscope:
- Formation of interference figures; Uniaxial and biaxial interference figures
- Determination of the Optic sign of uniaxial and biaxial minerals.Optical indicatrix of uniaxial and biaxial minerals.
- Vibration directions and sign of elongation in minerals. Extinction and extinction angle. Determination of Optic axial angle (2V).

Unit 3

- Mineralogical expression of radioactivity – metamictization, fracturing, discoloration, pleochroic haloes and fission tracks
- Chemical classification of minerals. AAS, X, ICP, Electron probe micro analysis,scanning and transmission electron microscopy.

Unit 4

- Rock and Ore forming minerals: Structure, P-T stabilities, paragenesis and mode of alteration of silicates, oxides, carbonates, phosphates, sulphates and halides.

Unit 5

- Earth mineralogy: Average mineralogical composition of crust and mantle.
- Mineral transformations in the mantle with depth.

Reference:-

1.Deer, W.A., Howie, R.A. & Zussman, J. 1962. Rock forming minerals. Vol. 1 to 5. Longmans, London.

2. Blackburn, W.H. & Dennen, W.H. 1988. Principles of mineralogy. WCM Publishers, Iowa.

3. Kerr, P.F. 1959. Optical mineralogy. 3rd edition. McGraw Hill, New York.

4. Winchell, A.N. & Winchell, H. 1951. Elements of optical mineralogy. Part II. 4th edition.
Wiley, New York.

GLO7IB13 - ADVANCED GEOMORPHOLOGY

Credit: 4 **Total Hours: 64**

Course outcome:

Students will be able to understand about
CO1: Various geomorphological principles and processes
CO2: Tectonic geomorphology
CO3: Practical Applications of geomorphological studies in various fields
CO4: Geomorphic features of India and Kerala

Unit 1

- Introduction: geomorphic principles and processes.
- Theory of uniformitarianism, Control of geomorphological features by geological structures, lithology, diastrophism, climate and time.
- Human effects on geomorphic processes
- Ocean Basin Shape: Heat Conduction; Ocean Basin Shape
- Contraction and Isostasy

Unit 2

- Tectonic Geomorphology: Crustal Change and Faulting - Crustal Thickening, Erosion, and Mantle Response; Fault-Scale Tectonic Deformation
- Deformation and Flexure - Paleo seismology; Geomorphic Evidence of Long-term Deformation; Flexure of the Lithosphere

Unit 3

- Hillslopes: forms relation to lithology and structural weakness in rock, environmental control and mass movement, modification by overland flow of hillslopes.
- Applied Geomorphology: Application of Geomorphology in Civil Engineering, Hydrogeology, and Environmental Studies

Unit 4

- Wetlands Geological significance, classification and mode of formation. The Indian scenario conservation and management in India. Backwaters (Kayals) of Kerala.
- Soils formation, classification, soil profile, soils of Kerala.
- Geomorphology of Kerala classification, relief features, geological Significance, rivers of Kerala.

Unit 5

- Geomorphic features of India: Extra-Peninsular region, Indo-Gangetic plain and Peninsula - their geomorphic evolution.
- Environmental geomorphology: elementary concept.

References

1.W.D. Thornbury (1969) Principles of Geomorphology. Wiley Eastern Ltd. New Delhi.

2. H.S. Sharma (1990) Indian Geomorphology. Concept Pub. Co., New Delhi.

3. L.B.Leopold (1976) FluviaL processes in geomorphology. E.P.H.Publishing House, New Delhi.

4. Duff, P.Mc L. D. (Ed) (1992) Holmes principles of physical geology. 4th edition, Chapman & Hall, London.

5.Anderson, R.S. & S.P. Anderson, 2010, Mechanics and Chemistry of Landscapes, Cambridge University Press.

6. Anderson, R.S., The Little Book of Geomorphology - available as a ~15MB download from: http://instaar.colorado.edu/~andersrs/The_little_book_010708_print.pdf

GLO7IB14 – ADVANCED IGNEOUS AND METAMORPHIC PETROLOGY

Credit: 4 **Total Hours: 80**

Course outcome:

Students will be able to understand about

CO1: The significance of texture and structure of igneous rocks
CO2: The application of phase rule in silicate systems
CO3: Phase diagrams study helps to understand the course of crystallization of various chemical systems
CO4: Classification of igneous rocks
CO5: The detailed learning of metamorphism in space and time

Unit 1.

- Introduction: Concept of heat and temperature inside the Earth. Melting and crystallization.
- Magma and magmatic processes.
- Major, minor, trace and rare earth element geochemistry of igneous rocks. Significance of isotopic studies in the petrogenesis of igneous rocks.
- Genetic significance of the textures and structures of the igneous rocks.

Unit 2

- Classification of igneous rocks- concept of mode and norm,
- Differentiation Index IUGS diagrams, TAS classification of volcanic rocks.
- Mineralogical and chemical description and significance of important igneous rocks of continental and oceanic association.

Unit 3.

- Phase rule and concept of phase diagrams- Unary, Binary, Ternary, Quaternary.
- Study of the course of crystallisation of the following ternary systems: Forsterite-Diopside – Silica, Forsterite - Anorthite - Silica, Diopside - Anorthite – Albite, Albite – Anorthite - Orthoclase, MgO - Al_2O_3 - SiO_2. Quaternary System, Di- An- Ab- Fo.

Unit 4.

- Concept of metamorphism- Changes in pressure and temperature.
- Equilibrium and non-equilibrium reactions.
- Agents of metamorphism.
- Types of metamorphism, metamorphic grade and facies of metamorphism.

Unit 5.

- Solid-solid reactions, Genetic significance of textures and structures of metamorphism.
- Application of thermodynamics in metamorphic rock formation.

- Paired metamorphic Belts and plate tectonics.
- Mineral paragenesis- Graphical representation of metamorphic mineral paragenesis, composition plotting ACF, AKF, AFM. Diagrams.

Reference:-

1. Best, M.G., 2002, Igneous and metamorphic petrology, 2nd Edition, Blackwell Publishers
2. Philpots A.R., 1990, Principles of Igneous and metamorphic petrology, Prentice Hall.2.
3. Yardley, B.W., 1989, An introduction to metamorphic petrology, Longman
4. Tyrrell, G.W. 1978 -Principles of petrology – Chapman and Hall Ltd., London.
5.Mihir K.Boss- Igneous Petrology

GLO7IB15 - ADVANCED STRATIGRAPHY

Credit: 4 **Total Hours: 80**

Course outcome:

Students will be able to understand about
CO1: Detailed stratigraphy concepts and processes
CO2: Major Extinctions in Present Eon
CO3: Detailed Stratigraphy of India
CO4: Detailed Geology of India

Unit 1

- Development of stratigraphic concepts
- Stratigraphic classification & nomenclature, study of stratigraphic elements
- Stratification: processes controlling stratification- physical, chemical and biological
- Vertical succession, lithological uniformity, heterogeneity, patterned succession, alternations, varve's, cycles (symmetrical and asymmetrical)
- Lateral variations and facies concept
- Unconformity
- Methods of Correlation: Shaw's Graphic Correlation
- Brief ideas of Magnetostratigraphy, cyclostratigraphy, pedostratigraphy, chemostratigraphy and sequence stratigraphy
- Major Extinction events in Phanerozoic Eon
- K-T Boundary extinction and its causes

Unit 2.

- Precambrian Stratigraphy; Precambrian geochronology; Archean Geology of India: (i) Dharwar Craton, (ii) Singhbhum Craton; Proterozoic Geology of India: (i) Central Indian Tectonic Zone, (ii) Vindhyan Supergroup, (iii) Cuddapah Supergroup; PrecambrianCambrian boundary.

Unit 3

- Paleozoic Stratigraphy; Igneous activities and paleogeography during the Paleozoic Era; Paleozoic of Kashmir; Permian-Triassic Boundary Concept, classification, fauna, flora and age limits of Gondwana Supergroup and related paleogeography, paleoclimate, and depositional characteristics

Unit 4

- Mesozoic Stratigraphy; Classification, depositional characteristics, fauna, and flora of: Triassic of Spiti, Jurassic of Kutch, Cretaceous of Trichinapalli; Deccan Volcanic Province; Cretaceous- Tertiary Boundary.

Unit 5

- Cenozoic Stratigraphy; Paleogene Systems of India; Neogene Systems of India; Evolution of Himalayas; Siwalik Supergroup; Pleistocene-Holocene Boundary; Concept of Meghalayan.
- Detailed Geology of Kerala

Reference:-

- Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.
- Danbar, C.O. and Rodgers, J. (1957): Principles of Stratigraphy, John Wiley and Sons.
- Doyle, P. and Bennett. M.R. (1996): Unlocking the Stratigraphic Record, John Wiley and Sons.
- Harold L. Lewis (1987): Earth through Time; 3rd Edition. Saunders College Publishing, New York
- K. S. Valdiya (2010): The Making of India-Geodynamic Evolution; Macmillan Publishers India Ltd.
- Krishnan, M.S. (1982): Geology of India and Burma, C.B.S. Publ. and Distributors, Delhi.
- M. Ramakrishnan and R. Vaidyanadhan (2008): Geology of India (Vol. I and II); Geological Society of India, Bangalore.
- M. S. Krishnan (1982), Geology of India and Burma; 6th Ed. CBS Publishers and Distributors (India).
- Naqvi, S.M. and Rogers, J.J.W. (1987): Precambrian Geology of India, Oxford University Press.
- Pascoe, E.H. (1968): A Manual of the Geology of India and Burma (Vols. I-IV), GSI, Govt. of India Press, Delhi.
- Pomerol, C. (1982): The Cenozoic Era? Tertiary and Quaternary, Ellis Harwood Ltd., Halsted Press. Schoch,
- Robert, M. (1989): Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.
- Roy, R. Lemon (1990): Principles of Stratigraphy; Merrill Publishing Company, Ohio
- Wadia, D.N. (1984), Geology of India; 4th edition. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

GLO8IB16 - ADVANCED STRUCTURAL GEOLOGY

Credit: 4 **Total Hours: 96**

Course outcome:

Students will be able to understand about
CO1: Mathematical explanation of structural features
CO2: Plotting of linear and planar structures
CO3: Structural analysis of geological features

Unit 1

- Stress and Strain: Mechanical properties of rocks. Two dimensional stress and strain analyses. Relationships for elastic, plastic and viscous materials; Strain and displacement
- Graphical representation of finite strain: Strain ellipsoid; Flinn diagram and Mohrs circle. Types of strain ellipsoids and their geological significance.
- Strain analysis of naturally deformed rocks. Rheology.
- Geological mapping and map reading; Attitudes of planes and lines and their representation.

Unit 2

- Folds: Mechanics of folding; Geometric classification after Ramsay; Genetic classification after Donath and Parker
- Minor folds and their uses in determining the major fold structure; Pumpelley's rule. Evidence of buckling. Interference patterns of superposed fold.
- Distribution of strains in folds.

Unit 3

- Faults: Dynamics of faulting; Displacement, slip and separation
- Fault geometry and classification; Characteristics of faults and fault zones.
- Causes and dynamics of faulting. Strain significance of faults.Fault-related folding.
- Shear zones: Strain variation in shear zones. Shear sense indicators. Brittle and ductile shear zones, geometry and products of shear zones; shear sense indicators; Mylonites and cataclasites, their origin and significance.
- Crustal scale faults: Strike-slip, transpression, and transtension

Unit 4

- Joints and fractures: Distinction; Joint formation in response to loading and stress; Fracture development and propagation;
- Classification of joints and extension fractures.
- Analysis of joints and their tectonic significance.
- Unconformity:Importance of unconformity in tectonostratigraphic correlation.

Unit 5

- Tectonites: Fabric elements and classification; L-, L-S and S-tectonic fabrics.; Petrofabric analysis.
- Structural analysis: Principles and elements of structural analysis.
- Geometrical analysis of simple and complex structures on mesoscopic to macroscopic scale. Gravity induced structures.
- Stereographic projections: linear and planar features.

References:

1. Ramsay, J.G. & Huber, M.I. 1983. The Techniques of modern structural geology. V.1. Strain Analysis.

2. Ramsay, J.G. & Huber, M.I. 1987. The Techniques of modern structural geology. V.2. Folds and Fractures.

3. Park, R.G. Foundations of structural geology.

4. Turner, F.J. & Weiss, L.E. 1963. Structural analysis of metamorphic tectonites.

5. Price, N.J. & Cosgrove, J.W. 1990. Analysis of Geological structures. Cambridge University Press.

6. Davis, G.H. 1984. Structural Geology of Rocks and Regions.

7. Ghosh, S.K. 1993. Structural Geology: Fundamentals and modern developments.

8. Suppe, J. 1985 Principles of structural geology. Printice-Hall.

9. Fossen H. Structural Geology , Cambridge University press

10. Ragan D. M., Structural Geology , Cambridge University press

11. Billings M. P. Structural Geology, 1960, 514 pp

GLO8IB17 - EXPLORATION GEOPHYSICS AND FIELD TECHNIQUES

Credit: 4 **Total Hours: 96**

Course outcome:

Students will be able to understand about

CO1: Gravity methods exploration
CO2: Magnetic method exploration
CO3: Seismic method exploration
CO4: Radiometric method exploration

Unit 1

- Scope of exploration geophysics – physical properties of the earth – Electrical methods – SP, IP, EM and Resistivity - methods of electrode arrangement – field methods – interpretation – application
- FIELD TECHNIQUES: - Resistivity surveys – Wenner and Schlumberger methods – electrical sounding and profiling – problems on these methods –methods –calculation of auxiliary point - SP methods - Interpretation of data – curve matching use of standard computer packages in interpretation

Unit 2

- Gravity methods - Principle –density and rock types-- regional and local anomalies - field methods – gravimeters – corrections – interpretation of gravity data – determination of shape and depth of ore bodies — corrections & applications – GRACE mission
- FIELD TECHNIQUES:- Problems on gravity methods - Preparation of anomaly maps - methods of corrections.

Unit 3

- Magnetic methods – principle - field procedure – magnetometers – interpretation of magnetic data – size and shape of bodies – correction of magnetic data - applications - airborne geophysical surveys
- FIELD TECHNIQUES:- Problems on magnetic methods – preparation of anomaly maps – methods of corrections

Unit 4

- Seismic method: Seismic waves – elastic properties of materials - travel velocity in various geological formations – principles – field operation – refraction and reflection survey – correction of seismic data – methods of interpretation – determination of attitude and depth of formations – various types of shooting

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

Unit 5

- Radiometric method: Fundamentals of radioactivity – principle of radioactivity methods – types of counters – field methods and interpretation – Well logging - Self potential – resistivity – radioactivity logging methods – caliper and other miscellaneous logging methods – field procedure and interpretation of data
- FIELD TECHNIQUES: - Radioactive methods - problems on well logging – interpretation of data.

REFERENCES

1. Arnaud Gerkens, J. C. d'. Foundation of exploration geophysics. Amsterdam ; New York : Elsevier ; New York, NY, U.S.A, 1989.

2. Burger, H.R., Exploration Geophysics of the Shallow Subsurface, Prentice Hall, 1992.

3. Dobrin, M.B An introduction to geophysical prospecting, McGraw Hill, New Delhi,1984

4. Ramachandra Rao, M.B. Outline of geophysical prospecting. Wesley press, Mysore, 1975

5. Rama Rao, B.S and Murthy I.B.R Gravity and magnetic methods of prospecting. Arnold Heinmann Pub. New Delhi, 1978

6. Robinson, Edwin S., Cahit Coruh, Basic exploration geophysics. New York : Wiley, 1988.

GLO8IB18 – ADVANCED ECONOMIC GEOLOGY

Credit: 4 **Total Hours: 96**

Course outcome:

Students will be able to understand about

CO1: Mineral deposits in detail
CO2: Metallogenesis process
CO3: Uranium and Thorium deposits of India

Unit 1

- Mineral deposits – types, morphology and forms of ore bodies.
- Source of ore forming material. Physico-chemical environment of ore formation.
- Genetic classification of mineral deposits. Magmatic Ore Deposits- Chromite, Magnetite and Platinum Group Element Deposits of the Bushveld Complex.
- Hydrothermal Deposits; Volcanogenic Massive Sulfide (VMS), Porphyry, Sedimentary Exhalative (SEDEX), Mississippi Valley Type (MVT) Deposits. Iron-Oxide Copper Gold (IOCG) Deposits

Unit 2

- Ore microscope - Polishing and mounting of ores. Mineralogical, trace element and stable isotope geothermometers; fluid inclusion studies.
- Physical and optical properties of important ore minerals.
- Textures and structures of ore and gangue minerals.
- Ore genesis. Paragenetic sequences,zoning. Metallogenic epochs and provinces. Ore forming solutions and their migration.

Unit 3

- Global Tectonics and Metallogeny; Patterns in the distribution of mineral deposits,
- Crustal evolution and metallogenesis, Metallogeny through time, Plate tectonics and ore deposits.
- Strata bound and stratiform ore deposits - distribution, form, setting and origin

Unit 4

- Nature and origin of mineral deposits associated with different rocks and their Indian examples: magmatic deposits in ultramafic, mafic and felsic association; Anorthosite - Fe - Titanium oxide distribution, setting, constitution and origin.
- Post-magmatic deposits; sedimentary deposits; syn-sedimentary deposits; deposits formed in a near surface environment by residual concentration and mechanical concentration- Placer Deposits, Sedimentary Fe Deposits.
- Infiltration and supergene enrichment, Metamorphic and metamorphosed deposits.

Unit 5

- Genetic classification of U and Th deposits.
- Geology and genesis of U deposits of Jaduguda.Pb - Zn deposits of Rajasthan, Cu deposits of Singhbhum and Malanjkhand, East coast Bauxite,Iron ore deposits of Bailadila and Kundremukh.
- Brief introduction to gas hydrates.
- Strategic, critical and essential minerals of India; National mineral policy of India.

References:

1. Barnes, H.L. (Ed.). 1997. Geochemistry of hydrothermal ore deposits. John Wiley & Sons.
2. Craig, J.R. & Vaughan, 1994. Ore microscopy and ore petrography. John Wiley & Sons.
3. Evans, A.M. 1992. Ore geology and industrial minerals. Blackwell Science.
4. Jensen, M.L. & Bateman, A.M. 1981. Economic mineral deposits. John Wiley & Sons.
5. Misra, K.C. 1999. Understanding mineral deposits. Kluwer Academic Publishers.
6. Mookherjee, A. 1998. Ore genesis – a holistic approach. Allied Publishers.
7. Stanton, R.L. 1981. Ore Petrology. Mcgraw Hill.
8. Nicholas Arndtand Clement Ganino. 2012. Metals and Society—An Introduction to Economic Geology, Springer Verlag, Berlin Heidelberg. Pp. 160. ISBN 978-3-642-22995-4.
9. Laurence Robb, 2004. Introduction to ore-forming processes. Blackwell science ltd., malden, ma, 373 p.
10. 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, Pp. 550.

GLO9IB19 - APPLIED SEDIMENTOLOGY

Credit: 4 **Total Hours: 80**

Course outcome:

Students will be able to understand

CO1: Principles in fluid dynamics relevant for transport and deposition of sediments.
CO2: Formation of different sedimentary structures.
CO3: How sediments are converted into sedimentary rocks.
CO4: Methods of formations of siliciclastic sediments and carbonate sediments.
CO5: Use composition of the rock and sedimentary structures to interpret sedimentary processes.
CO6: Defined geological terms to describe sedimentary structures, textures and processes

Unit 1

- Sedimentary processes: weathering, sediment transport by fluids. Simple fluid flow concept.
- Textures of clastic and non-clastic rocks.
- Sedimentary structures: classification, genesis and significance.
- Use of structures and textures in basin studies.

Unit 2

- Description and classification of siliciclastic rocks; sediment maturity; introduction to stream flow; grain transport and deposition
- Sedimentary environment: physical and chemical properties of depositional environment and its classification.
- Lithologies, structures and vertical sequences formed in fluvial, deltaic, coastal, deep sea, glacial, aeolian and carbonate depositional environments
- Processes that influence the formation of sediments and sedimentary rocks, as well as focusing on the physical, chemical, and biological aspects of sediments and sedimentary rocks.

Unit 3

- Provenance: light minerals, heavy minerals and insoluble residue in provenance studies and correlation of sedimentary rocks.
- Diagenesis: compaction, cementation, chemical alteration and recrystallisation.
- Sedimentation and Tectonics: tectonic control of sedimentation. Geosynclines and their lithological associations.
- Plate Tectonics in relation to type and evolution of basins. Sedimentary basins-classifications, introduction to basin analysis. Post-depositional sedimentary processes- clastic and carbonate diagenesis

Unit 4

- Clay Minerals: classification, techniques of identification, diagenesis and use in environmental interpretation.

Unit 5

- Analytical techniques in sedimentology

Reference

- F.J. Pettijohn (1975) Sedimentary rocks. Harper and Row Publ., New Delhi.
- Blatt, Middleton & Murray (1980) Origin of sedimentary rocks. Printice Hall Inc.
- J.D. Collins and D.B. Thompson (1982) Sedimentary Structures. George Allen & Unwin, London.
- M.E. Tucker (1981) Sedimentary Petrology: an introduction. John Willey & Sons, New York.
- Collinson, J., Mountney, N., Thompson, D., Sedimentary Structures, Terra Publishing, 3rd Edn., 2006
- Nicholls, G. Sedimentology and Stratigraphy. Wiley-Blackwell, 1999
- Prothero, D.R. and Schwab, F. Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy, 2nd Edn., W.H. Freeman, 2003
- Selley, R.C., Applied sedimentology, 2nd Edn., Academic Press, 2000
- Tucker, M.E. Sedimentary Petrology, 3rd Edn., Blackwell Science, 2001

GLO9IB20 - HYDROGEOLOGY

Credit: 4 **Total Hours: 80**

Course outcome:

Students will be able to understand

CO1: The relation between Geology and hydrogeology
CO2: The occurrence of groundwater in different types of rocks
CO3: Quality criteria of ground water
CO4: Methods of ground water recharge
CO5: Different methods of ground water prospecting

Unit 1

- Geology and Hydrogeology and their relationship.
- Surface and sub-surface distribution of water, aquifers, aquicludes, aquitard, aquifuge.
- Physical properties of reservoir rocks.
- Darcy's law and its range validity.
- Groundwater flow under steady and unsteady conditions.
- Occurrence of groundwater in different rock types.

Unit 2

- Fresh and saltwater relationship in coastal areas.
- Ghyzen-Herzberg principle. Prevention and control of sea water intrusion.
- Overexploitation of groundwater. Groundwater contamination and pollution.

Unit 3

- Quality and geochemistry of groundwater.
- Groundwater exploration and management.
- Natural and artificial recharge of groundwater.
- Modelling of aquifer systems.

Unit 4

- Critical velocity ratio, Bligh's Creep Theory for Seepage Flow, Measurement of Precipitation, Hydrograph and Runoff, Well Hydraulics

Unit 5

- Groundwater prospecting - Gravity, resistivity surveys, Magneto-tellurics; Water divining and other historical methods. Pumping tests and well yield.

Reference: -

1.Todd, D.K. 1988. Groundwater Hydrology. John Willey and Sons.
2. Davis, S.N. & De Wiest, R.J.N. 1966. Hydrogeology. John Wiley & Sons, New York.
3. Raghunath, H.M. 1983. Groundwater. Willey Eastern, Calcutta.

GLO9IB21 - ADVANCED REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM

Credit: 4 **Total Hours: 64**

Course outcome:

Students will be able to understand

CO1: The process of digital Image processing and image classification
CO2: Fundamental interaction of electromagnetic radiation with earth surface objects.
CO3: Different type of remote sensing data products and analysis technique and select the more appropriate to solve a real-world problem.
CO4: Various kind of data from several sources and analyses using GIS concept and tools
CO6: Quantitative remote-sensing principles and integrate different tools GIS for remote sensing data analysis.

Unit 1

- Multispectral Remote Sensing,Types of satellite imageries.
- Introduction to satellite/digital image processing: concept of digital images, data acquisition, image registration, radiometric and geometric correction of satellite data, Image enhancement techniques, image transformation- Principal Component Analysis (PCA), Intensity Hue Saturation (IHS), Brovey method and Wavelet transformation.
- Image classification: Supervised classification and Unsupervised classification, Advantages, Disadvantages and limitations, Accuracy assessment; principles of Remote sensing in geology, Spectral characteristics of rocks and minerals

Unit 2

- Hyperspectral remote sensing, Spectral Signatures and BRDF in the Visible, Near Infrared and Shortwave Infrared regions of EMR, Hyperspectral Issues.
- Hyperspectral Data cube. Radiation science basics - Thermal radiation principles, thermal interaction behavior of terrain elements, thermal sensors and specifications; Image characters, spatial and radiometry; interpretation of thermal image; Comparison of Multispectral, Hyperspectral and thermal Image Data

Unit 3

- Introduction to microwave remote sensing – concept and principle; Interactions between radar and surface materials - complex dielectric properties, roughness polarization; Passive & active microwave remote sensing
- Application of microwave remote sensing and microwave image interpretation.

Unit 4

- Introduction to Geographic Resources Analysis Support System (GRASS)

- GIS - Raster data handling – Reclassification, recode - map algebra - Resampling and interpolation of raster data – Overlaying - Spatial analysis Neighborhood analysis and cross-category statistics - Buffering - Cost surfaces - Terrain and watershed analysis – Modeling raster data – Vector data handling - Topological operations – Buffering – Overlay – Dissolve – clip,union intersect – Network analysis – Spatial interpolation – handling lidar point cloud data
- Drainage mapping and morphometric analysis
- Digital elevation model (DEM) in hydrological modelling using GIS, Integration of Remote Sensing and GIS, Water quality monitoring and hydrogeological modeling using GIS.
- Database design; analysis for urban and regional resource mapping, Urban hazards and risk management through GIS

Unit 5

- Concept of Digital Elevation model, Digital elevation model (DEM) in hydrological modelling using GIS.
- Integration of Remote Sensing and GIS. Database design & analysis for urban and regional resource mapping, Urban hazards and risk management through GIS

References

1.Remote sensing and image interpretation by Lillisand, T. M. and Keifer, R. W., 2007, John Willey and Sons, USA

2. Introduction to environmental remote sensing by Barrett, E. C. and Curtis L. F., 1999, Chapman and Hall Publishers, USA.

3. Fundamentals of remote sensing by Joseph G., 2003, Universities Press, Hyderabad.

4. Introduction to geographic information systems by Chang, Kang-taung, 2002, Tata McGraw-
Hill, USA.

GLO10IB22 - ADVANCED PALAEONTOLOGY

Credit: 4 **Total Hours: 80**

Course outcome:

Students will be able to understand

CO1: The concept of adaptation and functional morphology
CO2: Evolution of man and vertebrate fossils of India
CO3: Application of micropalaeontology and sampling methods
CO4: Identification and uses of important microfossils

Unit 1:

- Species concept, Describing Single specimen, Ontogenetic variations, The population as a unit; the species as a unit, Grouping of species into higher categories.
- Adaptation and functional morphology

Unit 2:

- Trace fossils, Evolution of Vertebrates, Siwalik Mammals
- Evolution of Man, Cretaceous Vertebrates,
- Important Gondwana, Intertrappean and Tertiaries flora of India,

Unit 3:

- Subsurface and surface sampling methods, processing of samples.
- Paleoenvironmental interpretation using microfossils, Role of Micropaleontology in Hydrocarbon exploration.

Unit 4:

- Morphology, Classification and evolution of Foraminifera; Stratigraphy of foraminifera with special reference to India, Stable isotopic study of foraminifera and interpretation of paleo ecology, spores and pollens.

UNIT 5:

- Morphology and geological distribution of Ostracoda, Radiolaria, Calcareous algae, calcareous nannofossils, Diatoms, Dinoflagellate. deep sea records

References:

1. G.H.B von Koenigswald, J.D. Ernies W.L Buning C. W. Wange (Editors), Evolutionary Trends in Foraminifera, Elsevier, 1963
2. Ager, D.V., Principles of Palaeontology, McGraw Hill, 1963

3. Arkell, W. J., Jurassic Geology of the World, Oliver and Boyd, 1960
4. Brouwer A., General Palaeontology. Olier and Boyd, 1967
5. Colebert H. Edwin, Evolution of the vertebrates, John Wiley and Sons, 1961
6. Cushman A. Joseph, Foraminifera, Harvvard University Press, 1959
7. Woods Henry, Invertebrate Palaeontology, Cambridge University Press, 1961
8. Zittel Karl A. Von, Text Book of Palaeontology, Parts I and II, McMillan, 1964.
9. Noa Version, Stratigraphic Principles of Palaeontology, Oxford University Press, 1952
10. John J. Daniel, Introduction to Microfossils, Harper and Brothers, 1956
11. Moore R.C., Lalicker C.G., Fisher A.G., Invertebrate Fossils, McGraw Hill, 1952

GLO10IB23 - GEOCHEMISTRY AND ISOTOPE GEOLOGY

Credit: 4 **Total Hours: 80**

Course Outcome:

Students will be able to understand

CO1: Origin of solar system and geochemical of elements in earth
CO2: Thermodynamic control over the distribution of elements
CO2: Chemical parameters of water and its calculations
CO3: Radioactive decay and dating methods
CO4: Stable isotope geochemistry and their applications

Unit 1

- Different processes of nucleosynthesis Meteorites, Chondrites and chondritic ratios.
- Origin of the solar system and distribution of elements with respect to distance from the Sun. Geochemical and Cosmo chemical classification of elements

Unit 2

- Thermodynamics and thermodynamic control on distribution of chemical species (between coexisting phases).
- Thermodynamics of mixing and solutions. Kinetics and metastability. Clapeyron equation. Simple thermodynamic calculations involving phase changes and equilibrium reactions.

Unit 3

- Aqueous geochemistry: Molarity and molality, solubility product and solubility, acids and bases, dissociation constant, pH, hydrolysis, ionic concentration. CO2-H2O interaction to form carbonic acid, dissolution of calcite, weathering reactions.

Unit 4

- Discovery of radioactivity, stable and radiogenic isotopes Nuclear structure and energies.
- Stability of nuclides. Radioactive decay schemes. Decay constant, half life, parent-daughter relations.
- Methods of dating: Isochron method, model/mineral ages, Fission track, 40Ar-39Ar, U and Th disequilibrium, choncordia method, 14C, Be and Al.
- Interpretation and geological significance of ages.
- Isotope systematics of K-Ar, Rb-Sr, Sm-Nd, U-Th-Pb in igneous, metamorphic and sedimentary rocks and in evolution of ocean, crust and mantle. Short-lived isotopes..

Unit 5

- Stable isotopes: Isotopes of oxygen and hydrogen, carbon, nitrogen and sulphur.
- Processes of isotope fractionation, fractionation factor. O isotopes: fractionation in the hydrologic cycle, paleoclimatology.
- C and N isotopes fractionation in biological processes.
- Use of S isotopes in ore geology. Stable isotope geothermometry and geobarometry.
- Isotopes in mineral exploration, petroleum exploration, paleo-climate evaluation, health and environmental aspects.

Reference

1. Faure, G. (1986). Principles of Isotope Geology. John Wiley, 589p.
2. Doe, B.R. (1970) Lead isotopes. Springer Verlag, 137p.
3. Faure, G. and Powell, J.L. (1972) Strontium Isotope Geology. Springer Verlag, 188p.

CORE COURSE: GEOLOGY
(PRACTICALS)

GLO1IH01(P) - FIELD GEOLOGY

Credit: 0 **Total Hours: 32**

Course outcome:

Students will be able to

CO1: Read a Survey of India Toposheet
CO2: Decipher Different information's in the Toposheet
CO3: Identify Structural features in the Toposheets
CO4: Understand different Geological Instruments and their use in Field

- Description of features in Survey of India toposheet.
- Study of marginal information.
- Interpretation of intramarginal and extramarginal information.
- Study of geological conventional signs, symbols, physical and socio-cultural features.
- Instructional training on uses of Clinometer, Brunton compass and GPS.

GLO2IH02(P) - GEOMORPHOLOGY

Credit: 0 **Total Hours: 32**

Course outcome:

Students will be able to

CO1: Witness natural examples which are studied in the theory classes
CO2: Geomorphology of the adjacent areas

- Field trip to understand the geomorphology and topography of an adjacent locality.
- Report preparation on field trip

GLO3IH03(P) - CRYSTALLOGRAPHY

Credit: 0 **Total Hours: 48**

Course outcome:

Students will be able to

CO1: Identify the axial disposition, axial relationship and axial analysis of crystal systems
CO2: Identification and description of crystal models in normal class.
CO3: Identification and description of simple twin models

Crystallography

- Study of axial disposition, axial relationship and axial analysis of crystal systems.
- Classification of normal classes of all systems by studying the symmetry elements.
- Identification and description of the following crystal models in normal classes only.
- Isometric system: Galena, garnet, Fluorite, Magnetite.
- Tetragonal System: Zircon, Cassiterite, Rutile, Octahedrite, Apophyllite.
- Hexagonal: Beryl, Calcite.
- Orthorhombic: Olivine, Topaz, Barite.
- Monoclinic: Gypsum, Orthoclase, Augite, Amphibole.
- Triclinic: Axinite, Albite, Kyanite.
- Study of simple twin models.
- Galena-Flourite-Pyrite-rutile-calcite-quartz-staurolite-Gypsum-augite-orthoclase-albite-Calamine
- Study of axial disposition, axial relationship and axial analysis of crystal systems.

GLO4IH04(P) – CRYSTALLOGRAPHY AND MINERALOGY

Credit: 3 **Total Hours: 48**

Course outcome:

Students will be able to

CO1: Identify the axial disposition, axial relationship and axial analysis of crystal systems
CO2: Identification and description of crystal models in normal class.
CO3: Identification and description of simple twin models
CO4: Identification of mineral specimens based on physical properties.
CO5: Identification of mineral thin sections.

*This course will include the practical component of the course GLO3IH03(P) – Crystallography

Mineralogy

Megascopic identification:

Megascopic identification and description of the following: Quartz, smoky quartz, milky Quartz, Rosy quartz, Amethyst, Chalcedony, Agate, Flint, Jasper, Chert, Opal, Orthoclase, Microcline, Albite, Oligoclase, Labradorite, Nepheline, Leucite, Sodalite, Enstatite, Bronzite, Hypersthene, Diopside, Augite, Spodumene, Acmite, Rhodonite, Wollastonite, Anthophyllite, Tremolite, Actinolite, Hornblende, Olivine, Serpentine, Muscovite, Biotite, Vermiculite, Phlogpite, Chlorite, Epidote, Garnet, Natrolite, Stilbite, Apophyllite, Talc, Steatite, Andalusite, Kyanite, Sillimanite, Staurolite, Cordierite, Apatite, Beryl, Topaz, Calcite, Dolomite, Tourmaline, Zircon, Fluorite.

Microscopic identification:

Microscopic identification and description of the following: Quartz, smoky quartz, milky Quartz, Rosy quartz, Amethyst, Chalcedony, Agate, Flint, Jasper, Chert, Opal, Orthoclase, Microcline, Albite, Oligoclase, Labradorite, Nepheline, Leucite, Sodalite, Enstatite, Bronzite, Hypersthene, Diopside, Augite, Spodumene, Acmite, Rhodonite, Wollastonite, Anthophyllite, Tremolite, Actinolite, Hornblende, Olivine, Serpentine, Muscovite, Biotite, Vermiculite, Phlogpite, Chlorite, Epidote, Garnet, Natrolite, Stilbite, Apophyllite, Talc, Steatite, Andalusite, Kyanite, Sillimanite, Staurolite, Cordierite, Apatite, Beryl, Topaz, Calcite, Dolomite, Tourmaline, Zircon, Fluorite.

GLO5IH05(P) - PETROLOGY

Credit: 4 **Total Hours: 64**

Course outcome:

Students will be able to

CO1: Identify and describe important igneous rock specimens in hand and thin section.
CO2: Identify and describe important Metamorphic rock specimens in hand and thin section.
CO3: Identify and describe important Sedimentary rock specimens in hand and thin section.
CO4: Identify different structures and textures of igneous rocks
CO5: Identify different structures and textures of metamorphic rocks
CO6: Identify different structures and textures of sedimentary rocks

Megascopic identification and description of the following rocks:

Granite, Graphic granite, Pegmatite, Aplite, Granite Porphyry, Syenite, Syenite porphyry, Diorite, Gabbro, Anorthosite, Dunite, Pyroxenite, Dolerite, Basalt, Rhyolite, Felsites, Obsidian, Pumice, Scoria.

Slate, Phyllite, Schists, Gneisses, Quartzite, Marble, Amphibolite, Eclogite, Leptynite, Charnockite, Khondalite, Schorl rock, Banded Magnetite Quartzite

Conglomerate, Breccia, Sandstone, Arkose, Shale, Limestone, Laterite, Chert, Grit, Lignite.

Microscopic identification and description of the following rocks:

Mica Granite, Hornblende Granite, Graphic Granite, Syenite, Nepheline Syenite, Diorite, Gabbro, Dunite, Peridotite, Granite porphyry, Diorite, Dolerite, Anorthosite, Basalt.

Slate, Chlorite schist, Mica schist, Kyanite schist, Charnockite, Eclogite, Amphibolite, Khondalite, Augen Gneiss, Garnet Biotite Gneiss,

Conglomerate, Breccia, Sandstone, Arkose, Shell limestone.

GLO5IH06(P) – STRUCTURAL GEOLOGY

Credit: 4 **Total Hours: 64**

Course outcome:

Students will be able to

CO1: Identify and explain different types of geological structures in the field, their geometries and types, and relate them to distinct deformation regime.
CO2: Draw, interpret geological maps, construct geological cross sections, read topographic maps.
CO3: Determine the thickness, width of an outcrop, attitude of a formation both by construction and calculation methods.
CO4: Identify different types of geological structures in the map (horizontal bed, inclined bed, fold, fault, unconformity.

Illustration with the help of neat diagrams of the following:
Attitude of beds, true and apparent dip, strike and dip symbols, rules of 'V', types of Folds, Faults, Joints and Unconformities. Maps with suitable sections and geological descriptions

- Simple horizontal beds – two maps.
- Study of effect of relief on 'V' of outcrops – four maps.
- Simple dipping beds – three maps.
- Simple dipping beds with intrusions – three maps.
- Tracing the outcrops –with three point problems- Three maps.
- Problems involving bore hole data, thickness, dip and apparent dip –three maps.
- Simple dipping beds with unconformity – five maps.
- Folded beds – five maps.
- Maps with different types of faults –five numbers.
- Combination of intrusions, unconformity, folds and faults –six maps.

Structural problems:
Problems involving true and apparent dip, true vertical thickness and width of outcrops.
Three-point problems.

GLO6IH07(P) - ECONOMIC GEOLOGY AND PALEONTOLOGY

Credit: 3 **Total Hours: 64**

Course outcome:

Students will be able to

CO1: Identify the Common Economically important minerals in Hand Specimen
CO2: Identify megascopic fossils based on their morphological characters.

Economic Geology

Megascopic identification and description of Indian occurrences & uses of the following ore and industrial Minerals: -

- Sulphides: Realgar, Orpiment, Stibnite, Molybdenite, Galena, Sphalerite, Chalcophyrite, Pyrite, Arsenopyrite, Marcasite.
- Sulphates: Barite, Celestite, Gypsum,
- Oxides: Cuprite, Corundum, Hematite, Ilmenite, Magnetite, Chromite, Cassiterite, Rutile, Pyrolusite, Psilomelane, Goethite, Limonite, Bauxite,
- Carbonates: Calcite, Dolomite, Magnesite, Siderite, Aragonite, Witherite, Strontianite, Cerussite, Azurite, Malachite.
- Industrial Minerals: Halite, Fluorite, Phosphatic Nodule, Monazite, Graphite, Coal and its varities, Asbestos.

Paleontology

Megascopic identification and description of the following fossils with neat diagrams:-

- **Anthozoa:** Calceola, Zaphrentis, Lithostrotion, Favosites, Halysites, Montlivaltia, Isastrea, Thecosmilia;
- **Brachiopoda**: Sprifer, Productus, Terebratula, Rhynchonella, Athyris, Orthis, Lingula
- **Echinoderma**: Cidaris, Hemicidaris, Micraster, Holaster, Hemiaster, Pentremites,
- **Mollusca-Lamellibranchia**: Arca, Cardium, Cardita, Pecten, Trigonia, Megaladon,
- Spondylus, Gryphaea, Exogyra, Ostrea, Inoceramus, Alectryonia, Hippurities, Venus
- **Mollusca-Gastropoda:** Natica, Turbo, Trochus, Turritella, Cerithium, Conus, Murex, Fusus, Physa, Bellerophon,
- **Mollusca-Cepalopoda**: Nautilus, Goniatites, Ceratites, Acanthoceras, Phylloceras, Scaphites, Baculites, Turrilites and Belemnites,
- **Trilobites**: Paradoxides, Calymene, Phacops, Olenus, Olenellus.
- **Graptolites**: Phyllograptus, Tetragraptus, Didymograptus, Diplograptus, Monograptus,
- **Plant fossils**: Glossopteris, Gangamopteris, Ptillophylum, Lepidodendron, Sigillaria, Calamites, Elatocladus, Vertibraria.

GLO7IH08(P) – MINERALOGY, CRYSTALLOGRAPHY, GEOMORPHOLOGY, IGNEOUS AND METAMORPHIC PETROLOGY

Credit: 3 **Total Hours: 64**

Course outcome:

Students will be able to

CO1: Depict the angular relationships between crystal faces –Stereographic projections
CO2. Calculate Axial ratios,zone symbols, Napiers's rule ,Laws of anharmonic ratios
CO3: Identify Gnomonic projections of the normal class.
CO4: Identify mineral specimens based on physical properties
CO5: Determine different optical characters by classical methods.
CO6: Identify thin sections of important rock forming minerals
CO7: Prepare thin sections of igneous and metamorphic rock samples
CO8: Identify Petrography of igneous and metamorphic rocks.
CO9: Identify metamorphic mineral paragenesis in hand specimens and thin sections and arranging them according to the intensity of metamorphism

Crystallography:

Spherical projection of Cube, Octahedron and Dodecahedron.

Stereographic projection of holohedral classes of all the systems, pyritohedral, tetrahedral, plagiohcdral classes of Isometric system and Rhombohedral classes of Hexagonal system.

Gnomonic projections of the normal class of Isometric, Tetragonal, Hexagonal and Orthorhombic systems.

Calculations of Axial ratios, Zone symbols, Napier's rule, Laws of anharmonic ratio.

Mineralogy:

Identification of mineral specimens based on physical properties.
Determination of the following optical characters by classical methods:

- Order of interference colour
- Sign of elongation
- Birefringence
- Scheme of pleochroism
- Optic orientation
- Determination of the vibration directions of polariser and analyzer
- Extinction and extinction angle determination
- Optic sign
- Refractive index by Becke line method

- Identification of thin sections of important rock forming minerals

Recalculation of mineral formula from EPMA analysis – Garnet; Pyroxene; Feldspar; biotite; hornblende

Geomorphology:

Interpretation of toposheets and identification of geomorphic features, fluvial and coastal land forms. Calculation of surface area and slope. Study of drainage pattern and morphometric analysis.

Igneous and Metamorphic Petrology:

Preparation of thin sections of igneous and metamorphic rock samples. (2 nos. each). Petrography of igneous and metamorphic rocks. Textures and structures of igneous and metamorphic rocks and their genetic significance with neat sketches.

Determination of modal composition, Calculation of norm (25 exercises). Niggli values. Variation diagrams Harker, Larsen, Niggli. Calculation of Differentiation index. Peacock alkali-lime index. Use of triangular diagram in the classification of igneous rocks. Use of triangular diagram in the classification of igneous rocks.

Identification of metamorphic mineral paragenesis in hand specimens and thin sections and arranging them according to the intensity of metamorphism. Graphical representation of metamorphic mineral parageneses. ACF and AKF diagrams. AFM diagrams.

Construction of phase diagrams based on experimental data of the following systems- Albite-anorthite, Forsterite-fayalite, Diopside- anorthite, Diopside - albite, Forsterite -silica.

GLO8IH09(P) - STRUCTURAL GEOLOGY, GEOPHYSICS AND ECONOMIC GEOLOGY

Credit: 3 **Total Hours: 80**

Course outcome:

Students will be able to

CO1: Interpret geologic maps.
CO2: Learn stereographic solutions to problems in structural geology.
CO3: Understand geometric analysis of planar and linear structures
CO4: Identify ore mineral specimens using physical properties
CO5: Identify thin sections of important ore forming minerals

Structural Geology:

Interpretation of geologic maps. Trigonometric, graphic and stereographic solutions to problems in structural geology. Geometric analysis of planar and linear structures. Fabric diagrams, Rose diagrams and histograms

Geophysics

Electrical profiling and sounding. Gravity measurement at few selected points, study of the drift of gravimeter. Measurement of horizontal and vertical components of the earth's magnetic field. Simple exercises on seismic exploration.

Economic Geology:

Identification of important ore minerals. Collection and display of data on production, consumption and export of important minerals. Identification of ore minerals under ore microscope. Genetic significance of important ore.

GLO9IH10(P) – SEDIMENTOLOGY, HYDROGEOLOGY, REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

Credit: 3 **Total Hours: 48**

Course outcome:

Students will be able to

CO1: Learn sieve analysis, plotting and interpreting the data
CO2: Identify heavy minerals in thin section.
CO3: Do problems on Porosity, permeability, void ratio and Darcy's Law. Computation of aquifer parameters from pump test data.
CO4: Prepare and interpret water table contour maps.
CO5: Understand graphical representation of hydro chemical data.
CO6: Do hands on exercises on GIS software.

Sedimentology

Study of clastic and non-clastic rocks in hand specimen. Microscopic examination of important rock types. Separation of heavy minerals and study of their microscopic charcteristics.

Grain size analysis by sieving, plotting of size distribution data. Determination of roundness and sphericity of grains.

Hydrogeology

Preparation and interpretation of water table contour maps.
Problems on Porosity, permeability, void ratio and Darcy's Law. Computation of aquifer parameters from pump test data.
Graphical representation of hydro chemical data - Piper trilinear diagram, USSL Diagram, Stiffs polygon.
Calculation of various parameters based on chemical data, electrical resistivity survey and interpretation of data.

Remote Sensing and Geographic Information System

Georeferencing, Plotting of points, lines, polygons.

Length and area calculation

Map making – layout creation

Basics of digital image processing

Band combinations of satellite data

Gathering satellite images from USGS and Bhuvan

Extraction of features

Classification of features.

GLO10IH11(P) – ADVANCED PALAEONTOLOGY AND GEOCHEMISTRY

Credit: 3 **Total Hours: 48**

Course outcome:

Students will be able to

CO1: Identify different microfossils in thin section
CO2: Prepare microfossil slides of their own.
CO3: Determine different elements and oxides in rock samples/water samples.

Advanced Palaeontology

Separation of microfossils and preparation of slides of Ostracoda, Foraminifera and Bryozoa.
Identification and study of microfossils in slides, at least 10 Nos.

Geochemistry

Chemical Analysis of elements and oxides for Rock Sample/Sediments/Water samples using various methods (Titration, AASS, UV Spectrophotometer and Flame Photometer)
Calculation of isotope proportions in samples.
Determination of pH of groundwater samples
Calculation of bulk rock compositions from modal mineralogy and mineral chemistry
Calculation of $\delta 18O$ in water reservoirs and ice-cores
Calculation of palaeo sea-surface temperatures
Calculation of age of rock samples based on different decay schemes

CORE COURSE: ELECTIVE
(THEORY)

GLO6IE01(E01a) - REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

Credit: 3 **Total Hours: 64**

Course outcome:

Students will be able to understand about

CO1: Basics of Remote Sensing
CO2: Basic of Global Positioning System
CO3: Basic of Geographic Information System
CO4: Basics of Geographic Information System database

Unit-1:

- History and development of Remote Sensing. Basic concepts and principles of Remote Sensing.
- Introduction to electromagnetic radiation and electromagnetic spectrum. Interaction of EMR with objects and Atmosphere.
- Passive and Active remote sensing. Platforms and Sensors. Different resolutions concepts, pixel size and scale.

Unit-2

- Introduction to the basics of aerial photography and photogrammetry
- Introduction to GPS, Orbit elements, Types of orbits, Motions of planets and satellites
- Satellites and their characteristics, Sun synchronous and geo-synchronous satellites, basics of visual interpretation of satellite images and their keys.

Unit: 3

- Brief history of GIS; Introduction to GIS – definition, concepts and components of GIS,Geospatial data type
- GIS system, GIS science and GIS applications; Definition of map, different types of thematic maps, scale
- Geographic coordinate system, Datum; Types of map projections; Commonly used map projections; Projected Coordinate System.

Unit 4

- Visualization of geographical data, Basic ideas about data visualization, Geo-referencing, Maps and cartographic communication.
- Digital representation of geographic data: Data structure, spatial data model, raster and vector models. Comparison of raster and Vector data.

Unit 5

- GIS Data Management: GIS File Data Formats-Vector Data File Formats and Raster Data File Formats

- Database design - editing and topology creation in GIS, linkage between spatial and non spatial data
- Database Management System, Types of data management system

References:

1. Drury S.A. 1987. Image interpretation in Geology. Chapman and Hall.

2. Gupta R.P. 1991 Remote Sensing Geology. Springer-Verlag.

3. Lillisand, T. M. and Keifer, R. W., 2007 : Remote sensing and image interpretation John Willey and Sons, USA

4.Chang.T.K. 2002: Geographic Information Systems. Tata McGrawHill

5. Heywood.I, Cornelius S and CrverSteve. 2003: An Introduction to Geographical Information Systems. Pearson Education

6. Wise S.2002: GIS Basics. Taylor Publications

7.ESRI Map book: GIS the Language of Geography by ESRI-USA ESRI-2004

GLO6IE01(E01b) - ENVIRONMENTAL GEOLOGY

Credit: 3 **Total Hours: 48**

Course Outcome:

Students will be able to understand

CO1: Various biosphere- geosphere interactions
CO2: How earth processes create hazards to life and property
CO3: The occurrence and formation of earth resources and significant environmental effects caused by their extraction, processing, and use.
CO4: The major sources of water pollution and methods for their management
CO5: Methods of solid and radioactive waste management
CO6: Various aspects of environmental regulations in India

Unit 1

- Introduction: Earth, man and environment: Basic environmental problems. Geoscience factors in environmental planning. Environmental Geosciences-fundamental concepts.
- The Earth Systems and Biosphere: Conservation of matter in various geospheres - lithosphere, hydrosphere, atmosphere and biosphere. Concepts of ecology / Ecosystems. Biogeographical zonations of earth. The earth's major ecosystems-terrestrial and aquatic.

Unit 2

- Earth's Processes and Geological Hazards Earth's Processes and Geological Hazard: Earth's processes; Concept of residence time and rates of natural cycles.
- Catastophic geological hazards. Study of floods, landslides, earthquakes, volcanism and avalanche, with a view to assess the magnitude of the problem, prediction and perception of the hazards.

Unit 3

- MINERAL RESOURCES AND ENVIRONMENT: Resource and Reserves. Environmental impact of exploitation, processing and smelting of minerals.
- ENERGY RESOURCES AND ENVIRONMENT: Environmental effects associated with each types of energy resource, viz. Petroleum, natural gas, hydropower, nuclear, coal, solar and wind energy.

Unit 4

- WATER RESOURCE AND ENVIRONMENT: Global Water Balance. Ice Sheets and fluctuations of sea levels. Origin and composition of sea water. Resources of oceans. Ocean pollution by toxic wastes. Human Use of Surface and Ground Waters. Ground Water Pollution.

Unit 5

- WASTE DISPOSAL: Solid waste disposal - geology in planning and siting of land fills. Radioactive waste management.

- ENVIRONMENTAL LAW: Environmental legistation in India.

Reference

1. Keller, E.A.: Environmental Geology: CBS Publisher, New Delhi.
2. Valdiya, K.S. : Environmental Geology-Indian Context. Tata McGraw Hill Publ. Co., Bombay.
3. Coates, D.R: Geology and Society. Chapman & Hall,New York.
4. Bryant, E.: Natural Hazard. Camb. Univ. Press.

GLO6IE01(E01c) - ENGINEERING GEOLOGY AND HYDROGEOLOGY

Credit: 3 **Total Hours: 48**

Course Outcome:
Students will be able to understand

CO1: Basic information regarding groundwater geology
CO2: Different Surface and subsurface methods of groundwater explorations
CO3: Preliminary information's about engineering geology

Unit 1.

- Hydrologic cycle and its components.
- Origin, occurrence, accumulation and migration of water
- Introduction to Hydrological properties of rocks

Unit 2

- Groundwater geology: Aquifer systems, Type and properties.
- Natural and Artificial Recharge of Ground Water
- Ground Water flow: Head distribution, Darcy's Law

Unit 3

- Surface and Subsurface method of Ground water Exploration
- Physical and Chemical Quality of Ground Water.
- Ground water provinces of India

Engineering Geology

Unit 4.

- Introduction to Role of Geology in civil construction.
- Stages of Geological site Investigations for selection of site for engineering structures: **Desk study:** Analysis of Remote sensing data, Geological maps, cross sections and written reports.
- **Subsurface site characterization:** Coring, logging, introduction to application of geophysical methods. Emphasis on preconstruction geological analysis to recognize potential hazards and problems.

Unit 5

- Physical and Mechanical properties of rocks: Concepts of stress, strain, Mohr circle and failure theories.
- Strength, deformation, hydraulic aspects, geostresses, Weathering and Discontinuities in rock masses. Engineering classification of Rocks. Construction materials

References:

1. K.R Karanth, 1989. Hydrogeology, Tata McGraw Hill
2. Bell, F.G. 1983. Fundamentals of engineering geology, Butterworths
3. D.K. Todd, 1980.Groundwater Hydrology, John Wiley and Sons.
4. C.F. Tolman, 1937.Groundwater, McGraw Hill, New York.
5. H.M. Raghunath, 1987Groundwater, Wiley Eastern. Calcutta.
6. Beavis, F.C. 1985. Engineering geology.
7. Krynine, D.P. Judd, W.P. 1957, Principles of Engineering Geology, McGraw Hill,
8. Davis, S.N. & De Wiest, R.J.N. 1966. Hydrogeology. John Wiley & Sons, New York.
9. Krynine, D.P. & Judd, W.R. 1957. Principles of engineering geology and geotechnique. McGraw Hill, New Yprk.
9. Goodman, R.E. 1980. Introduction to rock mechanics.
10. Schuster, R.L. & Krizek, R.J. 1978. Landslide analysis and control. National Academy of Science, Washington DC.

GLO9IE02(E02a) - ADVANCED ENVIRONMENTAL GEOLOGY

Credit: 3 **Total Hours: 48**

Course Outcome:

Students will be able to understand

CO1: Major geological processes on the surface of the Earth
CO2: How anthropogenic activities are modifying natural environmental processes
CO3: Remedial measures for management of natural resources and mitigation of environmental pollution.

Unit 1

- Foundations of Environmental Geology- Environmental Crisis- Human population growth and Sustainability.
- Earth Cycles and Systems- hydrologic-, Rock-, Geochemical-, cycles, Earth as a system- Environmental Ethics.
- Ecology and geology-ecosystem- ecosystem function-Stream Processes and Ecology. Natural Service Functions of Ecosystems. Geology and Biodiversity- Factors that Increase or Decrease Biodiversity. Human Domination of Ecosystems- Ecological Restoration.

Unit 2:

- Water: A Brief Global Perspective. Surface Runoff and Sediment Yield. Factors Affecting Runoff and Sediment Yield. Groundwater Movement. Interactions between Surface Water and Groundwater. Desalination. Water use and conservation. Measures of Water Quality, Water management.
- Water pollution- Residence Time, Pollutants- Biochemical Oxygen Demand, Eutrophication, Oxygen-Demanding Waste. Pathogenic Organisms, Nutrients, oil. Toxic substances- Synthetic Organic Chemicals. Heavy Metals.
- Surface-Water Pollution and Treatment- Point and Nonpoint Sources of Surface- Water Pollution. Reduction of Surface-Water Pollution. Urban Flooding and Water Pollution. Groundwater Pollution and Treatment, Tracing Pollution's Path, Saltwater Intrusion, Water-Quality Standards. Wastewater Treatment- Wetlands as Wastewater Treatment Sites, Reversing the Damage- Surface water and Ground Water- Decontamination after Extraction, In Situ Decontamination

Unit 3:

- Environmental Impact of Mineral Development- Impact of Mineral Exploration and Testing. Impact of Mineral Extraction and Processing. Recycling Mineral Resources- Minerals and Sustainability, Mine Reclamation.
- Energy Supply and Energy Demand- Fossil Fuels- Environmental impact of coal mining- Fossil fuels and acid rain- solution to acid rain problem. Radioactive Waste and Management- Transuranic Waste- High-Level Radioactive Wastes.
- Geology of Geothermal Energy- Environmental Impact of Geothermal Energy Development. Renewable Energy Sources- Sustainable Energy Policy.

Unit 4:

- Soil Profiles- Soil Properties, Soil erosion, Strategies for Reducing Erosion. Sediment Pollution- Land Use and Environmental Problems of Soils. Geology and Environmental Health- Chronic Disease and the Geologic Environment.
- Air Pollution- Geologic Perspective, Types and Sources of Air Pollution- Particulate Matter: PM 10 and PM 2.5. Urban Air Pollution. Influence of Meteorology and Topography. Indoor Air Pollution. Air-Quality Standards, Carbon Sequestration
- Waste Management and Geology- Integrated Waste Management. Solid Waste Disposal, Reducing Solid-Waste Volume, Recycling, Hazardous Waste Management, Radioactive Wastes, Bedrock Disposal of Solid High-Level Wastes

Unit 5:

- Environmental Analysis- Site Selection, Environmental Impact Analysis.
- Environmental Law, Pollution and Its Control- International Initiatives. Laws Relating to Geologic Hazards

Reference:

1. Environmental Geology, Tenth Edition, Montgomery, C. W., 2013
2. Introduction to Environmental Geology, Vth Edn, Edward A. Keller, Pearson Education, Inc., 2012

GLO9IE02(E02b) - PRECAMBRIAN CRUSTAL EVOLUTION

Credit: 3 **Total Hours: 48**

Course Outcome:
Students will be able to understand

CO1: Earth processes through Geological time.
CO2: Structures of Earth and describe the properties of different layers.
CO3: The early atmosphere and how and why free oxygen finally increased.
CO4: How the early continents came together
CO5: Orogenic processes and mineral deposits through geological time.

Unit 1

- Geological time span.
- Early earth features. Mountain Building activity. Era- Breaking up of Pangea- the Precambrian- Hadean, Archean, Proterozoic, Structure of the Earth.

Unit 2

- A magma of Ocean- Composition of early Crust- Solidifying Basalt. The earth hotspot and fluid basalts.
- Lithosphere and Mantle reactions.
- Origin of the crust. Lower crust-first continents. early continental crust. growth of crust-Mechanism of continental growth and its growth rate. Growth of Continents.

Unit 3

- Primary Atmosphere. Secondary Atmosphere. Oxygen in the atmosphere, geologic indicators of atmosphere-BIFs of Precambrian. Red beds, sulfates and Detrital uraninite and Pyrites, Decreasing Heat in Precambrian Time. paleosols –Biological indicators. Ocean prevailing theory, outgassing.
- Life in Archean Proterozoic orogeny. Earth- Moon system. Plate tectonics in the Precambrian.

Unit 4

- Precambrian mineral Deposits. Proterozoic life. oldest rocks. Continental foundation.
- Distribution of Precambrian rocks. Proterozoic tectonics. Proterozoic assembly of lauresia, Proterozoic oxygen rocks. atmosphere- Precambrian assembly of Rodinia- grenville orogeny – Proterozoic rifting. Mid-continent rift- snowball earth.

Unit 5

- Crustal provinces- Precambrian provinces of India.

- Cratons of I- hadean Crust. Archean and Proterozoic. Shield areas- Canadian Shield. Archean rocks. Green stone belt of India. Cratons,Origin of Cratons, Rift Valleys, Mobile belts, Archean mineral Resources and Proterozoic Sedimentary Basin in India.

References

1. Archaean Geology- C.S. Pichamuthu
2. Early Precambrian supracrustal of southern Karnataka-Memoir 112. Geol.Surv. Ind
3. Geology of Karantaka- B.P Radhakrishna
4. Geology of India (Volume 1 and 2)- R.Vaidyanathan and M. Ramakrishnan
5. Geology of India and Burma- M.S Krishnan
6. Geology of India- M. Wadia
7. Crustal Evolution and Metalogeny in India- Sanib Chandra Sarkar and Anupendu Gupta

GLO9IE02(E02c) - QUATERNARY GEOLOGY AND PALEOCLIMATE

Credit: 3 **Total Hours: 48**

Course outcome:

Students will be able to understand about

CO1: Quaternary stratigraphy
CO2: Quaternary dating methods
CO3: Quaternary stratigraphy of India
CO4: Paleoclimate and its reconstruction

Unit 1

- Quaternary Geology Definition of Quaternary, The Character of Quaternary, Duration of the Quaternary and development of Quaternary studies.
- Quaternary stratigraphy- Oxygen isotope stratigraphy, biostratigraphy and magnetostratigraphy.

Unit 2

- Response of geomorphic, neotectonic, active tectonics and their application to natural hazard assessment.
- Quaternary dating methods: Radiocarbon, Uranium series Luminescence, Amino Acid, Relative dating methods.

Unit 3

- Application of pollen, spores and phytoliths in Quaternary stratigraphy.
- Quaternary stratigraphy of India.
- Continental records (fluvial, glacial, Aeolian, Paleosols and duricrust); marine records; continental marine correlation of Quaternary record.
- Evolution of Man and Stone Age culture.
- Plant and animal life in relation to glacial and interglacial cycles during Quaternary.

Unit 4

- Paleoclimatology: Introduction to climate and climate systems, Global climate pattern, Climate controlling factors.
- Global energy budget, Plate tectonics and climate change, Milankovitch cycles, Atmosphere and Ocean interaction and its effect on climate.

Unit 5

- An Overview of Paleoclimatic reconstruction; Pleistocene Glacial-Interglacial cycles
- Future Climate: Anthropogenic activity and its effect on Global climate.

References

- Earth's climate past and future By Ruddimen
- Bigg, G., Ocean and Climate
- Bradley, Paleoclimatology Reconstructing Climates of The Quaternary.
- Maher and Thompson, Quaternary Climates, Environments and Magnetism.

GLO9IE03(E03a)- MARINE GEOLOGY AND OCEANOGRAPHY

Credit: 3 **Total Hours:48**

Course Outcome:
Students will be able to understand

CO1: Ocean bottom topography
CO2: Physical and Chemical properties of seawater
CO3: Distribution and classification of marine sediments
CO4: Major Surface currents in world ocean
CO5: Atmospheric disturbances – El Nino and LaNina
CO6: Coastal geomorphology and processes

Unit 1

- History of Marine geological studies contribution of Challenger Expedition JOIDES resolution.
- Hypsometry-Sea bottom topography, Submarine canyons, trenches, volcanoes, midoceanic ridges and abyssal plains.
- Marine Mineral resources: Controlling factors and distribution
- Eustatic changes of sea level: evidences

Unit 2

- Physical properties of seawater: distribution of temperature, pressure and density-Thermocline, Pycnocline, halocline.
- Chemical properties of seawater elements and dissolved gases present in sea water.
- Salinity and distribution of salinity.
- Marine sediments: Distribution and classification, CCD, Oxygen Minimum layer in Ocean

Unit 3

- Coriolis effect, Circulation: general circulation of the atmosphere boundaries - major surface currents of the world oceans, Ekman spiral, geostrophic currents, upwelling and sinking, diverging and converging surface water
- Thermohaline circulation

Unit 4

- Coupled ocean atmosphere system.
- EL Nino southern oscillation (ENSO), LaNina,
- General weather systems of India, Monsoon system
- Cyclone and anticyclone, Jet stream.

Unit 5

- Coastal processes: waves, currents and tides.
- Coastal geomorphology, classification of coasts; Coastal erosion. Coastal protection structures seawalls, jetties, groins.

- Coastal Regulatory zone (CRZ) Continental margin: features of continental shelf, continental slope and continental rise.

References

1. Tom Garrison – Essentials of Oceanography
2. Trujillo and Thurman – Essentials of Oceanography
3. John Marshall, R Alan Plumb – Atmosphere, Ocean and Climate Dynamics- An introductory Text
4. Robert H Stewart – Introduction to physical Oceanography
5. Yasso, W. E., Oceanography
6. Trask, P. D., Recent Marine sediments, Dover publications, 1939
7. Weisberg, J., and Parish, R, Introductory Oceanography. .McGraw Hill, 1974Text Books
8. J.P.Kennet (1982) Marine geology. Printice Hall Inc., New Jersy, 813p.
9. E. Seibold & W.H.Berger (1982) The sea floor. Springer-Verlag, Berlin.
10. J.Weisberg & H. Parish (1974). Introductory Oceanograpghy. McGraw Hill.
11. B.W.Pipkin, D.S.Gorslin, R.E.Casey & D.E. Hammord (1972). Laboratory exercises in oceanography. W.H.Freeman & Co., San Francisco, 255p.

GLO9IE03(E03b)- DISASTER MANAGEMENT

Credit: 3 **Total Hours: 48**

Course Outcome:
Students will be able to understand

CO.1: Various causes of natural, manmade disasters and mitigation measures to reduce its effects on humans
CO. 2: To device strategic approaches towards disaster risk reduction and the relation between vulnerability, disasters, disaster prevention and risk reduction
CO. 3: Major hazards of Kerala, its causes and vulnerability of its communities

Unit 1:

- Introduction- Hazard and Disaster: Definition and Terminologies, Classification.
- Understanding Disaster Management: Comprehensive Disaster Management Plan and it's Elements
- Disaster Management Act-2005 and its Institutional Framework- Policy and Administrative frame work for Disaster Management

Unit 2:

- Understanding Natural Disasters: Earth Quake, Landslides, Avalanches, Volcanic eruptions. Heat and Cold waves, Coastal Disasters, Cyclone, Flood, Drought ,Tsunami

Unit 3:

- Understanding Man-made Disasters: Nuclear Disasters, Chemical Disasters,
- Biological Disasters, Building fire, Coal fire, Forest fire and Oil fire, Rail accident, Road accidents, Air accidents, Sea accidents, Dams and Dam bursts, Air pollution,
- Water pollution, Industrial pollution, Climate change: Global warming, sea level rise, Ozone Depletion

Unit 4:

- Hazard, Risk and Vulnerability: Concept and Elements, Risk Reduction Disaster Management
- Prevention, Preparedness and Mitigation
- Disaster Preparedness Plan, Role of Information, Education, Communication and Training
- Role of various Agencies in Disaster Response, NGO's, Armed Forces, Police and other Forces

Unit 5

- Potential hazards in Kerala with special reference to landslides and coastal erosion during the monsoons.

- Manmade drought during summer, saline water intrusion along the coastal aquifers – mitigation measures.
- Cyclone, drought and flood in various parts of India – frequency of occurrence, vulnerable areas- reasons

References

1. Abbot.P.C (2002): Natural Disaster, McGraw Hill Publications New Delhi

2. Coates.D.R (1985) Geology & Society – Chapman & Hall Publishers New Delhi

3. Davis et.al (1976) Environmental Geosciences – Wiley Eastern

4. Howard A.D & Irwin Remson (1978) – Geology in Environmental Planning –McGraw Hill Publishers 5. Keller E.A (1976) – Environmental Geology – Charles E Merril publishers – New Jersey

6. Lundgren.L(1986) Environmental Geology – Prentice Hall Publication- New Jersey

7. Strahler N & Strahler A.H (1973) – Environmental Geosciences Wiley eastern publishers

GLO9IE03(E03c)-APPLIED RIVER SCIENCE

Credit: 3 **Total Hours: 48**

Course Outcome:

Students will be able to understand

CO1: Various components of stream hydrology, methods of analyses and representation of hydrological properties
CO2: Sediment distribution and its resident time across the basin
CO3: To apply quantitative methods for drainage network analyses
CO4: Fluvial geomorphological features and explain the formation mechanisms.

Unit 1

- Basic stream hydrology, Physical properties of water, sediment and channel flow, River discharge
- River hydrographs (UH, IUH, SUH, GIUH) and its application in hydrological analysis, Flood frequency analysis.

Unit 2

- River basin, Sediment source and catchment erosion processes, Sediment load and sediment yield, Sediment transport process in rivers, Erosion and sedimentation processes in channel.

Unit 3

- Drainage network, Quantitative analysis of network organization – morphometry
- Random Topology (RT) model and fractal analysis, Role of drainage network in flux transfer, Evolution of drainage network in geological time scale.

Unit 4

- River diversity in space, Patterns of alluvial rivers - braided, meandering and anabranching channels
- Dynamics of alluvial rivers, Channel patterns in Stratigraphic sequences
- Different classification approaches in fluvial geomorphology and its applications.

Unit 5

- Bedrock channels, Bedrock incision process
- River response to climate, tectonics and human disturbance, Bedrock channel processes and evolution of fluvial landscapes.
- Fluvial hazards, integrated approach to stream management, Introduction to river ecology.

References

1. Davie, T., 2008. Fundamentals of hydrology. Routledge Publications.
2. Knighton, D., 1998. Fluvial forms and processes: A new perspective. Arnold Pubs.
3. Julien, P.Y., 2002. River Mechanics. Cambridge University Press.
4. Robert, A., 2003. River Processes: An introduction to fluvial dynamics. Arnold Publications.
5. Tinkler, K.J., Wohl, E.E. (eds.) 1998. Rivers over rock. American Geophyscial Union Monogrpah, Washington, DC. nd climatic variations within the basin: Environmental Geology, v.43.

GLO10IE04(E04a) -GEOTECHNICAL ENGINEERING

Credit: 3 **Total Hours: 48**

Course Outcome:

Students will be able to understand

CO1: Intrusive and non-intrusive techniques of site investigation
CO2: Various sampling techniques including drilling and boring
CO3: Borehole monitoring and tests
CO4: Logging of soil and rocks
CO5: Application of soil and rock properties in geotechnical engineering
CO6: Basics of earth retaining structures

Unit 1

- Planning and reconnaissance: Toposheets, historical maps, geological maps, Aerial photographs and remote sensing
- Site investigation: Design of site investigations-selection of methods and geology of the area. Field/Site investigations – Intrusive and non-intrusive methods
- Non-intrusive - Geophysical methods - seismic tomography, resistivity, gravity.

Unit 2

- Excavations- trial pits
- Boreholes-Methods of drilling and boring- cable drilling, rotary drilling, augur drilling, wireline, air hammer etc. Sampling methods associated with above drilling methods. Backfilling excavations and boreholes.
- Sampling the ground - Disturbed and undisturbed samples Types of samplers - Open-tube samples, Stationary piston sampler, Continuous soil sampling, Sand samplers, Rotary core samplers, Window sampler, Bulk samples. Handling and labelling of samples.

Unit 3

- Tests in boreholes: Standard penetration test (SPT). Permeability test and Packer test. Pressure meter test, Pumping tests,Borehole geophysics.
- In situ monitoring of borehole and monitoring of groundwater
- Soil and Rock Logging as per standards (Indian standards ISI, BS5930 and Eurocode Standards, ASTM). Description of soils and rocks.

Unit 4

- Classification and mechanical properties of soils
- Soil stress: effective and total stress, pore pressure parameters
- Soil testing: triaxial, shear box, Particle size distribution, consistency limits, consolidation, Atterberg limits, California bearing ratio
- Rock testing- UCS, point load.
- Types of foundations and Bearing capacity: shallow and deep foundations Settlement of foundations. Earth pressures: active and passive pressures and their application in geotechnical engineering.

- Stability analysis: basic knowledge and various methods used- application in geotechnical engineering. slope stability analysis

Unit 5

- Basic knowledge of Earth retaining structures; gravity and cantilever retaining walls, diaphragm walls and secant pile walls, sheet piling, reinforced earth. Geotechnical parameters used in the design
- Compaction test - MDD vs OMC relationship (proctor), Insitu density calculation.

References:

1. Krynine, D.P. & Judd, W.R. 1957. Principles of engineering geology and geotechnics. McGraw Hill, New York.
2. Bell, F.G. 1983. Fundamentals of engineering geology.
3. Beavis, F.C. 1985. Engineering geology.
4. Goodman, R.E. 1980. Introduction to rock mechanics.
5. Schuster, R.L. & Krizek, R.J. 1978. Landslide analysis and control. National Academy of Science, Washington DC.

GLO10IE04(E04b)- TECTONIC GEOMORPHOLOGY

Credit: 3 **Total Hours: 48**

Course outcome:

Students will be able to understand

CO1: Role of tectonic interaction in landform evolution
CO2: The effect of tectonics in river systems
CO3: Landforms associated with faults
CO4: Geomorphic indices that help to identify active tectonics in an area

Unit 1

- Definition and scope of tectonic geomorphology.
- Landscape evolution. Concept of Form-Process relationship in landscape evolution.

Unit 2

- Geomorphic Markers of active tectonics: Planar and Linear.
- Landforms of active strikeslip faults, normal faults, reverse faults and folds.

Unit 3

- River response to active tectonics.
- Sudden (coseismic) versus gradual modifications in river systems.
- Tectonic modifications of alluvial and bedrock-channeled rivers: longitudinal profiles, river pattern, sinuosity, drainage patterns and drainage anomalies.
- Effects of base level.

Unit 4

- Geomorphic Indices of active tectonics – Morphometric analysis: mountain-front sinuosity, hypsometric curve and hypsometric integral, drainage basin asymmetry, stream-length gradient index, and valley-floor width to valley height ratio.

Unit 5

- Fundamentals of space geodetic techniques of measuring active tectonic deformations: Global Positioning System (GPS) and Radar Interferometry.

References

1. Burbank, D.W. and Anderson, R.S. (2011). Tectonic Geomorphology 2nd Edition. Blackwell Science.
2. Burbank, D.W. and Anderson, R.S. (2001). Tectonic Geomorphology 1st Edition. Blackwell Science.

3. Keller, E.A. and Pinter, N. (1996). Active tectonics: Earthquakes, Uplift, and Landscape. Prentice Hall
4. Bull, William. (2009). Tectonically active landscapes. Wiley-Blackwell
5. Schumm, S.A, Dumont, J.F. and Holbrook, J.M. (2000). Active tectonics and alluvial rivers. Cambridge University Press.
6. Bull, W . (2007). Tectonic Geomorphology of Mountains: A new approach to palaeoseismology. Blackwell Publishing

GLO10IE04(E04c) - COAL AND PETROLEUM GEOLOGY

Credit: 3 **Total Hours: 48**

Course outcome:

Students will be able to understand

CO1: Origin and classification of coal and petroleum
CO2: Identification of macroscopic and microscopic constituents of coal
CO3: Exploration methods for coal and petroleum
CO4: Causes for migration of petroleum and its importance in exploration

Unit 1

- Origin of Coal, sedimentology of coal bearing strata, mode of occurrence of structures associated with coal seams, classification of coal, chemical analysis of coal.

Unit 2

- Study of Macroscopic and Microscopic constituents of coals.
- Elementary knowledge about the application of reflectance and fluorescence study of coal
- Basic idea about the coal preparation, carbonization, coal forming epochs in the geological past.
- Coal deposits of India and depositional environment of some important coal fields of India. Methods of Coal prospecting and estimation of its reserves.
- Coal Industry in India.

Unit 3

- Historical development of petroleum geology.
- Physical and chemical properties of petroleum and related substances.
- Surface and subsurface geographic and stratigraphic occurrence of petroleum.

Unit 4

- Origin of petroleum: inorganic and organic theories of source of petroleum.
- Environments and processes of transformation of source material to petroleum hydrocarbons.
- Migration of petroleum hydrocarbons: primary and secondary migration. Factors causing migration of petroleum
- Reservoir rocks: characteristics of reservoir rocks and their types. Principles of determination of porosity and permeability.
- Traps: characteristics and classification. Structural, stratigraphic, combination and fluid barrier traps. Accumulation of fluid petroleum

Unit 5

- Exploration: a review of prospecting methods as applied to the exploration of petroleum accumulations
- Estimation of petroleum reserves: brief outline of methods of estimation of petroleum reserves Petroleum prospects:
- Important oil & gas fields and petroleum prospects of India.

References:

1. Stutzar,O and NOC, A.C.: Geology of Coal. University of Chicago Press, Chicago.
2. Moor, E.S.(ed): Coal, its properties, analysis, classification, geology, extraction, uses and
3. distribution. John Wiley & Sons.
4. Stach et.al.: Text book of Coal Petrology. Gebruder Borntraegu, Stuttgart.
5. Scott, A.C.: Coal and Coal-bearing Strata: Recent Advances. Geol. Soc. Publ. No.32, Blackwell.
6. Levorson, A.I. Geology of Petroleum.
7. Lanes, K.K. Petroleum Geology.
8. Russel, W.L. Principles of Petroleum Geology
9. Pirson, S.J. Oil Reservoir Engineering.
10. Lalicker, C.G. Principles of Petroleum Geology

GLO10IE05(E05a) - ADVANCED MAPPING TECHNIQUES AND EXPLORATION GEOLOGY

Credit: 3 **Total Hours: 48**

Course Outcomes:

Students will be able to understand

CO1: Procedure of RADAR and microwave remote sensing
CO2: Application of hyperspectral remote sensing in mapping
CO3: LIDAR remote sensing techniques
CO4: Stages of mineral exploration
CO5: Geophysical survey methods and their uses in mineral exploration

Unit 1

- Radar-Real and synthetic aperture radars, - Principles - different platforms and sensors, System parameters, Target parameters, Radar equation measurement and discrimination,
- Airborne Data products and selection procedure - SEASAT, SIRA, SIRB, ERS , JERS, RADARSAT missions.
- Radar data processing - Radar grammetry, Image processing, SAR Interferrometry – Polarimetry- Interpretation of microwave data - Physical mechanism and empirical models for scattering and emission, volume scattering.
- Applications of microwave remote sensing - Geological interpretation of RADAR –sites-default-files, Application in Agriculture -forestry, Hydrology - ice studies – land use mapping and ocean related studies. Introduction to Thermal Remote Sensing

Unit 2

- Multispectral and hyperspectral remote sensing, Comparison of Multispectral and Hyperspectral Image Data, Spectral Signatures and BRDF in the Visible, Near Infrared and Shortwave Infrared regions of EMR, Hyperspectral Issues.
- Sensors and hyperspectral imaging devices - Scanner types and characterization - specifications of various sensors hyperspectral sensors, Design tradeoffs. Data formats and systems, AVIRIS, CASI, NASA Terra Moderate Resolution Imaging Spectrometer (MODIS), Hyperion.

Unit 3

- LIDAR remote sensing platforms - Introduction to the LIDAR remote sensing platform - Historical development of LIDAR remote sensing platforms Airborne platforms, Laser Scanning, Fixed- Wing Platforms, Rotary-Wing Platforms - Terrestrial, airborne, and spacebar types – Space borne platforms. Introduction to UAV/drone-based sensing

Unit 4

- Stages of exploration – Reconnaissance survey; criteria for exploration method (guides to ores).
- Collection and processing of exploration data. Field work in sedimentary, igneous and metamorphic terrains.
- Maps of different scales used in exploration, Trenching and pitting – selection of trench sites, logging and sampling of trenches and pits
- Drilling – design of a drilling programme, drilling methods – vertical and inclined drill holes. Types of drilling, logging of boreholes, borehole deviations. Preparation of sections and level plans, mineral maps of the area, fence diagrams.
- Subsurface mapping – floor and roof contouring. Sampling –Purpose of sampling. Sample types, methods of sampling; Sample preparation and errors in sampling.

Unit 5

- Geophysical survey, surface investigation, subsurface investigation, Gravity survey, Seismic survey, refraction methods, reflection methods, applications, Magnetic survey and Electrical resistivity survey, self-potential methods, potential drop methods, resistivity values, data interpretation, Curve fitting.

References

1. Arogyaswamy R. N. P. Courses in Mining Geology. Oxford and IBH, New Delhi.
2. Bagchi T. C. Elements of prospecting and exploration. Kalyan Publishers.
3. Banerjee P. K. and Ghosh S. Elements of prospecting for non – fuel mineral deposits 1997.
4. Boyle R. W. Geochemical prospecting for thorium and uranium deposits. Elsevier.
5. C Gokceoglu, H R Pourghasemi 2019 Spatial Modeling in GIS and R for Earth and Environmental Sciences Berlin: Elsevier Science, 798p
6. Compton R. R. Manual of Field Geology. Wiley.
7. Dobrin M. B. Introduction to geophysical prospecting. Pergamon Press.
8. Drury, S. A. Image interpretation in Geology,. Chapman and Hall, London. 1993
9. Ginzburg D. H. Principles of geochemical prospecting. Pergamon GL Prost 2019
10. Remote Sensing for Geoscientists: Image Analysis and Integration, London:Taylor & Francis 702p
11. Gupta RP 2013 Remote Sensing Geology Springer Berlin 656p
12. Gupta, R.P Remote sensing Geology, Springer, 2003. 32 MS

GLO10IE05(E05b) - ELEMENTS OF MINING AND ORE DRESSING

Credit: 3 **Total Hours: 48**

Course outcomes:

Students will be able to understand

CO1: Surface and underground mining methods
CO2: Mining hazards and safety measures
CO3: Ore dressing methods and beneficiation
CO4: Processes for the concentration of ores

Unit 1

- Elements of Mining, Classification of mining methods.
- Mining Methods: Placer mining methods, open pit methods, Underground mining methods, Coal Mining methods and Ocean bottom mining methods; their advantages and disadvantages.

Unit 2

- Ventilation in underground mining: Purpose, types and arrangements of ventilation in underground mining. Mining hazards and safety measures.

Unit 3

- Ore Dressing - Ore dressing and its importance, low grade ores and their beneficiation
- Ore-microscopy and its contribution to ore-dressing techniques.
- Aggregate properties of minerals and rocks and their consideration in ore dressing techniques.

Unit 4

- Basic ore dressing operations viz. crushing (Primary crushing and Secondary/Tertiary Crushing), grinding, sizing, screening and classification.

Unit 5

- Concentration processes: Magnetic and electrostatic separation, gravity concentration; Froth Floatation, Amalgamation and Agglomeration.

References

1. McKinstry, H.E. Mining Geology, Prentice Hall, Englewood Clifts, N.J.
2. Clark, G.B. (1967) Elements of Mining, III ed. John Wiley • Arogyaswami, R.P.N. (1996) Courses in Mining Geology, IV Ed. Oxford IBH
3. Gaudin, A.M. Principles of Mineral Dressing. McGaw Hill Pub. Co. Ltd. Bombay
4. Wills, BA. 1988. Mineral Processing Technology. Pergamon Press. Oxford.

5. Vijayendra, MG. 1995. Handbook of Mineral Dressing. Vikas Publishing House Pvt Ltd. 23 Course No. GLM-405: P Dressing of Indian Metallic and non-metallic ores, Beach Sand & coal.

GLO10IE05(E05c) - CLIMATOLOGY

Credit: 3 **Total Hours: 48**

Course outcomes:

Students will be able to understand

CO1: Geographical distribution of climate types and effect of global warming
CO2: Factors affecting atmospheric stability
CO3: Effects of changing temperature on weather
CO4: Management of natural hazards related to climate

Unit 1

- Latitudes & Longitudes | Standard Time
- Motions of the earth: Rotation and Revolution, Atmosphere: Role, Structure & Composition Temperature Distribution on Earth Insolation & Heat Budget
- Geographical distribution of the climatic types – Koppen's and Thornthwaite's classification of climate
- Global warming

Unit 2

- Lapse rate – Atmospheric stability, Latent Heat of Condensation, Atmospheric Pressure Belts and Wind Systems
- Factors Affecting Wind movement, Coriolis Force, Types of Winds: Permanent, Secondary & Local Winds

Unit 3

- Temperature Inversion: Types & Effects on Weather, Geostrophic Wind, Jet Streams & Rossby Waves, Major Jet Steams: Subtropical Jet Stream & Polar Jet Stream

Unit 4

- Air Mass - Air masses based on Source Regions, Fronts, Types of Fronts: Stationary Front, Warm Front, Cold Front & Occluded Front, Humidity: Relative Humidity & Dew point, Condensation, Forms of Condensation: Dew, Fog, Frost, Mist, Types of Clouds

Unit 5

- Smog: Photochemical smog & Sulfurous smog
- Precipitation: Types of Precipitation, Types of Rainfall, Thunderstorm, Thunder & Lightning, Tornado,

- Tropical Cyclones: Favourable Conditions for Formation, Stages of Formation & Structure, Storm Surge, Naming of Cyclones, Cyclones in Arabian Sea, Bay of Bengal, Temperate Cyclones (Mid Latitude Cyclone or Extra tropical cyclones or Frontal Cyclones)

References

1. BerneardHauruitz and James, M. Austin, Climatology, Mc Graw Hill publications, Newyork & London.
2. D.S. Lal., Climatology
3. Austin Miller. A., Climatology
4. B.S. Negi., Climatology and oceanography.
5. Climatology: Thomas A Blair
6. Grant R Bigg: The Oceans and Climate

CORE COURSE: OPEN COURSE
(THEORY)

GLO5ID01 - GEOSCIENCE AND ENVIRONMENT

Credit: 3 **Total Hours: 48**

Course Outcome:

Students will be able to understand

CO1: The subject meaning of Geology and its branches; describe the characters of earth; explain hydrologic cycle and role of groundwater.
CO2: Various exogenic and endogenic processes that form a part of earth system, including earthquakes and volcanoes; and explain the role played by the geological agents in shaping earth.
CO3: Global climate change, causes and effects; explain the significance of pollution and waste disposal.

Unit–I

Introduction to Geology - branches of Geology, the earth - size, shape, density, volume and internal structure. Hydrologic cycle, groundwater - Infiltration, zones of groundwater, ground and perched water tables, open wells and bore wells.

Unit–II

Exogenic processes: Weathering – agents, types and products of weathering.

Mass wasting - types, Landslides.

Brief ideas of role played by streams, oceans, wind and glaciers on earth's surface.

Unit–III

Endogenic processes: Volcanoes – types and distribution of major volcanoes, products of volcanism - gas, dust, lava and pyroclastics.

Unit–IV

Earthquakes – Seismic waves and propagation, epicenter and focus, intensity and magnitude scales, Seismographs and seismogram, Tsunami.

Unit–V

Global Climate change: Greenhouse effect, Global warming, Ozone depletion - causes and effects. Pollution and waste disposal – air, water and land pollution; brief ideas of causes and effects.

References

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

2. Bloom, A. L. (1992) Geomorphology, Second Edition, Prentice Hall India Pvt. Ltd., New Delhi.
3. Holmes, A. (1981) Principles of Physical Geology, ELBS, Third Edition. Thomas Nelson.
4. Judson, S. and Kauffman, M. E. (1990) Physical Geology. Eighth Edition, Prentice Hall, New Jersey.
5. Parbin Singh (2012) General and Engineering Geology. S. K. Kataria and Sons.
6. Mukherjee, P.K. (1984) A Text Book of Geology, World Press.
7. Valdiya, K.S. (1987) Environmental Geology: Indian Context, Tata Mc-Graw Hills.
8. Strahler, A.N. and Strahler, A.H. (1973) Environmental Geosciences: Interaction between natural systems and man. John Wiley & Sons Inc.
9. Donald R Caotes (1981) Environmental Geology. John Wiley and Sons.

GLO5ID02- DISASTER MANAGEMENT

Credit: 3 **Total Hours: 48**

Course Outcome:

Students will be able to understand

CO1: Basic concepts, terminologies and classification of Hazard and Disaster; Disaster Management and Disaster Management Plan.
CO2: Various natural disasters with suitable examples; Understand and explain the Environmental disasters by citing suitable examples; Describe facts related to climate change, causes and effects.
CO3: Disaster Risk management strategies; the institutional frameworks; explain the application of IT in Disaster Risk management; understand, categorize and describe disaster relief and its components; and explain Disaster Management Act and Policy.
C04: Hazard and vulnerability situation in India and Kerala; types of disasters in Kerala; explain accident-related disasters, their prevention and mitigation; the application of GIS in Disaster management; and describe the significance of Emergency procedures and warning systems.

Unit–I

Introduction – Hazard and Disaster: Definition and Terminologies - Classification. Concept of Disaster management - Comprehensive Disaster Management Plan. Elements of Disaster Management Plan.

Unit–II

Natural Disasters - Earthquake, Landslide, Avalanches, Volcanic eruptions - Their case studies. Heat and Cold Waves, Coastal disasters, Coastal regulation Zone, Cyclone, Flood, Drought, Tsunami.

Environmental Disasters - Dam collapse and Mitigation measures. Nuclear disasters, Chemical Disasters, Biological Disasters, Forest fire and Oil fire.

Unit–III

Climate change: global warming, sea level rise, ozone depletion, carbon sink and sources - causes and effects.

Unit–IV

Disaster Risk Management; Institutional arrangement: Prevention, Preparedness, and Mitigation; Disaster Preparedness Plan. Application of Information Technology in Disaster Preparedness. Hazards and Vulnerability scenario in India; Disaster relief and its components – water, food, sanitation, shelter, health and waste management; Disaster Management Act and Policy.

Unit–V

Kerala and disasters: types – Flood, Drought, Coastal erosion, Landslides, Pesticide contaminations. Accident-related disasters, their prevention and mitigation. Application of GIS in Disaster Management. Emergency procedures and warning systems.

References

1. David Alexander (1993) Natural Disasters, UCL Press, London.
2. Edward Bryant (2005) Natural Hazards, Cambridge University Press.
3. Patrick L. Abbott (2008) Natural Disasters, McGraw Hill International edition.
4. Rajib Shaw and Krishnamurthy R.R. (2008) Disaster management: Global Challenges and Local Solutions, Universities Press, Hyderabad, India.
5. Govt. of India (2005) Disaster Management Act, New Delhi.
6. Govt. of India (2009) National Disaster Management Policy.
7. Gupta, A.K. and Nair, S.S. (2011) Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi.
8. Murthy, R.K. (2012) Disaster management, Wisdom Press, New Delhi.
9. Vasudevan, V., Krishnan, K.R.S., Baba, M. and Kumar, P. (Eds.) (2006) Natural Hazards and Management Strategies, XVIII Kerala Science Congress – 2006, KSCSTE.

GLO5ID03- GROUND WATER EXPLORATION AND MANAGEMENT

Credit: 3 **Total Hours: 48**

Unit 1

Origin- meteoritic, juvenile and connate waters. Hydrological cycle, occurrence; ground water occurrences in igneous, sedimentary and metamorphic rocks- vertical distribution of ground water, movement; classification and types of aquifers, definition of porosity, permeability, specific yield, specific retention, storage and transmissibility

Unit 2

Groundwater detection; surface methods-geomorphological, structural and biological evidences. Surface geophysical methods; principles, field procedures, electrode arrangements, instruments and interpretations involved in electrical resistivity method of ground water exploration. Brief account of role of remote sensing in ground water targeting

Unit 3

Well design and well development; brief introduction about dug wells, tube wells, jetted wells, infiltration galleries and collector wells, well screening and artificial packing. Well development through surging and acidizing. Methodology and need for pump test

Unit 4

Water quality; Quality of water in various rock types, water quality parameters and their standards proposed by WHO and BIS. Physical parameters of water quality. Chemical parameters and determining methods. Diseases and virological aspects of ground water and remedial measures

Unit 5

Ground water management; meaning of water shed and river basins. Ground water provinces of India. Ground water potentiality in Kerala. Seawater intrusions and remedies. Cloud seeding, artificial recharge and ground water harvesting techniques

References

1. Davis S.N and Dewiest(1966)-Hydrogeology, John wiley and sons.
2. Bouwer . H. Ground water hydrology,1978
3. Todd,D,K. ground water hydrology,John wiley and sons 1980
4. Tolman C. F, Ground water,Mc Graw Hill
5. Walton,W.C., Ground water resource evaluation, Mc Graw Hill,1970

MODEL QUESTION PAPERS
(THEORY)

MODEL QUESTION PAPER

THIRD SEMESTER B.Sc. DEGREE EXAMINATION
SUBJECT: GEOLOGY
GLO3IB03 – CRYSTALLOGRAPHY AND MINERALOGY

Time: Two Hours **Maximum Marks: 60**

Answer *all* questions
(Draw neat sketches, wherever necessary)

Section A

I. Answer in one or two sentences (Each question carries 2 marks)

1. Horizontal Prisms
2. Compositional Plane
3. Weiss notation
4. Enantiomorphic Forms
5. Twin axis
6. Contact Goniometer
7. Polymorphism
8. Cleavage
9. Mineraloid
10. Hardness
11. Lustre
12. Inosilicate

(Maximum 20 marks)

Section B

II. Write short notes (Each question carries 5 marks)

13. Laws of twinning
14. Macro and brachydomes
15. Symmetry elements in the normal class of orthorhombic system
16. Hemimorphic forms
17. Determination of hardness of minerals using Moh's hardness scale
18. Polymorphism and Pseudomorphism
19. Specific gravity

(Maximum 30 marks)

Section C

III. Write long essay on any of the following (Each question carries 10 marks)

20. Describe the symmetry elements and forms present in the normal class of the Tetragonal system
21. Briefly describe the various physical characters of minerals

(Maximum 30 marks)

MODEL QUESTION PAPER

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION
SUBJECT: GEOLOGY
GLO6IB12– STRUCTURAL GEOLOGY AND GEOTECTONICS

Time : 2½ Hours **Maximum Marks : 80**

Answer *all* questions
(Draw neat sketches, wherever necessary)

Section A

I. Answer in one or two sentences (Each question carries 2 marks)

1. Angular unconformity
2. Benioff zone
3. Conrad discontinuity
4. Dip slip
5. Hade
6. Monocline
7. Palaeomagnetism
8. Strike joints
9. Triple junction
10. Drag fold
11. Throw of a fault
12. Release joints
13. Foliation and lineation
14. Polar wandering
15. Asthenosphere

(Maximum 25 marks)

Section B

II. Write short notes (Each question carries 5 marks)

16. Elastic deformation
17. Brunton Compass
18. Isostasy
19. Mid Oceanic Ridge
20. Overlap
21. Converging boundaries
22. Structural map
23. Criteria for recognition of folds in the field

(Maximum 35 marks)

Section C

III. Write long essay on any of the following (Each question carries 10 marks)

24. Write an essay on the geometric classification of faults
25. Give an account on the sea floor spreading in the light of modern tectonic hypothesis
26. What are Folds? Describe the different types of folds
27. Give an account on the different types of plate margins and their products

(Maximum 20 marks)