

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**

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# **DEGREE OF B. Sc. Geology**

**BACHELOR OF SCENCE IN GEOLOGY**

**(CHOICE BASED CREDIT AND SEMESTER SYSTEM FOR  
UNDERGRADUATE CURRICULUM)**

**UNDER THE FACULTY OF SCIENCE**

## **SYLLABUS**

**(FOR THE STUDENTS ADMITTED FROM THE ACADEMIC YEAR 2019 – '20 ONWARDS)**

**BOARD OF STUDIES IN GEOLOGY (UG)**

***CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA - 680125, KERALA, INDIA***

**JUNE, 2019**

## **1. TITLE**

These regulations shall be called “Christ College Calicut University Regulations for Choice Based Credit and Semester System for Under Graduate Curriculum 2019” (CC CUCBCSS UG 2020).

## **2. SCOPE, APPLICATION & COMMENCEMENT**

The regulations provided herein shall apply to all Regular UG programme in Geology at Christ College Autonomous under Faculty of Science conducted by the Christ College for the admissions commencing from 2019, with effect from the academic year 2019-2020. 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 undergraduate programme in Geology will be as per the rules and regulations of the University. Minimum qualification for the admission is a pass in higher secondary (Pre-Degree or 10+2 Science scheme) or qualifications announced by the University from time to time.

The applicants for B.Sc. Geology 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. GAI/JI/4440/99(2) Dated 13-05-2004)*

## **4. PROGRAMME STRUCTURE**

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

The programme shall include five types of courses, viz, Common Courses (Code A), Core courses (Code B), Complementary courses (Code C), Open Course (Code D) and Audit courses (Code E).

- Common Courses (10 theory) with 38 credits (22 for common English courses + 16 for common languages other than English)
- Core courses (11 Theory, 8 Practical, 1 Elective theory, and Project and Study tours) with 55 credits
- Open Course (one from other department) with 3 credits; and
- Complementary courses (4 Theory and 4 Practical Courses from Chemistry as compulsory complementary course and 4 theory courses of Physics/Mathematics/ Statistics/Remote Sensing & GIS with 4 practical courses in Physics/Remote Sensing & GIS).
- Altogether, there shall be a total of 120 credits for Common, Core, Complementary, and Open courses.
- Ability Enhancement course/Audit course: These are courses which are mandatory for a programme but not counted for the calculation of SGPA or CGPA. There shall be one Audit course each in the first four semesters. These courses are not meant for class room study. 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.

## 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	22
2.	Common	Additional Language	16
3.	Core	Geology	55
4.	Complementary Course I	Chemistry	12
5.	Complementary Course II	Physics/Statistics	12
6.	Open Course	One theory course offered by any other department	3
7.	Audit Course	One theory course	16
8.	Extra Credits		4

**(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<sup>+</sup>, A, B<sup>+</sup>, 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 <sup>+</sup>	Excellent	9	8.50–9.49	
75 to below 85	A	Very Good	8	7.50–8.49	
65 to below 75	B <sup>+</sup>	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:

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

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:

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

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. CORE COURSE STRUCTURE

Sem	Course Type	Course Code	Course Title	Hrs per week	Credits	Max Marks		
						Internal	External	Total
I	Theory	GEO1B01	Essentials of Geology	3	3	15	60	75
	Practical*	GEO1B02(P)	Field Geology	1	0	-	-	-
II	Theory	GEO2B03	Dynamic Geology and Geoinformatics	3	3	15	60	75
	Practical*	GEO2B04(P)	Geoinformatics	1	0	-	-	-
III	Theory	GEO3B05	Crystallography and Mineralogy	3	3	15	60	75
	Practical*	GEO3B06(P)	Crystallography	2	0	-	-	-
IV	Theory	GEO4B07	Optical and Descriptive Mineralogy	3	3	15	60	75
	Practical*	GEO4B08(P)	Geoinformatics, Crystallography, and Mineralogy	2	4	20	80	100
V	Theory	GEO5B09	Structural Geology and Geotectonics	3	3	15	60	75
		GEO5B10	Stratigraphy and Sedimentology	3	3	15	60	75
		GEO5B11	Igneous Petrology	3	3	15	60	75
		GEO5B12	Metamorphic Petrology	3	3	15	60	75
	Practical <sup>±</sup>	GEO5B13(P)	Structural Geology	4	0	-	-	-
		GEO5B14(P)	Petrology	4	0	-	-	-
	Project <sup>±</sup>	GEO5B15(PR)	Project work	1	0	-	-	-
Study Tour <sup>±</sup>	GEO5B16(ST)	Study Tour	1	0	-	-	-	
VI	Theory	GEO6B17	Palaeontology	4	4	20	80	100
		GEO6B18	Indian Geology	4	4	20	80	100
		GEO6B19	Economic Geology	4	4	20	80	100
	Practical <sup>±</sup>	GEO6B20(P)	Structural and Economic Geology	4	4	20	80	100
		GEO6B21(P)	Petrology and Palaeontology	4	4	20	80	100
	Elective <sup>#</sup>	GEO6B22(E01)	Environmental Geology	3	3	15	60	75
		GEO6B22(E02)	Disaster Management					
		GEO6B22(E03)	Geo Exploration					
		GEO6B22(E04)	Geotechnical Engineering					
	Project <sup>±</sup>	GEO6B23(PR)	Project work	1	2	15	60	75
Study Tour <sup>±</sup>	GEO6B24(ST)	Study Tour	1	2	20	80	100	
<b>Total</b>					<b>55</b>	<b>290</b>	<b>1160</b>	<b>1450</b>

\*Exam will be held at the end of 4<sup>th</sup> semester

±Exam will be held at the end of 6<sup>th</sup> semester

#An institution can offer any one among these courses

## 6.1 OPEN COURSE\*

Sem	Course	Course Code	Course Title	Hrs per week	Credits	Max Marks		
						Internal	External	Total
V	Open	GEO5D01	Understanding the Earth	3	3	15	60	75
		GEO5D02	Gemmology					
		GEO5D03	Ground Water Exploration and Management					

\*Courses offered by the Faculty of Geology for other Stream students

## 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, Class room 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/Organisation 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 or sixth 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
	<b>Total</b>	<b>20</b>

**(b) External Evaluation**

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

## **GEO1B01 – ESSENTIALS OF GEOLOGY**

*Number of Credits: 3*

*Number of Contact Hours: 48 Hrs.*

### **Course Outline**

#### **Module 1:**

- **Definition, scope and branches of Geology.**
- Elementary information on the Universe and the Solar system – The Eight Planets; Meteorites; Comets; Asteroids.
- Origin of the Earth – Big-Bang theory; Nebular hypothesis; Planetesimal hypothesis.
- Concept of lithospheric plates, plate tectonics and types of plate boundaries, Continental drift theory.

#### **Module 2:**

- Age of the Earth – Determination of Earth's age, Relative and absolute dating. Introduction to non-radioactive methods and radioactive methods.
- Geological Time scale: Eons; Eras; Periods; and Epochs.

#### **Module 3:**

- 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.
- Building blocks of earth materials – Chemical elements and periodic table; Bonding of atoms – Metallic, Covalent, Ionic and Van der Waal's Bonding in Minerals

- A brief introduction to minerals – Silicates – Carbonates – Sulphides –Phosphates.
- Rocks – Types of rocks - brief introduction to Igneous, sedimentary and metamorphic rocks; Concept of rock cycle

#### Module 4:

- Earthquakes – Properties of seismic waves; Magnitude and Intensity – Richter and Mercalli's Scales; Seismogram and Seismograph. Origin, distribution and prediction of earthquakes. Tsunami – Origin and effects.
- Study of Earth's interior by using seismic waves
- Mass movements – Types of mass wasting. Landslides – causes, effects and remedial measures.

#### Module 5:

- Volcanoes – Classification based on Lava Types; Styles of Eruptions – Products - Global Distribution; Causes; Effects; Prediction.
- Oceans and Seas: Waves, tides and currents; Geological work of oceans.
- Description of continental margins and ocean bottom topography – Continental shelf, Continental slope, submarine canyons, sea mount, Guyots, Midoceanic ridges, trenches.
- Transitional landforms- Introduction to Estuaries and backwaters of Kerala- nature, distribution and evolution.

#### ***Essential Reading:***

1. Condie, K.C., 2015. *Earth as an Evolving Planetary System*, 3<sup>rd</sup> Edition, Academic Press, USA.
2. Marshak, S., 2001. *Earth: Portrait of a Planet*. W.W. Norton & Co., Inc., USA
3. Tarbuck, E.J. and Lutgens, F.K., 2008. *Earth: An Introduction to Physical Geology*. 9<sup>th</sup> Edition, Pearson Education, Inc., New Jersey, USA
4. Wicander, R. and Monroe, J., 2006. *Essentials of Geology*. 4<sup>th</sup> Edition, Thomson Learning Inc., USA.
5. Carlson, D. and Plummer, C.C. and Hammersley, L., 2018. *Physical Geology*, McGraw-Hill Education.
6. Soman, K. 2002 *Geology of Kerala*, Second Rev. Edition, Geological Society of India, 335 p

## **GEO2B03 – DYNAMIC GEOLOGY AND GEOINFORMATICS**

*Number of Credits: 3*

*Number of Contact Hours: 48 Hrs.*

#### **Course Outline**

#### Module 1:

- Weathering, erosion and soil – Types of weathering – Physical, Chemical and Biological; Products of weathering; Factors influencing weathering

- Geological work of wind: Erosional and depositional landforms – Loess, types of dunes, pediplanation, playas and inselbergs; Formation of desert landforms
- Glaciers – Formation of glaciers; Types; Accumulation and wastage; Movements;
- Erosional and depositional landforms; Glacial ages

#### **Module 2:**

- Running water as a geological agent: Development of a typical Stream-Drainage system; Consequent and subsequent streams; Drainage basin and Drainage patterns; Graded, Braided and Meandering streams
- Geological work of stream, erosional and depositional fluvial landforms
- Concept of base level, peneplanation, monadnocks, Stream terrace, Rejuvenation, Knick Point.

#### **Module 3:**

- Underground water: Occurrence, Zone of aeration and saturation; Water table – Perched water table; Porosity, Permeability,
- Aquifers – Confined and unconfined, aquicludes, aquitard and aquifuge. Artesian wells, Geysers and springs. Erosional and depositional landscapes produced by action of ground water; Origin of limestone caverns – Stalactite and stalagmites; Karst topography

#### **Module 4:**

- Geoinformatics – Definition.
- Geographic Information System (GIS) – The purpose of GIS; Maps; Components of GIS; GIS software. Types of Data – Raster and Vector.
- Spatial data input – Digitizing paper maps. Geo-referencing. Transformation and Projection. Spatial data analysis; Overlay functions.
- GIS Applications in Geosciences – Geology; Groundwater; Mineral Exploration.

#### **Module 5:**

- Remote sensing- basic principles.
- Satellite data products- panchromatic, multispectral, hyper-spectral images.
- Sensors and platforms- type, sensor parameters- spatial, spectral, radiometric, temporal resolution.

#### ***Essential Reading:***

1. Lo, C.P. and Yeung, A.K.W., 2007. *Concepts and Techniques in Geographic Information Systems*.
2. Tarbuck, E.J. and Lutgens, F.K., 2008. *Earth: An Introduction to Physical Geology*. 9<sup>th</sup> Edition, Pearson Education, Inc., New Jersey, USA.
3. Wicander, R. and Monroe, J., 2006. *Essentials of Geology*. 4th Edition, Thomson Learning Inc., USA.
4. Joseph, G, 2005. *Fundamentals of Remote Sensing*. Universities Press, 486 p.

# GEO3B05 – CRYSTALLOGRAPHY AND MINERALOGY

*Number of Credits: 3*

*Number of Contact Hours: 48 Hrs.*

## **Course Outline**

### **Module 1:**

- Crystallography – A brief introduction to scope and its applications.
- 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.

### **Module 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, Fluorite, Diamond, Pyrite, Tetrahedrite, Boracite and cuprite.
- Study of symmetry elements and forms of Normal, Hemimorphic, Tripyramidal, Sphenoidal and Trapezohedral 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.

### **Module 3:**

- Study of the symmetry elements and forms of the Normal and Sphenoidal classes of 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.

### **Module 4:**

- Definition of Mineral and Mineraloid – Scope and aim of Mineralogy.
- Coordination number- the making of minerals.
- Structure and classification of silicate minerals.

## Module 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.

## *Essential Reading:*

1. Borchardt-Ott, W., 2011. *Crystallography– An Introduction*. Springer Heidelberg, 355p.
2. Dana, F.S., 1955. *A Text Book of Mineralogy*. Asia publishing House, Wiley.
3. Klein, C., Hurlbut, C.S., 1985. *Manual of Mineralogy*, John Wiley & Sons.
4. Perkins, D., 2015. *Mineralogy*. Pearson Education (3Ed), 568 p.
5. Nesse W.D., 2000. *Introduction to Mineralogy*. Oxford and New York (Oxford University Press), 442 pp.

## **GEO4B07 – OPTICAL AND DESCRIPTIVE MINERALOGY**

*Number of Credits: 3*

*Number of Contact Hours: 48 Hrs.*

### **Course Outline**

#### **Module 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.

#### **Module 2:**

- Optical accessories and uses – Quartz wedge (Determination of order of Interference Colour), Gypsum plate and Mica plate (Determination of Fast and Slow vibration directions).
- 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.

### **Module 3:**

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

### **Module 4:**

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

### **Module 5:**

- Chemistry, Physical and optical 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, Wollastonite and Corundum.

### ***Essential Reading:***

1. M.D. Dyar, M.E. Gunter and D. Tasa, 2007. *Mineralogy and Optical Mineralogy*. Mineralogical Society of America, USA. 708p.
2. Demange, M., 2012. *Mineralogy for Petrologists: Optics, Chemistry, and Occurrence of Rock Forming Minerals*. CRC Press (Taylor & Francis Group), 182 p.
3. Nesse, W.D., 2012. *Introduction to Optical Mineralogy*. Oxford University Press; 4 edition, 384p.
4. Pichler, H., Riegraf, C.S., 2011. *Rock-forming Minerals in Thin Section*. Springer, 220 p.
5. Deer, W.A., Howie, R.A., Zussman, J., 2013. *Introduction to the Rock-forming Minerals*. Mineralogical Society of Great Britain & Ireland, 510 p.
6. Paul F. Kerr, 1959. *Optical mineralogy*. New York: McGraw-Hill, 442 p.

## **GEO5B09 – STRUCTURAL GEOLOGY AND GEOTECTONICS**

*Number of Credits: 3*

*Number of Contact Hours: 48 Hrs.*

### **Course Outline**

#### **Module 1:**

- Introduction to Structural Geology. Methods for representing relief features; contours, topographic and geologic maps- their preparation and uses, geological surface and their attitudes-Dip and strike- trend of outcrops - rules of 'V' – relation between true dip and apparent dip-width of outcrops; true thickness and vertical thickness and their mutual relation. Uses of clinometers and Brunton compass.
- Rock deformation-uniform pressure- differential pressure- stress and strain, types of stress-type of strain -stress strain diagram. Stages of deformation, mechanism of elastic, plastic and brittle deformation

## Module 2:

- Folds: Geometry and elements of folded surface-classification- descriptive study of different types of folds- recognition in the field and on the maps.
- Shear Zones – Shear sense indicators – prominent shear zones of southern India
- Fault: Definition, terminology, classification, description and recognition in the field and on the map

## Module 3:

- Joints: Definition, classification, descriptive study and geological significance of joints.
- Foliation and lineation- primary and secondary and their types.
- Unconformities: Definition, and types, significance and recognition in the field and on the maps. Overlaps and offlaps, outlier and inlier.
- Introduction to equal area and stereographic projections; methods of construction; Pie Diagram, contour diagram, Beta diagram.

## Module 4:

- Structure and characteristics of layers of the Earth: Crust (Continental and Oceanic), Mantle (Lower and Upper), Core (Inner and Outer);
- Structure, Physical and mineralogical characteristics of Lithosphere and Asthenosphere
- Models of mantle convection
- Mantle plumes; Hot spots; Super swells

## Module 5:

- Seafloor spreading; Palaeomagnetism
- Plate tectonics: Basic concepts , definition and evidence.
- Features associated with divergent, convergent, and transform plate margins.
- Triple junctions, Benioff zones, Island arcs, rift valleys, transform faults

## Essential Reading:

1. Condie, K.C., 2011. *Earth as an Evolving Planetary System*, Academic Press, Oxford, UK, 574p.
2. Frisch, W., Meschede, M., and Blakey, R., 2011. *Plate Tectonics – Continental Drift and Mountain Building*, Springer-Verlag, Berlin Heidelberg, 212p.
3. Moores, E.M., Twiss, R.J., 2014. *Tectonics*. W.H. Freeman, 672 p.
4. Turcotte, D.L. and Schubert, G., 2014. *Geodynamics*, Cambridge University Press, 636p.
5. Twiss, R.J., Moores, E.M., 2007. *Structural Geology*. W.H. Freeman, 500p.
6. Jain A. K. (2014): Introduction to structural Geology, Geological Society of India

# GEO5B10 – STRATIGRAPHY AND SEDIMENTOLOGY

*Number of Credits: 3*

*Number of Contact Hours: 48 Hrs.*

## **Course Outline**

### **Module 1:**

- Laws of Stratigraphy: Concept of uniformitarianism; Law of order of super position; Law of faunal succession; Law of original horizontality; Principle of Lateral Continuity; Principle of Inclusion; Law of cross cutting relationship
- Physical and biological criteria of correlation and homotaxis.
- Concept of Mass extinction

### **Module 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.

### **Module 3:**

- Sedimentary process: disintegration & decomposition of rocks – transportation – deposition – diagenesis. Fluid sediment interaction, Goldirich series.
- A broad classification of sedimentary rocks
- Structures of sedimentary rocks-mechanical, chemical and organic structures.
- Textures of sedimentary rocks – clastic and non – clastic textures
- Brief introduction to Depositional environments – terrestrial, marine and transitional

### **Module 4:**

- Mechanical deposits – rudaceous, arenaceous and argillaceous groups
- Chemical deposits – siliceous, carbonaceous, ferruginous and salt deposits
- Organic deposits – calcareous, siliceous, phosphatic, and carbonaceous deposits.
- Residual deposits – terra rossa, clay, laterite and bauxite and soils.

### **Module 5:**

- A descriptive study of Conglomerate, Breccia, Sandstones and Shales
- Heavy minerals-definition, types, distribution and uses of heavy minerals

- A brief study of fossiliferous limestone, radiolarian chert, diatomaceous earth, Guano

### ***Essential Reading:***

1. Boggs, S., 2016. *Principles of Sedimentology and Stratigraphy*. Pearson Education. 568 p.
2. Brookfield, M.E., 2003. *Principles of Stratigraphy*. Wiley-Blackwell, 340 p.
3. Nichols, G., 2016. *Sedimentology and Stratigraphy*. Wiley-Blackwell, 419 p.
4. Prothero, D.R., Schwab, F., 2013. *Sedimentary Geology*. W.H. Freeman, 593 p.
5. Maurice E. Tucker (2013): *Sedimentary Petrology*, John Wiley & Sons

## **GEO5B11 – IGNEOUS PETROLOGY**

*Number of Credits: 3*

*Number of Contact Hours: 48 Hrs.*

### **Course Outline**

#### **Module 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.

#### **Module 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 hypidimorphic, 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

#### **Module 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.

#### **Module 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, Albite-orthoclase system. Introduction to ternary eutectic system.
- Reaction principle and Bowen's reaction series - Causes for the diversity of Igneous rocks – Magmatic Differentiation: Fractional Crystallization, Liquid immiscibility, Assimilation - Short notes on: Consanguinity, Variation diagrams.

#### **Module 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 mineralogy of Pegmatites, Lamprophyres, Carbonatite, Kimberlite, Komatiite, Dunite, Peridotite and Anorthosites

#### ***Essential Reading:***

1. Frost, B.R., Frost, C.D., 2014. *Essentials of Igneous and Metamorphic Petrology*. Cambridge University Press. 318 p.
2. Raymond, L.A., 2002. *Petrology: The Study of Igneous, Sedimentary and Metamorphic Rocks*, 720p.
3. Winter, J.D., 2009. *Principles of Igneous and Metamorphic Petrology*. Pearson, 720 p.
4. Mikhir K. Bose (1997): *Igneous petrology*, World Press
5. Philpotts A. R (1990)., *Principles of Igneous and Metamorphic Petrology*, Prentice-Hall Publishing Co.,
6. Ernest G. Ehlers and Harvey Blatt (1982): *Petrology: igneous, sedimentary and metamorphic*, W.H. Freeman publishing

## **GEO5B12 – METAMORPHIC PETROLOGY**

*Number of Credits: 3*

*Number of Contact Hours: 48 Hrs.*

#### ***Course Outline***

#### **Module 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, regional (burial, ocean-ridge, orogenic); based on plate tectonic setting – metamorphism at convergent, divergent, and transform plate margins.
- Fault-zone and impact metamorphism

### Module 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

### Module 3:

- Metamorphic grades and isograds; metamorphic zones and Barrovian 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.

### Module 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, bornblende gneiss, amphibolite, marble, charnockite, eclogite, and mylonite, mafic granulite

### Module 5:

- Prograde and retrograde metamorphism
- metasomatism
- Introduction to UHP and UHT metamorphism; anatexis and migmatites; metamorphic differentiation

### ***Essential Reading:***

1. Barker, A.J., 1990. *Introduction to Metamorphic Textures and Microstructures*. Blackie, 162p.
2. Bucher, K. and Grapes, R., 2011. *Petrogenesis of Metamorphic Rocks*. Springer-Verlag, Berlin-Heidelberg, 428p.
3. Frost, C.D., Frost, B.R., 2013. *Essentials of Igneous and Metamorphic Petrology*, Cambridge University Press, 336p.
3. Kretz, R., 1994. *Metamorphic Crystallization*. John Wiley & Sons, 507p.

4. Miyashiro, A., 1978. *Metamorphism and Metamorphic Belts*. 3<sup>rd</sup> Edition. George Allen & Unwin, London, 492p.
5. Vernon, R.H. and Clarke, G.L., 2008. *Principles of Metamorphic Petrology*. Cambridge University Press, 446p.
6. Winter, J.D., 2011. *Principles of Igneous and Metamorphic Petrology*, Prentice-Hall, 728p.

## **GEO6B17 – PALAEOLOGY**

*Number of Credits: 4*

*Number of Contact Hours: 64 Hrs.*

### **Course Outline**

#### **Module 1:**

- An outline of life through ages, its evolution and distribution
- Definition of Palaeontology – organic world – classification – Flora and Fauna – vertebrates and invertebrates
- Definition of fossils – nature and modes of preservation of fossils: Unaltered hard parts: Altered hard parts : Petrification, 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

#### **Module 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

#### **Module 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 rings, chambers, suture lines, (Nautilitic, Goniatitic, Ceratitic and Ammonitic) – shell forms – ornamentation – classification evolution, geological history- morphology of a Belemnite shell.

#### **Module 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 – geological 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

#### **Module 5:**

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

#### ***Essential Readings:***

1. Henry woods : Invertebrate palaeontology – 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 Stanley, M.S.: Principles of Palaeontology, CBS Publishers.
6. Moore, R.C., Laliker, C.G. & Fisher, A.G.: Invertebrate Fossils, Harper brothers
7. Shrock. R.R. and Twenhofel, W.H – 1953 : Principles of invertebrate Palaeontology, Arnold publication

# GEO6B18 – INDIAN GEOLOGY

*Number of Credits: 4*

*Number of Contact Hours: 64 Hrs.*

## **Course Outline**

### **Module 1:**

- 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

### **Module 2:**

- Paleozoic Stratigraphy: Distribution of Paleozoic rocks in India; Cambrian of Salt Range; Age of Saline Series; Upper Carboniferous and Permian rocks of Salt Range; Paleozoic rocks of Kashmir Valley; Paleozoic rocks of Spiti Valley; Paleozoic rocks of Peninsular India

### **Module 3:**

- Mesozoic Stratigraphy: The Depositional Environment–distribution–life–classification and economic importance of Gondwana formations of India, Coastal Gondwana of India, Gondwana formations of Tamil Nadu, Triassic of Spiti – The Lilang System, Jurassic of Kutch, Cretaceous of Tiruchirapalli – Pondicherry – Bagh Beds, Deccan traps: distribution, structure, Lameta beds – infratrapean and intertrapean beds, age of the Deccan traps

### **Module 4:**

- Cenozoic Stratigraphy: Comprehensive account of the geological events took place during Cenozoic Era in India, rise of Himalayas, stratigraphy of Siwalik system, fauna and flora of Siwaliks, Tertiary rocks of Assam, Karewa formation, Tertiary rocks of Tamil Nadu, Tertiary rocks of Kerala, Pleistocene Glaciation – Cenozoic oil bearing formations of India

### **Module 5:**

- Introduction to major quaternary deposits in India
- Stratigraphy and geology of Kerala

### **Essential Reading:**

1. Sharma, R.S., 2009. *Cratons and Fold Belts of India*. Springer.
2. Krishnan M.S. (2003)- *Geology of India and Burma*, 6th Edition, CBS.
3. Wadia D.N. (1953) – *Geology of India*, TATA McGraw – Hill.

4. Pascoe, E. H. (1968) - A manual of the Geology India and Burma, Govt of India Publications.
5. Ramakrishnan, M, Vaidyanathan, R (2008): Geology of India Vol 1 & 2, GSI publications, Bangalore.
6. Valdiya, K. S. (2016): The making of India, geodynamic evolution. Springer.
7. Soman, K. (1997): Geology of Kerala, Geological society of India publications

## **GEO6B19 – ECONOMIC GEOLOGY**

*Number of Credits: 4*

*Number of Contact Hours: 64 Hrs.*

### **Course Outline**

#### **Module 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.
- Brief study of metallogenic epochs and provinces – geologic thermometers.
- 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.
- UNFC classification.

#### **Module 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.
- Metamorphic processes – Formation of Graphite, Asbestos, Talc, Soapstone and Sillimanite group of minerals

#### **Module 3:**

- 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.
- 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 enrichment – Gossans and capping.

#### **Module 4:**

- Occurrence and distribution in India of metalliferous deposits - base metals, iron, manganese, aluminium, chromium, nickel, gold, silver, molybdenum.
- Indian deposits of non-metals – Diamond, mica, asbestos, barytes, gypsum, graphite, apatite and beryl. Gemstones, refractory minerals, abrasives and minerals used in glass, fertilizer, paint, ceramic and cement industries.

#### **Module 5:**

- Coal and its properties: Different varieties and ranks of coal. Origin of coal. Geology and coal petrography of different coalfields of India.
- Origin, migration and entrapment of natural hydrocarbons. Characters of source and reservoir rocks. Structural, stratigraphic and mixed traps. Geographical and geological distributions of onshore and offshore petroliferous basins of India.

#### ***Essential Reading:***

1. Pohl, W.L., 2016. *Economic Geology Principles and Practice*. Wiley-Blackwell, 678 p.
2. Sarkar, S.C., Gupta, A., 2012. *Crustal Evolution and Metallogeny in India*. Cambridge University Press, 912 p.

## **GEO1B02(P) – FIELD GEOLOGY**

*Number of Contact Hours: 16 Hrs.*

#### **Course Outline**

- Introduction to Gt Aide (Academy) learning tool / Software
- Toposheet search, UTM Zones, Coordinates and Latitude and Longitude converter etc, Interactive sessions and tasks to extract information on toposheets and UTM zones using Gt Aide (Academy) software.
- Study of conventional signs, symbols, physical and socio-cultural features in Survey of India toposheet.
- Study of marginal information.
- Instructional training on uses of Clinometer, Brunton compass and GPS.
- Field trip to understand the geomorphology and topography of an adjacent locality.
- Report preparation on field trip

## **GEO2B04(P) – GEOINFORMATICS**

*Number of Contact Hours: 16 Hrs.*

### **Course Outline**

- Download and install QGIS software
- Scanning of paper maps / toposheets
- Georeferencing
- Digitisation of points, lines and polygons
- Adding attribute data
- Calculation of length and area of features
- Preparation of map layouts
- Record of the practical done

## **GEO3B06(P) – CRYSTALLOGRAPHY**

*Number of Contact Hours: 32 Hrs.*

### **Course Outline**

- 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.

## **GEO4B08(P) – CRYSTALLOGRAPHY, MINERALOGY & GEOINFORMTICS**

*Number of Credits: 4*

*Number of Contact Hours: 32 Hrs.*

### **Course Outline**

### **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:**

- 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.

### **GIS Practicals:**

- Toposheet search, UTM Zones, Coordinates
- Latitude and Longitude converter
- Georeferencing
- Digitisation of Point, Line and Polygon features
- Calculation of length and area
- Making of map layout

### **Record preparation**

\*This course will include the practical component of the course GEO1B02(P) – Field Geology, GEO2B04(P) – Geoinformatics and GL3B06(P) – Crystallography.

## **GEO5B13(P) – STRUCTURAL GEOLOGY**

*Number of Contact Hours: 64 Hrs.*

### **Course Outline**

#### **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.

## **GEO5B15(P) – PETROLOGY**

*Number of Contact Hours: 64 Hrs.*

### **Course Outline**

#### **Megascope 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:**

- 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.

## **GEO6B20(P) – STRUCTURAL & ECONOMIC GEOLOGY**

*Number of Credits: 4*

*Number of Contact Hours: 64 Hrs.*

### **Course Outline**

**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 varieties, Asbestos.

### **Record preparation**

\*This course will include the practical component of the course GEO5B13(P) – Structural Geology.

## **GEO6B21(P) – PETROLOGY & PALAEOLOGY**

*Number of Credits: 4*

*Number of Contact Hours: 64 Hrs.*

### **Course Outline**

**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, Trigonina, Megaladon,
- Spondylus, Gryphaea, Exogyra, Ostrea, Inoceramus, Alectryonia, Hippurites, Venus
- **Mollusca-Gastropoda:** Natica, Turbo, Trochus, Turritella, Cerithium, Conus, Murex, Fusus, Physa, Bellerophon,
- **Mollusca-Cephalopoda:** 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.

**Record preparation.**

\*This course will include the practical component of the course GEO5B14(P) – Petrology.

## **GL6B23(E01) – ENVIRONMENTAL GEOLOGY**

*Number of Credits: 3*

*Number of Contact Hours: 54 Hrs.*

### **Course Outline**

**Module 1:**

- Our place in the environment-humans as agents of geologic change-fundamental concepts of environmental geology. Man, as a geologic agent- de forestation-human population explosion-urbanization

**Module 2:**

- Man, and geologic hazards-mass wasting and its human impacts-factors that influence slope stability-earth quakes hazards and risks- prediction and control of earth quakes

**Module 3:**

- Man, and hydrosphere- pollution of surface water-pollution of ground water-saline water intrusion-pollution in the marine environment

**Module 4:**

- Man, and atmosphere- atmospheric change as a natural process-anthropogenic impacts on the atmosphere- depletion of ozone-global warming- greenhouse effect

**Module 5:**

- The global energy scenario- energy from fossil fuels- energy alternatives- environmental impacts of mining-waste management

***Essential Reading:***

1. Donald R coates, Ed 1973 Environmental Geomorphology and Environmental geo science. Willey international
2. Donald R coates, 1981, Environmental geology, John wiley and sons
3. Peter T Elawan ,1970. Environmental geology, Harper & Raw

# GL6B23(E02) – DISASTER MANAGEMENT

*Number of Credits: 3*

*Number of Contact Hours: 54 Hrs.*

## **Course Outline**

### **Module 1:**

- Introduction- Hazard and Disaster: Definition and terminologies - Classification. Concept of Disaster Management- Comprehensive Disaster Management Plan. Elements of Disaster Management Plan. Disaster Management Act, 2005. Institutional frame work - Policy and Administrative frame work for Disaster Management

### **Module 2:**

- Natural Disasters - Earth quake, Land Slide, Avalanches, Volcanic eruptions - Their Case Studies. Heat and Cold waves. Coastal Disasters. Coastal Regulation Zone. Cyclone - Case Studies. Flood - Case Studies. Drought - Case Studies. Tsunami - Case studies

### **Module 3:**

- Man-made Disasters. Rail, Road, Air and Sea accidents. Dams and Dam bursts. Environmental Planning and Design of Dams. Environmental Impact of Dam. Dam safety, failure and mitigation measures Nuclear Disasters, Chemical Disasters. Biological Disaster. Building fire, Coal fire/Forest fire and Oil fire. Air pollution, Water pollution, Industrial pollution: Types of Pollutants - Heavy metals Pesticides, Petroleum Hydro Carbons. Abatement, Mitigation and Management of Environmental pollution Hazards. De-forestation. Climate change: Global warming, sea level rise, Ozone Depletion- Causes and Effects

### **Module 4:**

- Risk Assessment and Vulnerability Analysis- concepts and elements, Hazard, Risk and Vulnerability, Understanding risk, Risk Reduction. Vulnerability: Social and Economic Factors. Strategies for Survival. Vulnerability and Development

### **Module 5:**

- Disaster Management. Prevention, Preparedness and Mitigation; Disaster Preparedness Plan. Application of Information Technology in Disaster Preparedness. Applications of GIS in disaster management. Trauma and Stress Management. First Aid, and Emergency procedures, Warning Systems

### **Essential Reading:**

1. Abbott P. C (2002); Natural Disasters, Mcraw- Hill Publications-New Delhi
2. Coates D. R (1985); Geology and society chapman and hall publishers- New Delhi

3. Davis et al (1976) Environmental Geoscience Niley Eastern
4. Howard A. D and Irwin Remson (1978); Geology in Environmental Planning, M.C Graw-hill publications
5. Keller. E.A (1976); Environmental Geology. Charles E.Merril Publishers, New Jerseys
6. Lundgren. L. (1986) Environmental Geology. Prentice-Hall publishers, New Jerseys

## **GL6B23(E03) – GEO EXPLORATION**

*Number of Credits: 3*

*Number of Contact Hours: 54 Hrs.*

### **Course Outline**

#### **Module 1:**

- Geological exploration; marginal information of toposheets and working principles with Brunton compass. Principle of making pits and trenches. An introductory knowledge of different types of drilling. Stratigraphic, structural, mineralogical and geomorphological guides in ore search

#### **Module 2:**

- Geophysical exploration; scope and limitations of geophysical techniques. Principles involved in geoelectrical survey. A brief introduction about self-potential and resistivity surveys. Basic principles of well logging surveys

#### **Module 3:**

- Geodetic aspects of earth. Newtons law of gravitation- gravity corrections- gravimeters- applications of gravity in exploration. Geomagnetic field of earth. Principles of magnetism, Hysterisis loop-magnetometers-interpretation magnetic data- application magnetic survey

#### **Module 4:**

- Elastic constants, properties of seismic waves-geophones-refraction path of seismic waves in simple, horizontal two layer case. Basic principles of seismic reflection, application of seismic survey. Principles of radioactivity and its utility in geo exploration

#### **Module 5:**

- Geochemical exploration; abundance and types of elements in earth crust, mobility of elements, the electronic structure of atoms and the periodic table, chemical bonds, Geochemical exploration for copper and gold, principles of bio geo exploration-indicator plants, interrelation between geo exploration techniques

### ***Essential Reading:***

1. Dohr.G.(1984) Applied geophysics- English Book Department
2. Dobrin.M.B (1981) Introduction to geophysical prospecting- McGraw Hill
3. Kearney. P and Brooks M (1984) An introduction to geo physical exploration- ELBS
4. Mckinstry. H. E (1960) mining geology. Asia publisher house
5. Mason. B. (1966) principles of geo chemistry-Willey Toppan
6. Ramachandra Rao. M. B (1975) out lines of geo physical prospecting- a manual for geologist university of Mysore
7. Hawkes. H. E and Webh. V. S. (1962) geo chemistry in mineral exploration.

## **GL6B20(E04) – GEOTECHNICAL ENGINEERING**

*Number of Credits: 3*

*Number of Contact Hours: 54 Hrs.*

### **Course Outline**

#### **Module 1:**

- Geo-technical engineering as a field science related to construction. Scope of geo-technical engineering. Ground investigations – Introduction, Types of ground investigation, Geological mapping for ground investigation

#### **Module 2:**

- Field investigations - Introduction, Excavations and boreholes - Shallow trial pits, Deep trial pits and shafts, Headings (adits), Hand auger boring, Light cable percussion drilling, Mechanical augers, Wash boring and other methods, Backfilling excavations and boreholes

#### **Module 3:**

- Sampling. Frequency of sampling. Sampling the ground - General principles, Sample quality. Disturbed samples from boring tools or from excavating equipments, Types of samplers - Open-tube samples and samplers, Stationary piston sampler, Continuous soil sampling, Sand samplers, Rotary core samplers, Window sampler, Block samples. Handling and labelling of samples
- Field and lab tests  
Field tests – Introduction, Tests in boreholes - Standard penetration test (SPT). Permeability test and Packer test. Pressuremeter test. Pumping tests. Geophysical surveying (Electrical resistivity, Gravity, Magnetic, Seismic methods.
- Laboratory tests on samples - Tests on soil - Classification tests - Moisture content/ water content determination, Liquid and plastic limits (Atterberg Limits), Particle size distribution (grading) by

sieving. Soil strength tests - Triaxial compression test and Unconfined compression test. Compaction-related tests - Dry density (dry unit weight)

#### **Module 4:**

- Tests on rock
- Rock classification tests - Saturation moisture content (alteration index), Bulk density, Moisture content, Petrographic analysis, Hardness and abrasiveness, Carbonate test, Swelling test. Rock strength tests - Point load test, Uniaxial Compression, Direct tension test, Indirect tensile strength test (Brazil test).

#### **Module 5:**

- Logging - Description of soils and rocks
- Description of soils - Mass characteristics of soils. Material characteristics of soils – Colour, Particle shape, grading and composition.
- Description and classification of rocks - General description - Strength of rock material, Structure, Colour, Texture, Grain size, State of weathering, Rock name.
- Total core recovery (TCR), solid core recovery (SCR), Rock Quality Designation (RQD)

#### ***Essential Reading:***

1. Canadian Geotechnical Society, Canadian Foundation Engineering Manual. 3rd Ed.
2. Canadian Geotechnical Society, Technical Committee on Foundations, BiTech Publishers Ltd., Richmond, British Columbia, 1992.
3. Nielsen, David M., (ed.). Practical Handbook Of Ground-Water Monitoring. Lewis Publishers Inc., Chelsea, Michigan, 1991.
4. Coduto, D.P., Component: Geotechnical Engineering: Principles and Practices. Prentice Hall, NJ, 1999.
5. Lambe, T.W., Soil Testing for Engineers. BiTech Publishers, Vancouver, 1991.
6. Hoek, Evert and John Bray, Rock Slope Engineering. London: Institution of Mining and Metallurgy, 1981.
7. Hoek, Evert and Edwin T. Brown, Underground Excavations in Rock. London: Institution of Mining and Metallurgy, 1982.
- 8.
- 9.
- 10.
- 11.
- 12.

## **GEO5D01 – UNDERSTANDING THE EARTH**

*Number of Credits: 3*

*Number of Contact Hours: 48 Hrs.*

#### ***Course Outline***

#### **Module 1:**

- Internal structure of earth-crust, mantle, core – Layers, discontinuities and their properties.
- Types of rocks - brief introduction to Igneous, sedimentary and metamorphic rocks; Concept of rock cycle.

#### Module 2:

- Continental drift; sea floor spreading and evolution of plate tectonic theory.
- Different kinds of plate margins; Convergent-divergent-transform;

#### Module 3:

- Ocean bottom topography- mid ocean ridges; guyots; seamount; trenches; submarine canyons; continental rise; continental slope; continental shelf.
- Geological work of Oceans

#### Module 4:

- Natural hazards – Earthquake- seismology; focus and epicenter; different kinds of seismic waves; intensity; magnitude; Richter scale; Seismograph and seismogram;
- Tsunami.
- Landslide – Mass wasting- types, causes and prevention

#### Module 5:

- Earth processes: Geological agents – running water; erosional and depositional features.
- Weathering and soil formation

#### ***Essential Reading:***

1. Plumer, Carlson, Mc Geary (2003), Physical geology, published by Mc Graw -Hill
2. Bloom,A, Geomorphology,CBS, New Delhi
3. Ahamed, E. Coastal geomorphology of india. Orient long man, New Delhi, 1972
4. Thornbury. W. D Principles of geomorphology, Wiley 1968
5. Tarbuck, E.J. and Lutgens, F.K., 2008. *Earth: An Introduction to Physical Geology*. 9<sup>th</sup> Edition, Pearson Education, Inc., New Jersey, USA
6. Wicander, R. and Monroe, J., 2006. *Essentials of Geology*. 4<sup>th</sup> Edition, Thomson Learning Inc., USA.
7. Carlson, D. and Plummer, C.C. and Hammersley, L., 2018. Physical Geology, McGraw-Hill Education.

## **GEO5D02 – GEMMOLOGY**

*Number of Credits: 3*

*Number of Contact Hours: 48 Hrs.*

### **Course Outline**

**Module 1:**

- Gems and Jewelry. Navarathnas. Evolution of science of gemology. History of Gem industry In India- ancient and recent. Diamond cutting industry. Coloured stone industry. Gems in ayurvedha. Geological distribution

**Module 2:**

- Minerals and rocks. The formation of gemstones in the earth crust. Essential qualities of gem materials, organic and inorganic gems, gem testing. The major gem occurrences of the world

**Module 3:**

- Chemical composition of gemstones. The relationship between chemical composition and durability. Important Physical and optical properties of gemstones. Groups, species and varieties of gemstones with special reference to Ruby, Sapphire, Aquamarine, Alexandrite, Emerald, Opal, Topaz, Tourmaline and Diamonds

**Module 4:**

- Factors influencing the choice of a precious stone, definition of synthetic gem. Cutting and polishing of gemstones. Cutting with reference to diamonds, artificial colouring of synthetic gems, distinction between natural and synthetic gemstones

**Module 5:**

- Gemstone occurrences in India. Marketing values of gemstones

***Essential Reading:***

1. R.V. Karanth. Gems and Gem industry in India (2000)
2. Peter G.Read gemmology
3. Philips.W.R. (1986); Optical Minerology-Giffen
4. Dana.F.S.(1955); A text book of Minerology Asia publishing House Willey

## **GEO5D03 – GROUND WATER EXPLORATION AND MANAGEMENT**

*Number of Credits: 3*

*Number of Contact Hours: 48 Hrs*

**Course Outline****Module 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.

#### **Module 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

#### **Module 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

#### **Module 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

#### **Module 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

#### ***Essential Reading:***

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

## **GEO1C01 – INTRODUCTION TO REMOTE SENSING AND GIS**

*Number of Credits: 2*

*Number of Contact Hours: 32 Hrs*

### **Course Outline**

#### **Section A – Remote Sensing**

#### **Module 1:**

- Introduction to Aerial Photography- Overlaps, Flight lines, Drift, Crab, Tilt, Dead ground

- Geometry of aerial photography- Scale, Principal point, Perspective centre, Fiducial marks, nadir, Focal length, Airbase, Photo base, Isocentre, Relief displacement.
- Types of cameras and films
- Types of aerial photographs- Based on scale, orientation of camera axis, lens system, special properties of films, filters or photographic equipment.

#### **Module 2:**

- Introduction to image interpretation
- Elements of image interpretation- Tone, Texture, Shape, Association, Pattern, Shadow, Size
- Stereoscopy
- Photogrammetric Instruments

#### **Module 3:**

- Concept of Remote Sensing. Basic principles of remote sensing- Stages in remote sensing process.
- Energy source- EMR. Characteristic of EMR –wave nature and particle nature. EMR spectrum
- Interactions of EMR with atmosphere-Absorption, atmospheric windows, Scattering, Refraction, Reflection.
- Interactions of EMR with earth's surface features- Absorption, Reflection- Specular & Diffuse, Transmission

### **Section B – GIS**

#### **Module 4:**

- Definition of GIS, Components of GIS-Hardware, Software, People, Methods, Data
- Important GIS software producers and their products
- Functions of GIS
- Limitations of GIS

#### **Module 5:**

- Map: Overview
- Elements of a map-Scale, Datum, Coordinate system, Projection.
- Types of Map Projections (Azimuthal, Conical, Cylindrical).
- Types of Maps-Topographical map, Cadastral map, Thematic map.

## **GEO2C03 – DATA SOURCES OF REMOTE SENSING AND GIS**

*Number of Credits: 2*

*Number of Contact Hours: 32 Hrs*

### **Course Outline**

**Module 1:**

- Blackbody radiation- Kirchoff's Law, Stefan Boltzmann Law, Wein's displacement Law.
- Types of remote sensing based on energy source – active & passive
- Types of remote sensing with respect to wavelength regions- Optical Remote sensing, Thermal infrared remote sensing, Microwave remote sensing
- Spectral reflectance of land covers- Soil, Clear water, Turbid water, Vegetation-Healthy and diseased.

**Module 2:**

- Platform: Types of platforms- Ground borne, Airborne (Balloons, Aircrafts, UAV) & Spaceborne (Sun-synchronous & Geo-synchronous)
- Attitude of platform- a. Rotation angles around the three axes;roll, pitch and yaw b. Jitter.
- Attitude control of a satellite (spin control and three axis control). Attitude sensors
- Orbital elements of satellite- six elements of Keplerian orbit.
- Orbit of satellite- Geosynchronous orbit, Sun synchronous orbit, Semi-recurrent orbit.
- GNSS – GPS, GAGAN

**Module 3:**

- Sensors- Classification of Sensors. Sensor Parameters-Spatial Resolution, Spectral Resolution, Radiometric Resolution, Temporal Resolution.
- Components of sensors-Dispersing element, Spectroscopic filter, Spectrometer, Optical detectors
- Methods of scanning- Across-track scanning & Along-track scanning
- Hyperspectral imaging
- Atmospheric sensor, Sonar, LiDAR.

**Module 4:**

- GIS as a multidisciplinary science- Geography Statistics Cartography Operations Research Remote Sensing Computer Science Photogrammetry Mathematics Surveying Civil Engineering Geodesy Urban Planning etc.
- Areas of GIS applications- Facilities Management, Environment and Natural Resources Management, Street Network, Planning and Engineering, Land Information System.
- GIS for decision support.

**Module 5:**

- Sources of data in GIS- Introduction, Analog Map-Topographical map Thematic map and Geologic maps, Aerial photos, satellite imageries, Ground survey with GPS, Reports and Publications- Socioeconomic data, census data.
- Data model: Spatial data model-Raster data model and vector data model, Advantage and Disadvantages of Raster and vector data model; Non spatial data model- Hierarchical model, Relational model, Network model, Relational model; Hybrid data model – Quad tree and vector topology.

# **GEO3C05 – SATELLITE REMOTE SENSING AND GIS DATA MANAGEMENT SYSTEM**

*Number of Credits: 3*

*Number of Contact Hours: 48 Hrs*

## **Course Outline**

### **Section A – Remote Sensing**

#### **Module 1:**

- Optical Remote Sensing- Panchromatic, Multispectral, Hyperspectral, superspectral.
- Microwave Remote Sensing- Introduction, attenuation of microwave, microwave radiation, surface scattering, volume scattering, Synthetic aperture radar, Real aperture radar, Types of antenna.
- Thermal remote sensing.

#### **Module 2:**

- History of Indian Remote Sensing
- Satellite remote sensing scenario in India- IRS & INSAT satellite system, Launch vehicles, Antrix, Bhuvan
- Major Indian Space Centres- ISRO, NRSC, IIRS

#### **Module 3:**

- Earth resource satellites: Landsat series & SPOT
- Geostationary meteorological satellites: GOES, Meteosat

### **Section B –GIS**

#### **Module 4:**

- Data input –Introduction, Entering the data -Analogue, Digital data. Methods of entering data -Manual digitizing –Heads-up digitising, and Heads down digitizing; Automatic digitizing-Scanning and Electronic line following; Electronic data transfer, Keyboard entry.
- Data management in GIS-Database approach, Database management system, Designing a Database, GIS database applications.

#### **Module 5:**

- Data editing - Detecting and correcting errors- Dangles, Psuedonode, Duplicate lines, Silver polygon. -Reprojection, Transformation, Reduction and Generalization. - Edge-matching and Rubber sheeting.
- Querying Data-Queries, Types of Queries- Spatial and Non Spatial, Combining Queries-Boolean Operators AND, OR and NOT

# **GEO4C07 – APPLICATIONS OF REMOTE SENSING & GIS**

*Number of Credits: 3*

*Number of Contact Hours: 48 Hrs*

## **Course Outline**

### **Module 1:**

- Application of Remote Sensing in:
  - Land use Land cover mapping
  - Agriculture: Crop monitoring, crop damage assessment, NDVI
  - Geology: Structural mapping, lineament extraction, mineral exploration
  - Hydrology: Water quality monitoring
  - Mapping: Planimetry, DEMs, Topographic & BTM
  - Oceans: Measurement of SST, Oil spill detection

### **Module 2:**

- Introduction to digital images
- Digital Image Processing- Preprocessing (Radiometric Correction, Geometric Correction), Image Enhancement, Spatial Filtering, Classification Methods (Supervised & Unsupervised)

### **Module 3:**

- Topology: Definition of Topology. Topology and Spatial Relationships- Adjacency, Containment, Connectivity. Topological Data Structure- Nodes, Arcs, Polygons. Advantages of the Topological Data Structure. Building a Topology in GIS.
- Layering Concept in GIS

### **Module 4:**

- Sources of error in GIS- Obvious sources of errors, Error resulting from natural variation or from original measurement, Error arising through processing.
- Data Analysis: Spatial Analysis Surface Analysis, Network Analysis.
- Output in GIS: Cartographic Output and Non-cartographic Output.

### **Module 5:**

- Installation of GIS-
- Keys for successful GIS, Reasons for unsuccessful GIS
- Human resources for GIS
- Cost analysis for GIS project

### ***Essential reading:***

1. Elements of Cartography, 6th edition - Robinson, Arthur H., Morrison

2. Geographical Information Systems and Computer Cartography- Jones, Christopher. 1997
3. *Remote sensing and image interpretation (5th ed.)*- Lilles and, T.M.; R.W. Kiefer, and J.W. Chipman
4. Remote Sensing of the Environment- Jensen, John R
5. Introductory Digital Image Processing- Jensen, John R., 2005
6. Remote Sensing and Geographical Information system (sec ed)-M.Anji Reddy
7. Principles of Geographical Information Systems for Land Resources Assessment-Burrough P.A and Frank A V
8. Geographical Information Systems for Natural Resources Assessment- Burrough P.A
9. *Remote sensing digital image analysis: an introduction (4th ed.)*.
10. Principles and Applications of Photogeology - SHIV N. PANDEY
11. GIS Fundamentals, A First Text on Geographic Information Systems- Bolstad, Paul. 2005
12. Introduction to GIS –Dr M A Siddiqui
13. Basics of Remote sensing and GIS-Dr S Kumar
14. A guide to Image Interpretation-Dr Gary Prost
15. GIS: A Visual Approach- Davis, Bruce E. 2001
16. GIS and AutoCAD Map-NIIT
17. [Physical Principles of Remote Sensing](#)- W. G. Rees
18. [An Introduction to Ocean Remote Sensing](#)- Seelye Martin
19. Spatial Databases- Shekhar, Shashi, and Sanjay Chawla.
20. GIS Work Book Fundamental course Shunji Murai
21. GIS Work Book Technical course Shunji Murai
22. Remote Sensing Notes- Japan Association of Remote Sensing
23. [Remote Sensing of Landscapes with Spectral Images](#)- John B. Adams, Alan R. Gillespie

## **GEO1C02(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL - I**

*Number of Contact Hours: 32 Hrs*

### **Course Outline**

1. Draw Spectral reflectance signature curve for different land covers
2. Cartography (Manual)- Choropleth map, Dot map, Isarithmic map, Proportional symbol map
3. Digitization

## **GEO2C04(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL - II**

*Number of Contact Hours: 32 Hrs*

### **Course Outline**

1. From the aerial photographs supplied to you, identify the cultural/ geomorphological features and mark them on the corresponding toposheet.
2. Photogrammetry exercises (without the aid of instruments)
  - a. Calculation of Photoscale
  - b. Calculation of Relief displacement
  - c. Calculate the number of aerial photographs for the given area
3. Viewing Photographs Stereoscopically
4. Stereoscopic depth perception
5. On screen digitization -Georeferencing

## **GEO3C06(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL - III**

*Number of Contact Hours: 36 Hrs*

### **Course Outline**

1. Preparation of aerial mosaic.
2. Prepare a base map-Drainage, Road network, contour from the given grid of toposheet/satellite imagery by using Light table
3. Interpretation aerial photographs.
4. Aerial photographs stereoscopic vision-Measurement of height,Parallax measurement
5. On screen digitization- Georeferencing- attribute data entry

## **GEO3C08(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL - IV**

*Number of Contact Hours: 36 Hrs*

### **Course Outline**

1. Satellite image interpretation - Panchromatic image, Multispectral, True colour, False colour composite
2. Digital image processing.
3. On screen digitization- Georeferencing -attribute data entry- Linking of Spatial data and Non spatial data -Spatial Analysis-Query-model-GIS Output in the form of Map/Graph/Chart
4. Preparation of different thematic layers from satellite imageries / Toposheet by using GIS

## **GEO1C09 – EARTH AS A SYSTEM**

*Number of Credits: 2*

*Number of Contact Hours: 32 Hrs*

### **Course Outline**

**Module 1:**

- Introduction to Earth Science: Earth in the solar system; size, shape and dimension of the earth.
- Lithosphere; Hydrosphere; Atmosphere; Biosphere; Geological significance of major interfaces.
- Geological processes: Types of rocks; Rock cycle; Weathering– Physical and chemical and biological

**Module 2:**

- Mass movement: definition, causes, types-Landslides- Soil – types. Ground water-source- types, Hydrologic cycle.
- Water bearing rock formation- Types of wells- Geological work of ground water. Ground water flow.

**Module 3:**

- Streams- Types- Drainage pattern and drainage basin. Geological work of streams. Land forms developed by streams.
- Wind- Geological work of wind. Types of Aeolian land forms. Deserts of the world.

**Module 4:**

- Glaciers- Types, distribution, geological work of glaciers, glacial land forms- Ice ages. Oceans- composition of sea water- eustatic change of sea level and their causes. Marine sediments and environment, submarine topography. Coral reefs, coral landforms. Mineral deposits of ocean floor.

**Module 5:**

- Earthquake- causes, types, seismic waves, epicenter, focus, isoseismal lines, intensity and magnitude. Seismograph- seismic belt- Interior of the earth.
- Volcanoes- classification and distribution Volcanic landforms. Volcanic products

***Essential Reading:***

1. Arthur Holmes-Principles of Physical Geology
2. Arthur N. Strahler- The Earth Sciences
3. Lennis Barlin (!980), Earthquakes and urban Environment, Vol.1, 2 & 3.
4. Davis etal (1976) Environmental Geoscience Niley Eastern.
5. Weller, Stratigraphic principles and practice,Harper and Raw ,1959
6. Donald R coates, 1981, Environmental geology, John wiley and sons
7. Plummer, Mc Geary Carlson- Physical Geology
8. Parbin singh- Engineering and general Geology

# GEO2C11 – ROCKS & MINERALS

*Number of Credits: 2*

*Number of Contact Hours: 32 Hrs*

## **Course Outline**

### **Module 1:**

- Crystalline and non-crystalline substances: Amorphous material; Minerals; Physical properties of minerals (Colour, Streak, Luster, Fracture, Cleavage, Hardness, Transparency, Specific gravity)
- Crystals – Crystal systems and their symmetry; Significance of the study of crystals as an aid to mineral identification

### **Module 2:**

- Chemical composition and diagnostic properties of the following minerals:

Quartz, Feldspar, Mica, Amphiboles, Pyroxenes, Magnetite, Haematite, Gypsum, Garnet, Kyanite, Sillimanite, Calcite, Barite, Apatite, Corundum, Chromite, Ilmenite, Pyrite, Sphalerite, Graphite, Diamond, Gold, Silver, Chalcopyrite, Talc, Galena, Fluorite, Magnesite, Beryl, Psilomelane, Pyrolusite, Dolomite.

### **Module 3:**

- Magma – Lava: Types, Origin, Physical properties and chemical composition.
- Textures and Structures of igneous rocks.
- Modes of occurrences: Dyke, Sill, Laccolith, Lopolith, Stock, Batholiths, Traps.
- Classification of igneous rocks; Megascopic study of the following rocks: Granite, Pegmatite, Rhyolite, Basalt, Gabbro, Dolerite, Dunite, Syenite, Pumice, Diorite.

### **Module 4:**

- A Brief study on the origin of sediments and sedimentary rocks.
- Texture and structures of sedimentary rocks.
- Field classification of Sedimentary rocks.
- Megascopic study of Conglomerate, Breccia, Sandstone, Shale, Limestone, Laterite and Lignite.

### **Module 5:**

- Metamorphism and Metamorphic rocks.
- Metamorphic Processes. Textures and Structures of metamorphic rocks.
- Megascopic study of the following metamorphic rocks: Slate, Phyllite, Schist, Amphibolite, Gneiss, Granulite, Marble, Charnockite, Khondalite

### ***Essential Reading:***

1. Dana, F.S. 1955 – A text book of mineralogy – Asia publishing House, Wiley.
2. Read, H.H- 1974 - Rutley's elements of mineralogy – Thomas murby & co.
3. Mason B and Berry, L.G - Elements of Mineralogy – W.H. Freeman & Co.
4. Deer. W. A. Howie. R. A and Zussman J. -1966. An introduction of the Rock forming minerals. Longmans.
5. Berry, Mason, Dietrich,2000 - Mineralogy, CBS Publication
6. Cornelis Klen and Cornelius S. Hurlbut, 1985 – Manual of Minerology, John wiley & Sons
7. Chakrapani-
8. Naidu, P.R.J, Optical Mineralogy.
9. Philips, W. R Mineral Optics-Principles and techniques.
10. Kerr. P. F- Optical Mineralogy.
11. Winchell. A.N-Elements of Optical Mineralogy.
12. Battey M.H., Mineralogy for students.
13. Tyrrell, G.W. 1978 -Principles of petrology – Chapman and Hall Ltd., London.
14. Bowen, N.L.-The Evolution of the Igneous Rocks – Dover publication, Inc, New York.
15. Barth, FW. 1962-Theoretical petrology - Wiley.
16. Walstrom E. E. 1961- Theoretical Igneous petrology, Wiley.
17. Turner. F. J and Verhoogen. J –1960.- Igneous and Metamorphic petrology – McGraw Hill.
18. Hatch, F.H. Wells, A.K.-Petrology of Igneous Rocks, Thomas Murby & Wells, M.K. – 1949
19. Johannesen, A – 1962-Descriptive petrography of Igneous Rocks, Vols. I to IV - Allied Pacific.

## **GEO3C13 – GEOLOGICAL STRUCTURES, FOSSILS AND TIME**

*Number of Credits: 2*

*Number of Contact Hours: 48 Hrs*

### **Course Outline**

#### **Module 1:**

- Rock out crops: Attitude of beds- Primary and secondary structures. Measurement of attitude of planar and linear structures- unconformities and their geological significance.
- Folds- geometrical elements- Geometric classification. Antiform, synform, anticline, syncline, anticlinorium, synclinorium, geanticline, gesyncline, isoclinal folds, recumbent fold, overturned fold, Nappe

#### **Module 2:**

- Faults- Basic terminology, Types of faults. Mechanics of faulting- Normal fault, Reverse fault, strike slip fault, dip slip fault, oblique slip fault, horst, graben, rift valley. Joints- Types of joints and their geological significance. Planar and linear structures- Foliation, lineation

### **Module 3:**

- Geotectonics- Plate tectonics- Continental movement, Plate margins- Palaeomagnetism, Ocean floor spreading.
- Mountains- Orogenic and epirogenic movements, Types of mountains.
- Structural maps, topographic maps, geological maps- Map study and interpretation- Preparation of maps, Conventional symbols.

### **Module 4:**

- Palaeontology- Fossilization and fossils- Uses of fossils, Types of fossilization, Index fossils. General morphology of typical Trilobites, Brachiopods, Lamellibranchs, Gastropods, and Cephalopods

### **Module 5:**

- Stratigraphy- Laws of Stratigraphy; concept of Uniformitarianism, law of order of super position, law of faunal succession, law of original horizontality, law of cross cutting relationship, physical and biological criteria of correlation
- Geologic Time scale and its units - Eon, Era, Period, Epoch

### ***Essential Reading:***

1. Billings M.P. structural geology, 11 edition,prentice hall,1974
2. Hills,E.S. elements of structural geology
3. Hobbs. B. E., means,W.D and William P.F an outline of structural geology, John wiley,1976
4. John L. Robbers, introduction to geological maps and the structures, Pergamon press
5. Ken McClay the mapping of geological structures, geological society of London, John wiley and Sons.
6. Henry woods : Invertebrate palaeontology – Cambridge.
7. Romer A. S.: Vertebrate palaeontology, Chicago press.
8. Arnold, C.A., An introduction to Palaeobotany., MC-Graw Hill.
9. B.U. Haq and A. Boersma (1978) Introduction to marine Micropalaeontology. Elsevier, Netherlands
10. Raup, D.M. and Stanelly, M.S.: Principles of Palaeontology, CBS Publishers.
11. Moore, R.C., Laliker, C.G.& Fishcher, A.G.: Invertebrate Fossils, Harper brothers
12. Shrock. R.R. and Twenhofel , W.H – 1953 : Principles of invertebrate Palaeontology, Amold publication
13. Ravindrakumar K.R. - Stratigraphy of India.
14. Lemon R.Y (1990) - Principles of Stratigraphy, Merrill Publishing Co.
15. Gregory J.W. and Barret B.H- General Stratigraphy.
16. Dunbar C. O & Rogers. J 1961 Principles of Stratigraphy. Willey.
17. Krumbein W. C. & Sloss.L.D 1963 Stratigraphy & Sedimentation. Freeman

# **GEO4C15 – GEOLOGY AND MINERAL WEALTH OF INDIA**

*Number of Credits: 2*

*Number of Contact Hours: 48 Hrs*

## **Course Outline**

### **Module 1:**

- Major Geological divisions of India – Precambrian, Cuddapah Super Group, Vindhyan Super Group, Deccan Traps, Jurassic of Kutch, Cretaceous of Trichinopoly, Tertiary formation, Quarternary, Indo Gangetic Alluvium, Brief study of the Stratigraphy of Kerala - Precambrian, Tertiary and Quaternary

### **Module 2:**

- Economic Geology- Ore and gangue minerals. Industrial minerals.
- Bauxite, Copper deposits, Lead and Zinc deposits, Iron deposits, Radioactive minerals, Manganese deposits, Chromite deposits, Gold deposits, Beach sands

### **Module 3:**

- Types of ore formation- Brief study.
- Magmatic process, hydrothermal process, Residual formation, Mechanical concentration.
- Selected mineral deposits in India: Kundremukh Iron ore, lead and zinc deposit of Zawar, Kolar and Wayanad gold fields, Nellur mica deposits, Manganese deposits of Karnataka, Khetri copper deposits, Bauxites of Kerala, Neyvelli Lignite, Petroleum deposits of Bombay High, Cauvery and North East. Coal deposits of Bihar

### **Module 4:**

- Environmental Geology: Human impact on environment. Waste management. Ecology and environment. Air pollution, Water pollution, Impact of chemical residues on human health. Change of life style- Water conservation. Salt water intrusion. Sustainable development

### **Module 5:**

- Geoscience and Disaster Management. Disasters - Natural and human made. Role of geologists in disaster management. Effect of earthquake, landslides, flooding and Tsunami on human being- Mitigation measures. Warning system for natural disasters

### **Essential Reading:**

1. Krishnan M.S. (2003) - Geology of India and Burma, 6<sup>th</sup> Edition, CBS.
2. Wadia D.N. (1953) – Geology of India, TATA McGraw – Hill.
3. Ravindrakumar K. R - Stratigraphy of India.
4. Pascoe E. H. (1968) - A manual of the Geology India and Burma, Govt of India Publications.
5. GSI publications, Bangalore. Geology of India Vol 1 &2, 2008

6. Gokhale and Rao – Ore deposits of India.
7. Jensen and Bateman A.M. – Economic Mineral Deposits.
8. Krishnaswamy, S. – Indian Mineral Resources.
9. Krauskopf – Introduction to Geochemistry.
10. Park and Macdiarmid -Ore deposits.
11. Umeshwer Prasad- Economic geology
12. Abbott P. C (2002); Natural Disasters, Mcraw- Hill Publications-New Delhi
13. Coates D.R (1985); Geology and society chapman and hall publishers- New Delhi
14. Davis etal (1976) Environmental Geoscience Niley Eastern
15. Howard A.D and Irwin Remson (1978); Geology in Environmental Planning, M.C Graw-hill publications
16. Keller. E.A (1976); Environmental Geology. Charles E.Merril Publishers, New Jerseys
17. Lundgren. L. (1986) Environmental Geology. Prentice-Hall publishers, New Jerseys
18. Strahler. N. and Strahler. A.H (1973); Environmental Geoscience; Willey eastern
19. Donald R coates, Ed 1973 Environmental geomorohology and Environmental geo science. Willey international
20. Donald R coates, 1981, Environmental geology, John wiley and sons
21. Peter T Elawan, 1970. Environmental geology, Harper & Raw

## **GEO1C10(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL - I**

*Number of Contact Hours: 36 Hrs*

### **Course Outline**

#### **I. Preparation of neat diagrams/charts/maps/models of the following:**

1. Solar system.
2. Seismic Belt of the World.
3. Rock types- Igneous, sedimentary, metamorphic.
4. Soil profile.
5. Hydrologic cycle.
6. Drainage pattern.
7. Confined aquifer- artesian wells.
8. Seismic waves.
9. Seismograph.
10. Seismogram.
11. Seismic zones of India.

#### **II. Preparation of neat Block diagrams/Models of the following:**

1. Dyke.

2. Sill.
3. Laccolith.
4. Lopolith.
5. Batholiths.
6. Volcanoes.
7. Earth quake with focus and epicenter. Movement of waves.
8. River terraces.
9. Slumping.
10. Landslide.

### **III. Exercise**

Identification of salient topographic and drainage features using toposheets. (1:50000 or 1: 25000) of Survey of India – 3 exercises. Covering 100 Sq. Km.

### **IV. Collections**

Different types of soil/mineral/rock- put it in polythene cover pack it on a display board with neat labeling. Brief description of its physical properties.

### **V. Preparation of record**

## **GEO2C12(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL - II**

*Number of Contact Hours: 36 Hrs*

### **Course Outline**

#### **I. Preparation of neat diagrams/charts/maps/models of the following:**

1. Solar system.
2. Seismic Belt of the World.
3. Rock types- Igneous, sedimentary, metamorphic.
4. Soil profile.
5. Hydrologic cycle.
6. Drainage pattern.
7. Confined aquifer- artesian wells.
8. Seismic waves.
9. Seismograph.
10. Seismogram.
11. Seismic zones of India.

#### **II. Preparation of neat diagrams/charts/maps/models of the following:**

1. Solar system.

2. Seismic Belt of the World.
3. Rock types- Igneous, sedimentary, metamorphic.
4. Soil profile.
5. Hydrologic cycle.
6. Drainage pattern.
7. Confined aquifer- artesian wells.
8. Seismic waves.
9. Seismograph.
10. Seismogram.
11. Seismic zones of India.

### **III. Neat drawing of 6 crystal systems.**

1. Crystallographic axes.
2. Plane of symmetry.
3. Axis of symmetry.
4. Typical models-
5. Cube- Isometric.
6. Prism + Base- Tetragonal.
7. Prism+ Base- Hexagonal.
8. Pinacoids- Orthorhombic.
9. Pinacoids- Monoclinic.
10. Pinacoids- Triclinic.

### **IV. Megascopic identification of the following minerals:**

Quartz, orthoclase, plagioclase, microcline, biotite, muscovite, hornblende, chlorite, tremolite, actinolite, hypersthene, augite, diopside, magnetite, hematite, gypsum, garnet, kyanite, sillimanite, apatite, chromite, ilmenite, pyrite, sphalerite, graphite, chalcopyrite, beryl, talc, fluorite, magnesite, psilomelane, pyrolusite, dolomite, calcite.

### **V. Megascopic identification of the following igneous rocks:**

Granite, pegmatite, rhyolite, basalt, gabbro, dolerite, syenite, pumice, diorite, tuff.

### **VI. Megascopic identification of the following sedimentary rocks:**

Conglomerate, breccia, sandstone, shale, limestone, laterite, coal, lignite.

### **VII. Megascopic identification of the following metamorphic rocks:**

Slate, phyllite, mica schist, amphibolites, hornblende gneiss, biotite gneiss, khondalite, marble, charnockite, chlorite schist, tremolite- actinolite schist.

### **VIII. Preparation of record.**

## **GEO3C14(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL - III**

*Number of Contact Hours: 36 Hrs*

### **Course Outline**

1. Measurement of slope and distance using toposheets (3 Exercises)
2. Completion of outcrops in contour maps (3 Exercises)
3. Determination of attitude of beds from maps (3 Exercises)
4. Interpretation of geological maps with simple structures (Fold, fault, unconformity, intrusion [5 maps])
5. Diagrams/chart/block diagrams showing different kinds of folds, faults, unconformities, joints, foliation, lineation (3 Exercises)
6. Neat sketches of typical representation of the following fossil groups.
7. Brachiopoda, trilobites, lamellibranch, gastropoda, cephalopoda.
8. Geological time scale.

## **GEO4C16(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL - IV**

*Number of Credits: 2*

*Number of Contact Hours: 36 Hrs*

### **Course Outline**

1. Chart showing symbols of rocks and igneous, sedimentary, and metamorphic structures.
2. Megascopic identification of important ore and industrial minerals.
3. Geological map of Kerala showing major stratigraphic units.
4. In an India map mark the important places where ore minerals/ industrial minerals are found.
5. Preparation of mineral map of Kerala.
6. Revision of Practical-I
7. Revision of Practical-II
8. Revision of Practical-III

**MODEL QUESTION PAPER**  
**FIRST SEMESTER B.Sc. DEGREE EXAMINATION**  
**GEO1B01 – ESSENTIALS OF GEOLOGY**

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 Sial and Sima
- 2 Era
- 3 Oldest stratigraphic period
- 4 Focus
- 5 Relative dating
- 6 Covalent bonding
- 7 Amorphous substance
- 8 Asteroids
- 9 Creep
- 10 Pahoehoe lava
- 11 Abyssal plain
- 12 Guyots

(Maximum 20 marks)

**Section B**

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

- 13 Age of the Earth
- 14 Products of volcanic eruption
- 15 Seismograph
- 16 Classification of volcanoes
- 17 Causes of landslides
- 18 Origin and effects of Tsunami
- 19 Mid Oceanic Ridges

(Maximum 30 marks)

**Section C**

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

- 20 Describe Geologic Time Scale
- 21 Write an essay on Layered structure of the earth and its major discontinuities.

(Maximum 10 marks)

**MODEL QUESTION PAPER**  
**SECOND SEMESTER B.Sc. DEGREE EXAMINATION**  
**GEO2B03 – DYNAMIC GEOLOGY AND GEOINFORMATICS**

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 Exfoliation
- 2 Loess
- 3 Peneplanation
- 4 Perched water table
- 5 Deflation
- 6 Porosity
- 7 Inselbergs
- 8 Snowline
- 9 Raster data
- 10 Panchromatic data
- 11 Confined aquifer
- 12 Temporal resolution

(Maximum 20 marks)

**Section B**

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

- 13 Types of chemical weathering
- 14 Depositional work of stream
- 15 Braided and Meandering streams
- 16 Karst topography
- 17 Describe different drainage patterns
- 18 Components of GIS
- 19 Multispectral scanner

(Maximum 30 marks)

**Section C**

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

- 20 Describe various geological work of glaciers
- 21 Erosional and depositional landforms of wind

(Maximum 10 marks)

**MODEL QUESTION PAPER**  
**FOURTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**SUBJECT: GEOLOGY**  
**GEO4B07 – OPTICAL AND DESCRIPTIVE 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 Refractive index
- 2 Optic axis
- 3 2V
- 4 Pleochroism
- 5 Symmetrical extinction
- 6 Uniaxial minerals
- 7 Structure of pyroxene
- 8 Composition of olivine
- 9 Extinction of tourmaline
- 10 Polymorphous varieties of quartz
- 11 Industrial uses of talc
- 12 Composition of Staurolite

(Maximum 20 marks)

**Section B**

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

- 13 Isotropic and anisotropic minerals
- 14 Biaxial indicatrix
- 15 Determination of order of Interference Colour
- 16 Optical accessories and uses
- 17 Aluminium silicates
- 18 Optical and physical properties of garnet
- 19 Structure and chemistry of feldspar group

(Maximum 30 marks)

**Section C**

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

- 20 Describe various parts of petrological microscope
- 21 Describe briefly the Amphibole group of minerals.

(Maximum 10 marks)

**MODEL QUESTION PAPER**  
**THIRD SEMESTER B.Sc. DEGREE EXAMINATION**  
**SUBJECT: GEOLOGY**  
**GEO3B05 – 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 10 marks)

**MODEL QUESTION PAPER**  
**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**

**SUBJECT: GEOLOGY**

**GEO5B09 – STRUCTURAL GEOLOGY AND GEOTECTONICS**

Time : 2 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 Angular unconformity
- 2 Benioff zone
- 3 Conrad discontinuity
- 4 Hade
- 5 Monocline
- 6 Triple junction
- 7 Drag fold
- 8 Throw of a fault
- 9 Release joints
- 10 Foliation and lineation
- 11 Polar wandering
- 12 Asthenosphere

(Maximum 20 marks)

**Section B**

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

- 13 Elastic deformation
- 14 Brunton Compass
- 15 Isostasy
- 16 Overlap
- 17 Converging boundaries
- 18 Structural map
- 19 Criteria for recognition of folds in the field

(Maximum 30 marks)

**Section C**

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

- 20 Write an essay on the geometric classification of faults
- 21 Give an account on the different types of plate margins and their products

(Maximum 10 marks)

**MODEL QUESTION PAPER**  
**THIRD SEMESTER B.Sc. DEGREE EXAMINATION**  
**SUBJECT: GEOLOGY**  
**GEO5B10 – STRATIGRAPHY AND SEDIMENTOLOGY**

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 Chronostratigraphy
- 2 Law of original horizontality
- 3 Correlation
- 4 Phanerozoic eon
- 5 Hiatus
- 6 Index Fossils
- 7 Lithification
- 8 Sphericity
- 9 Graded bedding
- 10 Guano
- 11 Arkose
- 12 Alluvial Fan

(Maximum 20 marks)

**Section B**

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

- 13 Concept of Uniformitarianism
- 14 Lithostratigraphic classification
- 15 Types of Unconformities
- 16 Primary Structures of sedimentary rocks
- 17 Brief outline of classification of Sedimentary rocks
- 18 Diagenesis
- 19 Briefly explain about various Marine Depositional environments

(Maximum 30 marks)

**Section C**

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

- 20 Present is the key to the past – Elucidate your answer utilising the various stratigraphic laws
- 21 Briefly describe the various textures of sedimentary rocks.

(Maximum 10 marks)

**MODEL QUESTION PAPER**  
**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**GEO5B11 – IGNEOUS PETROLOGY**

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 Eutectic crystallization
- 2 Porphyritic texture
- 3 Vesicular structure
- 4 Batholith
- 5 Sills and dykes
- 6 Lever rule
- 7 Columnar joints
- 8 Colour index
- 9 Mineralogy of granite
- 10 Mafic magma
- 11 Reaction textures
- 12 Liquidus curve

(Maximum 20 marks)

**Section B**

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

- 13 Composition of magma
- 14 Discordant igneous intrusions
- 15 Unary Magma
- 16 Solid solution series
- 17 Classification of basalts
- 18 Bowen's reaction series
- 19 Liquid immiscibility

(Maximum 30 marks)

**Section C**

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

- 20 Describe the Forsterite-Silica system giving its petrogenetic significance
- 21 Write an essay on textures of igneous rocks

(Maximum 10 marks)

**MODEL QUESTION PAPER**  
**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**SUBJECT: GEOLOGY**  
**GEO6B17 - PALAEOLOGY**

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 What is a trace fossil
- 2 Petrification
- 3 Dimorphism
- 4 Columella
- 5 Stipes
- 6 Cephalon
- 7 Palaeomagnetism
- 8 Guard in belemnites
- 9 Calceoloa
- 10 Suture lines
- 11 Lepidodron
- 12 Taxodont dentition
- 13 Prolocus
- 14 Blastoids
- 15 Monomyarians

(Maximum 25 marks)

**Section B**

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

- 16 Explain various uses of Fossils
- 17 Important morphology of Brachipod shell
- 18 Geological History of Trilobites
- 19 Gondwana Plant fossils
- 20 Siwalik Mammals
- 21 Dentition in Lamellibranch
- 22 Morphology of Gastropod Shell
- 23 Brief outline of classification of vertebrates

(Maximum 35 marks)

**Section C**

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

- 24 Describe the morphology distribution and palaeontological significance of Foraminifera
- 25 Define Fossils, Explain various modes of fossilisation.
- 26 Describe the morphology distribution and palaeontological significance of Graptolite
- 27 Describe the general morphology and important suture patterns of Cephalopods

(Maximum 20 marks)

**MODEL QUESTION PAPER**  
**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**GEO5B09 – GEO6B18 – INDIAN GEOLOGY**

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 Closepet granite
- 2 Lameta beds
- 3 Karewa formation
- 4 Talchir series
- 5 Alwar group
- 6 Craton and mobile belts
- 7 Infra-trappean beds
- 8 Main boundary fault
- 9 Barakar formation
- 10 Muth quartzite
- 11 Rajmahal traps
- 12 Fossils in upper Vindhyan groups
- 13 Lilang System
- 14 Niniyur formation
- 15 Raniganj coal fields

(Maximum 25 marks)

**Section B**

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

- 16 Age of deccan traps
- 17 Kurnool group
- 18 Quilon formation
- 19 Climate of Gondwana
- 20 Sargur super group
- 21 Fauna of Siwaliks
- 22 Cenozoic oil bearing formation of India
- 23 Granulites of South India

(Maximum 35 marks)

**Section C**

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

- 24 Describe the Dharwar Supergroup
- 25 Write an essay on Palaeozoic rocks of Spiti
- 26 Describe in detail on Cretaceous of Trichinapally
- 27 Write an essay on Tertiary rocks of Kerala

(Maximum 20 marks)

**MODEL QUESTION PAPER**  
**SIXTH SEMESTER B.Sc. DEGREE EXAMINATION**  
**GEO6B19 – ECONOMIC GEOLOGY**

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 Tenor
- 2 Gangue
- 3 Sublimation
- 4 Epigenetic deposits
- 5 Wall rock alteration
- 6 Ladder veins
- 7 Hypothermal zone
- 8 Immiscible liquid segregation
- 9 Gossan
- 10 Bonanza
- 11 Minerals used in ceramic industry
- 12 Anthracite
- 13 Reservoir rocks
- 14 Gypsum
- 15 Eolian placers

(Maximum 25 marks)

**Section B**

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

- 16 Metallogenic epochs and provinces
- 17 Contact metasomatic process
- 18 Secondary sulphide enrichment
- 19 Pb-Zn deposits in India
- 20 Industrial minerals
- 21 Placer deposits of Kerala
- 22 Origin of coal
- 23 Proliferous basins of India

(Maximum 35 marks)

**Section C**

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

- 24 Describe various types of hydrothermal deposits
- 25 Give an account on bauxite deposits of India
- 26 Describe varieties and properties of coal. And also add a note on Geology and coal petrography of different coalfields of India.
- 27 Describe Lindgren's and Bateman's classification of ore deposits

(Maximum 20 marks)

**MODEL QUESTION PAPER**  
**THIRD SEMESTER B.Sc. DEGREE EXAMINATION**  
**SUBJECT: GEOLOGY**  
**GEO5D01 - UNDERSTANDING THE EARTH**

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 Gorges
- 2 U shaped Valleys
- 3 Oxidation
- 4 Epicentre
- 5 Seismic waves
- 6 Creep
- 7 Mid oceanic ridges
- 8 Barchans
- 9 Pyroclastic material
- 10 Tsunami
- 11 Conrad Discontinuity
- 12 Alluvial Fan

(Maximum 20 marks)

**Section B**

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

- 13 Briefly explain the concept of rock cycle
- 14 Distribution of global water
- 15 Process of soil formation
- 16 Transform plate margin
- 17 Products of weathering
- 18 Erosional features Wind
- 19 Depositional features of glacier

(Maximum 30 marks)

**Section C**

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

- 20 Write an essay on the interior structure of the earth.
- 21 Write an essay on geological work of streams

(Maximum 10 marks)