CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

IRINJALAKUDA, THRISSUR - PIN 680 125

DEGREE OF
BACHELOR OF SCIENCE
(CHOICE BASED CREDIT AND SEMESTERSYSTEM)

UNDER THE

FACULTY OF SCIENCE

SYLLABUS

(FOR THE STUDENTS ADMITTED FROM THE ACADEMIC YEAR 2014 – 15 ONWARDS)

BOARD OF STUDIES IN GEOLOGY (UG)

IRINJALAKUDA, THRISSUR - PIN
680 125 KERALA, 673 635, INDIA
JULY, 2014

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

Scheme of Undergraduate (UG) Programme in Geology

Rules, Regulations, and Syllabus

1. Rules and regulations

The Christ College (Autonomous), Irinjalakuda regulations for undergraduate curriculum 2014 (CUCBCSS 2014) is applicable to undergraduate programme in GEOLOGY.

1.1. 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 (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. A bonus mark of 20 should be given for those candidates who have taken Geology as an optional subject at higher secondary or equivalent examination. 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

1.2. Programme structure

Duration of the programme shall be six semesters distributed in a period of three years. Each semester consists of a minimum of 90 working days, inclusive of all examinations, distributed over 18 weeks each of 5 working days. 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 leading to B.Sc. Geology shall have the following courses from four types of courses viz. Common Course, Core Course, Complementary Course and Open Course.

- Common Courses (10 theory) with 38 credits
- Core courses (13 Theory, 3 Practical, 1 Elective theory, and 1 Project/Study tour) with 56 credits
- Open Course (one from other department) with 2 credits; and
- Complementary courses (4 Theory and 1 Practical Courses of Chemistry as compulsory complementary course and 4 theory courses of Physics/Statistics/Remote Sensing & GIS with 1 practical courses in Physics//Remote Sensing & GIS) with a total of 24 credits.

There shall be a total of 39 (for those who opt Physics/Remote Sensing & GIS as complementary II) and 38 (for those who opt Statistics as complementary II) courses with total credit of 120.

1.3. Evaluation and Grading

Mark system is followed instead of direct of direct grading for each question. For each course in the semester letter grade, grade point and percentage of marks are introduced in 7- point indirect grading system. After external and internal evaluations marks are entered in the answer scripts. All other calculations, including grading, will be done by the university using software. Each course is evaluated by assigning marks with a letter grade (A+, A, B, C, D, E or F) to that course by the method of indirect grading.

(a) Mark

Distribution: **Sl.**

No.	Course		Credits	Marks
1.	Common	English	22	600
2.	Common	Additional Language	16	400
3.	Core	Geology	56	1750
4.	Complementary Course	Chemistry	12	400
5.	Complementary Course II	Physics/Statistics/Remote Sensing & GIS	12	400
6.	Open Course	One theory course offered by any other department	2	50
		Total	**120**	**3600**

(b) Seven point Indirect Grading System

% of Marks	Grade	Interpretation	Grade Point Average	Range of Grade points	Class
90 and above	A^+	Outstanding	6	5.50–6.00	First Class with distinction
80 to below 90	A	Excellent	5	4.50–5.49	
70 to below 80	B	Very good	4	3.50–4.49	First Class
60 to below 70	C	Good	3	2.50–3.49	
50 to below 60	D	Satisfactory	2	1.50–2.49	Second Class
40 to below 50	E	Pass/Adequate	1	0.50–1.49	Pass
Below 40	F	Failure	0	0–0.49	Fail

1.4. Course Structure

Sem	Course		Course Code	Course Title	Hrs per week	Credits	Max Marks		
							Internal	External	Total
	Common	English	A01	Communication	5	4	20	80	100
		English	A02	Critical	4	3	20	80	100
		Malayalam†	MA1A07(	*Sargathmaka*					
		Hindi†	HN1A07(	Communication					
		Arabic†	AR1A07(	Communication					
	Cor	Geology–	GL1B01	Earth	3	2	20	80	100
		Geology–	GL1B02(	Field Geology	1	0	-	-	-
	Complementa	Chemistry–	CH1C01	General Chemistry	2	2	16	64	80
		Chemist	CH1C02(	Complementary	2	0	-	-	-
		Complementa	XX‡1C01	Physics#/Statistics	2#/4*	2#/3*	16#/	64#/8	80#/10
		Complemen	XX‡‡1C0	Physics/Remote	2	0	-	-	-
	Common	English	A03	Reading	5	4	20	80	100
		English	A04	Reading on Indian	4	3	20	80	100
		Malayalam	MA2A08(	*Vivarthanavu*					
		Hindi	HN2A08(	Translation and					
		Arabic	AR2A08(	Translation					
	Cor	Geology–	GL2B03	Dynamic	3	2	20	80	100
		Geology–	GL2B04(	Geoinformatics	1	0	-	-	-
	Complement	Chemistry–	CH2C03	Inorganic and	2	2	16	64	80
		Chemist	CH2C04(	Complementary	2	0	-	-	-
		Complementa	XX‡2C07	Physics#/Statistics	2#/4*	2#/3*	16#/	64#/8	80#/10
		Complemen	XX‡‡2C0	Physics/Remote	2	0	-	-	-
		English	A05	Literature and	5	4	20	80	100

		Malayalam	MA3A09(	*Malayala*					
		Hindi	HN3A09	Literature in Hindi					
		Arabic	AR3A09(	Literature in	5	4	20	80	100
	Cor	Geology–	GL3B05	Crystallography	3	3	20	80	100
		Geology–	GL3B06(	Crystallography	2	0	-	-	-
	Complementary	Chemistry	CH3C05	Organic and biochemistry	3	2	16	64	80
		Chemistry–Practical	CH3C06(P)	Complementary Course (Practical) III	2	0	-	-	-
		Complementary II	XX2C011	Physics#/Statistics*/Remote Sensing & GIS#	3#/5*	2#/3*	16#/20*	64#/80*	80#/100*
		Complementary II (Practical)	XX2C012(P)	Physics/Remote Sensing & GIS	2	0	-	-	-
IV	Common	English	A06	History and Philosophy of Science	5	4	20	80	100
		Malayalam	MA4A10(01)	*Samskaaravum Naagarikathayum*	5	4	20	80	100
		Hindi	HN4A10	Culture and Civilization					
		Arabic	AR4A10(01)	Culture and Civilization					
	Core	Geology–Theory	GL4B07	Mineralogy	3	3	20	80	100
		Geology–Practical	GL4B08(P)	Crystallography and Mineralogy	2	4	20	80	100
	Complementary	Chemistry	CH4C07	Physical chemistry	3	2	16	64	80
		Chemistry–Practical	CH4C08(P)	Complementary Course (Practical) III	2	4	16	64	80
		Complementary II	XX2C015	Physics#/Statistics*/Remote Sensing & GIS#	3#/5*	2#/3*	16#/20*	64#/80*	80#/100*
		Compl II (Practical)	XX2C016(P)	Physics/Remote Sensing & GIS	2	4	16	64	80
V	Core	Geology–Theory	GL5B09	Stratigraphy and Physiography of India	2	3	20	80	100
			GL5B10	Indian Geology	3	3	20	80	100
			GL5B11	Igneous Petrology	3	3	20	80	100
			GL5B12	Sedimentology	3	3	20	80	100
			GL5B13	Metamorphic Geology	3	3	20	80	100
		Geology–Practical	GL5B14(P)	Field Description of Rocks	3	0	-	-	-
			GL5B15(P)	Petrography	3	0	-	-	-
		Project/Study Tour	GL5B16(Pr)	Project work/Study Tour	2	0	-	-	-
	Open	One theory course offered by any other department		Open Course	3	2	10	40	50
VI	Core	Geology–Theory	GL6B17	Structural Geology and Geotectonics	3	3	20	80	100
			GL6B18	Palaeontology	3	3	20	80	100
			GL6B19	Ore Forming Processes	3	3	20	80	100
			GL6B20	Indian Mineral Deposits	3	3	20	80	100
		Geology–Practical	GL6B21(P)	Structural and Economic Geology	4	5	20	80	100
			GL6B22(P)	Petrology and Palaeontology	4	5	20	80	100
			GL6B23(E01)	Environmental Geology					

		Elective	GL6B23(E02)	Disaster Management	3	3	20	80	100
			GL6B23(E03)	Geo Exploration					
			GL6B20(E04)	Geotechnical Engineering					
		Project/Study Tour	GL6B23(Pr)	Project work/Study Tour	2	2	10	40	50
						56	**720**	**2880**	**3600**

†Students can opt any one course as second language; ‡XX can be either PH (Physics) or Statistics (ST) or Remote Sensing (RS); ‡‡XX can be either PH (Physics) or Remote Sensing (RS)

1.4.1. Core Course

Sem	Course	Course	Course Title	Hrs	Cred	Max Marks		
						Intern	Extern	Total
I	Theory	GL1B01	Earth Systems and	3	2	20	80	100
	Practical	GL1B02(P	Field Geology	1	0	-	-	-
II	Theory	GL2B03	Dynamic	3	2	20	80	100
	Practical	GL2B04(P	Geoinformatics	1	0	-	-	-
III	Theory	GL3B05	Crystallography	3	3	20	80	100
	Practical	GL3B06(P	Crystallography	2	0	-	-	-
IV	Theory	GL4B07	Mineralogy	3	3	20	80	100
	Practical	GL4B08(P	Crystallography and	2	4	20	80	100
V		GL5B09	Stratigraphy and	2	3	20	80	100
		GL5B10	Indian Geology	3	3	20	80	100
		GL5B11	Igneous Petrology	3	3	20	80	100
		GL5B12	Sedimentology	3	3	20	80	100
		GL5B13	Metamorphic Geology	3	3	20	80	100
	Practical	GL5B14(P	Field Description of	3	0	-	-	-
		GL5B15(P	Petrography	3	0	-	-	-
	Project/	GL5B16(P	Project work/Study	2	0	-	-	-
		GL6B17	Structural	3	3	20	80	00
		GL6B18	Palaeontology	3	3	20	80	100
		GL6B19	Ore Forming Processes	3	3	20	80	100

		GL6B20	Indian Mineral	3	3	20	80	100
	Practical	GL6B21(P	Structural and	4	5	20	80	100
		GL6B22(P	Petrology and	4	5	20	80	100
	Elective#	GL6B24(E	Environmental					
		GL6B24(E	Disaster Management					
		GL6B24(E	Geo Exploration					
		GL6B24(E	Geotechnical					
	Project/	GL6B23(P	Project work/Study	2	2	10	40	50
Total				**65**	**56**	**350**	**1400**	**1750**

*Exam will be held at the end of 4th semester

±Exam will be held at the end of 6th semester

#An institution can offer any one among these courses

1.4.2. Open Course*

Se	Cours	Course	Course Title	Hrs	Credi	Max Marks		
						Inter	Exter	Total
		GL5D01	Understanding the Earth					
		GL5D02	Gemmology					
		GL5D03	Ground Water					

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

1.5. 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.

1.5.1. Components of Internal Assessment

Sl. No.	Components	Marks
1.	Attendance	5
2.	Test papers: I & II	5 + 5
3.	Assignment/Seminar/Viva	5
	Total	**20**

(a) Percentage of Attendance and Eligible Marks

% of attendance	Marks
Above 90%	5
85-89%	4
80-84%	3
76-79%	2
75%	1

(b) Pattern of Test Papers

Duration	Pattern	Total number of questions	Number of questions to be answered	Marks for each question	Marks
1.5 Hours	One word	4	4	1	4
	Short answer	5	4	2	8
	Paragraph	5	3	6	18
	Essay	2	1	10	10
				Total Marks*	**40**

*90% and above = 5, 80 to below 90% = 4.5, 70 to below 80% = 4, 60 to below 70% = 3.5,

50 to below 60% = 3, 40 to below 50% = 2, 35 to below 40% = 1, below 35% = 0

1.5.2. Components of External Evaluation

External evaluation carries 80% marks. University examinations will be conducted at the end of each semester.

(a) Pattern of Question Paper

Duration	Pattern	Total number of questions	Number of questions to be answered	Marks for each question	Marks
3 Hours	One word or one phrase or true or false	10	10	1	10
	Short answer (one or two Sentences)	12	10	2	20
	Paragraph/half page	8	5	6	30
	Essay	4	2	10	20
				Total Marks*	80

1.5.3. Core Course Project/Study Tour: Evaluation Scheme

Project/Study Tour is an integral part of the course and evaluation the same will be conducted at the end of sixth semester.

(a) Internal Assessment

Sl. No.	Criteria	Marks
1.	Punctuality & Field Note	2
2.	Field work/Skill	2
3.	Specimen collection	3
4.	Viva-Voce	3
	Total	**10**

(b) External Evaluation

Sl. No.	Criteria	Marks
1.	Project/Study Tour	10
2.	Specimen Display	10
3.	Presentation	10
4.	Viva-Voce	10
	Total	**40**

Internal Evaluation of Assignment/Seminar/Viva (Marks)

Excellent	5
Very good	4

Good	3
Above average	2
Average	1
Poor	0

Crystallography & Mineralogy Practical Examination (Question Paper pattern)

1. Identification of crystal models $10 \times 2\frac{1}{2} = 25$
2. Identification of mineral specimens $10 \times 2\frac{1}{2} = 25$
3. Identification of mineral thin section $6 \times 5 = 30$

(Total = 80 marks)

Petrology & Palaeontology Practical Examination (Question Paper pattern)

1. Megascopic identification of rock specimens $8 \times 4 = 32$
2. Microscopic identification of rock sections $4 \times 4 = 16$
3. Fossil identification $8 \times 4 = 32$

(Total = 80 marks)

Economic Geology & Structural Geology Practical Examination (Question Paper pattern)

1. Megascopic identification of Ore minerals $8 \times 4 = 32$
2. Map drawing $1 \times 32 = 32$
3. Three point structural problem $1 \times 16 = 16$

(Total = 80 marks)

CORE COURSE: GEOLOGY THEORY SYLLABUS

GL1B01 - EARTH SYSTEMS AND PROCESSES

Credits: 2 **Total Hours: 54**

Module 1:

- Earth Systems: Geosphere, Atmosphere, Hydrosphere, Lithosphere, and Biosphere.
- Atmosphere: Structure and Composition – Troposphere, Stratosphere, Mesosphere and Thermosphere; Temperature variations in the atmosphere; Green house gases and effects – Climate Change, Ozone depletion, Global Warming, Global Sea Level variations.
- Hydrosphere – Origin of Earth's water; Reservoirs in the hydrosphere (World oceans, Glaciers, Ice caps and Ice sheets); Hydrological Cycle.
- Biosphere and its interaction with other spheres

Module 2:

- Solar system – The Eight Planets; Meteorites; Comets; Asteroids.
- Origin of the Earth – Big-Bang theory; Nebular hypothesis; Planetesimal hypothesis; Gaseous tidal hypothesis and Gas dust cloud hypothesis.
- Age of the Earth – Determination of Earth's age, Non-radioactive methods and Radioactive methods

Module 3:

- Earthquakes – Properties of seismic waves; Magnitude and Intensity – Ritcher and Mercalli's Scales; Seismogram and Seismograph

- Origin, distribution and prediction of earthquakes.
- Tsunami – Origin and effects
- Study of Earth's interior by using seismic waves – Major discontinuities and layered structure of the earth

Module 4:

- Volcanoes – Classification based on Lava Types; Styles of Eruptions – Products
- Global Distribution; Causes; Effects; Prediction
- Mountains – Origin, types and distribution
- Basic concepts of Isostasy and Geosynclines

Module 5:

- Weathering, erosion and soil – Types of weathering – Physical, Chemical and Biological; Products of weathering; Factors influencing weathering
- Mass movements – Types of mass wasting
- Landslides – causes, effects and remedial measures.

Essential Reading:

1. Hudson, T., 2012. *Living with Earth – An Introduction to Environmental Geology*. Pearson Education Inc., New Jersey, USA
2. Marshak, S., 2001. *Earth: Portrait of a Planet.* W.W. Norton & Co., Inc., USA
3. Wicander, R. and Monroe, J., 2006. *Essentials of Geology*. 4th Edition, Thomson Learning Inc., USA.
4. Tarbuck, E.J. and Lutgens, F.K., 2008. Earth: An Introduction to Physical Geology. 9th Edition, Pearson Education, Inc., New Jersey, USA

GL2B03 - DYNAMIC GEOLOGY AND GEOINFORMATICS

Credits: 2 **Total Hours: 54**

Module 1:

- 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 2:

- 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 3:

- 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 4:

- 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.

- Coral reefs – types and

origin **Module 5:**

- Geoinformatics – Definition and various disciplines constituting it
- Geographic Information System (GIS) – The purpose of GIS; Maps - The real world and representations of it; Components of GIS; GIS software.Types of Data – Raster and Vector.
- Spatial data input – Digitizing paper maps. Georeferencing. Transformation and Projection. Direct spatial data acquisition;
- Spatial data analysis – analytical capabilities of a GIS; Overlay functions; Mapping qualitative and quantitative data
- GIS Applications in Geosciences – Geology; Groundwater; Mineral Exploration; Urban planning

Essential Reading:

1. Hudson, T., 2012. *Living with Earth – An Introduction to Environmental Geology*. Pearson Education Inc., New Jersey, USA
2. Lo, C.P. and Yeung, AKW., 2007. *Concepts and Techniques in Geographic Information Systems*.
3. Marshak, S., 2001. *Earth: Portrait of a Planet.* W.W. Norton & Co., Inc., USA
4. Tarbuck, E.J. and Lutgens, F.K., 2008. Earth: An Introduction to Physical Geology. 9th Edition, Pearson Education, Inc., New Jersey, USA
5. Wicander, R. and Monroe, J., 2006. *Essentials of Geology*. 4th Edition, Thomson Learning Inc., USA.

GL3B05 - CRYSTALLOGRAPHY

Credits: 3 **Total Hours: 54**

Module 1:

- Definition of crystal; Morphological characters of crystal – faces, forms, edges solid angles Interfacial angle; Contact Goniometer
- 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, Flourite, Diamond, Pyrite, Tetrahedrite, Boracite and cuprite.

Module 3:

- Study of symmetry elements and forms of Normal, Hemimorphic, Tripyramidal, Pyramidal Hemimorphic, Sphenoidal and Trapezphedral classes of Tetragonal system with special reference to well developed crystals of zircon, Rutile, Cassiterite, Vesuvianite, Apophyllite, Sheelite, Meionite, Wulfenite and Chalcopyrite.

Module 4:

- Study of the symmetry elements and forms of Normal, Hemimorphic, Tripyramidal, Pyramidal hemimorphic, Trapezohedral, Rhombohedral, Rhombohedral Hemimorphic, Trirhombohedral and Trapezohedral classes of Hexagonal system with special reference to well developed crystals of

Beryl , Zincite, Apatite, Calcite, Corundum, Tourmaline, Phenacite and Quartz.

- Study of the symmetry elements and forms of the Normal, Hemimorphic and Sphenoidal classes of Orthorhombic system with special reference to well developed crystals of Barite, olivine topaz, staurolite, Sulphur, Calamine, Struvite and Epsomite.

Module 5:

- Study of the symmetry elements and forms of the Normal classes of the Monoclinic and Triclinic systems with special reference to well developed crystals of Gypsum, Orthoclase, Albite, Augite, Axinite and Kyanite
- 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. Study of twin laws pertaining to the following crystals – Flourite (spinel law), Pyrite (iron cross twin), Rutile (geniculate), Calcite, Quartz (Brazil laws), Aragonite (mimetic twin), Staurolite (cruciform), Gypsum, Augite and Feldspars (Carlsbad, Baveno , Manebach, Albite and Pericline)

Essential Reading:

1. Borchardt-Ott, W., 2011. *Crystallography– An Introduction.* Springer Heidelberg, 355p.
2. Buerger, M.J., 1978. *Elementary Crystallography*. Wiley, New York.
3. Dana, F.S., 1955. *A Text Book of Mineralogy*. Asia publishing House, Wiley.
4. McKie, D. and McKie, C., 1990. *Essentials of Crystallography*. Blackwell, Oxford.
5. Read, H.H., 1974. *Rutley's Elements of Mineralogy*. Thomas Murby & Co.
6. Sands, D.E., 1975. *Introduction to Crystallography*. Dover Publications, Inc., 165p.
7. Schwarzenbach, D., 1996. *Crystallography*. John Wiley & Sons Ltd., Chichester, 241p.

GL4B07 - MINERALOGY

Credits: 3 **Total Hours: 54**

Module 1:

- Definition of Mineral and Mineraloid – Scope and aim of Mineralogy.
- Chemical elements and periodic table; Bonding of atoms – Metallic, Covalent, Ionic and Vander Walls Bonding in Minerals.
- Structure and classification of silicates; Compositional variation and coupled ionic substitution, Isomorphism, Polymorphism, Pseudomorphism, solid solution and ex- solution in minerals
- Physical properties of minerals depending upon cohesion and elasticity, specific gravity, light, heat, electricity, magnetism and the senses. Determination of specific gravity of minerals – Joly's spring balance and Walker's steelyard methods

Module 2:

- 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; Polaroid.
- Petrological microscope and its parts – Optical accessories, their construction and uses – Quartz wedge (Determination of order of Interference Colour), Gypsum plate and Mica plate (Determination of Fast and Slow vibration directions)

Module 3:

- Optical classification of minerals; Isotropic and anisotropic minerals
- Optical properties of isotropic and anisotropic minerals observed under parallel and crossed Nicols
- Extinction – Types, angles, determination, and uses

- 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; Optical anomalies

Module 4:

- Mineralogy, Structure, Chemistry, Optical and Physical properties, Modes of occurrence and uses of the following groups of minerals: Olivine, Garnet, Epidote, Aluminium silicates, Pyroxene, Amphiboles, Mica, Chlorite, Feldspars, Feldspathoids and Zeolites.

Module 5:

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

Essential Reading:

1. Mason, B. and Berry, L.G., *Elements of Mineralogy*. W.H. Freeman & Co.
2. Deer, W.A., Howie, R.A., and Zussman, J., 1992. *An Introduction to the Rock-Forming Minerals.* 2nd Edition, Pearson United Kingdom, 712p.
3. Klen, C. and Hurlbut, C.S., 1985. *Manual of Minerology*, John Wiley & Sons.
4. Philips, W.R., Mineral Optics: Principles and techniques.
5. Kerr, P.F., Optical Mineralogy.
6. Winchell. A.N., Elements of Optical Mineralogy.
7. Battey, M.H., Mineralogy for students.

GL5B09 - STRATIGRAPHY AND PHYSIOGRAPHY OF INDIA

Credits: 3 **Total Hours: 54**

Module 1:

- Geological Time scale: Eons; Eras; Periods; and Epochs
- Relative and absolute dating
- Standard stratigraphic time scale-Indian geological time scale,
- Geological records of Proterozoic; Palaeozoic; Mesozoic and Cenozoic Era **Module 2:**
- 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.

Module 3:

- Facies and facial changes-litho and bio facies
- Imperfections in geological records- break in stratigraphic records: Angular unconformity, Disconformity, non-sequences, diastems.

Module 4:

- Stratigraphic classification:
- BiostratigraphIc classification- Biozones, biohorizon, index fossil
- Range zone- Taxon rangezone concurrent range zone, intercal zone assemblage zone, Acme zone
- Lithostratigraphic classification Group, Formation, Member, Bed
- Chronostratigraphic classification- Eonothem, erathem, system, seris **Module 5:**
- Physiographic divisions of India-major Stratigraphic divisions of India
- Major rivers of India, Mountains of

India **Essential Reading:**

1. Krishnan M.S. (2003)- Geology of India and Burma, 6th Edition, CBS.
2. Wadia D.N. (1953) – Geology of India, TATA McGraw – Hill.
3. Ravindrakumar K.R. - Stratigraphy of India.
4. Lemon R.Y (1990) - Principles of Stratigraphy, Merrill Publishing Co.
5. Pascoe, E.H.(1968) - A manual of the Geology India and Burma, Govt of India Publications.
6. Gregory , J.W. and Barret B.H- General Stratigraphy
7. Dunbar.C.O & Rogers.J 1961 Principles of Stratigraphy
8. GSI publications, Bangalore. Geology of India Vol 1 &2, 2008

GL5B10 - INDIAN GEOLOGY

Credits: 3 **Total Hours: 54**

Module 1:

- Early Precambrian Stratigraphy: Sargur supracrustals; Granulite blocks of southern 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 intertrappean 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

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. GSI publications, Bangalore. Geology of India Vol 1 &2, 2008

GL5B11 - IGNEOUS PETROLOGY

Credits: 3 **Total Hours: 54**

Module 1:

- Definition of Petrology – Earth zones. 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 strctures 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 and Ternary system (Ab–An– Di). 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 and petrographic provinces.

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 origin of Pegmatites, Lamprophyres, Alkaline rocks, Dunite, Peridotite and Anorthosites

Essential Reading:

1. Tyrrell, G.W. 1978 -Principles of petrology – Chapman and Hall Ltd., London.
2. Bowen, N.L.-The Evolution of the Igneous Rocks – Dover publication, Inc, New York.
3. Barth, FW. 1962-Theoretical petrology - Wiley.
4. Turner.F.J and Verhoogen.J –1960.- Igneous and Metamorphic petrology – McGraw Hill.
5. Hatch, F.H. Wells, A.K.-Petrology of Igneous Rocks, Thomas Murby & Wells, M.K. – 1949
6. Johannesen, A – 1962-Descriptive petrography of Igneous Rocks, Vols. I to IV - Allied Pacific.
7. Huang, W.T. -Petrology, MC Graw Hill
8. Harker, A. -Petrology for Students, Cambridge,
9. Walstrom, E.E. 1961- Theoretical Igneous petrology, Wiley.
10. Williams, H, Turner, F.j. & Gillibert, C.M. - Petrography, Freeman.

GL5B12 - SEDIMENTOLOGY

Credits: 3 **Total Hours: 54**

Module 1:

- Sedimentary process: disintegration & decomposition of rocks – transportation – deposition –diagenesis.
- A broad classification of sedimentary

rocks **Module 2:**

- Residual deposits – terra rossa, clay, laterite and bauxite and soils.
- Mechanical deposits – rudaceous, arenaceous and argillaceous groups.
- Heavy mineral

deposits **Module 3:**

- Organic deposits – calcareous, siliceous, phosphatic, ferruginous and carbonaceous deposts.

Module 4:

- Structures of sedimentary rocks-mechanical, chemical and organic structures.
- Textures of sedimentary rocks – clastic and non – clastic

textures **Module 5:**

- A descriptive study of Conglomerate, Breccia, Sandstones and Shales. Chemical deposits – siliceous , carbonaceous, ferruginous and salt deposits
- A brief study of Flint, Chert, Siderite, Gypsum, Rock Salt, Caliche. Guano and Kiesellgher. Descriptive study of different types of calcareous and carbonaceous deposits

Essential Reading:

1. Pettijhon, F.J. -Sedimentary Rocks, Harper & Bros.
2. Maurice E. Tucker, Sedimentary Petrology
3. S. M. Sengupta Introduction to Sedimentology
4. D. M. McConchie, D. W. Lewis Practical Sedimentology

GL5B13 - METAMORPHIC GEOLOGY

Credits: 3 **Total Hours: 54**

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, shock, high-strain, regional (burial, ocean-ridge, orogenic); based on plate tectonic setting – metamorphism at convergent, divergent, transform plate margins and plate interiors.

Module 2:

- 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.
- Mineral parageneses

Module 3:

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

Module 4:

- Metamorphic effects on – argillaceous rocks; calcareous rocks; arenaceous rocks; basic igneous rocks
- Petrography and origin of slate, phyllite, schists, gneisses, amphibolite, marble, granulites, eclogite, mylonite

Module 5:

- Prograde and retrograde metamorphism;
- Fluid characteristics of the conintental crust and mantle; metasomatism
- UHP and UHT metamorphism; anatexis and migmatites; metamorphic differentiation
- Geothermometry and geobarometry; *P-T-t* paths and tectonic environments.

Essential readings:

1. Barker, A.J., 1990. *Introduction to Metamorphic Textures and Microstructures.* Blackie, 162p.
2. Best, M.G., 2003. *Igneous and Metamorphic Petrology*. Blackwell Science Ltd., 729p.
3. Bucher, K. and Grapes, R., 2011. *Petrogenesis of Metamorphic Rocks*. Springer- Verlag, Berlin-Heidelberg, 428p.
4. Frost, C.D., Frost, B.R, 2013. *Essentials of Igneous and Metamorphic Petrology*, Cambridge University Press, 336p.
5. Kornprobst, J., 2012. *Metamorphic Rocks and Their Geodynamic Significance: A Petrological Handbook*, Springer, 206p.
6. Kretz, R., 1994. *Metamorphic Crystallization*. John Wiley & Sons, 507p.
7. Raymond, L.A., 2002. *Petrology: The Study of Igneous, Sedimentary and Metamorphic Rocks*, 720p.
8. Spear, F.S. 1995. *Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths*. Monograph, Mineralogical Society of America, 799p.
9. Vernon, R.H. and Clarke, G.L., 2008. *Principles of Metamorphic Petrology*. Cambridge University Press, 446p.
10. Winter, J.D., 2011. *Principles of Igneous and Metamorphic Petrology*, Prentice-Hall, 728p.

GL6B17 - STRUCTURAL GEOLOGY AND GEOTECTONICS

Credits: 3 **Total Hours: 54**

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.
- 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-overlaps and offlaps, outlier and inlier.

Module 4:

- Structure and characteristics of layers of the Earth: Crust (Continental and

Oceanic), Mantle (Lower and Upper), Core (Inner and Outer);

- Geophysical and petrochemical characteristics of Lithosphere and Asthenosphere
- Mantle petrology and chemical composition; Models of mantle convection
- Continental Drift; Sea floor spreading and age of the oceanic crust; Polar wandering; Palaeomagnetism
- Mantle plumes; Hot spots; Super

Swells **Module 5:**

- Plate tectonics: Basic concepts and definition. Types of plate margins.
- Features associated with divergent, convergent, and transform plate margins.
- Triple junctions, Benioff zones
- Plate tectonic models for the origin of mountain belts.
- Island arcs, rift valleys, mid oceanic ridges, oceanic trenches, transitional faults
- Tectonic evolution of Indian

subcontinent **Essential readings:**

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 MeClay. The mapping of geological structures, Geological Society of London, John Wiley and Sons.
6. Kondie, K.C., 2011. *Earth as an Evolving Planetary System,* Academic Press, Oxford, UK, 574p.
7. Turcotte, D.L. and Schubert, G., 2014. *Geodynamics*, Cambridge University Press, 636p.
8. Frisch, W., Meschede, M., and Blakey, R., 2011. *Plate Tectonics – Continental Drift and Mountain Building,* Springer-Verlag, Berlin Heidelberg, 212p.

GL6B18 - PALAEONTOLOGY

Credits: 3 **Total Hours: 54**

Module 1:

- Definition of Palaeontology – organic world- Animal Kingdom – classification of animals – Habitats and Habits of animals.
- Definition of fossils – nature and modes of preservation of fossils: Unaltered hard parts: Altered hard parts : Petrifaction, permineralisation, carbonisation, recrystallisation, silicification , mould, casts, tracks , trails, borings, uses of fossils – stratigraphic indicators – climatic indicators- indicators of palaeogeography – indicators of evolution and migration of life forms – indicators of new deposits of coal and petroleum

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 ringes, chambers, suture lines, (Nautilitic , Goniotitic , 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 Echonodermata: - Class Echinoidea:- General morphology, periproct, apical system (Anus, ocular plates, Genetal plates, madriporic plates), corona (Ambulacra , inter ambulacra) – peristome – Regular and irregular echinoids – classification – geologicial history. Class crinoidea:- General morphology , calyx , dorsal cup, (Radicals , basals, intrabasals), arms, stem, classification, geological history. Class

Blastoidea: - General morphology – calyx, dorsal cup (Basals, radials, deltoids, ambulacra). Brachioles, cicatrix, geological history

Module 5:

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

Essential Readings:

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

GL6B19 - ORE FORMING PROCESSES

Credits: 3 **Total Hours: 54**

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.

Module 2:

- 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.

Module 3:

- 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.

Module 4:

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

Module 5:

- 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.

Essential Readings:

1. Krauskopf – Introduction toGeochemistry.
2. Park and Macdiarmid - Ore deposits.
3. Umeshwer Prasad- Economic geology

GL6B20 - INDIAN MINERAL DEPOSITS

Credits: 3 **Total Hours: 54**

Module 1:

- Diagnostic physical properties, chemical composition, uses, modes of occurrence and distribution in India of the following:
- Economic Minerals- Gold, Silver, Copper, Lead, Zinc, Iron, Manganese, Chromium, Tin, Aluminium

Module 2:

- Radioactive metals - Thorium, Uranium, and Titanium.
- Industrial Minerals- Asbestos, Barite, Graphite, Gypsum and Mica.

Module 3:

- Abrasives- Diamond, Corundum, Emery garnet, Abrasive sand, Tripoli, Pumice, Sand feldspar, Limestone, Clay, Talc etc.
- Refractories- fireclay, graphite, Dolomite and sillimanite group of minerals, diaspore, pyrophillite, zircon etc
- Ceramic minerals- Clay, Feldspar, Wollastonite,
- Gemstones.

Module 4:

- Fossil fuels – coal and lignite – uses, classification, constitution, origin and distribution in India.
- Petroleum- composition, uses, theories of origin, oil traps, and important oil fields of India.

Module 5:

- A brief account of mineral deposits in Kerala.
- Significance of minerals in National Economy.
- Strategic, critical and essential minerals

Essential Readings:

1. Gokhale and Rao – Ore deposits of India.
2. Jensen and Bateman A.M. – Economic Mineral Deposits.
3. Krishnaswamy, S. – Indian Mineral Resources.

CORE COURSE: GEOLOGY PRACTICAL SYLLABUS

GL1B02(P) – FIELD GEOLOGY

Credits: 0 **Total Hours: 18**

- Description of features in Survey of India toposheet.
- Study of marginal information.
- Interpretation of intramarginal and extramarginal information.
- Study of geological conventional signs, symbols, physical and socio-cultural features.
- Visual observation of features in satellite imagery.
- Stereoscopic visualization of aerial photos.
- 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

GL2B04(P) – GEOINFORMATICS

Credits: 0 **Total Hours: 18**

- Practical understanding of hardware & software component of a GIS
- Computer Peripherals – Scanning and digitising the map of an area of interest.
- Methods of Data Transfer using CD ROM, Flash/Thumb Drives.
- Thematic maps preparation – manual & digital
- Internet & Academic Search Techniques – Wikipedia, creating educational Blogs.
- Downloading and installation of free GIS software.
- Hands on experience with Vector and Raster data.
- Practical Applications of Geological Software: Surfer, G-Stat, Rockworks, Aquachem.
- Preparation of digital record of the practical done

GL3B06(P) – CRYSTALLOGRAPHY

Credits: 0 **Total Hours: 36**

- 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.

GL4B08(P) – CRYSTALLOGRAPHY & MINERALOGY

Credits: 4 **Total Hours: 36**

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.

Record preparation

*This course will include the practical component of the course GL3B06(P) – Crystallography.

GL5B14(P) – FIELD DESCRIPTION OF ROCKS

Credits: 0 **Total Hours: 72**

Megascopic identification and description of the following rocks:

- Granite, Graphic granite, Pegmatite, Aplite, Granite Porphyry, Syenite, Syenite porphyry, Diorite, Gabbro, Anorthosite, Dunite, Pyroxenite, Dolerite, Basalt, Rhyolite, Felsites, Obsidian, Pumice, Scoria.
- Slate, Phyllite, Schists, Gneisses, Quartzite, Marble, Amphibolite, Eclogite, Leptynite, Charnockite, Khondalite, Schorl rock, Banded Magnetite Quartzite
- Conglomerate, Breccia, Sandstone, Arkose, Shale, Limestone, Laterite, Chert, Grit, Lignite.

GL5B15(P) – PETROGRAPHY

Credits: 0 **Total Hours: 72**

Microscopic identification and description of the following rocks:

- Mica Granite, Hornblende Granite, Graphic Granite, Syenite, Nepheline Syenite, Diorite, Gabbro, Dunite, Peridotite, Granite porphyry, Diorite, Dolerite, Anorthosite, Basalt.
- Slate, Chlorite schist, Mica schist, Kyanite schist, Charnockite, Eclogite, Amphibolite, Khondalite, Augen Gneiss, Garnet Biotite Gneiss,
- Conglomerate, Breccia, Sandstone, Arkose, Shell limestone.

GL6B21(P) – STRUCTURAL AND ECONOMIC GEOLOGY

Credits: 5 **Total Hours: 72**

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.

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

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

Record preparation.

GL6B22(P) – PETROLOGY AND PALAEONTOLOGY

Credits: 5 **Total Hours: 72**

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

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

Record preparation.

*This course will include the practical component of the course GL5B14(P) – FIELD DESCRIPTION OF ROCKS & GL5B15(P) – PETROGRAPHY

COMPLEMENTARY COURSE: GEOLOGY

(FOR OTHER STREAM)

GL1CO1 – EARTH AS A SYSTEM

Credits: 2 **Total Hours: 36**

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

GL2CO3 – ROCKS AND MINERALS

Credits: 2 **Total Hours: 36**

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, Diamoand, 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.

GL3CO5 – GEOLOGICAL STRUCTURES, FOSSILS, AND TIME

Credits: 2 **Total Hours: 54**

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 out line of structural geology, John wiley,1976
4. John L. Robbers, introduction to geological maps and the structures, Pergamon press
5. Ken MeClay the mapping of geological structures, geological society of London, John wiley and Sons.
6. Henry woods : Invertebrate palaeontolgy – 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 Stanely, 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

GL4CO7 – GEOLOGY AND MINERAL WEALTH OF INDIA

Credits: 2 **Total Hours: 54**

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, 6th 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

COMPLEMENTARY COURSE:

GEOLOGY PRACTICAL SYLLABUS

GL1CO2(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL-I

Credits: 0 **Total Hours: 36**

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

GL2CO4(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL-II

Credits: 0 **Total Hours: 36**

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.

GL3CO6(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL-III

Credits: 0 **Total Hours: 36**

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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.

GL4CO8(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL-IV

Credits: 4 **Total Hours: 36**

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1. Chart showing symbols of rocks and igneous, sedimentary, and metamorphic structures.
2. Megascopic identification or 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

COMPLEMENTARY COURSE: REMOTE SENSING AND GIS

GL1C09 - COMPLEMENTARY COURSE REMOTE SENSING AND GIS -I

Credits: 2 **Total Hours: 36**

Section A – Remote Sensing

Module 1:

- Concept of Remote Sensing. Basic principles of remote sensing-stages in of remote sensing process. Wavelength regions of electromagnetic radiation. Characteristic of electromagnetic radiation – wave nature and particle nature. Interactions between matter and electromagnetic radiation. Types of remote sensing with respect to wavelength regions- Visible Remote sensing, Infrared Remote sensing, Thermal infrared remote sensing, Microwave remote sensing.

Module 2:

- Definition of Radiometry. Blackbody radiation- Kirchoff's Law, Stefan Boltzmann Law, Wein's displacement Law. Reflectance-Specular and Diffuse. Spectral reflectance of land covers- Soil, Clear water, Turbid water, vegetation-Healthy and diseased. Spectral characteristics of solar radiation, Transmittance of the atmosphere- Atmospheric window. Radiative transfer equation- Multiplitive and Additive

Module 3:

- Platform: Types of platform. Atmospheric condition and altitude. Attitude of

platform- a. Rotation angles around the three axes**;** roll, pitch and yaw b. Jitter; random and unsystematic vibration. Attitude sensors- Attitude control of a satellite (spin control and three axis control**).** Types of Attitude sensors- Angular sensor, magnetic sensor**,** angular moment sensor, angular displacement sensor. Orbital elements of satellite- six elements of Keplerian orbit. Orbit of satellite- Geosynchronous orbit, Sun synchronous orbit, Semi-recurrent orbit. Satellite positioning system. Remote sensing Satellites

Section B–GIS

Module 4:

- Definition of GIS, Components of GIS-Hardware, Software, Brainware, Infrastructure. List of some important GIS software producers and their products. Why is a GIS needed. Required functions for GIS. Required hardware and software for GIS. Required functions of GIS. Required functions of GIS software

Module 5:

- Map: Overview, Geographic data-Spatial and Non spatial data, Elements of a map- Scale, Datum, Coordinate system, Projection. Types of coordinate system, Map projection-Types of Map Projection (Azhimuthal, Conial, Cylindrical). Types of Map- Topographical map, Large scale map, Thematic map. Methods of Map making

GL2C11 - COMPLEMENTARY COURSE REMOTE SENSING AND GIS -II

Credits: 2 **Total Hours: 36**

Section A – Remote Sensing

Module 1:

- Sensors- Types of Sensors, Sensor Parameters-Spatial Resolution, Spectral Resolution, Radiometric Resolution, Temporal Resolution. Characteristics of Optical sensors, Resolving power, Dispersing element, Spectroscopic filter, Spectrometer, Characteristic of optical detectors, Camera for remote sensing, films for remote sensing, Optical mechanical scanner, Push broom scanner, Imaging spectrometer, Atmospheric sensor, Sonar, Laser radar

Module 2:

- Aerial Photography: Basic information and Specification of aerial photography; Planning and execution of photographic flight lines, Crab, Cloud, Dead ground; Completion of Photographic task. Interpretation of aerial photographic elements-Tone, Texture, Shape, Association, Pattern etc. Photogrammetric Instruments

Section B–GIS

Module 3:

- PC based GIS for education, Image display, Color hard copy machine, Pen computer. 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 as an Information Infrastructure- Social infrastructure, Environmental infrastructure, Urban infrastructure, Economic infrastructure, Educational infrastructure. GIS for decision support.

Module 4:

- 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

Module 5:

- 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.

GL3C13 - COMPLEMENTARY COURSE REMOTE SENSING AND GIS -III

Credits: 2 **Total Hours: 54**

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, types of antenna. Thermal remote sensing

Module 2:

- Introduction to satellite Remote sensing, Earth resource satellite, Landsat series, Orbital characteristics of different satellite series, SPOT, NOAA, Geostationary meteorological satellites .Introduction to satellite data Interpretation

Module 3:

- Indian Space Program-Introduction. Aryabhatta, Bhaskara, Rohini, Apple satellite. IRS satellite system, INSAT satellite system, Launch vehicles, Launch Infrastructure, International Cooperation, Antrix, Indian Space centres.

Section B–GIS

Module 4:

- Data input –Introduction, Entering the data -Analogue, Digital data. Methods of entering data -Manual digitizing -Headsup 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

GL4C15 - COMPLEMENTARY COURSE REMOTE SENSING AND GIS -IV

Credits: 2 **Total Hours: 54**

Section A – Remote Sensing

Module 1:

- Application of Remote Sensing- Land cover classification, Land cover change detection, Global vegetation map, water quality monitoring, measurement of sea surface temperature, snow survey, monitoring of atmospheric constituents, lineament extraction, geological interpretation, Height measurement (DEM) generation. Integration Remote Sensing with GIS

Module 2:

- Digital Image Processing: Flow of Digital Image Processing, Radiometric Correction,
- Geometric Correction, Image Enhancement, Spatial Filtering, Feature Extraction, Classification Methods, Maximum Likelihood Classifier

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

Section B–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: Plan for GIS installation, Consideration for Installation of GIS, Key for successful GIS, Reasons for unsuccessful GIS, Required Human Resources for GIS, Cost analysis of 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.)- Lillesand, 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 Technicalcourse 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

COMPLEMENTARY COURSE:

REMOTE SENSING AND GIS PRACTICAL

GL1C10(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL-I

Credits: 0 **Total Hours: 36**

1. Draw Spectral reflectance signature curve for different land covers
2. Cartography(Manual)- Choropleth map, Dot map, Isarithmic map, Proportional symbol map
3. Digitization
4.

GL2C12(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL-II

Credits: 0 **Total Hours: 36**

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

GL3C14(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL-III

Credits: 0 **Total Hours: 36**

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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

GL4C16(P) – COMPLEMENTARY COURSE GEOLOGY PRACTICAL-IV

Credits: 4 **Total Hours: 36**

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1. Satellite image interpretation.-Panchromatic image,Multispectral,True colour,False colr 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

OPEN COURSE:

(FOR OTHER STREAM)

GL5D01 – UNDERSTANDING THE EARTH

Credits: 2 **Total Hours: 54**

Module 1:

- Earth – Structure and composition – 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;
- Evidences and significance plate motion.

Module 3:

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

Oceans **Module 4:**

- Natural hazards – Earthquake- seismology; focus and epicenter; different kinds of seismic waves; intensity; magnitude; Ritcher scale; Seismograph and seismogram;

- Volcanoes – classification; eruption style; products;
- Seismic and volcanic belts of the world. Tsunami.
- Landslide – Mass wasting- types, causes and prevention

Module 5:

- Earth processes: Geological agents – wind; running water; glaciers and work – 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

GL5D02 – GEMMOLOGY

Credits: 2 **Total Hours: 54**

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. Phlips.W.R. (1986); Optical Minerology-Giffen
4. Dana.F.S.(1955); A text book of Minerology Asia publishing House Willey

GL5D03 – GROUNDWATER EXPLORATION AND MANAGEMENT

Credits: 2 **Total Hours: 54**

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

COURE COURSE:

ELECTIVE

GL6B24(E01) – ENVIRONMENTAL GEOLOGY

Credits: 3 **Total Hours: 54**

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- green house 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.

GL6B24(E02) – DISASTER MANAGEMENT

Credits: 3 **Total Hours: 54**

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 etal (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 Strahler. N. and Strahler. A.H (1973); Environmental Geoscience; Willey eastern

GL6B24(E03) – GEO EXPLORATION

Credits: 3 **Total Hours: 54**

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:

- Geodectic 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.

GL6B24(E04) – GEOTECHNICAL ENGINEERING

Credits: 3 **Total Hours: 54**

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.