CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

Accredited by NAAC with 'A' Grade, Affiliated to University of Calicut

COURSE PLAN

M.Sc. Applied Geology

EVEN SEMESTER

(ACADEMIC YEAR 2020-2021 ONWARDS)

IRINJALAKUDA NORTH P.O., THRISSUR, KERALA -680125

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LIST OF CONTENTS		
SL No	**TITLE**	**PAGE NO**
1	**COURSE PLAN** **M.Sc. Applied Geology** **SEMESTER II** **2019 ADMISSION**	**4-44**
2	**COURSE PLAN** **M.Sc. Applied Geology** **SEMESTER IV** **2019 ADMISSION**	**45-84**

M.Sc. Applied Geology

SEMESTER 2

	Title	Contact Hours	Credits	Internal	External	Total Marks
Core	**GEL 2C 05** **CRYSTALLOGRAPHY &MINERALOGY**	**64**	**4**	**25**	**125**	**150**
Core	**GEL 2C 06** **ECONOMIC GEOLOGY**	**64**	**4**	**25**	**125**	**150**
Core	**GEL 2C 07** **HYDROGEOLOGY**	**64**	**4**	**25**	**125**	**150**
Core	**GEL 2C 08** **APPLIED PALAEONTOLOGY &SEDIMENTOLOGY**	**80**	**4**	**25**	**125**	**150**

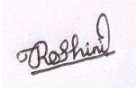
CHRIST COLLEGE
(AUTONOMOUS) IRINJALAKUDA - KERALA

COURSE PLAN

GEL 2C 05 - CRYSTALLOGRAPHY AND MINERALOGY

(SECOND SEMESTER)

M.Sc. Applied Geology

Teacher in charge	Roshini P.P.	
Course Co ordinator	Roshini P.P.	

GEL 2C 05 - CRYSTALLOGRAPHY AND MINERALOGY

Lecture hours per week:5, credits: 4

Internal: 25 External: 125, Examination 3 Hours

Objectives:

- The student will learn the basic principles of crystal projections, symmetries and how this is related to the external form, chemical composition, and physical properties of minerals.
- Identification, classification and interpretation of the occurrence of rock-forming minerals will be addressed.

Module1:

Crystallography-Crystalline state -Repetition theory. Translation periodicity of crystals. Basic rotational symmetries and possibility of simultaneous rotational symmetries in different directions of crystals-symmetrical plane and symmetrical lattices.

Derivation of 32 crystal classes. Stereographic projection of crystals**.**

(15 hours, 25 marks)

Module 2:

Crystal notation- Schoenflies notation. Herman Mauguin symbols-comparison between Schoenflies and International notations.

Calculation of crystal elements to test the knowledge of the application of tangent relation, anharmonic ratios, Napier's theorem and equation of the normal.

X-ray diffraction method- basic principles. X-ray diffractometer- Powder methods- Bragg’s law and its application- Calculation of cell dimensions-identification of minerals from X-ray diffraction patterns.

(15 hours, 30 marks)

Module 3:

Plane polarized and cross polarized light; Behaviour of isotropic and anisotropic minerals in polarized light.

Double refraction; Refractive index; Birefringence; Interference colours and determination of order.

Conoscopic observations of minerals under petrological microscope: Formation of interference figures; Uniaxial and biaxial interference figures; Determination of the Optic sign of uniaxial and biaxial minerals.

Optical indicatrices of uniaxial and biaxial minerals.

Vibration directions and sign of elongation in minerals. Extinction and extinction angle. Determination of Optic axial angle (2V).

(15 hours, 30 marks)

Module 4:

Structural and chemical principles of minerals: chemical bonds; ionic radii; coordination number (CN).

Structure, chemistry, physical and optical characters and paragenesis of mineral groups: Olivine, pyroxene, amphibole, mica and spinel groups; Feldspar, quartz, feldspathoid, aluminum silicate, epidote, garnet and zeolite groups. Accessory minerals: Apatite, calcite, corundum, scapolite, sphene and zircon.

(15 hours, 25 marks)

Module 5:

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

(4 hours, 15 marks)

(Crystallography and Mineralogy may be in the ratio of 40%and 60% respectively)

Reference Books:

1. Dyar, M.D., Gunter, M.E., 2007. *Mineralogy and Optical Mineralogy.* Min. Soc. America, 705p.
2. Demange, M., 2012. *Mineralogy for Petrologists: Optics, Chemistry, and Occurrence of Rock Forming Minerals*. CRC Press (Taylor & Francis Group), 182 p.
3. Nesse, W.D., 2012. *Introduction to Optical Mineralogy.* Oxford University Press; 4 edition, 384p.
4. Pichler, H., Riegraf, C.S., 2011. *Rock-forming Minerals in Thin Section*. Springer, 220 p.
5. Deer, W.A., Howie, R.A., Zussman, J., 2013. *Introduction to the Rock-forming Minerals*. Mineralogical Society of Great Britain & Ireland, 510 p.

Objectives:

- The student will learn the basic principles of crystal projections, symmetries and how this is related to the external form, chemical composition, and physical properties of minerals.
- Identification, classification and interpretation of the occurrence of rock-forming minerals will be addressed.

Course Outcome:

CO1: Derivation of 32 crystal classes and stereographic projections

CO2: Use of Crystal notations (Schoenflies notation, Herman Maugin)

CO3: Conoscopic observations of minerals under petrological microsope

CO4: Understanding the mineralogical composition of Crust and Mantle

Lesson Plan

Unit/ session/hours (time required)	Topics for student preparation (input)	Procedure (process) Student centric method of teaching	Activity	Learning outcome (output)	Assessment
Module 1 Basic rotational symmetries and projections 15 hours	Definitions- Concept of Repetition theory - Basic rotational symmetries- projections	Discussion Lecture Participative learning	Assignment	To understand projections and basic rotational symmetries of crystals.	Evaluation through class test
Module 2 Crystal notations 15 hours	Crystal notations- calculation of crystal elements- X-ray diffraction methods	Discussion Lecture Problem solving method	Note preparation on Crystal notation	To understand crystal notations, crystal calculations.	Evaluation through class test
Module 3 Optical Mineralogy 15 hours	Concept of polarised light- optical properties- optical indicatrix- conoscopic study	Discussion Lecture Participative learning	Identification of optical properties of mineral sections	To understand optical properties of minerals in detail	Evaluation through class test
Module 4 Descriptive Mineralogy 15 hours	Structural and chemical principles of minerals- Detailed study of mineral families	Discussion Lecture Participative learning	Seminar	To understand structural and chemical principles of minerals	Evaluation through MCQ

Module 5 Earth Mineralogy 4 hours	Average mineralogical composition of crust and mantle-Mineral transformations in the mantle with depth	Discussion Lecture	Seminar	To understand mineralogy of earth.	Evaluation through MCQ

UNIT WISE BREAKUP

Lecture Hours: 64

OBJECTIVE:

- The student will learn the basic principles of crystal projections, symmetries and how this is related to the external form, chemical composition, and physical properties of minerals.
- Identification, classification and interpretation of the occurrence of rock-forming minerals will be addressed.

Module Number	Topic	No. of Lecture hours	Pre- class activity	Pedagogy (in class)	Out of class assignment
Unit Module 1 Basic rotational symmetries and projections					
Unit 1	Crystallography-Crystalline state-Repetition theory.	2	To read about basics of crystallography	Lecture using ppt and crystal models	Group Discussion
Unit 2	Translation periodicity of crystals	2		Lecture using ppt and crystal models	Group Discussion
Unit 3	Basic rotational symmetries and possibility of simultaneous rotational symmetries in different directions of crystals-symmetrical plane and symmetrical lattices.	3	To read about unit cell, crystal lattices etc.	Lecture using ppt and crystal models	Group Discussion
Unit 4	Derivation of 32 crystal classes.	5	To read about symmetry elements of a crystal,	Lecture using ppt and crystal models	Explain crystal system

			morphology of a crystal		
Unit 5	Stereographic projection of crystals.	3	To read about the concept of projection	Lecture using ppt and crystal models	Group Discussion
Module 2 crystal notations					
Unit 1	Crystal notation- Schoenflies notation. Herman Mauguin symbols- comparison between Schoenflies and International notations.	5	To study about crystal system thoroughly	Lecture using ppt and crystal models	Crystal model identification
Unit 2	Calculation of crystal elements to test the knowledge of the application of tangent relation, anharmonic ratios, Napier's theorem and equation of the normal.	5	To read about trigonometric relation	Lecture using ppt and crystal models	Problems solving
Unit 3	X-ray diffraction method- basic principles. X-ray diffractometer- Powder methods- Bragg's law and its application- Calculation of cell dimensions- identification of minerals from X-ray diffraction patterns.	5	To read about X-ray diffraction	Lecture using ppt	Group discussion

Module 3 Optical Mineralogy					
Unit 1	Plane polarized and cross polarized light; Behaviour of isotropic and anisotropic minerals in polarized light. Double refraction; Refractive index; Birefringence; Interference colours and determination of order. Extinction and extinction angle.	4	To read about basics of optical mineralogy	Lecture using ppt, optical microscope, mineral thin section, accessories	Prepare assignment about optical microscope and optical properties of minerals
Unit 2	Conoscopic observations of minerals under petrological microscope: Formation of interference figures; Uniaxial and biaxial interference figures; Determination of the Optic sign of uniaxial and biaxial minerals.	5	To read about uniaxial biaxial minerals	Lecture using ppt	Group discussion

Unit 3	Optical indicatrices of uniaxial and biaxial minerals. Determination of Optic axial angle (2V).	3	To read about anisotropic minerals	Lecture using ppt	Group discussion
Unit 4	Vibration directions and sign of elongation in minerals.	3	To read about slow ray and fast ray also about its vibration directions	Lecture using ppt, optical microscope, mineral thin section, accessories	Group discussion
Module 4 Descriptive Mineralogy					
Unit 1	Structural and chemical principles of minerals: chemical bonds; ionic radii; coordination number (CN).	2	To read about bonding, coordination number	Lecture using ppt.	Group discussion
Unit 2	Structure, chemistry, physical and optical characters and paragenesis of mineral groups: Olivine, pyroxene, amphibole, mica and spinel groups;	5	To read about mineral properties	Lecture using ppt and mineral specimens	Mineral identification
Unit 3	Feldspar, quartz, feldspathoid, aluminum silicate, epidote, garnet and zeolite groups.	5	To read about mineral properties	Lecture using ppt and mineral specimens	Mineral identification
Unit 4	Accessory minerals: Apatite, calcite, corundum,	3	To read about mineral properties	Lecture using ppt	Mineral identification

	scapolite, sphene and zircon.			and mineral specimens	
Module 5 Earth Mineralogy					
Unit 1	Earth mineralogy: Average mineralogical composition of crust and mantle.	2	To read about Earth structure	Lecture using ppt	Draw the structure of earth
Unit 2	Mineral transformations in the mantle with depth	2	To read about earth structure	Lecture using ppt	Group discussion

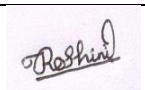
Teacher in charge: Roshini P.P.

COURSE PLAN

GEL 2C 06 – ECONOMIC GEOLOGY

(SECOND SEMESTER)

M.Sc. Applied Geology

Teacher in charge	**Asha Merin Jolly**
Course Co ordinator	**Roshini P.P.** 

GEL 2C 06 – ECONOMIC GEOLOGY

Lecture hours per week: 5 Credits: 4

Internal: 25 External: 125 Examination 3 Hours

Objectives:

- Students become familiar with formation of a wide range of mineral deposits and fossil fuels, including recognising the overall geometry, zonation and alteration patterns associated with specific classes of metallic mineral deposits
- Evaluate different processes of element enrichment by fluids and melts to from ore bodies.
- Students learn about the fundamentals of mineral prospecting,exploration of minerals and fossil fuels.

Module1:

Ore, Tenor, grade and specification for minerals.
Classification of ore deposits - Lindgren and Bateman classifications
Ore microscope- polishing and mounting of ores. Physical and optical properties of important ore minerals. Textures and structures of ore and gangue minerals.Fluid inclusions studies

(15 hours, 25 marks)

Module 2:

Metallogenic epochs and provinces, Strata bound and stratiform ore deposits - distribution, form, setting and origin. Mineralization at plate boundaries, Ore forming solutions and their migration. Wall rock alteration.Major theories of ore genesis. Paragenetic sequences, Zoning, Controls of ore localization.

(15 hours, 25 marks)

Module 3:

Ores in igneous rocks - ores of mafic and ultramafic associations - Ultra mafic-mafic Chromium platinoid associations - form, distribution, setting, constitution and origin. Ores of Felsic associations – the carbonatite associations - form, distribution, setting, constitution and origin. Anorthosite - Fe- Titanium oxide association, distribution, form, setting, Constitution and origin

(15 hours, 30 marks)

Module 4:

Genetic classification of U and Th deposits. Geology and genesis of U deposits of Jaduguda. Pb-Zn deposits of Rajasthan, Cu deposits of Singhbhum and Malanjkhand, East Coast Bauxite, Iron ore deposits of Bailadila and Kudremukh. Strategic, critical and essential minerals of India. National Mineral Policy of India

(4 hours, 15 marks)

Module 5:

Coal Geology classification, petrography, genesis and periods of coal formation Distribution of coal fields of India, Neyveli Lignite Field. • Petroleum Geology Introduction- physical properties and chemical composition, occurrence and origin. Source materials and source locations -conversion to petroleum. Reservoir rocks classification of reservoir traps -general, structural, stratigraphic, salt domes. Distribution of oil fields in India. • A brief introduction to gas hydrates.

(15 hours, 30marks)

(Theory and practical may be in the ratio of 70%and 30% respectively)

Reference Books:

1. Anthony, M. Evans, An introduction to Ore Geology, Blackwell Scientific Publication, 1980
2. Ashok Mukherji, Ore Genesis - A Holistic approach, Prentice Hall, Calcutta
3. Bateman A. M., Economic Mineral Deposits, Wiley, 1962
4. Brian Mason, Principles of Geochemistry, Wiley, 1966
5. Brown, J. C, and Dey, A. K., India's Mineral Wealth, Oxford, 1936
6. Cameron, E. N., Ore Microscopy, Wiley, 1961
7. Edwards, A. B., Textures of the Ore Minerals, Aus. Inst. Min. and Met. 1960
8. Jenson and A. M. Bateman, Economic Mineral deposits, 111 Edn. John Wiley
9. Krauskopf, K., Introduction to Geochemistry, McGraw Hill, 1967
10. Levorson, A. I., Geology of Petroleum, McGraw Hill, 1958
11. Lindgren, Mineral Deposits, McGraw Hill, 1933
12. Nininger, R. D., Minerals for atomic energy, von Nostrand, 1956
13. Park C. G., and Mac Diarmid, R. A. Ore Deposits, Freeman, 1964
14. Rankama, K., and Sahama, T. G., Geochemistry, Chicago Uty. Press, 1949
15. Stanton, R. K., Ore Petrology, McGraw Hi l l , 1972
16. Tissot, B. P., and Welta, D. H., Petroleum formation and occurrence, Springer Verlag, 1978
17. Van Krcsalon, D.. Coal, Elsevier, 1961

Objectives:

•Students become familiar with formation of a wide range of mineral deposits and fossil fuels, including recognising the overall geometry, zonation and alteration patterns associated with specific classes of metallic mineral deposits

• Evaluate different processes of element enrichment by fluids and melts to from ore bodies.

•Students learn about the fundamentals of mineral prospecting,exploration of minerals and fossil fuels

Course Outcome:

CO1: Identify ore minerals in hand specimen and under reflected microscope.

CO2: Assess mineral paragenesis and textures and thereby reconstruct ore genesis

CO3: Understand the distribution and tectonic settings of ore minerals and fossil fuels

CO4: Characterise each type of ore deposits, occurrence and mineralogy

Lesson Plan

Unit/ session/hours (time required)	Topics for student preparation (input)	Procedure (process) Student centric method of teaching	Activity	Learning outcome (output)	Assessment
Module 1 Fundamentals of economic geology and classification of mineral deposit 15 hours	Definitions-specification of minerals and major classifications of minerals	Discussion Lecture Participative learning	Assignment	To recollect the fundamental terms and concepts in economic geology.	Evaluation through Quiz
Module 2 Major theories of ore genesis 15 hours	Major theories and mineralisation at plate boundaries	Discussion Lecture	Seminar	To interpret and reconstruct ore genesis.	Evaluation through class test
Module 3 Ores in igneous rocks 15 hours	Association of ore minerals with mafic and ultramafic rocks	Discussion Lecture Participative learning	Assignment	To characterise the origin of ore minerals and its association	Evaluation through class test
Module 4 Strategic minerals and National Mineral Policy	Strategic ,critical and essential minerals,Salient features of MMRD act and NMP	Discussion Lecture Participative learning	Seminar	To understand the present status of country's mineral production	Evaluation through Quiz

4hours					
Module 5 Coal and petroleum Geology 15 hours	Fossil fuel- origin and distribution	Discussion Lecture	Seminar	To understand distribution, origin of fossil fuels	Evaluation through MCQ

UNIT WISE BREAKUP

Lecture Hours: 64

OBJECTIVE:

- Students become familiar with formation of a wide range of mineral deposits and fossil fuels, including recognising the overall geometry, zonation and alteration patterns associated with specific classes of metallic mineral deposits
- Evaluate different processes of element enrichment by fluids and melts to from ore bodies.
- Students learn about the fundamentals of mineral prospecting,exploration of minerals and fossil fuels.

Module Number	Topic	No. of Lecture hours	Pre- class activity	Pedagogy (in class)	Out of class assignment
Module 1 Fundamentals and classification of ore minerasl					
Unit 1	Specification of ore minerals	2	To read about basic terms in economic geology	Lecture using ppt	Group Discussion
Unit 2	Major classification of ore minerals	2		Lecture using ppt	Prepare Assignment
Unit 3	Ore microscopy	5	To read about physical properties of ore minerals	Lecture using ppt and handspecimen of ore minerals and ore microscope	Group Discussion
Unit 4	Fluid inclusion	3		Lecture using ppt	Demonstrating various instruments using ppt
Module 2 Major theories					
Unit 1		4	To find out important	Lecture using ppt	Group discussion

	Metallogenic epochs and provinces		epochs and provinces		
Unit 2	Mineralisation at plate boundaries	4	To read about plate tectonics	Lecture using ppt	Group discussion
Unit 3	Theories and control of ore localisation	4	To read about wall rock alterations	Lecture using ppt	Group discussion
Module 3 Ores in igneous rocks					
Unit 1	Ores of mafic and ultramafic associations	4	To read about igneous process ;mafic and ultramafic rocks	Lecture using ppt	Prepare assignment
Unit 2	Ores of felsic association	4	To read about felsic minerals	Lecture using ppt	Group discussion
Unit 3	Carbonatite association	4		Lecture using ppt	Group discussion
Unit 4	Anorthosite – Fe –Titanium oxide association	4	To read about Anorthosite	Lecture using ppt.	Group discussion
Module 4 Strategic minerals and Important policies					
Unit 1	Genetic classification of U and Thorium	3	To find out Uranium mines in India	Lecture using ppt.	Group discussion
Unit 2	Distribution and geology of important ore minerals in India	5	To prepare a map locating important mines in Rajasthan ,Jharkand and Orissa	Lecture using ppt	Preparing Assignment

Unit 3	Strategic and critical minerlas	4	To identify the strategic reserves of the country	Lecture using ppt	Seminar
Unit 4	National mineral policy	3	To read about present status of country in meral production and policies in mining sector	Lecture using ppt	Seminar
Module 5 Coal and Petroleum Geology					
Unit 1	Coal Geology	3	To read about origin and rank of coal	Lecture using ppt	Find out important coal fileds in India and mine safety measures
Unit 2	Petroleum Geology	2	To read about OPEC	Lecture using ppt	Group discussion
Unit 3	Gas Hydrates	1	To read about future potential reserves other than crude oil	Lecture using ppt	Seminar

Teacher in charge: Asha Merin Jolly

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COURSE PLAN

GEL 2C 07 Hydrogeology

(SECOND SEMESTER)

DEPARTMENT OF GEOLOGY

Teacher in charge: Dr. Swetha

Course Co Ordinator: Roshini P.P.

GEL 2C 07 Hydrogeology

Lecture Hours per week: 4, Credits

4 Internal: 20, External: 80

Examination 2.5 Hours

Objectives:

a) To provide the concepts related to the occurrence, movement and distribution of groundwater, which is a prime resource for development of a civilization.

b) To familiarize the students with various groundwater exploration methods and able to use them to solve practical problems.

c) To impart necessary knowledge in students to solve current water resource problems and to anticipate, mitigate and prevent future problems in the area of water resources management.

Module I

Origin of water: meteroic, juvenile, magmatic and sea waters, Hydrologic cycle: precipitation, runoff, infiltration and evapotranspiration, Hydrographs. Subsurface movement and vertical distribution of groundwater, Springs. Classification of aquifers. Concepts of drainage basin and groundwater basin. Hydrological properties of rocks – specific yield, specific retention, porosity, hydraulic conductivity, transmissivity, storage coefficient. Determination of permeability in laboratory and in field. Water table fluctuations – causative factors, concept of barometric and tidal efficiencies. Water table contour maps. (15 Hours, 15marks)

Module II

Theory of groundwater flow. Forces causing ground water movements. Darcy's Law and its applications. Unconfined, confined, steady, unsteady and radial flow conditions. Pump tests – methods, data analysis and interpretation for hydrogeologic boundaries. Evaluation of aquifer parameters using Thiem, Theis, Jacob and Walton methods.

(15 Hours, 20marks)

Module III

Groundwater quality – physical and chemical properties of water. Quality criteria for different uses - domestic, irrigation and industrial. Graphical presentation of water quality data - Stiff diagram, Pie diagram, Piper's trilinear diagram and USSL diagram. Problems of arsenic and fluoride in groundwater. Saline water intrusion in coastal and other aquifers. Ghyben-Herzberg relation. Prevention and control of saline water intrusion. Radioisotopes in hydrogeological studies.

(10 Hours, 10marks)

Module IV

Ground water exploration -Geologic and hydrogeologic methods. Surface geophysical methods –electrical resistivity method: Wenner and Schlumberger configurations for vertical electrical sounding. Subsurface geophysical methods – well logging for delineation of aquifers. Remote sensing for groundwater exploration - hydrogeomorphic mapping of the terrain using different images of different satellite missions, lineament mapping, shallow groundwater potential zone mapping using satellite images. **(12 Hours, 15 marks)**

Module V

Types of wells, drilling methods, construction, design, development and maintenance of wells, specific capacity and its determination. Groundwater problems related to foundation work, mining, canals and tunnels. Problems of over exploitation and groundwater mining. Groundwater development in urban areas and rain water harvesting, Artificial recharge methods. Groundwater provinces of India. (12 Hours, 15marks)

Reference Books:

1. Kevin M. Hiscock, ***Hydrogeology*** Principles and Practice, 2005
2. Bouwer,H Groundwater Hydrology. 1978
3. Davies and De Wiest, Hydrogeology, John Wiley and Sons, 1966
4. Dominico, P. A.. Concepts and models in Groundwater Hydrogeology, McGrawHill
5. Fletcher, G. Driscoll, Groundwater and wells, Science Publ., Jodhpur, 1986
6. Karanth, K. R., Groundwatcr and wells, Science Publ., Jodhpur, 1986
7. Linsley, R. K., Jkohler, M. A., and Paulhus, J. L. H., Applied Hydrology, Tata McGrawHill, 1975
8. Raghunath, H. M., Groundwater, Wiley Eastern, 1987
9. Todd, D. K., Groundwater Hydrology, John Wiley and Sons, 1980

10. Tolman, C. F., Groundwater, McGraw Hill
11. Walton, W. C, Groundwater Resource Evaluation, McGraw Hill, 1970
12. Freeze and Cherry – Groundwater.
13. Willis D.Weight Hydrogeology Field Manual
14. Rick Brassington, Field Hydrogeology

Objectives

a) To provide the concepts related to the occurrence, movement and distribution of groundwater, which is a prime resource for development of a civilization.
b) To familiarize the students with various groundwater exploration methods and able to use them to solve practical problems
c) To impart necessary knowledge in students to solve current water resource problems and to anticipate, mitigate and prevent future problems in the area of water resources management

Course Outcomes

CO1: Students understand the essential components and function of the hydrologic cycle including precipitation, evaporation/evapotranspiration, drainage basin characteristics, types of aquifers and its hydrological properties, and water table conditions

CO2: Students will be able to know basic methods for measuring and analyzing hydrological parameters and the principles of groundwater flow.

CO3: Students can understand the various water quality parameters and quality criteria to adequately protect the resource for the various uses, effects of over drafting in terms of salinization and application of isotope techniques in hydrological studies.

CO4: Students can transfer knowledge on the application of Remote sensing technique and geophysical methods for groundwater exploration and multi influencers responsible for the groundwater potential of an area.

CO5: Students can understand the science and engineering fundamentals related to groundwater problems, different methods and importance of rain water harvesting and artificial recharge methods for groundwater development.

Unit/ session/ hours (time Required)	Topics for student preparation(input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
Module 1 Introduction to Hydrogeology and its various aspect **15 hours**	Definitions-concept of Hydrological cycle, Infiltration: factors affecting infiltration-Hydrograph concepts assumptions and limitations	Discussion Participation PPT	Peer Group Discussion on Hydrological properties of rocks. Seminars Preparation and interpretation of water table contour maps	To Provide a background in the theory of hydrological processes and their measurement	Evaluation Through tests/seminar Observation
Module-2 Factors governing ground water flow and equations **15 Hours**	Groundwater flow conditions-Aquifer parameter evaluation	Lecture Problems PPT	Peer Group Discussion, Groundwater flow direction mapping and problems on aquifer properties (porosity, permeability, void ratio)	Students can understand the principle of groundwater flow in the nature .	Evaluation through participation
Module-3 Water quality parameters and criteria **10 Hours**	Major ions in groundwater and various graphical representation of water quality data	Lecture Discussion practical Learning	Go through national/international level articles and to understand various Water quality problems	Students to be able to interpret groundwater chemical data and correlate the geology with the groundwater chemistry	Evaluation through secondary data analysis and interpretation

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Unit/ session/ hours (time Required)	**Topics for student preparation (input)**	**Procedure (process) Student centric Method of teaching**	**Activity**	**Learning outcome (output)**	**Assessment**
Module-4: Groundwater exploration **12 Hours**	Vertical Electrical Sounding and configurations	Discussion PPT Experiential Learning	Field study Data Interpretation	Students will get a systematic awareness of the various methods and techniques used to measure, analyze groundwater system and forecast their variability	Group activity Involvement Participation Tests
Module-5: Groundwater over exploitation problems and various method for sustainable management of the resource **12 Hours**	Groundwater province in India and facing groundwater problems at present	Lecture Discussion Participative Learning	Identify groundwater problems of their own places from Central and state groundwater department reports	Students understand concepts of various groundwater problems, **Wells: designing and drilling**	Group activity Involvement Participation

Course Plan Even Semester M.Sc

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UNIT WISE BREAK UP

LECTURE HOURS:64

Objectives:

a) To provide the concepts related to the occurrence, movement and distribution of groundwater, which is a prime resource for development of a civilization.

b) To familiarize the students with various groundwater exploration methods and able to use them to solve practical problems.

c) To impart necessary knowledge in students to solve current water resource problems and to anticipate, mitigate and prevent future problems in the area of water resources management.

Module Number	Topic	No. of Lecture Hours	Pre- class activity	Pedagogy (in class)	Out of class assignment
Module 1 :Introduction to Hydrogeology (15 Hours)					
Unit 1.	Hydrologic cycle, movement and distribution of groundwater, water table maps	5	Read and develop knowledge of Hydrogeological units	Lecture and Discussion	To make Short note on Hydrological cycle
Unit 2.	Subsurface movement and occurrence of groundwater	5	Read and develop knowledge about groundwater occurrence	Lecture and Discussion	Read about groundwater occurrence in various aquifers
Unit 3	Hydrological properties of rocks	5	Read and develop knowledge about aquifer properties	Lecture PPT	To make shortnotes on the hydrological properties of rocks
Module 2: Groundwaterflow and aquifer conditions (15Hours)					
Unit 1.	Theory of groundwater flow	5	Prepare groundwater flow pattern of a drainage basin	Lecture and Discussion	Learn about groundwater modeling and its applications

Unit 2.	Pumping test method and its analysis and interpretation	5	Visit pumping test site of state groundwater department	Lecture and Discussion and videos	Expert discussion
Module 3: Water quality parameters (10 Hours)					
Unit 1	Groundwater quality	5	To go through various publication and learn water quality mapping	Lecture and Discussion	Learn about softwares using to plot and interpret water quality parameters
Unit 2	Groundwater quality problems due to Arsenic-fluoride and salt water intrusion	5	To read on the reasons for groundwater contaminations	Lecture Discussion	Instruments using to measure major ions in groundwater
Module 4 : Groundwater exploration (12 Hours)					
Unit 1.	Groundwater exploration surface methods	6	To study how a geophysical survey can be set up	Lecture and PPT	Assignments Seminar
Unit 2.	Groundwater exploration using Remote sensing methods	6	To read about satellite missions and images can use in groundwater exploration	Lecture and Illustration s	Collect papers of groundwater potential zone identification
Module 5 : Groundwater problems and method for sustainable management of the resource (12 Hours)					
Unit 1	Types of wells; Drilling methods and maintenance	6	To go through books and online reports about drilling methods	Lecture and Illustrations	Makes notes Seminar
Unit 2	Groundwater problems due to engineering works and over exploitation; groundwater development methods	6	To study about how identify artificial recharge site of an area	Lecture and Illustrations	Assignment and viva

Teacher in Charge:

Course Plan Even Semester M.Sc

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(AUTONOMOUS) IRINJALAKUDA - KERALA

COURSE PLAN

GEL 2C 08 - APPLIED PALAEONTOLOGY AND SEDIMENTOLOGY

(SECOND SEMESTER)

Dept. of Geology &Env. Science

Teacher in charge	**NIMMY, P. M.**	
Course Co ordinator	**Roshini P.P.**	

GEL 2C 08 - APPLIED PALAEONTOLOGY AND SEDIMENTOLOGY

Lecture hours per week : 5, credits : 4

Internal: 20 External: 80, Examination 3 Hours

Objectives

- To learn how to identify different microfossils and interpret their wide range of applications
- To acquire knowledge about the evolution histories of vertebrates
- To build the basic knowledge about sedimentary processes, textures and structures and its significance
- To introduce concepts of sedimentary facies and depositional environments

Module 1:

Fossils and fossilisation Definition and morphology. Modes of preservation and geometry of fossils. Physico- chemical conditions of fossilisation. Significance of fossils.

(5 hours, 10 marks)

Module 2:

Vertebrate paleontology: Succession of vertebrate life through geologic time. Broad classification. General characteristics and Evolution histories of Dinosaurs, Equus, Elephus and Man.

(15 hours, 10 marks)

Module 3:

Micropalaeontology - Scope and classification of microfossils. Techniques in collection, separation, preparation and preservation of microfossils. Classification, morphology, ecology, palaeoecology and stratigraphic importance of the following - Foraminifera, Ostracoda, Bryozoa, Radiolaria, Diatoms and Conodonts. Palynology: General morphology of spores and pollens –classifications. geological significance and applications. Application of microfossils in the petroleum exploration, palaeoenvironments, Palaeoecology and Palaeoclimate. Estimation of Palaeotemperature.

(20 hours, 20 marks)

Module 4:

Sedimentary processes, lithification and diagenesis of siliceous and Carbonate sediments. Elements of Hydraulics - behaviour of particles in fluids. Heavy minerals and their significance in Provenance studies.

(10 hours, 10 marks)

Module 5:

Sedimentary Textures - Grain size classification, grade scale and sediment classes. Grain size analysis-sieving and pipette analysis, graphic representation of size analysis data; statistical parameters and their geological significance. Sedimentary structures: classification, genesis and significance.

(15 hours, 15 marks)

Module 6:

Sedimentary Facies and Depositional environments - Terrestrial, marine and transitional environments. Lithologies and structures formed in various environments. Brief description about Basin analysis. Plate Tectonics and sedimentation.

(15 hours, 15 marks)

Reference Books:

1. Shrock R.R., Berk Twenhofel W.H. Principles of Invertebrate Palaeontology, McGraw Hill, 1953
2. Colebert H. Edwin, Evolution of the vertebrates, John Wiley and Sons, 1961
3. Biial u. Haq Anne Boersma, Introduction to Marine Micro-Palaeontology, Elsevier, 1998
4. Woods Henry, Invertebrate Palaeontology, Cambridge University Press, 1961
5. Tucker, Sedimentary Petrology: An introduction. John Willey & Sons, New York, 1981
6. Gary Nichols, Sedimentology and Stratigraphy, Wiley and Blackwell, 2009
7. S.M. Sengupta, Introduction to Sedimentology, CBS Publishers & Distributors Pvt. Ltd.

Objectives

- To learn how to identify different microfossils and interpret their wide range of applications
- To acquire knowledge about the evolution histories of vertebrates
- To build the basic knowledge about sedimentary processes, textures and structures and its significance
- To introduce concepts of sedimentary facies and depositional environments

Course Outcomes

CO1: The role of microfossils in petroleum exploration

CO2: Understanding the evolution history of ancient life

CO3: Significance of heavy minerals in provenance studies

CO4: Detailed understanding of basin analysis and sedimentation

Lesson Plan

Unit/ session/hours (time required)	**Topics for student preparation (input)**	**Procedure (process) Student centric method of teaching**	**Activity**	**Learning outcome (output)**	**Assessment**
Module 1 Fossils and Fossilisation 10 hours	Fossils – Definition, Modes of preservation of fossils, Significance of fossils	Discussion Lecture	Seminar	To understand the basics of paleontology.	Evaluation through class test
Module 2 Vertebrate paleontology 10 hours	Broad classification, General characteristics and Evolution histories of Dinosaurs, Equus, Elephus and Man	Discussion Lecture	Assignment	To understand evolution history.	Evaluation through class test
Module 3 Micropaleontology 20 hours	Microfossils, its classification and applications, preparation techniques of important	Discussion Lecture	Note preparation	To identify different microfossils and get a knowledge about its application	Evaluation through class test

	microfossils				
Module 4 Sedimentary processes 10 hours	Lithification and diagenesis of siliceous and Carbonate sediments Heavy minerals and their significance in Provenance studies	Discussion Lecture	Seminar	To interpret the sedimentary processes and to understand significance of heavy minerals in provenance studies	Evaluation through class test
Module 5 Sedimentary Textures and structures 15 hours	Grain size classification and analysis, classification, genesis and significance of sedimentary structures	Discussion Lecture	Note preparation	To identify different sedimentary textures and structures and understand its significance	Evaluation through class test
Module 6 Sedimentary facies and depositional environments 15 hours	Terrestrial, marine and transitional environments. Lithologies and structures formed in various environments. Brief description about Basin analysis.	Discussion Lecture	Assignment	Understand the depositional environment of a sedimentary rock based on recognition of facies associations	Evaluation through class test

UNIT WISE BREAKUP

Lecture Hours: 80

Objectives

- To learn how to identify different microfossils and interpret their wide range of applications
- To acquire knowledge about the evolution histories of vertebrates
- To build the basic knowledge about sedimentary processes, textures and structures and its significance
- To introduce concepts of sedimentary facies and depositional environments

Module Number	Topic	No. of Lecture hours	Pre- class activity	Pedagogy (in class)	Out of class assignment
Module 1 Fossils and fossilization					
Unit 1	Definition of fossils and how fossilisation take place	2	To read about basics of fossils	Lecture using ppt	Group Discussion, Answering competitive exam question papers
Unit 2	Modes of preservation of fossils	1	To read about different methods of preservation	Lecture using ppt	Group Discussion, Answering competitive exam question papers
Unit 3	Physico- chemical conditions of fossilisation. Significance of fossils.	3	To read about significance of fossils	Lecture using ppt	Group Discussion, Answering competitive exam question papers

Module 2 Vertebrate paleontology					
Unit 1	Succession of vertebrate life through geologic time. Broad classification.	6	To read about vertebrate life	Lecture using ppt	Group Discussion, Answering competitive exam question papers
Unit 2	General characteristics and Evolution histories of Dinosaurs, Equus	2	To read about evolution history	Lecture using ppt	Group Discussion, Answering competitive exam question papers
Unit 3	General characteristics and Evolution histories of Elephus and Man	2	To read about evolution history	Lecture using ppt	Group Discussion, Answering competitive exam question papers
Module 3 Micropalaeontology					
Unit 1	Scope and classification of microfossils.	2	Watch the images of different microfossils	Lecture using ppt	Group Discussion, Answering competitive exam question papers
Unit 2	Techniques in collection, separation, preparation and preservation of microfossils	4	To read about preparation techniques of microfossils	Lecture using ppt	Group Discussion, Answering competitive exam question papers
Unit 3	Classification, morphology, ecology,	5	Watch the SEM images of different	Lecture using ppt	Group Discussion,

	palaeoecology and stratigraphic importance of the following - Foraminifera, Ostracoda, Bryozoa		species of Foraminifera , Ostracoda, Bryozoa		Answering competitive exam question papers
Unit 4	Classification, morphology, ecology, palaeoecology and stratigraphic importance of the following- Radiolaria, Diatoms and Conodonts	5	Watch the SEM images of different species Radiolaria, Diatoms and Conodonts	Lecture using ppt	Group Discussion , Answering competitive exam question papers
Unit 5	Palynology: General morphology of spores and pollens –classifications. geological significance and Application	3	Watch the images of spores and pollens	Lecture using ppt	Group Discussion , Answering competitive exam question papers
Unit 6	Application of microfossils in the petroleum exploration, palaeoenvironments, Palaeoecology and Palaeoclimate. Estimation of Palaeotemperature	1	To read about applications of microfossils	Lecture using ppt	Group Discussion , Answering competitive exam question papers
Module 4 Sedimentary processes					
Unit 1	Lithification and diagenesis of siliceous and Carbonate sediments.	3	Read about lithification and diagenesis	Lecture using ppt	Group Discussion
Unit 2	Elements of Hydraulics - behaviour of particles in fluids.	3	Read about Elements of Hydraulics	Lecture using ppt	Group Discussion
Unit3	Heavy minerals and their significance in	4	Read about Heavy minerals and their	Lecture using ppt	Group Discussion

	Provenance studies.		significance in Provenance studies		
Module 5 Sedimentary Textures and Structures					
Unit 1	Grain size classification, grade scale and sediment classes.	5	Read about grain size classification	Lecture using ppt	Group Discussion
Unit 2	Grain size analysis-sieving and pipette analysis, graphic representation of size analysis data; statistical parameters and their geological significance.	5	Read about Grain size analysis	Lecture using ppt	Group Discussion
Unit 3	Sedimentary structures: classification, genesis and significance	5	Read about Sedimentary structures	Lecture using ppt	Group Discussion
Module 6 Sedimentary Facies and Depositional environments					
Unit 1	Terrestrial, marine and transitional environments.	5	Read about different depositional environments	Lecture using ppt	Group Discussion
Unit 2	Lithologies and structures formed in various environments	5	Read about Lithologies and structures formed in various environments	Lecture using ppt	Group Discussion
Unit 2	Brief description about Basin analysis. Plate Tectonics and sedimentation	5	Read about basin analysis and plate tectonics	Lecture using ppt	Group Discussion

M.Sc. Applied Geology

SEMESTER 4

Course	Title	Contact Hours	Credits	Internal	External	Total Marks
Core	GEL 4C 10 GEOCHEMISTRY &ISOTOPE GEOLOGY	96	4	25	125	150
Core	GEL 4E 04a EXPLORATION GEOLOGY	96	4	25	125	150
Core	GEL 4E 05 a ENGINEERING GEOLOGY	80	4	25	125	150

CHRIST COLLEGE
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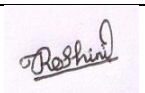
COURSE PLAN

GEL 4C 10 - GEOCHEMISTRY AND ISOTOPE GEOLOGY

(FOURTH SEMESTER)

Department of Geology and Environmental Sciences

Teacher In Charge	**Dr. C V Nandini**	
Course Co ordinator	**Roshini P.P.**	

GE 4C 10- Geochemistry and Isotope Geology

Lecture Hours per week: 6, Credits: 4

Internal: 20, External: 80 , Examination 3 Hours

Objectives:-

- To understand the application of chemical principles in Earth Science
- To learn the fundamentals of geochemistry , Isotope Geochemistry and its applications in Geoscience

Module 1:

Overview of the origin of the elements. Nuclides and atoms. Electronic configuration of atoms arrangement of atoms in periodic table, electronegativity, ionization potential, chemical bonding. Chemistry of the universe, stars, nucleosynthesis, origin of the solar system, meteorites. Structure and composition of earth. Distribution of elements in core, mantle, hydrosphere and atmosphere

(20 hours; 12 marks)

Module 2:

Elementary crystal chemistry and thermodynamics , Temperature and Equations of State; Laws of thermodynamics; Entropy; Enthalpy; Gibbs free energy; Trace elements and REE and their importance in fractional crystallization during magmatic/partial melting. Geochemistry of weathering transportation and deposition.

(20 hours; 15 marks)

Module 3:

Introduction to isotope geochemistry; applications in magmatic systems Major, minor and trace elements and their representation on variation and discriminant diagrams for presentation of geochemical data (bivariate, multivariate, element ratio variation, enrichment-depletion and vector diagrams) Geochemical cycle and principles of geochemical prospecting.

(16 hours; 15 marks)

Module 4:

Radioactivity, Decay of radioactive atoms and growth of radiogenic atoms , Geochronology and age of the Earth: Law of Radioactivity; Principles of isotopic dating, Decay schemes and Derivation of equation of age. Radiogenic isotope systems: K-Ar; Rb-Sr, Sm-Nd; Lu-Hf; Re-Os; U-Th–Pb methods of dating.

(20 hours, 20 marks)

Module 5:

Stable isotope systems; Notations; Mass independent fractionation; H, C, O, N and S isotopic systems Introduction to non-traditional stable isotope systems and their applications , Modern Analytical techniques: Methods based on Flame photometer, Spectrophotometer, AAS, XRF, ICP-MS, TIMS, SIMS, SHRIMP. Fission track and other radiation damage methods of dating

(20 hours; 18 marks)

Essential Reading:

1. Albarède, F., 2009. Geochemistry: An Introduction. Cambridge University Press, 356 p.
2. Faure, G., 1998. Principles and Applications of Geochemistry. Pearson, 624 p.
3. Faure, G., Mensing, T.M., Isotopes: Principles and Applications. Wiley, 928 p.
4. Hoefs, J., 2015. Stable Isotope Geochemistry. 7th Edition, Springer, 389 p. 5. White, W.M., 2015. Isotope Geochemistry. Wiley, 492 p

Course Outcomes

CO 1:- Students will understand the basics of Geochemistry and its application in earth science
CO 2: learn in details about the various basics of chemical bonding and it's role in Geological studies
CO 3:- Will understand the basic principle and applications of Isotopes and radiogenic atoms
CO 4:- Come across in details on radio radio active decay and different dating methods
CO:-5 Introduction to the modern analytical techniques like AAS, Spectrophotometer, ICP-MS, XRF etc.,

Lesson Plan

Objectives: -

- To understand the application of chemical principles in Earth Science
- To learn the fundamentals of geochemistry, Isotope Geochemistry and its applications in Geoscience

UNIT/ SESSION/ HOURS (TIME REQUIRED)	MODULE -1 OVERVIEW OF THE ORIGIN OF THE ELEMENTS
TOPICS FOR STUDENT PREPARATION (INPUT)	Nuclides and atoms. Electronic configuration of atoms arrangement of atoms in periodic table, electronegativity, ionization potential, chemical bonding. Chemistry of the universe, stars, nucleosynthesis, origin of the solar system, meteorites. Structure and composition of earth. Distribution of elements in core, mantle, hydrosphere and atmosphere
PROCEDURE (PROCESS) STUDENT CENTRIC METHOD OF TEACHING	Discussion on the basic concepts in chemistry and its core application in Geology. Giving a fundamentals through diagrams and charts
ACTIVITY	Power point preparation, Having individual and group interaction with students
LEARNING OUTCOME (OUTPUT)	Will learn the basic principles in Geochemistry
ASSESSMENT	Through Quiz and unit exams

UNIT/ SESSION/ HOURS (TIME REQUIRED)	MODULE- 2 *ELEMENTARY CRYSTAL CHEMISTRY AND THERMODYNAMICS, GEOCHEMISTRY OF WEATHERING*
TOPICS FOR STUDENT PREPARATION (INPUT)	Temperature and Equations of State; Laws of thermodynamics; Entropy; Enthalpy; Gibbs free energy; Trace elements and REE and their importance in fractional crystallization during magmatic/partial melting. Geochemistry of weathering transportation and deposition.

PROCEDURE (PROCESS) STUDENT CENTRIC METHOD OF TEACHING	Question and Answer session with students. Having discussion on previous class topics, Lecturing
ACTIVITY	Power Point presentation, Showing diagrams and pictures of the topic
LEARNING OUTCOME (OUTPUT)	An idea on magmatic melting and geochemistry of weathered material
ASSESSMENT	Quiz and Unit Exams

UNIT/ SESSION/ HOURS (TIME REQUIRED)	**MODULE- 3** **INTRODUCTION TO ISOTOPE GEOCHEMISTRY AND APPLICATIONS, GEOCHEMICAL PROSPECTING**
TOPICS FOR STUDENT PREPARATION (INPUT)	Major, minor and trace elements and their representation on variation and discriminant diagrams for presentation of geochemical data (bivariate, multivariate, element ratio variation, enrichment-depletion and vector diagrams) Geochemical cycle and principles of geochemical prospecting.
PROCEDURE (PROCESS) STUDENT CENTRIC METHOD OF TEACHING	Lecturing, Question and Answer session before starting the class, Discussions and doubt clearing of the current session.
ACTIVITY	Power point presentation, Seminars
LEARNING OUTCOME (OUTPUT)	Learn in details on Geochemical cycle and various geochemical prospecting
ASSESSMENT	Quiz and Unit exams

UNIT/ SESSION/ HOURS (TIME REQUIRED)	**MODULE-4** **RADIOACTIVITY, VARIOUS RADIOGENIC ISOTOPE SYSTEMS**

TOPICS FOR STUDENT PREPARATION (INPUT)	Decay of radioactive atoms and growth of radiogenic atoms , Geochronology and age of the Earth: Law of Radioactivity; Principles of isotopic dating, Decay schemes and Derivation of equation of age. Radiogenic isotope systems: K-Ar; Rb-Sr, Sm-Nd; Lu-Hf; Re-Os; U-Th–Pb methods of dating.
PROCEDURE (PROCESS) STUDENT CENTRIC METHOD OF TEACHING	Lectures and Discussions; Question and Answer Session
ACTIVITY	Power Point presentation, Seminars
LEARNING OUTCOME (OUTPUT)	Understanding the age of earth using the half-life equation and different methods of isotope dating
ASSESSMENT	Quiz and Unit exams; Assignments

UNIT/ SESSION/ HOURS (TIME REQUIRED)	**MODULE-5** **STABLE ISOTOPE SYSTEMS AND MODERN ANALYTICAL TECHNIQUES**
TOPICS FOR STUDENT PREPARATION (INPUT)	Notations; Mass independent fractionation; H, C, O, N and S isotopic systems Introduction to non-traditional stable isotope systems and their applications , Modern Analytical techniques: Methods based on Flame photometer, Spectrophotometer, AAS, XRF, ICP-MS, TIMS, SIMS, SHRIMP. Fission track and other radiation damage methods of dating
PROCEDURE (PROCESS) STUDENT CENTRIC METHOD OF TEACHING	Lectures; Question and Answer session, At the end of modules will have a discussion in details with students on the topics so far taken
ACTIVITY	Power point presentation, Summarize all the important topics in all the modules through diagrams and charts
LEARNING OUTCOME (OUTPUT)	Students will understand in details about the stable isotope and radio active

	isotopes. Will have a clear knowledge on various analytical instruments
ASSESSMENT	Students will understand

UNIT WISE BREAK UP (Lecture hours -96)

Objectives: -

- To understand the application of chemical principles in Earth Science
- To learn the fundamentals of geochemistry, Isotope Geochemistry and its applications in Geoscience

Module 1 :- Overview of the origin of the elements (20 hours)					
Number	**Topic**	**No. of Lecture Hours**	**Pre- class activity**	**Pedagogy (in class)**	**Out of class assignment**
Unit1	Overview of the origin of the elements.	2	Check the knowledge on Periodic Table	Lecturing, Question and Answering,	Note submission and seminars
Unit 2	Nuclides and atoms. Electronic configuration of atoms arrangement of atoms in periodic table, electronegativity, ionization potential, chemical bonding.	6	Question and Answering session, Discussion on the previous class topics and clarification of doubts.	Lecturing and Discussion	Note Submission and Seminars
Unit 3	Chemistry of the universe, stars, nucleosynthesis, origin of the	6	Show diagrams and charts	Explain using diagrams, Lecturing	Note submission and Seminars

	solar system, meteorites.			and discussion	
Unit 4	Structure and composition of earth.	2	Prepare a schematic representation of interior of earth	Lecturing using diagrams and pictures	Note submission and seminars
Unit 5	Distribution of elements in core, mantle, hydrosphere and atmosphere	4	Prepare a chart of elements	Lecturing and discussions	Note submission and seminar; Quiz and open book test

Module 2 :- Elementary crystal chemistry and thermodynamics, Geochemistry of weathering (20 hours)					
Number	**Topic**	**No. of Lecture Hours**	**Pre- class activity**	**Pedagogy (in class)**	**Out of class assignment**
Unit1	Elementary crystal chemistry and thermodynamics	4	Prepare a chart of equations	Lecturing using diagrams and charts	Note submission and Seminar
Unit 2	Temperature and Equations of State; Laws of thermodynamics; Entropy; Enthalpy; Gibbs free energy;	6	Prepare a chart of equations	Lecturein g using diagrams and charts, also solving the equations	Note submission and seminar
Unit 3	Trace elements and REE and their importance in fractional crystallization during	6	Prepare nice slides of diagrams showing partial melting, Question	Lecturing and discussion	Note Submission and Seminar

	magmatic/partial melting.		and answer session		
Unit 4	Geochemistry of weathering transportation and deposition.	4	Recollection of weathering	Lecturing and discussion, Question and Answer Session	Note submission and Seminar, Quiz and MCQ

Module 3 :- Introduction to geochemistry and applications, Geochemical prospecting(16 hours)					
Unit Number	**Topic**	**No. of Lecture Hours**	**Pre- class activity**	**Pedagogy (in class)**	**Out of class assignment**
Unit1	Elementary crystal chemistry and thermodynamics	4	Give basics of thermodynamics	Lecturing and Discussions	Note submission and seminar
Unit 2	Major, minor and trace elements and their representation on variation and discriminant diagrams for presentation of geochemical data (bivariate, multivariate, element ratio variation, enrichment-depletion and vector diagrams)	6	Prepare the diagrammatic representation of geochemical data	Lecturing an Discussion	Note submission and Seminar

Unit 3	Geochemical cycle and principles of geochemical prospecting	6	Prepare a schematic presentation of geochemical cycle	Lecturing and discussion; PPT presentation of all the diagrams.	Note submission and seminar; Quiz and MCQ

Module 4 :- Radioactivity, various radiogenic isotope systems (20 hours)					
Number	**Topic**	**No. of Lecture Hours**	**Pre- class activity**	**Pedagogy (in class)**	**Out of class assignment**
Unit1	Radioactivity, Decay of radioactive atoms and growth of radiogenic atoms	5	Give an account of history of radioactivity	Lecturing and discussion	Note submission and seminar
Unit 2	Geochronology and age of the Earth: Law of Radioactivity; Principles of isotopic dating, Decay schemes and Derivation of equation of age.	7	Prepare the half life period chart of elements and discuss	Lecturing and Discussion	Note submission and seminar
Unit 3	Radiogenic isotope systems: K-Ar; Rb-Sr, Sm-Nd; Lu-Hf; Re-Os; U-Th–Pb methods of dating.	8	Prepare the charts of all equations	Lecturing and discussion; Doubt clearing of the topics, Group discussion	Note submission and seminar; Quiz and MCQ

Module 5 :- Stable isotope system and modern analytical techniques (20 hours)

Number	Topic	No. of Lecture Hours	Pre- class activity	Pedagogy (in class)	Out of class assignment
Unit1	Stable isotope systems; Notations; Mass independent fractionation; H, C, O, N and S isotopic systems	4	Schematic diagrams of stable isotopes	Lecturing and Discussions;	Note submission and seminar
Unit 2	Introduction to non-traditional stable isotope systems and their applications	3	Introduction on traditional stable isotopes	Lecturing and Discussions;	Note submission and Seminars
Unit 3	Modern Analytical techniques: Methods based on Flame photometer, Spectrophotometer, AAS, XRF, ICP-MS, TIMS, SIMS, SHRIMP.	10	Understanding of the importance of various instruments	Lecturing and discussion	Note submission and seminars
Unit 4	Fission track and other radiation damage methods of dating	3	Understand about Zeolite	Lecturing and discussion; Group discussion;	Note submission and seminar, Quiz and MCQ

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COURSE PLAN

GEL 4E 04a - EXPLORATION GEOLOGY

(FOURTH SEMESTER)

Department of Geology and Environmental Sciences

Teacher In Charge	**Gopakumar P G**	
Course Co ordinator	**Roshini P.P.**	

GEL 4E 04a - EXPLORATION GEOLOGY

Lecture hours per week: 6; credits: 4
Internal: 20, external: 80, examination: 3hours

Objectives

a) To equip the students with a detailed knowledge about the exploration techniques used to locate the ore bodies and other valuable materials
b) To enable students the knowledge about the drilling and logging methods
c) To get a detailed theoretic knowledge about mineral exploration using advanced techniques

Module 1

Methods of surface and subsurface exploration. Prospecting for economic minerals. Drilling and its types. Different methods of sampling and assaying. Methods of ore reserve estimation.
(15 hours ,13 marks)

Module 2

Geochemical exploration techniques. Mobility of elements, pathfinder elements, threshold values and geochemical anomalies. Mode of occurrence of trace elements. Primary dispersion pattern of deep-seated origin. Diffusion and leakage anomalies. Geochemical surveys, principles and methods of sampling. Anomalies in ground and surface waters and sediments. Biochemical anomalies. Geobotanical survey techniques. Geobotanical indicators.

(26 hours, 20 marks)

Module 3

Geophysical exploration - Principles, scope, chief methods and their application. Electrical methods - principles, instruments used. Self-potential methods, resistivity methods. Application in ground water exploration.

(20 hours, 15 marks)

Module 4

Gravity methods - Density and rock types, correlation of gravity data, regional and local anomalies. Sample interpretation, instrument used -gravimeter. Magnetic methods - field procedure, magnetometer, interpretation of magnetic data, correlations and applications. Principles of air borne survey. Seismic method- Seismic waves, travel velocity in various geological formations – Principles Field operations. Refraction and reflection survey - correction of seismic data - methods if interpretation -determination of attitude and depth of formation. Various types of shooting. Seismic instruments and records. **(20 hours, 18 marks)**

Module 5

Radiometric methods principles of radioactivity, methods, types of counters: G.M. counters and Scintillometers. Field methods and interpretations. Geophysical well logging Electrical, radiometric, sonic and thermal logging of boreholes.

(15hours, 14 marks)

Reference books:

1. Compton.R.R., Manual of Field Geology, John Wiley
2. Dobrin M.B, Introduction to Geophysical Prospecting, Pergamon Press
3. Elements of Prospecting and Exploration, Kalyan Publishers
4. Ginzburg, I., Principles ofGeochefnical prospecting, Pergamon Press
5. Griflithis, D. and Kind, R. F., Applied Geophysics for Geologists and Engineers, Pergamon Press
6. Kovalarkim, Biochemical exploration for mineral deposits Co-Xinian Press
7. Lahee, F. H., Field Geology, Mc Graw Hill
8. Low, G.W., Geological Field Methods, Harper and brothers
9. Malyyuga,D.F.,Biochemical methods of prospecting, Consultants Bureau,NewYork
10. Reedman, J. H., Techniques in Mineral Exploration, Allied Scientific Publishers

Course outcome:-

CO1:- To get a detailed knowledge about the ore estimation and surface subsurface exploration methods

CO2:- To familiarise with the geochemical exploration methods and sampling techniques

CO3:- To study about the geophysical exploration methods used to find the ore bodies and ground water

CO4:- To know about the methods like gravity, magnetic and seismic methods for the exploration of minerals

CO5:- To know about the radiometric exploration methods to find the radioactive minerals and also to know about the well logging methods.

Lesson Plan

Objectives

a) To equip the students with a detailed knowledge about the exploration techniques used to locate the ore bodies and other valuable materials
b) To enable students the knowledge about the drilling and logging methods
c) To get a detailed theoretic knowledge about mineral exploration using advanced techniques

UNIT/ SESSION/ HOURS (TIME REQUIRED)	***MODULE-1*** ***SURFACE AND SUBSURFACE EXPLORATION WITH SAMPLING AND ASSAYING (15 HOURS)***
TOPICS FOR STUDENT PREPARATION (INPUT)	Methods of surface and subsurface exploration. Prospecting for economic minerals. Drilling and its types. Different methods of sampling and assaying. Methods of ore reserve estimation.
PROCEDURE (PROCESS) STUDENT CENTRIC METHOD OF TEACHING	Lecture Discussion Different problem situation analysis
ACTIVITY	Power point presentation, Showing various videos showing drilling
LEARNING OUTCOME (OUTPUT)	Will have understanding of different types of sampling and drilling.
ASSESSMENT	Question answer session and solving real scenarios

UNIT/ SESSION/ HOURS (TIME REQUIRED)	***MODULE :- 2*** ***GEOCHEMICAL EXPLORATION TECHNIQUE(26 HOURS)***
TOPICS FOR STUDENT PREPARATION (INPUT)	Geochemical exploration techniques. Mobility of elements, pathfinder elements, threshold values and geochemical anomalies. Mode of occurrence of trace elements. Primary dispersion pattern of deep-

	seated origin. Diffusion and leakage anomalies. Geochemical surveys, principles and methods of sampling. Anomalies in ground and surface waters and sediments. Biochemical anomalies. Geobotanical survey techniques. Geobotanical indicators.
PROCEDURE (PROCESS) STUDENT CENTRIC METHOD OF TEACHING	Lecture Discussion Different problem situation analysis
ACTIVITY	Power point presentation, seminars
LEARNING OUTCOME (OUTPUT)	Understanding on different types of anomalies and surveys
ASSESSMENT	Question answer session and solving real scenarios

UNIT/ SESSION/ HOURS (TIME REQUIRED)	***MODULE :-3*** ***GEOPHYSICAL EXPLORATION (20 HOURS)***
TOPICS FOR STUDENT PREPARATION (INPUT)	Geophysical exploration - Principles, scope, chief methods and their application. Electrical methods - principles, instruments used. Self-potential methods, resistivity methods. Application in ground water exploration.
PROCEDURE (PROCESS) STUDENT CENTRIC METHOD OF TEACHING	Lecture Discussion Different natural hazard situation analysis and demonstration with working models
ACTIVITY	Power point presentations and videos; Seminars and Assignments

LEARNING OUTCOME (OUTPUT)	Knowledge and understanding about various Geophysical exploration methods
ASSESSMENT	Question answer session and solving real scenarios

UNIT/ SESSION/ HOURS (TIME REQUIRED)	***MODULE :-4*** ***GRAVITY, MAGNETIC AND SEISMIC METHODS FOR EXPLORATION (20 HOURS)***
TOPICS FOR STUDENT PREPARATION (INPUT)	Gravity methods - Density and rock types, correlation of gravity data, regional and local anomalies. Sample interpretation, instrument used - gravimeter. Magnetic methods - field procedure, magnetometer, interpretation of magnetic data, correlations and applications. Principles of air borne survey. Seismic method- Seismic waves, travel velocity in various geological formations – Principles Field operations. Refraction and reflection survey - correction of seismic data - methods if interpretation - determination of attitude and depth of formation. Various types of shooting. Seismic instruments and records.
PROCEDURE (PROCESS) STUDENT CENTRIC METHOD OF TEACHING	Lecture Discussion Different geological setting analysis
ACTIVITY	Power point presentation and videos, Seminars, Exposure to real time surveys
LEARNING OUTCOME (OUTPUT)	Understanding of principles and field operations of gravity, magnetics and seismic methods

ASSESSMENT	Question answer session and solving real scenarios

UNIT/ SESSION/ HOURS (TIME REQUIRED)	***MODULE :-5*** ***RADIOMETRIC METHODS FOR EXPLORATION (15 HOURS)***
TOPICS FOR STUDENT PREPARATION (INPUT)	Radiometric methods principles of radioactivity, methods, types of counters: G.M. counters and Scintillometers. Field methods and interpretations. Geophysical well logging Electrical, radiometric, sonic and thermal logging of boreholes.
PROCEDURE (PROCESS) STUDENT CENTRIC METHOD OF TEACHING	Lecture Discussion Different scenario analysis
ACTIVITY	Power point presentation, seminars, and exposure to real time scenarios.
LEARNING OUTCOME (OUTPUT)	Understanding of filed methods of radiometric methods and different types of well logging
ASSESSMENT	Question answer session and solving real scenarios

Unit wise breakup (Lecture hours: 96)

Objective:

a) To equip the students with a detailed knowledge about the exploration techniques used to locate the ore bodies and other valuable materials
b) To enable students the knowledge about the drilling and logging methods.
c) To get a detailed theoretic knowledge about mineral exploration using advanced techniques

Module :-1 Planning, design, construction and problems of major civil structures (15 hours)

Number	Topic	No. of Lecture Hours	Pre- class activity	Pedagogy (in class)	Out of class assignment
Unit 1	Geological studies and evaluation in planning, design, construction and problems of major civil structures.	6	Introduction to mining activities	Lecture using multimedia presentation	Note submission on the related topics
Unit 2	Elementary concepts of rock mechanics and soil mechanics. Site investigation techniques for civil engineering structures, Building stone and aggregate properties.	6	Data mining on the topics	Lecture using multimedia presentation	Note submission on the related topics
Unit 3	Engineering properties of rocks, and soils.	3	Abstract on the topics	Lecture using multimedia presentation	Note submission on the related topics

Module :-2 Analysis of constructions Dams, Tunnels, Bridge, Highway and foundations (15 hours)					
Number	**Topic**	**No. of Lecture Hours**	**Pre- class activity**	**Pedagogy (in class)**	**Out of class assignment**
Unit 1	Dams: parts, types, forces acting on dams and reservoir problems. Geologic aspects of dam investigation	7	Introduction d to Dams	Lecture using multimedia presentation	Note submission on the related topics. Assignment of Dam breakages
Unit 2	Tunnels: parts, classification, ground conditions, geological considerations. **G**eological and geotechnical aspects of Bridge, Highways, Foundations.	8	Introduction to Tunnels	Lecture using multimedia presentation	Note submission on the related topics.

Module:- 3 Natural hazards- understand and mitigate, aseismic designing of building (20 hours)					
Number	**Topic**	**No. of Lecture**	**Pre- class activity**	**Pedagogy (in class)**	**Out of class assignment**

		Hours			
Unit 1	Geological hazards and mitigation-landslides and earth quakes, Landslides: classification, analysis of slope stability, monitoring slope movements, hazard zonation mapping	10	Brief writing about natural hazards	Lecture using multimedia presentation	Note submission on the related topics. Assignment on natural hazards in Kerala
Unit 2	Aseismic design of building, Geotechnical case studies of major projects in India.	10	Collection of pictures which collapsed in earth quakes and discussion about faulty design	Lecture using multimedia presentation	Note submission on the related topics.

Module:- 4 Different Mining methods and petroleum exploration (15 hours)					
Number	**Topic**	**No. of Lecture Hours**	**Pre- class activity**	**Pedagogy (in class)**	**Out of class assignment**

Unit 1	Mining geology: Planning, exploration, exploratory mining of surfaces and underground mineral deposits (methods and types).	8	YouTube videos about mining of different ores	Lecture using multimedia presentation	Note submission on the related topics. Assignment and slide presentation for each student about different mining methods adapted for different type of ores
Unit 2	Mining methods - Alluvial mining- river sand mining, Mining of beach placers, Clay mining, Coal mining, Seabed mining, Exploration of petroleum	7	Abstract on the environmental hazards of alluvial mining and seabed mining	Lecture using multimedia presentation	Note submission on the related topics. Assignment on gold rush

Module:- 5 Ore dressing methods and legislation of mining activity in India (10 hours)					
Number	**Topic**	**No. of Lecture**	**Pre- class activity**	**Pedagogy (in class)**	**Out of class assignment**

		Hours			
Unit 1	Fundamentals of ore dressing: crushing, grinding, sizing, concentration by washing, scrubbing, jigging, tabling, floatation, magnetic and electrostatic separation	7	YouTube video watching on different techniques of ore separation	Lecture using multimedia presentation	Note submission on the related topics. Animation video making for different ore separation methods
Unit 2	Mineral legislation in India	3	Different case studies in the courts about mining and illegal mining activities	Classes with case studies	News Paper cutting collection about the current issues about mining

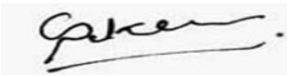
CHRIST COLLEGE
(AUTONOMOUS) IRINJALAKUDA - KERALA

COURSE PLAN

GEL 4E 05a - ENGINEERING GEOLOGY

(FOURTH SEMESTER)

DEPARTMENT OF GEOLOGY

Teacher in charge	Gopakumar P.G	
Co-Ordinator	Roshini P P	

GEL 4E 05a - ENGINEERING GEOLOGY

Lecture hours per week: 5; credits: 3

Internal: 20, external: 80, examination: 3hours

Objectives

d) To equip the students with a detailed knowledge about the civil engineering aspects of geology.
e) To enable students the knowledge about the major problems arising while constructions of large civil structures.

Module 1

Geological studies and evaluation in planning, design, construction and problems of major civil structures. Elementary concepts of rock mechanics and soil mechanics. Site investigation techniques for civil engineering structures, Building stone and aggregate properties. Engineering properties of rocks, and soils. **(20 hours ,20 marks)**

Module 2

Dams: parts, types, forces acting on dams and reservoir problems. Geologic aspects of dam investigation. Tunnels: parts, classification, ground conditions, geological considerations. **G**eological and geotechnical aspects of Bridge, Highways, Foundations. **(15 hours, 15 marks)**

Module 3

Geological hazards and mitigation- landslides and earth quakes, Landslides: classification, analysis of slope stability, monitoring slope movements, hazard zonation mapping. Aseismic design of building, Geotechnical case studies of major projects in India. **(20 hours, 20 marks)**

Module 4

Mining geology: Planning, exploration, exploratory mining of surfaces and underground mineral deposits (methods and types). Mining methods - Alluvial mining-river sand mining, Mining of beach placers, Clay mining, Coal mining, Seabed mining, Exploration of petroleum. **(15 hours, 15 marks)**

Module 5

Fundamentals of ore dressing: crushing, grinding, sizing, concentration by washing, scrubbing, jigging, tabling, floatation, magnetic and electrostatic separation, mineral legislation in India. **(10 hours, 10 marks)**

Reference books:

1. Compton, R. R., Manual of Field Geology, John Wiley
2. Reedman, J. K, Techniques in Mineral Exploration, Allied Scientific Publishers
3. Arogya swamy, R. N. F., Courses in Mining Geology, Oxford and IBH Pub. Co.
4. Fox, Engineering Geology
5. Peters, W. C, Exploration and Mining Geology, John Wiley
6. Bell, F.G. Fundamentals of Engineering Geology, Butterworths, 1983
7. Krynine and Judd, Principle of Engineering Geology and Geotectonic, McGraw Hill. 1957
8. Rose, A. W., Hawkes, H. F., and Webb, J. S., Geochemistry in Mineral Exploration, Academic Press
9. Gokhale, K.V.G.K. Principles of Engineering Geology B.S. Publications, 2006

Objectives

a) To equip the students with a detailed knowledge about the civil engineering aspects of geology.

b) To enable students the knowledge about the major problems arising while constructions of large civil structures.

Course outcome	
M-1	Understand the different methods of civil engineering constructions and problems faced
M-2	Introduce the dam constructions methods, bridge, tunnel and problems faced in details
M-3	Understand the natural hazards, its causes. also promote the remedies and prevention of natural hazards. Aware of aseismic building design

M-4	Understand the open cast and underground mining techniques. Also, about the alluvial mining and seabed mining methods. Introduction to petroleum exploration
M-5	Analyse and study about the ore dressing methods and mine legislation procedures in India

Lesson plan

Unit/session/hours (time required)	**Module 1** Planning, design, construction and problems of major civil structures 20 hours
Topics for student preparation (input)	Geological studies and evaluation in planning, design, construction and problems of major civil structures. Elementary concepts of rock mechanics and soil mechanics. Site investigation techniques for civil engineering structures, Building stone and aggregate properties. Engineering properties of rocks, and soils.

Procedure (Process) student centric method of teaching	Lecture Discussion Different problem situation analysis
Activity	Collection of different disasters happened in the studied topics and its fault finding
Learning outcome (output)	Over all sight over the planning, designing and construction of civil structures
Assessment	Question answer session and solving real scenarios

Unit/session/hours (time required)	Module 2 Analysis of constructions Dams, Tunnels, Bridge, Highway and foundations 15 hours
Topics for student preparation (input)	Dams: parts, types, forces acting on dams and reservoir problems. Geologic aspects of dam investigation. Tunnels: parts, classification, ground conditions, geological considerations. Geological and geotechnical aspects of Bridge, Highways, Foundations.

Procedure (Process)student centric method of teaching	Lecture Discussion Different problem situation analysis
Activity	Collection of different construction methods of famous Dams, Tunnels, Bridge, Highway and foundations in India and abroad
Learning outcome (output)	Different methods of constructions and the method adaptations to the geological settings
Assessment	Question answer session and solving real scenarios

Unit/session/hours (time required)	Module 3 Natural hazards- understand and mitigate, aseismic designing of building 20 hours

Topics for student preparation (input)	Geological hazards and mitigation- landslides and earth quakes, Landslides: classification, analysis of slope stability, monitoring slope movements, hazard zonation mapping. Aseismic design of building, Geotechnical case studies of major projects in India.
Procedure (Process)student centric method of teaching	Lecture Discussion Different natural hazard situation analysis and demonstration with working models
Activity	Collection of different natural disasters happened all over the world and discuss the strategies to solve future disasters
Learning outcome (output)	A detailed study about the natural disasters and its mitigation methods with earthquake resistance building
Assessment	Question answer session and solving real scenarios

Unit/session/hours (time required)	Module 4 Different Mining methods and petroleum exploration 15 hours

Topics for student preparation (input)	Mining geology: Planning, exploration, exploratory mining of surfaces and underground mineral deposits (methods and types). Mining methods - Alluvial mining-river sand mining, Mining of beach placers, Clay mining, Coal mining, Seabed mining, Exploration of petroleum
Procedure (Process)student centric method of teaching	Lecture Discussion Different geological setting analysis
Activity	Collection of different huge mining sites all over the world, slide presentation of each with adapted mining method and ore.
Learning outcome (output)	Different mining methods and its implication regarding the geological settings
Assessment	Question answer session and solving real scenarios

Unit/session/hours (time required)	Module 5 Ore dressing methods and legislation of mining activity in India 10 hours
Topics for student preparation (input)	Fundamentals of ore dressing: crushing, grinding, sizing, concentration by washing, scrubbing, jigging, tabling, floatation, magnetic and electrostatic separation, mineral legislation in India
Procedure (Process)student centric method of teaching	Lecture Discussion Different scenario analysis
Activity	Assignment on the old mining methods and ore dressing methods, improvement in ore dressing techniques and different clearence certificates to start a mine in India.
Learning outcome (output)	A better overall understanding over the ore dressing methods
Assessment	Question answer session and solving real scenarios

Unit wise breakup

Lecture hours: 80

Objective:

a) To equip the students with a detailed knowledge about the civil engineering aspects of geology.

b) To enable students the knowledge about the major problems arising while constructions of large civil structures.

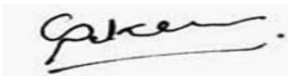
Module number	Topic	No. of lecture hours	Pre- class activity	Pedagogy	Out of class assignments
Module 1 Planning, design, construction and problems of major civil structures (20 hours)					
Unit 1	Geological studies and evaluation in planning, design, construction and problems of major civil structures.	7	Introduction to mining activities	Lecture using multimedia presentation	Note submission on the related topics

Unit 2	Elementary concepts of rock mechanics and soil mechanics. Site investigation techniques for civil engineering structures, Building stone and aggregate properties.	7	Data mining on the topics	Lecture using multimedia presentation	Note submission on the related topics
Unit 3	Engineering properties of rocks, and soils.	6	Abstract on the topics	Lecture using multimedia presentation	Note submission on the related topics
Module 2 Analysis of constructions Dams, Tunnels, Bridge, Highway and foundations (15 hours)					
Unit 1	Dams: parts, types, forces acting on dams and reservoir problems. Geologic aspects of dam investigation	7	Introduction d to Dams	Lecture using multimedia presentation	Note submission on the related topics. Assignment of Dam breakages
	Tunnels: parts, classification		Introduction to Tunnels	Lecture using multimedia	Note submission on the

Unit 2	, ground conditions, geological consideratio ns. **G**eological and geotechnical aspects of Bridge, Highways, Foundations.	8		presentati on	related topics.
Module 3 Natural hazards- understand and mitigate, aseismic designing of building (20 hours)					
Unit 1	Geological hazards and mitigation- landslides and earth quakes, Landslides: classification , analysis of slope stability, monitoring slope movements, hazard zonation mapping	10	Brief writing about natural hazards	Lecture using multimedi a presentati on	Note submission on the related topics. Assignment on natural hazards in Kerala
Unit 2	Aseismic design of building, Geotechnical case studies of major	10	Collection of pictures which collapsed in earth quakes and discussion	Lecture using multimedi a	Note submission on the related topics.

	projects in India.		about faulty design	presentation	
Module 4 Different Mining methods and petroleum exploration (15 hours)					
Unit 1	Mining geology: Planning, exploration, exploratory mining of surfaces and underground mineral deposits (methods and types).	8	YouTube videos about mining of different ores	Lecture using multimedia presentation	Note submission on the related topics. Assignment and slide presentation for each student about different mining methods adapted for different type of ores
Unit 2	Mining methods - Alluvial mining-river sand mining, Mining of beach placers, Clay mining, Coal mining, Seabed mining, Exploration of petroleum	7	Abstract on the environmental hazards of alluvial mining and seabed mining	Lecture using multimedia presentation	Note submission on the related topics. Assignment on gold rush

Module 5 Ore dressing methods and legislation of mining activity in India (10 hours)					
Unit 1	Fundamentals of ore dressing: crushing, grinding, sizing, concentration by washing, scrubbing, jigging, tabling, floatation, magnetic and electrostatic separation	7	YouTube video watching on different techniques of ore separation	Lecture using multimedia presentation	Note submission on the related topics. Animation video making for different ore separation methods
Unit 2	Mineral legislation in India	3	Different case studies in the courts about mining and illegal mining activities	Classes with case studies	News Paper cutting collection about the current issues about mining



Teacher in Charge: Gopakumar P G