Ref No:

SRI KRISHNA INSTITUTE OF TECHNOLOGY

LABORATORY PLAN

Academic Year 2019-2020

Program:	B E – Civil Engineering
Semester :	4
Course Code:	18CVL47
Course Title:	Engineering Geology Lab
Credit / L-T-P:	2 / 0-0-3
Total Contact Hours:	42
Course Plan Author:	DR. K. SATISH

Academic Evaluation and Monitoring Cell

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INSTRUCTIONS TO TEACHERS

- Classroom / Lab activity shall be started after taking attendance.
- Attendance shall only be signed in the classroom by students.
- Three hours attendance should be given to each Lab.
- Use only Blue or Black Pen to fill the attendance.
- Attendance shall be updated on-line & status discussed in DUGC.
- No attendance should be added to late comers.
- Modification of any attendance, over writings, etc is strictly prohibited.
- Updated register is to be brought to every academic review meeting as per the COE.

Table of Contents

Note : Remove "Table of Content" before including in CP Book
Each Laboratory Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

A. LABORATORY INFORMATION

1. Laboratory Overview

Degree:	B.Tech	*Program:*	CV
Year / Semester :	2/4	*Academic Year:*	2019-20
Course Title:	Engineering Geology lab	*Course Code:*	18CVL47
Credit / L-T-P:	2 / 0-0-3	*SEE Duration:*	180 Minutes
Total Contact Hours:	42 Hrs	*SEE Marks:*	60 Marks
CIA Marks:	40 Marks	*Assignment*	5/1 Experiment
Lab. Plan Author	DR. K. SATISH	*Sign*	Dt : 24/03/2020
Checked By:		*Sign*	Dt :

2. Laboratory Content

Expt.	Title of the Experiments	Lab Hours	Concept	Blooms Level
1	Identification of minerals as mentioned in theory, their properties, uses and manufacturing of construction materials.	08	Minerals	L3
2	Identification of rocks as mentioned in theory, their engineering properties and uses in construction and decorative purposes	08	Rocks	L3
3	Borehole problems: Determination of subsurface behavior of rocks, their attitude related to foundation, tunnels, reservoirs and mining. Triangular and Square methods. (2 methods)	04	Borehole problems	L4
4	Dip and Strike problems. Determine Apparent dip and True dip. (2 methods)	04	Attitude of Strata	L4
5	Calculation of Vertical, True thickness and width of the outcrops. (3 methods)	04	Thickness of Strata	L4
6	Study of Toposheets and Interpretation, Extraction of Drainage Basin and its Morphometric Analysis. (3Toposheets)	04	Toposheets	L5
7	Interpretation and drawing of sections for geological maps showing tilted beds, faults, unconformities etc. (10 Maps)	08	Geological maps	L5
8	Interpretation of Satellite Images. (2 Satellite images)	04	Satellite Imageries	L5
9	Field work– To identify Minerals, Rocks,	24	Field Work	L6

	Geomorphology and Structural features with related to the Civil Engineering projects			

3. Laboratory Material

Books & other material as recommended by university (A, B) and additional resources used by Laboratory teacher (C).

Expt.	Details	Expt. in book	Availability
A	**Text books (Title, Authors, Edition, Publisher, Year.)**	**-**	**-**
1-9	**Text Books :** 1. P.K.MUKERJEE, Textbook of Geology, WorldPress Pvt. Ltd., Kolkatta 2. Engineering and General Geology – Parbin Singh, Katson Educaitional Series. 3. MP Billings, Structural Geology, CBS Publishers and Distributors, New Delhi.		In Lib / In Dept
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	**-**	**-**
1, 2	1. Groundwater Hydrology, David Keith Todd, Wiley. 2. B.S. Satyanarayana Swamy, Engineering Geology Laboratory Manual, Dhanpat Rai Sons, New Delhi 3. LRA Narayan, remote sensing and its applications, UniversityPress. 4. Johnl Plattand John Challinor, Simple Geological Structures,ThomasMurthy&Co, London.		In Dept
C	**Concept Videos or Simulation for Understanding**	**-**	**-**
c1	https://www.youtube.com/results?search_query=igneous+rocks		
c2	https://www.youtube.com/watch?v=qFEBPD3JEOM		
c3	https://www.youtube.com/watch?v=32NG9aeZ7_c		
c4	https://www.youtube.com/watch?v=MwBVztOz2No		
c5	• https://www.youtube.com/watch?v=oz9VEkFsNoE		
c6	• https://www.youtube.com/watch?v=5KdMJOwHRc0		
c7	• https://www.youtube.com/watch?v=a1fU2BLNWRU		
c8	• https://www.youtube.com/watch?v=BuN6gEU-yK4		
c9	• https://www.youtube.com/watch?v=UTaQgdghKZs		
E	**Recent Developments for Research**	**-**	**-**
		?	In lib
F	**Others (Web, Video, Simulation, Notes etc.)**	**-**	**-**
1			
?			

4. Laboratory Prerequisites:

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

Students must have learnt the following Courses / Topics with described Content . . .

Expt.	Lab. Code	Lab. Name	Topic / Description	Sem	Remarks	Blooms Level
1	18CV47	Engg. Geology	Theoretical knowledge of Engg. Geology	3		L3

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.
Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Expt.	Topic / Description	Area	Remarks	Blooms Level
1	Identification of minerals as mentioned in theory, their properties, uses and manufacturing of construction materials.	Higher Education/ GATE/UPSC , etc.	Able to identify minerals in the field	L3
2	Identification of rocks as mentioned in theory, their engineering properties and uses in construction and decorative purposes	Higher Education/ GATE/UPSC , etc.	Able to identify rocks in the field	L3
3	Borehole problems: Determination of subsurface behavior of rocks, their attitude related to foundation, tunnels, reservoirs and mining. Triangular and Square methods. (2 methods)	Higher Education/ GATE/UPSC , etc.	Students will understand subsurface condition	L4
4	Dip and Strike problems. Determine Apparent dip and True dip. (2 methods)	Higher Education/ GATE/UPSC , etc.	Able to find out attitude of the strata	L4
5	Calculation of Vertical, True thickness and width of the outcrops. (3 methods)	Higher Education/ GATE/UPSC , etc.	Able to find out thickness of the strata	L4
6	Study of Toposheets and Interpretation, Extraction of Drainage Basin and its Morphometric Analysis. (3Toposheets)	Higher Education/ GATE/UPSC , etc.	Learn morphomeric analysis	L5
7	Interpretation and drawing of sections for geological maps showing tilted beds, faults, unconformities etc. (10 Maps)	Higher Education/ GATE/UPSC , etc.	Interpret the structural features	L5
8	Interpretation of Satellite Images. (2 Satellite images)	Higher Education/ GATE/UPSC , etc.	Learn to interpret false color images	L5

9	Field work – To identify Minerals, Rocks, Geomorphology and Structural features with related to the Civil Engineering projects	Higher Education/ GATE/UPSC , etc.	Students will apply their knowledge in identification of minerals, rocks and other structural features in the field.	L6

B. Laboratory Instructions

1. General Instructions

SNo	Instructions	Remarks
1	Observation book and Lab record are compulsory.	
2	Students should report to the concerned lab as per the time table.	
3	After completion of the program, certification of the concerned staff in-charge in the observation book is necessary.	
4	Student should bring a notebook of 100 pages and should enter the readings /observations into the notebook while performing the experiment.	
5	The record of observations along with the detailed experimental procedure of the experiment in the Immediate last session should be submitted and certified staff member in-charge.	
6	Should attempt all problems / assignments given in the list session wise.	
7	When the experiment is completed, should return all the components/instruments taken for the purpose.	
8	Any damage of the minerals and rocks will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year	
9	Completed lab assignments should be submitted in the form of a Lab Record	
10	Be careful while using acids.	

2. Laboratory Specific Instructions

SNo	Specific Instructions	Remarks
1	Before conducting any test, students shall come prepared with theoretical background of the corresponding test (indicated under the section 'theory' in each test).	
2	Students shall make sure to have the knowledge of using streak plate and Mohs scale of Hardness.	
3	Students shall give importance to accuracy and precision while conducting the test and interpreting the maps/images/toposheets.	
4	Students shall acquaint themselves with the safe and correct usage of instruments / equipment's under the guidance of teaching / supporting staff of the laboratory	

C. OBE PARAMETERS

1. Laboratory Outcomes

Expt.	Lab Code #	COs / Experiment Outcome	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
-	-	**At the end of the experiment, the student should be able to . . .**	-	-	-	-	-
1	18CVL47.1	Know and the engineering properties of minerals and their engineering uses.	08	Minerals	Lecture and demonstration	C.IA	L3
2	18CVL47.2	Know engineering properties of rocks and their engineering	08	Rocks	Lecture and demons	C.IA	L3

		uses			tration		
3	18CVL47.3	Determine subsurface behavior of rocks, their attitude related to foundation, tunnels, reservoirs and mining.	04	Borehole problems	Lecture and demonstration	C.IA	L4
4	18CVL47.4	Determine attitude of rocks in Civil Engineering projects (Railway lines, tunnels, dams, reservoirs).	04	Attitude of Strata	Lecture and demonstration	C.IA	L4
5	18CVL47.5	Determine/calculate vertical, true thickness and width of the outcrops.	04	Thickness of Strata	Lecture and demonstration	C.IA	L4
6	18CVL47.6	Interpret toposheets and learn to extract Drainage Basin and Morphometric Analysis.	04	Toposheets	Lecture and demonstration	C.IA	L5
7	18CVL47.7	Interpret geological maps related to Civil Engineering Projects.	08	Geological maps	Lecture and demonstration	C.IA	L5
8	18CVL47.8	Interpret satellite Images.	04	Satellite Imageries	Lecture and demonstration	C.IA	L5
9	18CVL47.9	Identify Minerals, Rocks, Geomorphology and Structural features with related to the Civil Engineering projects	24	Field Work	Lecture and demonstration	C.IA	L6
-		**Total**	**44**	-	-	-	-

Note: Identify a max of 2 Concepts per unit. Write 1 CO per concept.

2. Laboratory Applications

Expt.	Application Area	CO	Level
1	Able to identify minerals in the field	CO1	L3
2	Able to identify rocks in the field	CO2	L3
3	Students will understand subsurface condition	CO3	L4
4	Able to find out attitude of the strata	CO4	L4
5	Able to find out thickness of the strata	CO5	L4
6	Learn morphomeric analysis	CO6	L5
7	Interpret the structural features	CO7	L5
8	Learn to interpret false color images	CO8	L5
9	Students will apply their knowledge in identification of minerals, rocks and other structural features in the field.	CO9	L6

Note: Write 1 or 2 applications per CO.

3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

Expt.	Mapping		Mapping Level	Justification for each CO-PO pair	Level
-	CO	PO	-	'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'	-
1	CO1	PO1,2,6,7,8,9	MEDIUM	Student should be able to know engineering properties of rocks and their engineering uses.	L3
2	CO2	PO1,2,6,7,8,9	MEDIUM	Student should be able to determine subsurface behavior of rocks, their attitude related to foundation, tunnels, reservoirs and mining.	L3
3	CO3	PO1,2,3,4,6,7,8	HIGH	Student should be able to determine attitude of rocks in Civil Engineering projects (Railway lines, tunnels, dams, reservoirs).	L4
4	CO4	PO1,2,3,4,6,7,8	MEDIUM	Student should be able to calculate vertical, true thickness and width of the outcrops.	L4
5	CO5	PO1,2,3,4,6,7,8	HIGH	Student should be able to interpret toposheets and learn to extract Drainage Basin and Morphometric Analysis.	L4
6	CO6	PO1,2,3,4,6,7,8,9	HIGH	Student should be able to interpret toposheets and geological maps related to Civil Engineering Projects.	L5
7	CO7	PO1,2,3,4,6,7,8,9	HIGH	Student should be able to interpret satellite Images.	L5
8	CO8	PO1,2,3,4,6,7,8,9	HIGH	Student should be able to identify Minerals, Rocks, Geomorphology and Structural features with related to the Civil Engineering projects	L5
9	CO9	PO1,2,3,4,6,7,8,9	HIGH	The students will be able to use research-based knowledge and research methods including design of experiments, analysis and interpretation of dissolved oxygen content	L6

4. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

-	-	Experiment Outcomes	Program Outcomes													-
Expt.	CO.#	**At the end of the experiment student should be able to . . .**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	Level
1	CO1	Student should be able to know the engineering properties of minerals and their engineering uses.	3	3	-	-	-	2	3	3	2	-	-	-	-	-	-	L3
2	CO2	Student should be able to know engineering properties of rocks and their engineering uses.	3	3	-	-	-	2	3	3	2	-	-	-	-	-	-	L3
3	CO3	Student should be able to determine subsurface behavior of rocks, their	3	3	3	3	-	3	2	3	-	-	-	-	-	-	-	L4

		attitude related to foundation, tunnels, reservoirs and mining.																	
4	CO4	Student should be able to determine attitude of rocks in Civil Engineering projects (Railway lines, tunnels, dams, reservoirs).	3	3	3	3	-	3	2	3	-	-	-	-	-	-	-	L4
5	CO5	Student should be able to calculate vertical, true thickness and width of the outcrops.	3	3	3	3	-	3	2	2	-	-	-	-	-	-	-	L4
6	CO6	Student should be able to interpret toposheets and learn to extract Drainage Basin and Morphometric Analysis.	3	3	3	3	-	3	2	2	3	-	-	-	-	-	-	L5
7	CO7	Student should be able to interpret toposheets and geological maps related to Civil Engineering Projects.	3	3	3	3	-	3	3	3	3	-	-	-	-	-	-	L5
8	CO8	Student should be able to interpret satellite Images.	3	3	3	3	-	3	3	3	3	-	-	-	-	-	-	L5
9	CO9	Student should be able to identify Minerals, Rocks, Geomorphology and Structural features with related to the Civil Engineering projects	3	3	3	3	-	3	3	3	3	-	-	-	-	-	-	L6
-		**Average attainment (1, 2, or 3)**																	**-**
-	*PO, PSO*	*1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design*																	

5. Curricular Gap and Experiments

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

Expt	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					
4					
5					

Note: Write Gap topics from A.4 and add others also.

6. Experiments Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

Expt	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

D. COURSE ASSESSMENT

1. Laboratory Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Unit	Title	Teaching Hours	No. of question in Exam							CO	Levels
			CIA-1	CIA-2	CIA-3	Asg-1	Asg-2	Asg-3	SEE		
1	Identification of minerals as mentioned in theory, their properties, uses and manufacturing of construction materials.	08	-	-	-	-	-	-	1	CO1	L3
2	Identification of rocks as mentioned in theory, their engineering properties and uses in construction and decorative purposes	08	-	-	-	-	-	-	1	CO2	L3
3	Borehole problems: Determination of subsurface behavior of rocks, their attitude related to foundation, tunnels, reservoirs and mining. Triangular and Square methods. (2 methods)	04	-	-	-	-	-	-	1	CO3	L4
4	Dip and Strike problems. Determine Apparent dip and True dip. (2 methods)	04	-	-	-	-	-	-	1	CO4	L4
5	Calculation of Vertical, True	04	-	-	-	-	-	-	1	CO5	L4

	thickness and width of the outcrops. (3 methods)										
6	Study of Toposheets and Interpretation, Extraction of Drainage Basin and its Morphometric Analysis. (3Toposheets)	04	-	-	-	-	-	-	1	CO6	L5
7	Interpretation and drawing of sections for geological maps showing tilted beds, faults, unconformities etc. (10 Maps)	08	-	-	-	-	-	-	1	CO7	L5
8	Interpretation of Satellite Images. (2 Satellite images)	04	-	-	-	-	-	-	1	CO8	L5
9	Field work– To identify Minerals, Rocks, Geomorphology and Structural features with related to the Civil Engineering projects	24	-	-	-	-	-	-	1	CO9	L6
-	**Total**	**44**	**-**	**-**	**-**	**-**	**-**	**-**	**10**	**-**	**-**

2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	20	CO1 to CO9	L3-L6
	-		
	-		
	-		
Other Activities – define – Slip test			
Final CIA Marks	**40**	**-**	**-**

-

SNo	Description	Marks
1	Observation and Weekly Laboratory Activities	10 Marks
2	Record Writing	10 Marks for each Expt
3	Internal Exam Assessment	20 Marks
4	Internal Assessment	40 Marks
5	SEE	60 Marks
-	**Total**	**100 Marks**

E. EXPERIMENTS

Experiment 01 : Identification of Minerals based on their physical Properties

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Identification of i. Rock Forming minerals - Quartz group, Feldspar group, Garnet group, Mica group & Talc, Chlorite, Olivine, Asbestos, Calcite, Gypsum, etc. i. Ore forming minerals- Magnetite, Hematite, Pyrite, Pyralusite, Graphite, Chromite, etc.						
2	Course Outcomes	Student should be able to know the physical, engineering properties of minerals and their engineering uses.						
3	Aim	Identification of minerals based on their physical properties.						
4	Material / Equipment Required	Streak Plate, penknife, Chemicals						
5	Application Areas	Mineral resources, civil engineering uses.						
6	Remarks							
7	Faculty Signature with Date							

Mineralogy

1.1. Introduction

Mineralogy is a branch of Geology which deals with" the study of minerals". The subject of mineralogy attempts to study the various aspects of minerals.
The study of mineralogy includes the study of:

- Physical characters (Physical Mineralogy)
- Chemical characters (Chemical Mineralogy)
- The Optical properties (Optical Mineralogy)
- Mode of occurrence and the formation of minerals {X-Ray Mineralogy)

Due to the advancement of knowledge and improvement in techniques, Mineralogy also includes applied aspects.
A mineral can be defined as a" naturally occurring, homogeneous solid, inorganically formed having a definite chemical composition and ordered atomic arrangement".
According to this definition, a mineral will have the following characters:

1. It must have formed naturally; Minerals prepared in the laboratory by artificial method cannot be called minerals in the true sense.
2. Every mineral will be uniform or homogenous in composition.
3. It must be a solid, but the recent (latest) trend is to include coal and petroleum under minerals. But majority of the minerals are solids.
4. Inorganic processes form the minerals. Very rarely formation of certain minerals like Quartz, calcite etc. has been observed in certain parts of the human body, Even though such substances in the body possess the characters of minerals they cannot be called minerals.
5. Every mineral will have a definite chemical composition.

For example-- Quartz ($SiO_{2)}$

Graphite (C)
Calcite ($CaCO_3$)

6. Every mineral is characterized by a definite internal atomic arrangement of an atom.

1.2. Physical Properties of Minerals or External Characters of Minerals:

Minerals are characterized by a number of properties that can be observed externally. Such characters are called physical properties. The various physical properties can be studied under the following different headings:

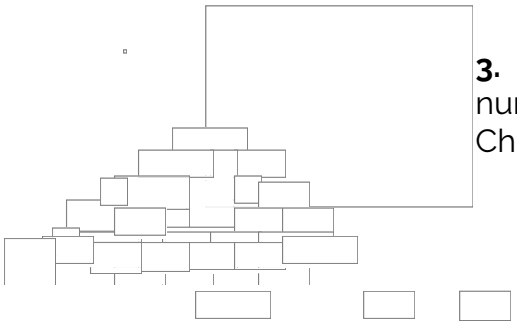
1. 1.Physical properties of minerals depending on Light, Such as Form, Colour, Streak, Diaphaneity, Lustre.
2. 2.Physical properties of minerals depending on state of aggregation, such as Cleavage, Fracture, Hardness.
3. 3.Physical properties of minerals depending on the specific gravity of the mineral.
4. 4.Physical properties of minerals depending on certain senses, such as Taste, Feel and Odour (Smell).
5. Special properties such as Dil. Hcl. test, Magnetism.

1.Physical properties of minerals depending on Light

FORM: Minerals assume different shapes, which depend upon the Internal structure of the minerals.
Different terms have been used to describe the forms of different minerals.
The important terms that are commonly used are:

1. Fibrous- when the mineral has a thread- like structure. Example Asbestos.

2. Columnar: - When the mineral has a thick or thin columnar structure. Example- Hornblende

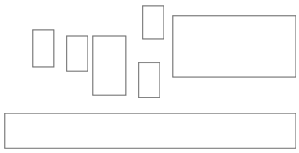


3. Granular-When the mineral has numerous grains, coarse or fine Example: Calcite, Chromite.

4. Crystalline- when the mineral has fine crystals packed together. Example: Galena, Pyrite.

5. Massive- when the mineral has an irregular structure. Example- Feldspar.

6. Bladed-



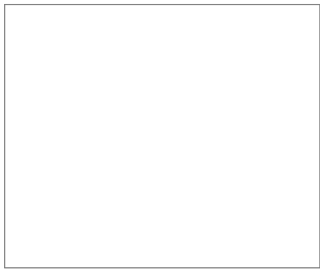
When a mineral appears to be composed of a blade- like structure. Example: Kyanite.

7. Acicular-

When the mineral consists of thin, sharp and slender needles as shown in the figure. Example: Natrolite.

8. Botryoidal - Rounded aggregates of minerals like a bunch of grapes. Example: Chalcedony.

9. Foliated-



When the mineral consists of thin separable sheets. Example: Mica.

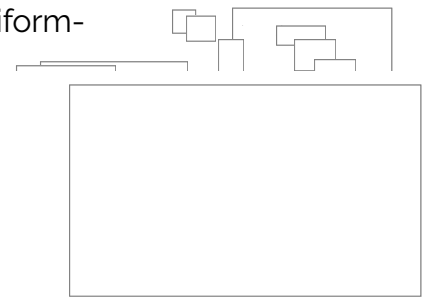
10. Radiating-

When the fibers or needles are arranged around a central point. Example: Iron Pyrite.

11. Tabular-

The mineral is flat rather than elongated as shown in the figure. Example: Calcite, Orthoclase.

12. Reniform-



When the mineral possesses rounded prominences like those of a Kidney as shown in the figure. Example: Hematite.

B) Colour: Colour is an important physical property of minerals, which depends upon light. The colour of any mineral depends up on the absorption of some and reflection of others of the colour of white light. If the mineral absorbs all the colour of white light, it appears Black.
If the mineral reflects all the colours of white light it appears, White.
A mineral appears red when it can absorb all the colours of white light except red colour.
Similarly, a mineral appears Green when it can absorb all the colours of white light except green colour.
C) Streak: Streak is nothing but the colour of the mineral in its powdery form. Rubbing the mineral against the streak plates can get streak. Some minerals will have the same colour from their massive form also in their powdery form.
For example, Natural gold is Yellow in both in its colour and powder form. There are some other minerals, which have different chloroform their massive form due to their powdery form.
For example, The mineral pyrite which is commonly called as "Fool's Gold" Is yellow in colour in its massive form but it gives a Black streak. Similarly Hematite, the ore of Iron will give Red or Brown Grayish brown in colour but it gives Cherry red Streak.

Table: 1.1 Colour of Streak of Some Minerals

Mineral	Streak
Barite	White
Biotite	Colourless
Chalcopyrite	Black
Chromite	Brown
Galena	Lead-grey
Gold	Natural yellow
Graphite	Black
Gypsum	White
Haematite	Cherry-red
Limonite	Yellowish-brown
Pyrite	Black
Quartz	Colourless

Siderite	White

D) Diaphaneity: Diaphaneity means ability to transmit light. The terms used are:
i) Transparent: when the mineral allows the light to pass through it. In the case of transparent minerals the objects can be clearly seen through such minerals.
Example: Quartz and Calcite (Coloured varieties).
ii) Translucent: When the minerals allow only a part of the light to pass through. The outlines of any object cannot be seen clearly through such a lines of translucent mineral.
Example: Quartz and Calcite (Milky white varieties)
iii) Opaque: When a mineral does not allow any light to pass through. The Objects are not seen through opaque mineral.
Example: Bauxite, Hematite, and Magnetite.

E) Lustre

The Lustre of a mineral is its appearance in a reflected light, which is independent of its colour.
The terms used are:
(i) Adamantine- when a mineral has lustre like Diamond.
Example: Zircon, Diamond, Sulphur etc.,
(ii) Resinous- when a mineral has lustre like Grease.
Example: Opal amber and a variety of Zincblende.
(iii) Vitreous-When a mineral has lustre like Glass.
Example: Quartz, Calcite and in many other Silicate Minerals.
(iv) Pearly- when a mineral has lustre like Pearls.
Example: Talc. Brucite, Micas etc.,
(v) Metallic-When a mineral has lustre like metals.
Example: Galena, Pyrite, and Chalcopyrite.
(vi) Silky lustre- Mineral with a Silky shine
Example- Asbestos
(Vii) Dull- when a mineral has no lustre.
Example- Bauxite.

2. Physical Properties Of Minerals Depending On State Of Aggregation:

(A) Cleavage: cleavage of the mineral is its tendency to Split along certain parallel planes producing more or less Smooth surface.
Cleavage lines are the weaklings or Divisional planes in a mineral.
The terms used are:
i) Perfect, Good or Distinct- When a mineral can split up with great ease and give smooth surface.
Example: Mica, Feldspar
ii) Imperfect, Poor, Imperfect or None- When a mineral does not split up with an average force.
Example: Quartz.

(B) Fracture: fracture of the mineral may be defined as the appearance of its broken surface, when the mineral is hammered and broken.

The terms used are:
i. Even fracture
ii. Uneven fracture
iii. Conchoidal fracture
iv. Hackly fracture
v. Earthy fracture

(i) Even fracture-Appearance of a mineral in its broken surface is Smooth.
Mineral examples: Chert, Mica.
(ii) Uneven fracture- when the mineral breaks with very rough and coarse surfaces.
Mineral examples: Chromite and various other minerals.
(iii) Conchoidal fracture- when a mineral breaks with curved Surfaces or concentric Rings or half moon shape.
Mineral example: Quartz
(iv) Hackly fracture- when a mineral breaks with irregular Surfaces having sharp edges.
Mineral example: Native copper.
(v) Earthy fracture- when the broken surface is soft and almost smooth.
Mineral example- Chalk.

(C) Hardness: The hardness of a mineral is the resistance it offers to abrasion, which is determined by observing the comparative ease or difficulty in scratching it with another mineral of known hardness. It is always expressed by Moh's Scale of Hardness given below-

Table-1.2 **Moh's Scale Of Hardness**

Standard Mineral and its composition	**Hardness scale**	**Remarks**

Talc $Mg_3 (Si_4O_{10}) (OH)_2$	1	Can be scratched by a fingernail
Gypsum $CaSO_4$	2	Can be scratched by a fingernail
Calcite $CaCO_3$	3	Can be scratched by a copper coin
Fluorite CaF_2	4	Can be scratched by a iron nail
Apatite $Ca_3 (F, CL, OH) (PO_4)$	5	Can be scratched by window glass
Orthoclase $KALSI_3O_8$	6	Steel pocket knife
Quartz SiO_2	7	Pen knife
Topaz $Al_2 (SiO_4) (SOH)_2$	8	Can be scratched by a Pen knife
Corundum Al_2O_3	9	Can be scratched by a Pen knife
Diamond C	10	Cannot be scratched by a Pen knife

A mineral with lowest hardness is talc and the mineral with the maximum hardness is Diamond. It has been observed that a soft mineral like Talc and Gypsum can be scratched with a Fingernail. A steel knife can cut Apatite and Orthoclase but not Quartz. The average hardness of a normal fingernail may be up to 2.5 whereas the hardness of penknife is 6.5

3. PhysicalProperties of Minerals Depending on Specific Gravity

The Specific gravity of a mineral is the ratio of its weight to the Weight of equal volume of water.

$$\text{Density} = \frac{\text{Mass}}{} = M$$

Specific gravity is depending on the weight of the specimen -Palm is the Judge
Low - Light minerals (less weight)
Medium - Intermediate minerals (medium weight)
High - Heavy minerals (much weight)

4. Physical Properties of Minerals Depending on Certain Senses Such as Taste, Feel and Odour

1. Taste: The terms used are-
(i) Alkaline-Taste of soda
(ii) Bitter-Taste of Epsom salt
(iii) Cooling- Taste of Saltpeter
(iv) Saline- Taste of common salt
(v) Sour- taste of Sulphuric acid

2. Feel: Feel is the sensation upon touching or handling minerals.
The terms used are-
"Greasy"
"Soapy"
"Rough"
"Harsh"

3. Odour: Some characteristic smell when rubbed breathed upon heated.
The terms used are-
(a) Arsenical
(b) Sulfurous
(c) Argillaceous

(a) Arsenical- Like the Odour of Garlic. Example-Orpiment
(b) Sulphurous- Like the Odour of burning Sulphur. Example-Pyrite
(c) Argillaceous-Like the Odour of clay.

Special Properties of Minerals:
Special properties of minerals such as:
(i) Magnetism
(ii) Reaction with Dil, Hcl acid

Magnetism--Only few minerals are attracted by a Bar magnet or Horseshoe magnet. Such minerals are called Ferromagnetic. The most common minerals that attract a magnet are Magnetite, Pyrrhotite, Magnet, etc.,
Based on the strength of the magnetism, the minerals can be grouped
Under the following headings.

(i) Highly Magnetic - Examples: Magnetite, Pyrrhotite
(ii) Moderate Magnetic- Example: Siderite, Iron Garnet, Ilmenite, and hematite
(iii) Weakly Magnetic- Example: Tourmaline, spinel, and monazite
(iv) Non magnetic - Example: Calcite, quartz, and feldspars

Reaction With Acid
Acid Test- Scratch a fresh even surface of the given mineral until grooved and powdered.
Certain carbonate minerals react with Hydrochloric acid.
Example: Calcite CaCO3 is got. Add one or two drops of Dilute HCL. Carefully to it. Immediate effervescence (fizzing) confirms Carbonate especially $CaCO_3$.

1.3 CLASSIFICATION OF MINERALS

A) Silicate minerals Rock forming minerals	1) Quartz group
	2) Feldspar group
	3) Mica group
	4) Amphibole group
	5) Garnet group
B) Non-silicate minerals Rock forming minerals	6) Carbonate group Calcite, Dolomite, Magnesite.
C) Non-silicate minerals Ore forming minerals	7) Sulphide group Galena, Pyrite, Chalcopyrite. 8) Oxide group Hematite, Magnetite, Bauxite, Corundum. 9) Sulphate group Gypsum, Barytes.

1.4 DESCRIPTION OF MINERALS:

1 Quartz Group
Form - Granular
Colour - (varieties of quartz)

Streak - Colourless
Luster - Vitreous
Cleavage – Absent
Fracture – Conchoidal to uneven
Hardness – 7 [High]
Sp. gr. – Low to Medium.
C C - $Si\ O_2$

Occurrence– widely distributed all over India occurs Beach Sand, River sand.
Uses: (1)Manufacture of glass, porcelain
(2) Flux in metallurgical operation
(3) Agates are used as Ornaments
(4) Amethysts are considered as semiprecious stone
(5) Pure quartz crystal shows piezoelectricity

(6)Quartz plates are used in controlling frequencies in radio circuits,radar,ultrasonic and multiple telephone lines.
(7) Fibre quartz wires are frequently used for transmission of telephone messages. Each minute fibre wire can send large messages.
(8) Quartz is used in refractories
(9) Pure silica is used in ceramics
(10)Pure sand, free from impurities is used in manufacturing Sand paper and Abrassive cloth.

Varieties of Quartz:

Crystalline Varieties

a) Rock crystal or colourless quartz [colourless, transparent]

b) Rosy quartz [Rose colour, Translucent.]

c) Milky quartz [Milk colour, translucent]

d) GREY quartz [Grey colour, translucent]

e) Amethyst [Purple or violet colour, translucent]

f) Smoky quartz [Smoky- yellow or smoky-brown colour, translucent]

g) Orange quartz [Orange colour, translucent]

h) Green quartz (Green translucent] colour,)

[2] Cryptocrystalline Varieties

a) Chalcedony [Botryoidal, uniform light colour]

b) Agate [Banded, zebra Agate- zebra colour]

c) Jasper [Blood red colour]

d) Chert [Brick red colour]

[3] Amorphous Varieties

a) Opal,

2. Feldspar Group

Properties	Orthoclase	Plagioclase	Microcline
Colour	Pink	White	Green
Form	Tabular	Massive	Tabular
Streak	Colour less	Colour less	Colour less
Lustre	Vitreous	Vitreous	Vitreous
Cleavage	Present	Vitreous	Vitreous

Hardness Sp.Gr. Chemical composition:	6 (Medium) 2.6 (Medium) Potash feldspar	Present 6 (Medium) 2.6 (Medium) Soda feldspar	Present 6 (Medium) 2.6 (Medium) Potash feldspar
Occurrence	Occurs in acidic igneous rocks – granites and pegmatites		
Uses	Used in the manufacture of Sanitary ware and Earthenware. Feldspars are also used in the manufacturing of porcelain bits. Feldspars are also used in the preparation of various types of glazed tiles		

3. Mica Group

Properties	Biotin Mica (Black Mica)	Muscovite Mica (White Mica)
Form	Foliated	Foliated
Colour	Black	White colour
Streak	Colourless	Colourless
Diaphaneity	Translucent	Transparent
Lustre	Pearly	Pearly
Cleavage	Present	Present
Fracture	Even	Even
Hardness	Medium	Medium
Sp.Gr.	Medium	Medium
Chemical	Silicate of Mg, Fe, Al	

composition-	and K with [OH] ions.	Silicate of Al and K
Occurrence.	Occurs in igneous and metamorphic rocks Lightweight concrete	Occurs in igneous and metamorphic rocks
Uses		Used as an insulating material in Electrical Apparatus Mica powders are used in mica bricks, steel plants, lubricants, filter in paints, rubber, plastic materials, wall papers, etc

Experiment 2 : Engineering Properties of Rocks: Identification of rocks based on their index properties

-	**Experiment No.:**	2	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Identification of rocks based on their index properties						
2	Course Outcomes	Student should be able to know the index and engineering properties of rocks and their engineering uses.						
3	Aim	Identification of rocks based on their index properties						
4	Material / Equipment Required	Penknife, Chemicals, Lenses						
5	Application Areas	Construction materials and civil engineering uses.						
6	Remarks							
7	Faculty Signature with Date							

2. Petrology (Greek, Petra=Rock, Logos=Science)

2.1.Petrology is the branch of Geology deals with the study of rocks. Especially their mode of formation, Composition and uses for all types of engineering works.
The study of petrology is most important for a civil engineering in the selection of suitable rocks for building stones, Road metals etc.,
Rocks reveal the geological events of our mother earth. Rocks of other planets also decipher the secrets of their geological evolution.
2.2 Definition of as rock
A Rock is defined as the aggregation of the mineral constituents, which forms the earth's crust. Some rocks may be hard like Granite or soft like sand or clay. The hard and resistant substances may be called stones.
Example- Granite, Sandstones, Marble etc., that is why all the stones are rocks, but at the. Same time all rocks are not necessarily stones
2.3. Classification of rocks based on their Genesis
Broad classification of rocks on the basis of their mode of origin (Ref-Table)

i) Igneous rocks or primary rocks-
Formed by the consolidation of hot molten material magma.
Example-Granite, Syenite, Diorite, pegmatite, Dolerite, Basalt.
ii) Secondary rocks or Sedimentary rocks-
Formed by the consolidification of Sediments in the layered or bedded rocks deposited in the ocean bottom or huge lake etc.,
Examples-Breccia, Conglomerrrate, Shale, Sand stone, Limestone.
iii) Metamorphic rocks- Formed by the effects of temperature, pressure of both (by a process is known as 'Metamorphism") on the preexisting rocks.
Examples- Slate, Schist, Gneiss, Marble, Quartzite

2.4 Table: Classification of rocks based on their Genesis

Igneous rocks or Primary rocks	Sedimentary rocks or Secondary rocks	Metamor rocks o rocks
Volcanic Examples-Basalt, Trachyte. Hypobyssal Examples-Pegmatite Plutonic Examples-Granite, Syenite, Diorite, Gabbro, Dunite etc.,	Organic Examples- Fossiliferos Limestone. Chemical Example-Limestone. Mechanical Example-Shale, Conglomerate, Breccia.	Thermal Example Dynamic Example Schist. Dynamo Example Quartzite

2.5. Terminology

IGNEOUS ROCKS Or First formed rocks Or Primary rocks OrHardrocks Or Consolidated rocks	SEDIMENTRY ROCKS or secondary formed or second formed Orsoftrocks or unconsolidated rocks	METAMORPHIC ROCKS or Altered rocks OrThirdformed OrHardrocks Or Consolidated rocks.

2.6.Classification of igneous rocks:

	Over Saturated ACID Silica content: SiO_2>66% Withfree quartz	Saturated INTERMEDIATE SiO_2: 55-66 %	 BASIC SiO2 44 - 55 %	Under Saturated ULTRA BASIC SiO_2< 44 %
Mineral composition	Q, F, B, H	OF+PF+Hbl	Augite +PF	Olivine and little or no feldspar
Colour	Leucocratic	Me Socratic	Melanocratic	
Specific gravity	2.6-2.7	2.9	3.0	3.1
VOLCANIC	Rhyolite	Trachyte	Basalt	Limbergite

(Extrusive)	Dacite Obsidian	Andesite Phonolite	Alkali-Basalt	Olivine-basalt
HYPOBYSSAL Minor Intrusive - sill, dyke, Laccolith.	Granite-porphyry Pegmatite	Syenite-porphyry Diorite-porphyry	Dolerite-porphyry Dolerite	
PLUTONIC Major Intrusive Batholith, Boss	Granite Grano-diorite	Syenite Diorite Nepheline-Syenite	Gabbro	Dunite Peridotite Picrite Perkinite.

2.7.Classification of Sedimentary Rocks

Mode of Formation	Texture and Mineral Composition	Rock types
Mechanically formed or Clastic	1.Rudaceous (Pebbly) ii) Arenaceous (Sandy) iii) Argillaceous (Clayey)	Breccia Conglomerate Sandstone Shale
Chemically Formed (Precipitation/evaporation /residual deposits)	Massive ($Caco_3$)- Calcite	Limestone
Organically formed	Fossiliferos (Animal remains, Shells, Corals) Calcite	Shell Limestone Or Coral Limestone
Sedimentary or Residual	Concretionary	Laterite

Deposits loosely cemented	(Clay, Fe2O $_{AL2O3}$	

2.8. Classification of Metamorphic Rocks:

Metamorphic agencies		Heat	Pressure (Stress)	Enormous heat and pressure together
Mode of Formation (Process)		Thermal Metamorphic Rocks	Dynamic Metamorphic rock	Dynamo thermal or Regional Metamorphic rock
Non foliated	Recrystallisation-Granulose	Marble_ Quartzite	_____	_____
Foliated	Reorientation Schistose	_____	Chlorite, Schist, Mica Schist	
Banded	Reorientation Gneissose	_____	_____	Gneiss Augen Gneiss

2.9. Mode of Origin

1) For Igneous Rocks

Mode of origin	Acidic	Intermediate	Basic	Ultra basi

Plutonic	Granite	Syenite Diorite	Gabbro	----
Hypobyssal	Pegmatite	Porphyries	Dolerite	----
volcanic	Rhyolite	Trachyte Andesite	Basalt	----

(2) For Sedimentary Rocks

Mode of Origin	Examples
1) Mechanical	Breccia. Conglomerate, shale, sand stone
2) Chemical	Lime stone
3) Organic	Fossiliferos shale, Fossiliferos lime stone

(3) For Metamorphic Rocks

Mode of Origin	Examples
1) Dynamic Metamorphism	Slate, Schist, gneiss
2) Thermal Metamorphism	Marble
3) Dynamo thermal Metamorphism	Quartzite

Parent Rocks To The:
1) Slate, Shale
2) M limestone
3) Gneiss Granite
4) G Sandstone

2.10 DESCRIPTION OF IGNEOUS ROCKS

Description of Plutonic Igneous Rocks:

Properties	**Granite**	**Syenite**	**Diorite**	**Dunite**
Colour	Light colour with White pink tint	Light colour	Light colour	Olive green, yellowish Green, greenish yellow
Grain size	Medium to coarse	Medium to coarse	Medium to coarse	Fine to medium
Texture	Equigranular (E)	Equigranular	Equigranular	Equigranular
Minerals Present	Quartz, Feldspar Biotite, Hornblende	Feldspars, Biotite, Hornblende	Quartz, Feldspars, Hornblende, Biotite	Olivine altering to Serpentine, Chromite, Magnetite
Mode of origin	PAIR	PIIR	PIIR	PUIR
Engineering Uses	a) Granite is one of the most important building stones Specially used for decoration, monumental and Architectural purposes b) Large blocks of granites are used as building	Though Syenite is not so common, yet it can be used instead of granite. b) Presence of Feldspar shows beautiful blue	Used as a building stone	Used for Ornamental purposes

	stone c) Smaller blocks of granites are used as Railway ballast or Road metal.	and green effect which improves its appearance and hence is used for decorative purposes		
Group	Igneous rock	Igneous rock	Igneous rock	Igneous rock

Hypobyssal Igneous Rocks:

Properties	**Pegmatite**	**Porphyries**	**Dolerite**
Colour	Light colour (White, pink. Green)	Light colour	Usually dark Being almost black When fresh

Grain Size	coarse	Medium to coarse	Medium to coarse
Texture	Pegmatitic	Porphyritic	Doleritic

Minerals Present	Feldspars, Quartz, Biotite	Because OfPorphyritic texture It may be Granite porphyry Syenite porphyry Diorite porphyry	Plagioclase. Augite and Hornblende with Some Olivine
Mode of Origin	HAIR	Hypobyssal	Hypobyssal, Basic igneous rock
Engineering Uses	a) The Muscovite mica is used-commercially is obtained from pegmatite	----------	Occurs Chiefly in dykes Used as a Road metal
Group	Igneous rock	Igneous rock	Igneous rock

Volcanic Igneous Rocks:

Properties	Rhyolite	Trachyte	Pumicite	Basalt

Colour	Dirty White with Reddish brown Patches	Dark	Silver Gray when Fresh, Ash grayish White	Dark
Grain Size	Fine	Fine	Fine	Fine
Texture	Vesicular	Trachytic	Vesicular	Vesicular, Amygdaloidal
Minerals present	Same as granite	Same as Syenite	Same as granite	Plagioclase, Augite

Mode of origin	Volcanic Acidic Igneous rock	Volcanic Intermediate Igneous rock	Volcanic Igneous rock	Basic volcanic Igneous rock

Engineering Uses	Used as filler, Abrassive Polisher	--------	Light weight concrete, Tooth powder,	The crushed basalt is used as a road metal

NOTE: PAIR- Plutonic Acidic Igneous Rock.

HIIR - Hypobyssal Intermediate Igneous Rock

PIIR- Plutonic Intermediate Igneous Rock

BVIR- basic volcanic igneous rock

PUIR-Plutonic ultra basic igneous rock

2.11 DESCRIPTION OF SEDIMENTARY ROCKS

Properties	Breccia	Conglomerate	Shale	Sand stone	Lime stone
Color	Light color	Light color (chocolate)	Light (white, pink, black)	Light (red, brown, pink)	Light
Grain size	Rudaceous	Rudaceous	Argillaceous	Arenaceous	Argillaceous
Minerals present	Angular pebbles	Rounded pebbles	Compaction of mud and clay	Quartz, feldspars	Calcite
Cementing material	Siliceous (much quantity	Ferruginous (because red or brown	Siliceous	Siliceous	Siliceous

	quartz)	color)	Ferruginous Calcareous	Ferruginous Calcareous	Ferruginous Calcareous
Mode Of origin	Mechanical	Mechanical	Mechanical	Mechanical	Chemical Organic Fossiliferos Limestone.

Engineering uses.	a) Used As a building stone b) Used for ornamental purposes	Harder and tougher varieties of conglomerates used as foundation, concrete and railway ballast's.	Used for bricks and Tile manufacture.	a) Siliceous and ferruginous sand stone are used as a building stone b) Calcareous sand stones are not used as a building stone	Note – Depending on the colour Of limestone's the varieties are classified as, 1]Siliceous limestone [Rich in quartz] 2]Ferruginous limestone [Red or brown colour. 3]Calcareous limestone [White colour] Limestone is used in cement industry.

2.12 DESCRIPTION OF METAMORPHIC ROCKS

Properties	Slate	Schist	Marble	Gneiss	Quartzite
Color	Bluish black	Dark	White, gray, red, blue, green and yellow	Alternate layers of dark and light	Light
Structure	Slaty	Schistose	Saccharoidal	Gneissose	Granulose

Minerals present	Very fine grained mixture of quartz, chlorite, Seri cite and felds par.	Flaky minerals such as muscovite, Biotite hornblende, chlorite, talc etc. Depending upon the type of flaky mineral present the schist's are described.	Calcite, quartz.	Quartz, felds par, Biotite, hornblende.	Quartz small amount of mica, tourmaline, graphite and iron minerals
Mode of origin	Dynamic metamorphis m Shale (SR) D.M. Slate (MR)	Dynamic metamorphis m Shale (SR) DM Schist (MR)	Thermal metamorphis m Lime stone (SR) TM Marble (MR)	Dynamic metamorphis m Granite (IR) DM Gneiss (MR)	Dynamo thermal metamorphis m Sand stone (SR) DTM Quartzite (MR)
Engineerin g uses	Used for a) Flooring Purposes	Schist being weak rock, are not use d for important works	a) Coarse grained marbles used for historical, monumental and architectural purposes.	Used as a road metal and concrete aggregates	Extensively used as a road metal and concrete aggregates

	b) For Roofing Materials c) Table Tops d) Stair Cases e) Switch Boards f) It is Seldom Used as a building Stone.		b) extensively used as a building stone for the decoration of columns, stair cases, floors etc a) Fine-grained marble used for statues.		

Rocks:
Format:

Q.2 Describe the Geological properties, uses, and group and identify the rock specimens kept in tray no 7 to 12 (6x2) 12 Marks

SL.NO	
Specimen NO	
Colour	Leucocratic-Light colour-Felsic Melanocratic-Mafic-Dark colour
Grain Size	Coarse-Grain size is >5m.mn diameter Medium-Grain size is>mm in diameter Fine-Grain size is < 1m.m. in diameter
Texture/ Structure	Texture is the mutual relationship among the

	minerals present in a roc The terms use are-Equigranular, Porphyritic, Pegmatitic.Ophytic, Trachytic, Vesicular, and Amygdaloidal
Minerals Present	
Name	
Mode of origin	
Engineering Uses	
Group	Igneous Rock

Igneous Rocks
Example:

Q.2 Describe the Geological properties, uses, and group and identify the rock specimens kept in tray no 7to 12 (6x2) 12 Marks

SL.NO	1
Specimen NO	1
Colour	Light-colour with a white or pink tint
Grain Size	Medium to coarse
Minerals Present	Quartz (Q), Feldspar (F) Biotite (B, Hornblende (H)
Name	Granite
Mode of Origin	Acidic plutonic igneous
Engineering Uses	a) Granite is one of the most important building stone Specially used f decoration, monumental and Architectural purposes b) Large blocks of granites are used as building stone c) Smaller blocks of granites are used as Railway ballast or Road metal.
Group	Igneous Rock

EXERCISE:

Q.2 Describe the Geological properties, uses, and group and identify the rock specimens kept in tray no 7 to 12 (6x2) 12 Marks

Format
Date

Sl.no	1	2	3	4
Sp.no				
Colour				
Grain Size				
Texture/ Structure				
Minerals Present				
Name				
Mode of Origin				
Engineering Uses				
Group				

2.15. Sedimentary Rocks

Q.2 Describe the Geological properties, uses, and group and identify the rock

Specimens kept in tray no 7 to 12 (6x2) 12 Marks

Format
Date

SL.NO	1

SP.NO	1
Colour	Leucocratic- Light colour Melanocratic-Dark colour
Grain Size	Rudaceous-Grainsizeis>2m.m.indiameter Arenaceous-Grain size is in Between 1 to 2mm in Diameter 10 Argillaceous less than 1 mm in Diamter 10
Cementing Material	Siliceous (Containing much Quantity of Quartz) Calcareous-White colour Ferruginous-(Red or Brown in colour)
Minerals present	
Name	
Mode of Origin	
Engineering Uses	
Group	

Example:

Date

Sl.no	1
Sp.no	1
Colour	Light colour
Grain Size	Rudaceous
Cementing Material	Siliceous
Minerals Present	Angular pebbles
Name	Breccia
Mode of Origin	Mechanical
Engineering Uses	I) Not used as a Building stone ii) Used for ornament al purposes
Group	Sedimentary Rock

Exercise:

Q.2 Describe the Geological properties, uses, and group and identify the rock specimens kept in tray no 6 to 12 (6x2) 12 Marks

Date

Format

SL.NO	1	2	3	4

SP.NO				
Colour				
Grain Size				
Cementing Material				
Minerals Present				
Name				
Mode of Origin				
Engineering Uses				
Group				

2.16. Metamorphic Rocks

Q.2 Describe the Geological properties, uses, and group and identify the rock specimens kept in tray no 7 to 12 (6x2) 12Marks

Format

Date

SL.NO	
SP.NO	
Colour	Felsic Mafic
Grain Size	Coarse Medium Fine
Texture/ Structure	Slaty structure Gneissose structure Schistose structure Granulose structure Saccharoidal structure
Minerals Present	
Name	
Mode of Origin	Thermal Metamorphism Dynamic Metamorphism Dynamo Thermal Metamorphism
Engineering Uses	
Group	Metamorphic Rock

Example:

Q.2 Describe the Geological properties, uses, and group and identify the rock specimens kept in tray no 7 to 12
(6x2) 12 Marks

Format:

Date:

SL.NO	
SP.NO	
Colour	Alternating layers of Dark and light
Grain Size	Coarse
Texture/ Structure	Gneissose
Minerals Present	Quartz, Feldspar Biotite, Hornblende
Name	Gneiss
Mode of Origin	Dynamo Thermal Metamorphism
Engineering Uses	Used as a road met And concrete aggregates
Group	Metamorphic Rock

EXERCISE-

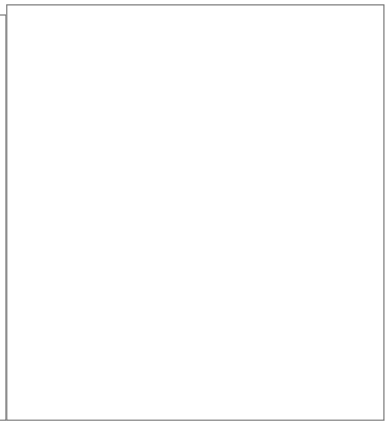
Q.2 Describe the Geological properties, uses, and group and identify the rock specimens kept in tray no 7 to 12
(6x2) 12 Marks

Format:

Date:

Sl.No.	1	2	3	4

SP.NO				
Colour				
Grain Size				
Texture/ Structure				
Minerals Present				
Name				
Mode of Origin				
Engineering Uses				
Group				



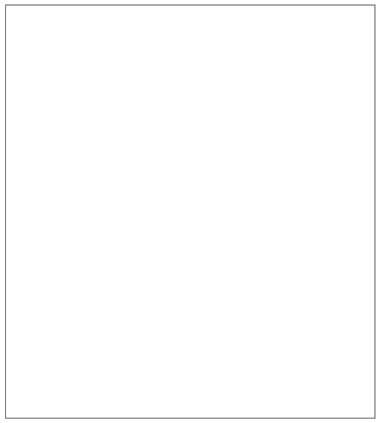


Photo 1

Granite

Photo 2

Granite Porphyry

Photo 3

Varieties of Pegmatites

Photo 4. Varieties of Basalts

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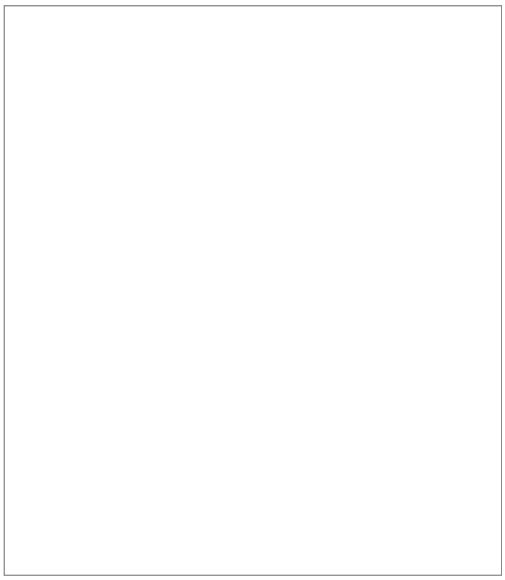


Photo: 2.5 Varieties of sand stones

Photo: 2.6 Quartzite

Experiment 03 : Borehole problems

	Experiment No.:	3	Marks		Date Planned		Date Conducted	
1	Title	Borehole Problems						
2	Course Outcomes	Student should be able to determine subsurface behavior of rocks, their attitude related to foundation, tunnels, reservoirs and mining.						
3	Aim	To determine subsurface behavior of rocks, their attitude (Dip&strike)						
4	Material / Equipment Required	Geometry Box						
5	Application Areas	Subsurface behavior of rocks, their attitude related to foundation, tunnels, reservoirs and mining						
6	Remarks							
7	Faculty Signature with Date							

Borehole Problems

(Horizontal Level Ground)

In order to determine the subsurface geology of an area, boreholes are sunk at convenient places in areas such as cultivated lands, forests deserts, alluvium, etc. The surface is completely covered and the outcrops are very few. Such boreholes reveal the presence of economic deposits of coal, petroleum etc. The subsurface geological formations, rock types and their dip and strike can be determined from such borehole data, Which render very valuable information for plans to exploit the hidden treasures.

Bore holes Sunk on Horizontal Ground

Example: Three boreholes are sunk at 3 points of an equilateral triangle whose sides are 480 m each. Is West of Q and R is North of midpoint PQ. Boreholes and R- reach the upper surface of a rich coal seam at 100m, 220m, and 260m depths respectively.

a) Determine the attitude (Dip and strike) of the coal seam.

b) Another borehole is sunk at S, Midpoint of QR. Determine at what depth the borehole S reaches the coal seam

Procedure: Construct an equilateral triangle with a suitable scale; Show the positions of the boreholes. The coal seam is reached at point P and Q at 100m and 220m. So the coal seam dips from p to Q. To determine the inclination (gradient) along PQ construct trough sketch depth diagram and determine the gradient It is 120m in 480m. So it is 1 in 4. Similarly construct the depth diagram along PR. It is 160m in 480m i.e. 1 in 3.Take convenient scale and mark 4 units (CMS) along P Q and 3 units (CMS) along P R from P. They are A and B. Join AB and extend. It is the true strike direction (TSD).

Draw a perpendicular to AB from P. It cuts AB at C. Measure PC. it is 2.85 CMS i.e. the gradient is 1 in 2.85. It is true dip.

To determine the direction of true dip, measures the angle CPQ=45^0 .So direction of true dip is the complementary angle from North direction. So (90^0-45^0) 45^0 . So it is N 45^0 E or NE.

True dip 1 In 2.85 along NE.
Strike = SE and NW.

To determine the depth at which the borehole S reaches the coal seam, Join PS it intersects AB line (true strike direction) at T. Measure PT with units selected it is 3 CMS. So the gradient along PT is 1IN 3. Measure PS it is 4.2cms =420m.

Depth Horizontal distance PS X Gradient + Depth of borehole at P
= 420 X 1/3 + 100
=140 + 100 =2
To check whether this calculation is correct or not, let us find out the gradient of coal seam along QR.
Draw depth diagram.
The Gradient is 1 in 12 from Q QS is 240m.

2) Three boreholes are sunk at SW, SE, and NW Cornersof Square level ground The Sides of the Square is 150m long. The boreholes are X, Y, Z respectively. The boreholes meet the Coal seam at 15m,in X, 45m in Y, and 60m in Z.
a) Determine the attitude of the coal seam.
b) Fourth borehole is proposed at P, the NE Corner of the square land. Calculate at what depth, the borehole encounters the coal seam.
True depth = 1 in 2.55 along North 30^0E
Strike = N60^0W and S60^0E

Depth of unknown point P = Horizontal distance X Gradient + depth of borehole at

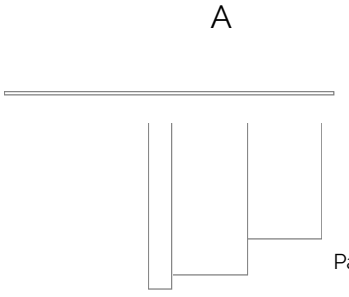
Minimum depth

= 216 X 1/ 2.7 + 15

= 80 + 15 = 95m

Experiment 04 : DIP AND STRIKE PROBLEMS

Dip: It is the angle of inclination of a rock bed with the horizontal plane.



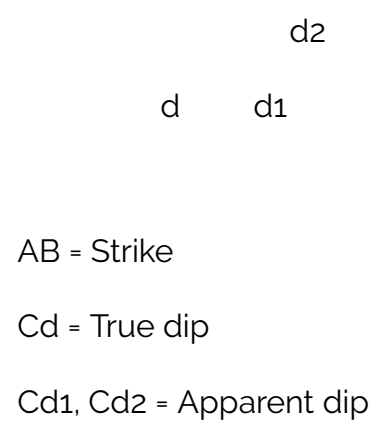


Fig.3.1 Showing Dip and Strike

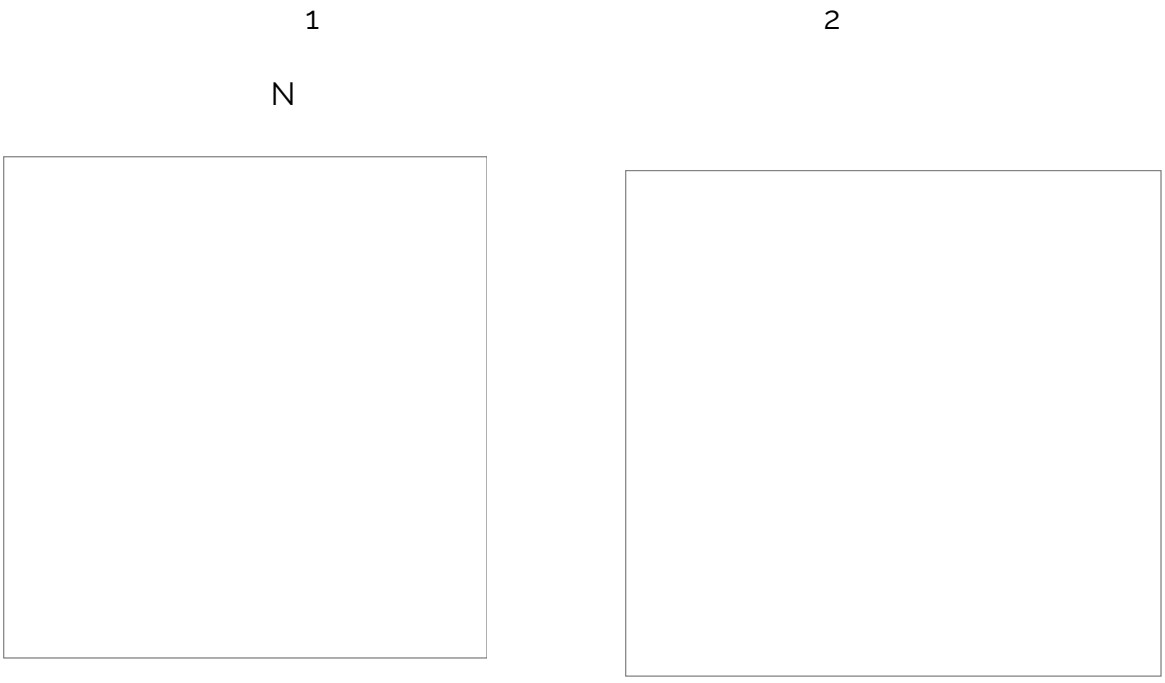
True dip: It is measured at right angles to the strike.
Apparent dip: If the angle is measured in any other direction as along Cd1, or Cd2 in the figure, it will have a value less than true dip. Such partial dip angles are called "Apparent dips".

STRIKE: It is the direction of a line formed by the direction of the plane of a bed the horizontal plane.
The strike is always at right angles to the true dip.

Task_: Dip and Strike Problems		
1.Method Determination of True Dip Direction [TDD] and True Dip Amount [TDA] ADA = ADD= ADA= ADD=	II Method Determination of Apparent dip Amount [A.D.A] TDA= TDD= ADA=? ADD=	III Method Determination Of ApparentDipDirection [ADD] TDA = TDD= ADA = A DD=?

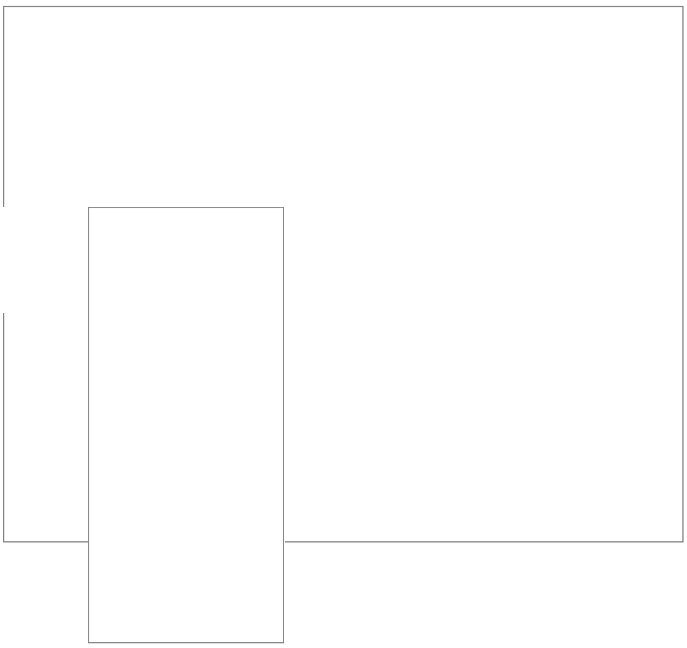
TDD=? TDA=?		

Fig.3.2



S S

3



W E

S

DUE NORTH = North is the direction. Similarly Duesouth.Due east. Due west.

1.METHOD: Determination of True Dip Direction [TDD] And True Dip Amount

Problem: A bed of sandstone dips at an angle of 30^0 in a direction of S30^0E and 30^0 along S15^0W. Find the amount of true dip.

Fig.3.3

Procedure:

1 Draw a Circle by convenient radius and mark N.S.E.W.directions with O as centre.

2 Draw the line OP=S30°E & OR=S15°W.

3 Draw a perpendicular line Op frompfrom point O, which cuts the circle at Q. Now at Q draw a complementary angle [90° - 30°=60°] that cuts the line OP at point P Join PQ.

4 Similarly draw a perpendicular to the line OR from point O, which cuts the circle atS.draw a complementary angle [90° - 30° =60°], which cuts the line, OR at point R. Join RS.

5 Now join the points P and R, which is the strike direction.

6 For finding amount of true dip draw a perpendicular from to the linePR which meets the line PR at A join OA.Draw a perpendicular to the line OA from point O, which cuts the circle at B. Join AB. Now angle OAB will give the amount of true dip. And OA is the direction of true dip.

Result-True Dip Amount (TDA)= 30^0
True Dip Direction (TDD) = $S8^0E$

Exercise

1) The apparent dip of a coal bed is 30^0in a direction of S 30^0E and in a direction of S 58^0W with an apparent dip of 45^0.Find the direction and amount of true dip.
Result - TDA= OAB=49^0-
TDD= OA= $S8^0E$
2) A Limestone bed dips 30^0 along $S25^0E$ and dips 33^0 along $N85^0E$. Determine its true Dip.
Result- TDA=OAB=36^0
TDD=OA=$N8^0E$
3) In a dam site a bed of limestone dips 25^0 along NW and 20^0 along NEE Determine its true dip.
Result- TDA= OAB=36^0
TDD=OA=$N6^0E$
4) A Coal bed dips 30^0 along $S30^0W$ And 38^0 along $N60^0W$. Determine its True dip.
Result-- TDA=OAB=42^0
TDD=OA=$S85^0W$
5) At a Dam site a bed of Quartzite dips 28^0 along $N20^0E$ And 34^0 alongS80^0E. Determine its true dip.
Result-- TDA=OAB=38^0
TDD=OA=$N68^0E$

11 Method: Determination of Apparent Dip Amount [ADA]

PROBLEM—Coal seam dips 35^0along $S40^0W$. Determine the amount of apparent dip in the direction of S 75^0W.

TD.A= 35^0 T.DD=S40 ^{0}W
ADA=? ADD=$S75^0W$

N

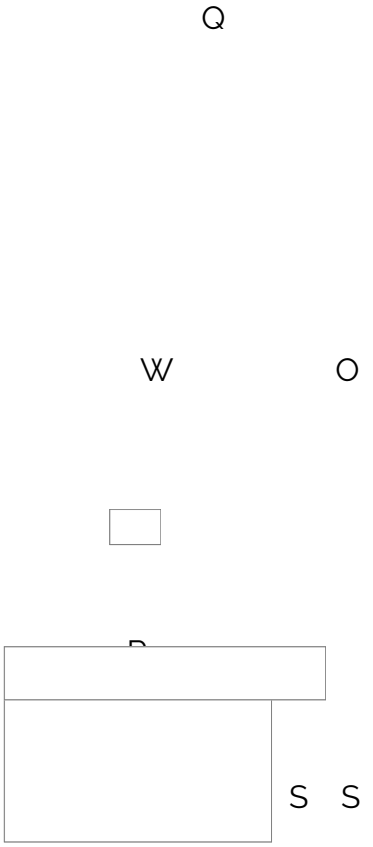


Fig. 3.4

Procedure

1 Draw a circle by convenient radius and mark N.S.E.W. directions with Oas centre.

2 Draw a line OP=S40^0 W Draw a perpendicular to the line OP from point O which cuts the circle at Q .Now at Q D raw a complementary angle 90^0 - 35^0=55^0 which cuts the line OP at point P. Join PQ.

3 From the intersection point P draw a parallel line to the line OQ that is the strike line.

4 Let a line equal to S 75^0 W.which cuts the strike line at point R. join OR – 0R Line.

5 Draw a perpendicular to the line OR from point O, which cuts the circle at S. Join R and S. Measure angle ORS, which is the amount of apparent dip.

Note: ORS should be less than the true dip.

Amount given in the problem.

Result: ADA alongN70^{0}W =ORS=30^0

-	**Experiment No.:**	4	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Dip and Strike problems.						
2	Course Outcomes	Student should be able to determine attitude of rocks in Civil Engineering projects (Railway lines, tunnels, dams, reservoirs).						
3	Aim	To determine attitude of rocks (Dip&strike)						
4	Material / Equipment Required	Geometry box						
5	Application Areas	Railway lines, tunnels, dams, reservoirs.						
6	Remarks							
7	Faculty Signature with Date							

Experiment 05: **Thickness problems**

-	**Experiment No.:**	5	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Thickness problems.						
2	Course Outcomes	Student should be able to determine thickness of rocks/strata in Civil Engineering projects (Railway lines, tunnels, dams, reservoirs).						
3	Aim	To determine thickness of rocks/strata/shale/minerals.						
4	Material / Equipment Required	Geometry box						
5	Application Areas	Railway lines, tunnels, dams, reservoirs.						
6	Remarks							
7	Faculty Signature with Date							

-	**Experiment No.:**	6	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Morphometric Analysis						
2	Course Outcomes	Student should be able to interpret toposheets and learn to extract Drainage Basin and Morphometric Analysis.						
3	Aim	To interpret toposheets and learn to extract Drainage Basin and Morphometric Analysis						
4	Material / Equipment Required	Toposheets, Tracing sheets						
5	Application Areas	Interpretation of toposheets and Morphometric Analysis which helps in reservoir and check dam planning						
6	Remarks							
7	Faculty Signature with Date							

Experiment 07 : Geological maps

-	**Experiment No.:**	7	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Geological maps						
2	Course Outcomes	Student should be able to interpret geological maps related to Civil Engineering Projects.						
3	Aim	Interpretation of geological maps and identifying geological structures which helps in Civil Engineering Projects.						
4	Material / Equipment Required	Geological Maps, Tracing sheets, graph sheets						
5	Application Areas	Identifying geological structures which helps in Civil Engineering Projects.						
6	Remarks							
7	Faculty Signature with Date							

Experiment 08: Satellite images

-	**Experiment No.:**	8	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Satellite Images.						
2	Course Outcomes	Student should be able to interpret satellite Images viz, land use/land covers, water bodies, forest, etc.						
3	Aim	Interpretation of satellite Images.						
4	Material / Equipment Required	satellite Images and tracingsheets.						
5	Application Areas	Through satellite Images one can extract land use/land covers, water bodies, forest, etc. maps.						
6	Remarks							
7	Faculty Signature with Date							

Experiment 09: Field Work

-	**Experiment No.:**	9	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Field work						
2	Course Outcomes	Student should be able to identify minerals, rocks, geological structures and their engineering importance.						
	Aim	Field work						
4	Material / Equipment Required	Haversack, Pick hammer, toposheets, GPS, etc.						
5	Application Areas	Students will master in identification of minerals, rocks, geological structures and their engineering importance.						
6	Remarks							
7	Faculty Signature with Date							

F. Content to Experiment Outcomes

1. TLPA Parameters

Table 1: TLPA – Example Course

Expt-#	Course Content or Syllabus (Split module content into 2 parts which have similar concepts)	Content Teaching Hours	Blooms' Learning Levels for Content	Final Blooms' Level	Identified Action Verbs for Learning	Instruction Methods for Learning	Assessment Methods to Measure Learning
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
1	Identification of minerals as mentioned in theory, their properties, uses and manufacturing of construction materials.	08	- L2 - L3	L3	Identification of Minerals-	- Lecture - demonstration -	- CIA - Assignment
2	Identification of rocks as mentioned in theory, their engineering properties and uses in construction and decorative purposes	08	- L2 - L3	L3	Identification of Rocks	- Lecture - demonstration -	-CIA Assignment - Assignment -
3	Borehole problems: Determination of subsurface behavior of rocks, their attitude related to foundation, tunnels, reservoirs and mining. Triangular and Square methods. (2	04	- L2 - L3 - L4	L4	Determining strata	- Lecture - demonstration	-CIA Assignment - Assignment

	methods)						
4	Dip and Strike problems. Determine Apparent dip and True dip. (2 methods)	04	- L2 - L3 - L4	L4	Determining Dip&strike	- Lecture - demonstration	- CIA - Assignment
5	Calculation of Vertical, True thickness and width of the outcrops. (3 methods)	04	- L2 - L3 - L4	L4	Determining Thickness	- Lecture - demonstration	- CIA - Assignment
6	Study of Toposheets and Interpretation, Extraction of Drainage Basin and its Morphometric Analysis. (3Toposheets)	04	- L2 - L3 - L4 -L5	L5	- Interpreting -	- Lecture - demonstration -	-CIA Assignment - -
7	Interpretation and drawing of sections for geological maps showing tilted beds, faults, unconformities etc. (10 Maps)	08	- L2 - L3 - L4 -L5	L5	- Interpreting -	- Lecture - Tutorial -	-CIA Assignment - -
8	Interpretation of Satellite Images. (2 Satellite images)	04	- L2 - L3 - L4 -L5	L5	- Interpreting -	- Lecture - demonstration	-CIA Assignment - -
9	Field work– To identify Minerals, Rocks, Geomorphology and Structural features with related to the Civil Engineering projects	24	- L2 - L3 - L4 -L5 -L6	L6	-Field knowledge -	- Lecture - demonstration -Field Visit	-CIA Assignment - -

2. Concepts and Outcomes:

Table 2: Concept to Outcome – Example Course

Expt - #	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or outcome)	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome **Student Should be able to ...**
A	*I*	*J*	*K*	*L*	*M*	*N*
1	-Physical properties of minerals -	Minerals	Minerals	Engineering properties of minerals	- Understand - Apply knowledge of minerals -	know the engineering properties of minerals and their engineering uses.
2	- Engineering Properties of	Rocks	Rocks	Engineering properties of rocks	- Understand - Apply knowledge of	know engineering properties of

	Rocks				rocks	rocks and their engineering uses.
3	Borehole problems	Subsurface condition	Subsurface condition	subsurface behavior of rocks	- Analyze - the problem	Determine subsurface behavior of rocks, their attitude related to foundation, tunnels, reservoirs and mining.
4	Dip and Strike problems	Attitude of beds	Attitude of beds	Attitude of rocks in Civil Engineering projects	Analyze - the problem	Determine attitude of rocks in Civil Engineering projects (Railway lines, tunnels, dams, reservoirs).
5	Thickness of strata	Thickness	Thickness	Vertical, true thickness and width of the outcrops	- Analyze - the problem	Determine/calculate vertical, true thickness and width of the outcrops.
6	Study of Toposheets and Interpretation	Toposheets	Toposheets	Extract Drainage Basin and Morphometric Analysis	- Evaluate/extract - River basin -	Interpret toposheets and learn to extract Drainage Basin and Morphometric Analysis.
7	Interpretation and drawing of sections for geological maps	Geological maps	Geological maps	Geological structures viz, faults, folds, joints, etc.	- Evaluate/extract structural features - -	Interpret geological maps related to Civil Engineering Projects
8	Interpretation of Satellite Images	Satellite Images	Satellite Images	Interpretation of satellite Images	- Evaluate/extract different layers	To interpret satellite Images.
9	Field work	Field work	Field work	Minerals, Rocks, Geomorphology and Structural features	- Locate and Create Geological map	To identify Minerals, Rocks, Geomorphology and Structural features with related to the Civil Engineering projects.