

Program Name : Diploma in Mining and Mine Surveying / Diploma in Mine Engineering / Mining Engineering

Program Code : MN / MS / MZ

Year : First

Course Title : Elements of Mining Geology

Course Code : 22108

1. RATIONALE

The student of first year of Mining and Mine surveying must know basics of geology. The knowledge of Origin of Earth, Mineralogy, and Petrology including Coal Geology is included in this course. This course will help the students to identify different types of rocks, minerals and nature of strata. The student can also identify geological features like fault and fold and prepare the geological maps of the area. This geological information will help mining engineer to choose appropriate method of working. The course will also provide useful information for the ground control in underground mines and slope stability in opencast mines.

2. COMPETENCY

Aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Apply basic principles of geology to solve geological problems in mines.

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

- Identify aspects of the earth.
- Identify physical and chemical properties of minerals.
- Interpret Physical Geology.
- Identify various types of rocks.
- Interpret features of Structural Geology.
- Identify physical and chemical properties of coal.

1. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | |
|-----------------|-----|-----|----------------|--------------------|-----|-----|-----|-----|-------|-----------|-----|-----|-----|-----|-------|----|
| L | T | P | | Theory | | | | | | Practical | | | | | | |
| | | | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| Max | Min | Max | Min | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | | |
| 3 | -- | 2 | 5 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25# | 10 | 25 | 10 | 50 | 20 |

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs. (#): external assessment



Legends: *L*-Lecture; *T* – Tutorial Teacher Guided Theory Practice; *P* -Practical; *C*- Credit, *EYE* –End Year Examination; *PA* - Progressive Assessment. #External Assessment

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

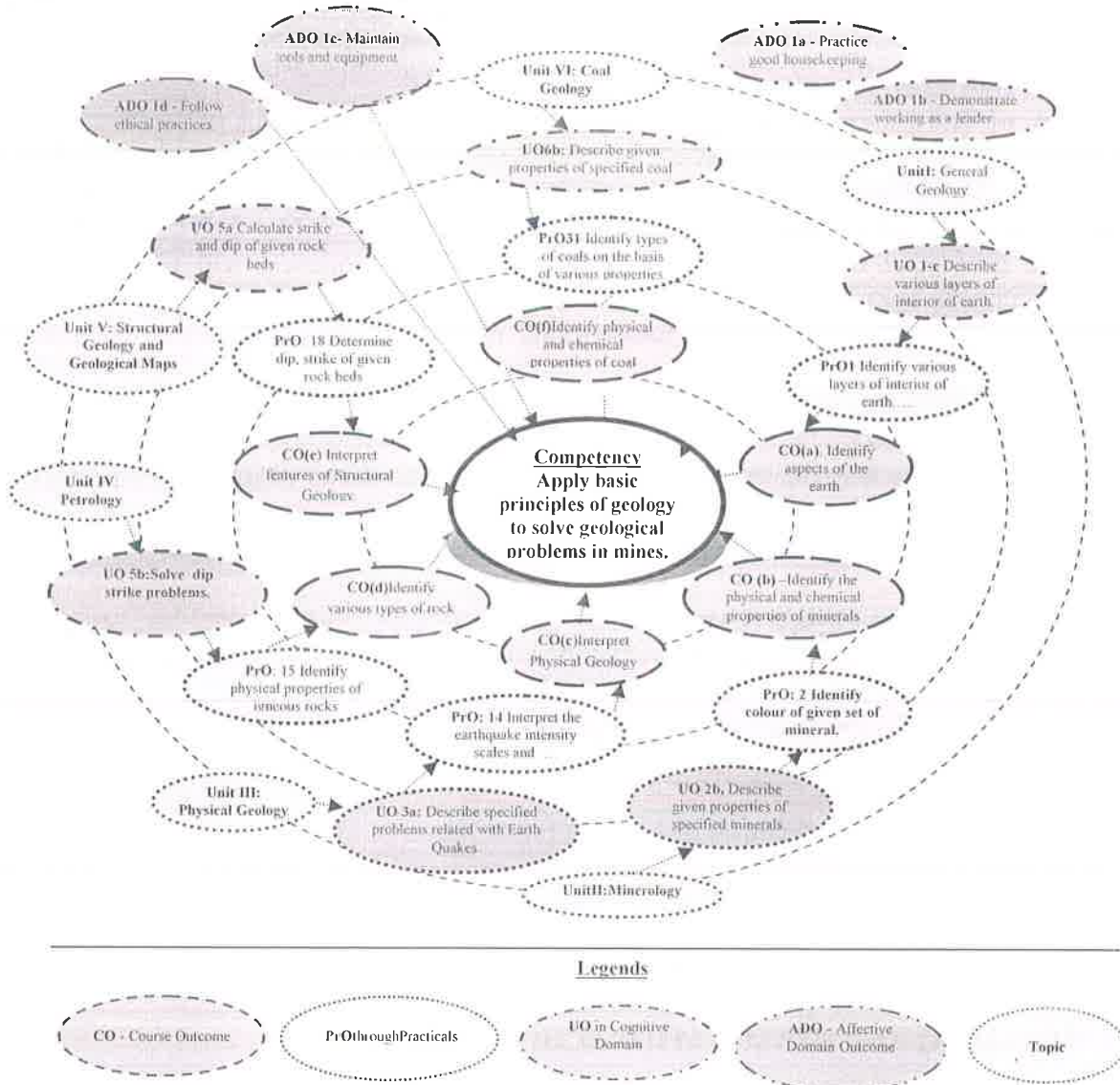


Figure 1 - Course Map

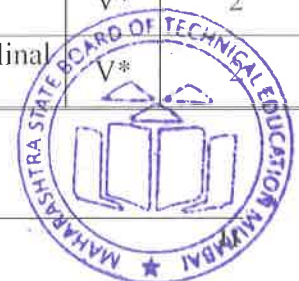
6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|--------|---------------------------|----------|-----------------------|
| | | | |



| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|--------|---|----------|-----------------------|
| 1. | Identify various layers of interior of earth, continental drift, and isostasy. | I* | 2 |
| 2. | Identify colour of given set of minerals. | II | 2 |
| 3. | Identify streak of minerals with the use of streak plate. | II* | 2 |
| 4. | Identify crystalline and non-crystalline forms of given set of minerals. | II* | 2 |
| 5. | Calculate Mohs scale of hardness of given specimen. | II* | 2 |
| 6. | Identify luster's of metallic and nonmetallic minerals. | II* | 2 |
| 7. | Identify Various types of fractures of minerals. | II | 2 |
| 8. | Identify Various types of cleavages. | II | 2 |
| 9. | Identify physical properties of Quartz Group minerals. Rock crystal, Amethyst, smoky, milky, rosy Quartz, Chalcedony, Agate, Flint, and Chart. | II* | 2 |
| 10. | Identify physical properties of Feldspar Group and Amphibole group minerals. Feldspar Group: Orthoclase, Microcline, Albite, and Plagioclase Amphibole Group: Hornblende, Actinolite, and Tremolite | II* | 2 |
| 11. | Identify physical properties of Pyroxene and Mica group minerals. Pyroxene group: Hypersthene, Enstatite, Augite, and Diopside Mica group: Muscovite, Biotite, and Phlogopite | II* | 2 |
| 12. | Identify physical properties of Miscellaneous Silicates Group minerals Olivine, Garnet, chlorite, Clay, Talc, Kyanite, Asbestos, Silliminate, Beryl, Tourmaline, and Topaz. | II* | 2 |
| 13. | Identify physical properties of Non Silicate Group minerals Calcite, Dolomite, Aragonite, Gypsum, Fluorite, Apatite, Graphite, Magnesite, Corundum, and Baryte. | II* | 2 |
| 14. | Interpret the earthquake intensity scales and volcanic eruptions. | III* | 2 |
| 15. | Identify physical properties of igneous rocks. Granite, Syenite, Diorite, Gabbro, Lamprophyre, Peridotite, Rhyolite, Trachyte, Andesite, Dolerite, Basalt, and Pegmatite. | IV* | 2 |
| 16. | Identify physical properties of sedimentary rocks. Sand Stone, Breccia, Conglomerate, Shale, Limestone, Coal, Chalk, Marl, Dolomite, Laterite, and Quartzite. | IV* | 2 |
| 17. | Identify physical properties of metamorphic rocks. Slate, Schist, Gneiss, Augen Gneiss, Quartzite, Marbles and Hornfelse. | IV* | 2 |
| 18. | Determine the Dip, Strike of given rock beds. | V | 2 |
| 19. | Draw and Interpret topography on the basis of contour map. | V* | 2 |
| 20. | Draw a geological section of horizontal beds. | V* | 2 |
| 21. | Draw a geological section of inclined beds by calculating strike and dip from contour lines. | V* | 2 |
| 22. | Draw a geological section of symmetrical anticlinal and synclinal folds by calculating strike and dip from contour lines. | V* | 2 |
| 23. | Draw a geological section of symmetrical anticlinal and synclinal folds when only angle of dip is given. | V* | 2 |



| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|--------|---|----------|-----------------------|
| 24. | Draw a geological section of beds having normal fault by calculating strike and dip from contour lines. | V* | 2 |
| 25. | Draw a geological section of beds having reverse fault by calculating strike and dip from contour lines. | V | 2 |
| 26. | Draw a geological section of beds having vertical fault by calculating strike and dip from contour lines. | V* | 2 |
| 27. | Draw a geological section of beds having inclined fault by calculating strike and dip from contour lines. | V* | 2 |
| 28. | Draw a geological section of beds having unconformable series of bed. | V* | 2 |
| 29. | Draw a geological section of beds having vertical fault and dykes and sills by calculating strike and dip from contour lines. | V | 2 |
| 30. | Draw a geological section of beds having double vertical faults. | V | 2 |
| 31. | Identify types of coals on the basis of various properties. | VI* | 2 |
| 32. | Determine proximate and ultimate analysis of given type of coal. | VI | 2 |

Note

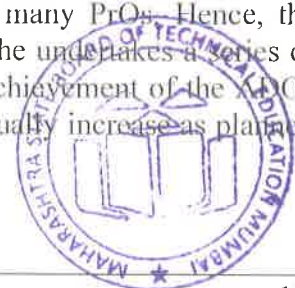
- A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 24 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

| S. No. | Performance Indicators | Weightage in % |
|--------------|---|----------------|
| 1 | Identification | 20 |
| 2 | Handling of Sample/Neatness | 20 |
| 3 | Observations and Recording | 20 |
| 4 | Interpretation of result and Conclusion | 20 |
| 5 | Answer to sample questions | 10 |
| 6 | Submission of report in time | 10 |
| Total | | 100 |

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- Practice good housekeeping.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:



- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year and
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

| S. No. | Equipment Name with Broad Specifications | PrO.No. |
|--------|---|---------|
| 1 | Charts showing interior of earth, wooden model of earth. | 1 |
| 2 | Kit of various colour of mineral (magnifying lense,) | 2 |
| 3 | Kit of Streak of minerals (magnifying lense, penknife and streak plates) | 3 |
| 4 | Kit of Forms of minerals (magnifying lense, penknife) | 4 |
| 5 | Mohs scale of hardness (magnifying lense, penknife ,glass plate) | 5 |
| 6 | Kit of of lusters of minerals (magnifying lense, penknife and streak plates) | 6 |
| 7 | Kit of fractures set (magnifying lense, penknife and streak plates) | 7 |
| 8 | Kit of cleavage set (magnifying lense, penknife and streak plates) | 8 |
| 9 | Hand specimens of 30 silicate and 15 non silicate group (magnifying lense, penknife and streak plates) <ul style="list-style-type: none"> • Silicate Minerals: Rock crystal ,Amethyst, smoky, milky, rosy Quartz, Chalcedony, Agate, Flint, Chert, Orthoclase, Microcline, Albite, Plagioclase Feldspar, Hornblende, Actinolite , Tremolite Hypersthene, Enstatite, Augite, Diopside. Nepheline ,Leucite,Sodalite, Muscovite, Biotite, Phlogopite Olivine, Garnet, chlorite, Clay, Talc, Kyanite, Asbestos, Silliminate, Beryl, Tourmaline, Topaz • Non silicates Minerals: Calcite, Dolomite, Aragonite ,Gypsum, Fluorite ,Apatite, Graphite, Magnesite, Corundum, Baryte. | 9 to 13 |
| 9 | Hand specimens of 10 igneous rocks. (magnifying lense, penknife and streak plates)Granite, Syenite Diorite, Gabbro, Lamprophyre, Peridotite, Rhyolite, Trachyte, Andesite, Dolerite, Basalt, Pegmatite. | 15 |
| 10 | Hand specimens of 10 sedimentary rocks (magnifying lense, penknife and streak plates)White, grey, Yellow, Red, Brown Sand Stone, Breccia, Conglomerate, Shale, Limestone, Coal, Chalk, Marl, Dolomite Laterite, Quartzite | 16 |
| 11 | Hand specimens of 10 metamorphic rocks(magnifying lense, penknife and streak plates) Slate, Phyllite. Schists-Talc, Chlorite, Mica, Hornblende schists, Gneiss, Augen Gneiss, Quartzite, various types of Marbles such as White, Yellow, Green, Rosy, etc. Hornfelse | 17 |
| 12 | Clinometer compass, brunton compass, geologists hammer, jollys spring balance, wooden models of various folds, faults, unconformity and other structures to demonstrate various structural features of earth. | |



| S. No. | Equipment Name with Broad Specifications | PrO.No. |
|--------|---|----------|
| 13 | Various geological section maps: set squares, roller scale, and protractor. | 20 to 30 |
| 14 | Topo sheets of survey of India and contour maps. | 19 |
| 15 | Various types of coal specimen | 31 |

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|--|--|
| Unit – I General Geology | 1a. Describe given branches of geology. 1b. Describe given theories of origin and age of earth. 1c. Describe various layers of interior of earth. 1d. Describe specified tectonic forces acting on earth. 1e. Describe given theories of isostasy. | 1.1 Branches, sub branches, allied branches of geology and scope of geology. 1.2 Origin of earth, Age of earth 1.3 Interior of earth 1.4 Continental drift 1.5 Isostasy |
| Unit – II Mineralogy. | 2a. Describe given type of minerals. 2b. Describe given properties of specified minerals 2c. Identify various crystal systems on given basis of elements of symmetry. | 2.1 Definition and classification of mineral. 2.2 Physical and chemical properties of minerals 2.3 Elements Of Crystallography Introductory Lesson On Various Crystal Systems, Cubic, hexagonal, orthorhombic, tetragonal, Monoclinic and Triclinic crystal system. |
| Unit- III Physical Geology | 3a. Describe given erosion and weathering process. 3b. Describe specified problems related with Earth Quakes. 3c. Describe given problems related with volcanos. | 3.1 Erosion and weathering, River and Wind Erosion 3.2 Terminology used in Earthquake, Classification, Intensity scale, origin, effects of earthquake, Earthquake Resistant structures, Earthquake zones. 3.3 Volcano and its Terminology, Classification, products of volcano, volcanic structures. Distribution of volcanos. |
| Unit– IV Petrology | 4a. Describe given characteristics of specified rocks. 4b. Describe given types of rocks. 4c. Describe classification of given rock. | 4.1 Rock cycle and characteristics of various rocks types. 4.2 Igneous rocks: Origin, classification, Structures and Occurrence & uses |

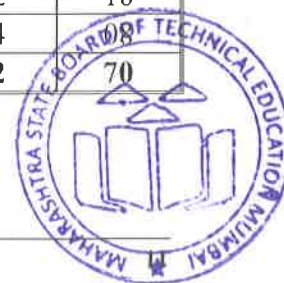


| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| | 4d. Describe structures of specified rocks. | 4.3 Sedimentary rocks: Origin and Classification, Structures, Occurrence and uses. 4.4 Metamorphic rocks: Origin and classification. Structures, Occurrence and uses |
| Unit– V Structural Geology and Geological Maps | 5a. Calculate strike and dip of given rock beds. 5b. Recognize given type of folds, faults and unconformity in the field. 5c. Identify given joints and cleavages. 5d. Draw and interpret given geological section map. 5e. Describe given characteristics of contour lines. 5f. Interpret given topography on the basis of contour lines. | 5.1 Strike and dip, apparent dip, True dip, Calculation of dip and strike on apparent and true dip. 5.2 Classification of folds and its recognition in field, Classification of faults and its recognition in field, Classification and recognition of unconformity in the fields. 5.3 Joints and cleavages, Outlier and inlier. 5.4 Procedure of drawing geological section maps, Description of geological maps 5.5 Characteristics of contour lines. |
| Unit– VI Coal Geology | 6a. Describe given type of coal. 6b. Describe given properties of specified coal. 6c. Describe structures of specified coal seam 6d. Describe given ranks of coal. | 6.1 Commercial classification of coal, Origin, occurrence and distribution of coal seam. 6.2 Physical and chemical properties of various types of coal. 6.3 Rank of coal, Banded constituents of Coal, Structural features of coal seam. |

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|----------|--|----------------|------------------------------|-----------|-----------|-------------|
| | | | R Level | U Level | A Level | Total Marks |
| I | General Geology | 10 | 02 | 02 | 04 | 08 |
| II | Mineralogy | 18 | 02 | 06 | 04 | 12 |
| III | Physical Geology | 12 | 02 | 04 | 04 | 10 |
| IV | Petrology | 18 | 04 | 06 | 04 | 14 |
| V | Structural Geology and Geological Maps | 22 | 02 | 04 | 12 | 18 |
| VI | Coal Geology | 16 | 02 | 02 | 04 | 14 |
| | Total | 96 | 14 | 24 | 32 | 70 |



Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- a. Collection of various samples related to topics.
- b. Library survey regarding any relevant topics.
- c. Power point presentation or animation regarding geology.
- d. Seminar on any relevant topic.
- e. Working model on any relevant topic.
- f. Group discussion on any relevant topic.
- g. Organization of awareness camp on any relevant topic on environmental aspect.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a. Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- b. '**L**' in *item No. 4* does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c. About **15-20% of the topics/sub-topics** which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- e. Guide student(s) in undertaking micro-projects.
- f. Show video demonstration on safety precautions while working in mining deptt.
- g. Demonstrate the actions and care to be taken in case of mine accidents.
- h. Arrange a visit to Geological Survey of India labs.
- i. Arrange expert lecture of industry person in the area mining geology.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed**

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to



maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- a. **General Geology:** Prepare chart showing our solar system. Prepare a chart of various department visited science centre and submit report.
- b. **Mineralogy:** Collect photographs and samples of minerals by visiting camp and prepare report. Prepare a table of Moh's scale of hardness. Prepare models in the form of geometrical figures and solids of any crystal models.
- c. **Physical Geology:** Visit to nearby earthquake recording station and submit the record of seismogram and its working. Prepare charts of earthquake intensity scale, classification of rock, classification of minerals. Prepare models representing erosional features of river and wind.
- d. **Petrology:** Prepare chart showing actual and corresponding schematic diagram of various type of rocks.
- e. **Structural Geology and Geological Maps:** Visit to remote sensing station. Collect satellite imaginaries of the earth. Prepare report on field visit to dominant site. Prepare wooden models of fold faults and unconformity.
- f. **Coal Geology:** Visit to nearby coal mine and collect the coal samples and prepare report.

13. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Book | Author | Publication |
|--------|-----------------------------------|---------------|--|
| 1 | Principles of Engineering Geology | Bangar K.M. | Standard Publishers Distributors Delhi, 2013, ISBN-13: 978-8180141157. |
| 2 | Engineering and General Geology | Parbeen Singh | S.K. Kataria and Sons, 2013, ISBN-13: 978-9350142677 |

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. www.geology.com
- b. www.discovery.com
- c. www.geologyshop.com
- d. <https://www.youtube.com/watch?v=hmgR4PiGp1E>
- e. <https://www.youtube.com/watch?v=lZnJ4iyBKN8>



