

**GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)****Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**  
Semester-V**Course Title: Mine Sampling, Assaying and Mineral Dressing**  
(Course Code: 4352201)

<b>Diploma programme in which this course is offered</b>	<b>Semester in which offered</b>
Mining Engineering	5 <sup>th</sup> Semester

**1. RATIONALE**

To predict the economic valuation of any mineral deposit, it is very much important to know the grade value of the mineralization of whole mine area, which is varying in nature from one point to another, for this purpose a huge number of sampling work is required in mining projects. A sound knowledge of grade variation will solve the continuing associated problems of mine evaluation, planning, operations and production scheduling.

A high degree of expertise in all aspects of this subject is essential requirement for professional success of a diploma mining engineering in any mining industry. Similarly its also become important to aware the students about the advent of new technology in mineral dressing and beneficiation processes.

The mining engineers are responsible for locating mineral rich area by exploration sampling, by calculation of grade values, ore reserves estimation, and concentration of mineral applying various ore beneficiation techniques. This course will improve the required skills of students to achieve the targeted outcome of the course.

**2. COMPETENCY**

The course should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency: -

- **Select true representative mineral sample for valuation purpose.**
- **Select suitable machine and procedure for mineral dressing.**
- **Achieve required grade of mineral by concentration techniques.**

**3. COURSE OUTCOMES (COs)**

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

**CO1:** Select suitable method of sampling with all safety and limitations.

**CO2:** Estimate ore reserve with its grade value for mine valuation.

**CO3:** Select suitable size reduction process and machine as per the need.

**CO4:** Adopt suitable mineral dressing process to improve concentration of mineral.

**CO5:** Design a flow sheet of coal beneficiation process.

### 3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/3+P/0)	Examination Scheme				
L	T	P		Theory Marks		Practical Marks		Total Marks
			C	ESE	CA	ESE	CA	
3	0	2	4	70	30	25	25	150

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

**Legends:** L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, CA - Continuous Assessment; ESE - End Semester Examination.

### 5. SUGGESTED PRACTICAL EXERCISE

The following practical outcomes (PrOs) are the sub-components of the COs. Some of the PrOs marked '\*' are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Prepare a specimen representative sample from run off mine material applying reduction techniques,	I	4
2	Reduce size of given rock sample by Jaw crusher and find reduction ratio of crushing.	III	4
3	Perform ball mill grinding on various rock samples and plot a graph showing effects of grinding with time.	III	6
4	Perform size liberation operation of given rock sample by various screen and plot a graph between screen size and input, output.	IV	6
5	Concentration of given sample of mineral by Jigging operation and analyze the result.	IV	4
6	Separate magnetic mineral by magnetic separation method and study effect of magnetic field on efficiency of the process.	IV	4

#### Note

- More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
For PrOs 1 to 6		

1	Calculation of quantities.	40
2	Preparing observation sheet.	30
3	Initiative of work allotted.	10
4	Answer the question related to exercises.	10
5	Timely completion and submission of given work.	10
<b>Total</b>		<b>100</b>

## 6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipments with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	Pr.No.
1	<b>Jaw crusher</b> – Specifications: a. Product size in mm – 0 to 30 b. Input size in mm – 50 c. Crushing capacity (t/h) – 0.5 to 400 d. Speed in rpm - 200 e. Product size in mm – 0 to 30 f. Jaw gap adjustment in mm - 2 to 6 g. Power – 35 kW h. Feed opening width – 800 mm i. Feed opening depth - 510 mm	II
2	<b>Ball mill</b> – Specifications: a. Final Fineness, micrometre – 1 b. No. of Grinding Stations – 1 c. Milling time setting - 5 Sec - 99 min d. Feed Size, max - < 8 mm e. Frequency Range – 30 Hertz f. Suitable Grinding Jars of Volume – 2x50 ml g. Batch/Sample Volume – 20 ml h. Milling time setting – 5 sec – 99 min	III
3	<b>Weighting Machine</b> – Specifications: a. Digital weighting machine/scale, b. Weighting capacity – Up to 5 kg	I, II, III & IV
4	<b>Vibrating screen</b> – Specifications: a. Capacity – 10 – 80 T/H b. Voltage – 380 V c. Transmission structure – Electromagnetic shaking d. Power – 11 to 40 kW	IV
5	<b>Jigging machines</b> – Specifications: a. Stroke – 1 mm b. Times of stroke – 8.5 to 12 r/min	V

S. No.	Equipment Name with Broad Specifications	Pr.No.
	c. Feed size – 8- to 180 mm d. Capacity - < 6 t/h e. Feedwater flow control – 2 to 4 m <sup>3</sup> / h f. Power – 0.05 kW	
6	<b>Magnetic separator</b> – Specifications: a. Drum size: Ø 300 – 400 mm b. Drum width: 200 to 350 mm c. Rotating speed: 5 to 30 RPM d. Capacity: up to 70tph e. Frequency: up to 50 Hz f. Concentrated deep magnetic field g. Adjustable magnetic strength	VI
7	<b>Various size sieves</b> – Specifications: a. Frame diameter – 200 to 203 mm b. Mesh size – 125 mm to 20 µm	I, II, III & IV

## 7. AFFECTIVE DOMAIN OUTCOMES

- Act as a team member/ individual in sampling, assaying and dressing operation.
- Displays a professional commitment to ethical practice on a daily basis.
- Adopt environmentally friendly methods during sampling, assaying and dressing.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1<sup>st</sup> year
- 'Organization Level' in 2<sup>nd</sup> year.
- 'Characterization Level' in 3<sup>rd</sup> year.

## 8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
<b>Unit – I</b>  <b>Mine Sampling</b>	1.a Explain various technical terms involved in mine sampling operation. 1.b Describe the need, Use and importance of sampling. 1.c Describe suitable method of	1.1 Definition: - Specimen, Sample, Sampling and Salting. 1.2 Purpose, Importance and various uses of sampling in mines. 1.3 Sampling methods with its applicable conditions. (Channel sampling, Chip sampling, Grab sampling, Bore hole

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	sampling in varying situation. 1.d Describe sample reduction procedure. 1.e List out suitable precautions while taking samples. 1.f Explain the sources of error while sampling. 1.g Describe measures against salting.	sampling, Bulk sampling and Wagon sampling) 1.4 Needs and Methods of Reduction of Sample. 1.5 Precautions taken while collection of samples. 1.6 Sources of errors in Sampling. 1.7 Salting-(Intentional and unintentional) Purpose and Precautionary measures against salting.
<b>Unit – II</b>  <b>Assaying &amp; Mine Valuation</b>	2.a Explain various technical terms involved in mine valuation 2.b Estimate ore reserve and grade value of mineral body. 2.c Explain suitable method for reserve estimation for varying situations. 2.d Calculate life of mine and its value from given conditions.	2.1 Definition: - assay map, assay plan factor, assay values, grade value, tenor of ore and different types of ore grade. 2.2 Calculations based on average assay value and average grade of ore. 2.3 Ore reserve estimation methods : - 2.3.1 Geometric method - Included area method, Extended area method, Triangle method and polygonal method. 2.3.2 Graphic method – Use of Isochore maps, use of stratum contour and use of transverse section. 2.4 Mine Valuation: - 2.4.1 Purpose, Factor affecting and Risk involved in mine valuation, 2.4.2 Net present value of Mine:- Hoskold's Formula, and Morkill Formula 2.4.3 Life of Mine – Taylor's rule and Lounge's rule.
<b>Unit – III</b>  <b>Size reduction of mineral</b>	3.a Describe purpose and objective of size reduction. 3.b Explain suitable type of crushing procedure as per the size reduction requirement.	3.1 Comminution/ Size reduction – Purpose And objective of size reduction, 3.2 Types of Crushers : - 3.2.1 Primary crusher :- Jaw crusher and Gyratory crusher - Constructional features, working mechanism and reduction ration. 3.2.2 Secondary crusher -Cone crusher and disk crusher- Constructional features, working mechanism and reduction ration. 3.2.3 Tertiary crusher – Ball mill, hammer mill and rod mill- Constructional features, working mechanism and reduction ration.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
<b>Unit – IV</b> <b>Mineral Dressing &amp; Concentration Techniques</b>	4.a Describe purpose and objective of Mineral dressing. 4.b Define various terms associated with mineral dressing. 4.c Explain various processes involved in mineral dressing. 4.d Explain suitable mineral dressing technique as per requirement and property of mineral.	4.1 Scope, objectives and advantages of Mineral Dressing. 4.2 Definition of associated terms in Mineral Dressing. 4.3 Process of Mineral Dressing and concentration techniques: - 4.3.1 Size Liberation / Screening :- Purpose, Types, Screen efficiency. 4.3.2 Gravity concentration methods:- Jigging Operation, Methods of Jigging, Advantages and disadvantages of jigs, Factors affecting in stratifications of Jigging- Hindered settling, Differential acceleration and Consolidation trickling. 4.3.3 Heavy media separation – Mechanism and working principle, Types of heavy media used. 4.3.4 Froth floatation Process – Principle of operation, preparation of mineral pulp, aeration and froth formation, adsorption, contact angle, collectors and frothers. 4.3.5 Magnetic separation – Mechanism and working principle. (Dry and wet separation) 4.3.6 Electrostatic separation- Mechanism and working principle, Conductivity of minerals and factors affecting the electrostatic separation. (Belt and Role type separators)
<b>Unit – V</b> <b>Coal Beneficiation</b>	5.a Explain purpose and objectives of coal beneficiation 5.b Draw flow sheet of coal Beneficiation process.	5.1 Purpose and Objectives of coal beneficiation, Dry and Wet coal beneficiation 5.2 Flow sheet of coal washing plant. Coal washing plant-features.

## 9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	<b>Mine Sampling</b>	06	04	06	02	12
II	<b>Assaying &amp; Mine Valuation</b>	10	04	08	08	20
III	<b>Size Reduction Of Mineral</b>	10	02	06	04	12

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
IV	Mineral Dressing & Concentration Techniques	12	04	12	04	20
V	Coal Beneficiation	04	02	04	00	06
<b>Total</b>		<b>42</b>	<b>16</b>	<b>36</b>	<b>18</b>	<b>70</b>

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

**Note:** This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly 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:

- Expert lecture on following topics : Mine Sampling, Assaying & Mine Valuation, Size reduction of mineral, Mineral dressing & concentration techniques and Coal beneficiation.
- Visit of nearby mineral dressing plant of mining industry.
- Case study on mineral concentration techniques.
- Group discussion on advance mineral dressing & concentration techniques.
- Undertake micro-project.

## 11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

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

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- Guide student(s) in undertaking micro-projects.
- 'L' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- About **20% of the topics/sub-topics** which are relatively simpler or descriptive in nature is to be given to the students for **self-learning**, but to be assessed using different assessment methods.
- With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- Guide students on how to address issues on environment and sustainability
- Video lectures showing operational principles of various machines used in size reduction and concertation.
- Case study on issues associated with mine sampling and mitigational measures.
- Animated documentaries on various coal beneficiation techniques.

## 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 three**.

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. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

- a) Prepare a poster showing various sampling techniques for various rock formation.
- b) Prepare an illustration banner related to precautions and safety during collection of sample.
- c) Presentation on any case study related to collection of mine sampling.
- d) Prepare a poster showing machines involved in primary, secondary & tertiary crusher.
- e) Make slides showing various principals used behind working of concentrators.
- f) Draw a schematic diagram of froth floatation process.
- g) Prepare a chart showing various collectors, frothers, reagents used in froth floatation.
- h) Prepare a chart showing types of heavy media used for various mineral separation as per specific gravity.
- i) Prepare an illustration sheet showing various graphical methods of ore reserve estimation.
- j) Draw a flowsheet of coal washing plant.

### 13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Mine Economics	Arvind Kumar	Lovely Prakashan, Dhanbad
2	Surface Mining Technology	S. K. Das	Lovely Prakashan, Dhanbad
3	Mine And Mineral Economics	Subhash C. Ray, Indra N. Sinha	PHI Learning Publisher, Delhi ISBN: 978-8120351745
4	Principles Of Mineral Dressing	A.M.Gaudin	McGraw – Hill Inc., US. Year: 1939 ISBN-13: 987-0070230309
5	Wills' Mineral Processing Technology	Barry A. Wills, T.J. Napier Munn	Butterworth – Heinemann Year: 2006 ISBN-13: 978-0750644501
6	Mineral Processing	S.K.Jain	CBS Publication, New Delhi Year: 2019 ISBN-13: 978-8123907536
7	Textbook Of Mineral	D.V. Subba Rao	Scientific Publishers, New Delhi

S. No.	Title of Book	Author	Publication with place, year and ISBN
	Processing		Year: 2017 ISBN-13: 978-9386347992
9	Mineral Processing (Including Mineral Dressing, Experiments and Numerical Problems)	Vandana Rao, Sonam Patel, Avinash Lele	Dreamtech Press, New Delhi Year – 2020 ISBN-13: 978-9389633214

#### 14. SOFTWARE/LEARNING WEBSITES

a) NPTEL MOOC Course – Introduction To Mineral Processing by IIT Kharagpur  
[Introduction To Mineral Processing - IITKGP - YouTube](#)

b) Mine Sampling -

Part 1: <https://www.youtube.com/watch?v=X7sNG5FR0oM>

Part 2: <https://www.youtube.com/watch?v=0O40bWARltg>

Part 3: <https://www.youtube.com/watch?v=yqgh1KM1qJc&t=8s>

Part 4: <https://www.youtube.com/watch?v=SdpHtk6Usw&t=365s>

Part 5: <https://www.youtube.com/watch?v=t3n9wGKL1aA&t=90s>

c) Assaying & Mine Valuation –

Part 1: <https://www.youtube.com/watch?v=MKagoBMMj2I>

Part 2: <https://www.youtube.com/watch?v=QNpUqG9zW9Q>

Part 3: <https://www.youtube.com/watch?v=AfatnNYkJuM>

Part 4: <https://www.youtube.com/watch?v=77S68M1YREY>

Part 5: [https://www.youtube.com/watch?v=aaldp\\_9ra3U](https://www.youtube.com/watch?v=aaldp_9ra3U)

d) Size reduction of mineral –

Part 1: <https://www.youtube.com/watch?v=1Rq1F1i7BN4>

Part 2: <https://www.youtube.com/watch?v=Pi6LAFRj9c>

Part 3: <https://www.youtube.com/watch?v=Lv7rNtag2pc>

Part 4: <https://www.youtube.com/watch?v=kbe05JrXbJs>

Part 5: <https://www.youtube.com/watch?v=-oDT3gkEMl0>

Part 6: <https://www.youtube.com/watch?v=4fAHK2L7jM>

Part 7: <https://www.youtube.com/watch?v=RE4ACl7TC-l>

Part 8: <https://www.slideshare.net/sandeepdahiyasaini1/rod-mill-74815388>

Part 9: <https://www.youtube.com/watch?v=1r1ZOmbOczk>

## 15. PO-COMPETENCY-CO MAPPING

Semester V	MINE SAMPLING, ASSAYING AND MINERAL DRESSING (Course Code:4352201)									
	POs and PSOs									
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design / development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning	PSO 1	PSO 2	PSO 3 (If needed)
<u>Competency</u>	<ul style="list-style-type: none"> <li>Select true representative mineral sample for valuation purpose.</li> <li>Select suitable machine and procedure for mineral dressing.</li> <li>Achieve required grade of mineral by concentration techniques.</li> </ul>									
<u>Course Outcomes</u>										
CO1: Select suitable method of sampling with all safety and limitations.	3	2	1	1	-	2	2	-	-	-
CO2: Estimate ore reserve with its grade value for mine valuation.	3	2	1	-	2	2	2	-	-	-
CO3: Select suitable size reduction process and machine as per the need.	3	2	1	2	-	2	2	-	-	-
CO4: Adopt suitable mineral dressing process to improve concentration of mineral.	3	2	2	2	-	2	2	-	-	-
CO5: Design a flow sheet of coal beneficiation process.	3	1	1	-	1	-	1			

Legend: '3' for high, '2' for medium, '1' for low or '-' for the relevant correlation of each competency, CO, with PO/ PSO

## 16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

SR. No.	Name and Designation	Institute	Contact No.	Email
1	Mr. S. G. Srivastav I/c Head of Dept. Mining Engineering.	Government Polytechnic, Bhuj	9428546433	<a href="mailto:shivkumarsrivastav11@gmail.com">shivkumarsrivastav11@gmail.com</a>
2	Mr. S. S. Shah Lecturer In Mining Engineering.	Government Polytechnic, Bhuj	9428546433	<a href="mailto:samayshah02@gmail.com">samayshah02@gmail.com</a>
3	Mr. J. K. Patel Lecturer In Mining Engineering.	Government Polytechnic, Bhuj	8000776838	<a href="mailto:jigar.patel2320@gmail.com">jigar.patel2320@gmail.com</a>