VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY
JNANASAGARA CAMPUS, BALLARI-583105

Department of Studies in

Master of Science (M.Sc.) /

Master of Technology (M.Tech)

SYLLABUS

Master of Science
(II Semester)

With effect from
2021-22

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

Department of Mineral Processing

Jnana Sagara, Ballari - 583105

Distribution of Courses/Papers in Postgraduate Programme I to IV Semester as per Choice Based Credit System (CBCS) Proposed for PG Programs

M.Sc/M.Tech (Mineral Processing) II-SEMESTER

Semester	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	SEE	Total	L	T	P		
Second	DSC5	21MNP2C5L	Ore Genesis and Ore Microscopy	30	70	100	4	-	-	4	3
	DSC6	21MNP2C6L	Comminution and Sizing	30	70	100	4	-	-	4	3
	DSC7	21MNP2C7L	Ore Classification and Gravity Separation Processes	30	70	100	4	-	-	4	3
	DSC8	21MNP2C8L	Indian Mineral Deposits	30	70	100	4	-	-	4	3
	SEC2	21MNP2S2LT	Computational Techniques in MineralProcessing	20	30	50	2	-	-	2	1
	DSC5P	21MNP2C5P	Ore Microscopy Lab	20	30	50	-	-	4	2	4
	DSC6P	21MNP2C6P	Comminution and Sizing Lab	20	30	50	-	-	4	2	4
	DSC7P	21MNP2C7P	Ore Classification and Gravity SeparationProcesses Lab	20	30	50	-	-	4	2	4
	Total Marks					**600**				**24**	

M.Sc./M.Tech (Mineral Processing) Second semester

Course: Ore Genesis and Ore Microscopy	**Course Code: 21MNP2C5L**
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 30 Marks	**Semester End Examination:** 70 Marks

Objective: The Prime objective of this course is to study the various processes of ore formation and their classification and to study the optical properties of different minerals under the reflected light withthe help of ore microscope.

UNIT-1 **09 Hours**

Introduction to ore geology: magmas and magmatic ore formations – differentiation, concentration, magma mixing, sublimation etc.

Hydrothermal process – cavity filling, contact metasomatism, replacement; wall rock alteration,

mineral paragenesis and zoning in mineral deposits. Geological thermometers

UNIT-II 09 Hours

Ore deposits associated with acidic, mafic and ultramafic rocks layered intrusive and the associated ore deposits mineral deposits associated with kimberlites, komatites and carbonatites. Classification of ore deposits.

UNIT-III 11 Hours

Ore deposits formed by sedimentary processes: Iron, Manganese, Carbonates, Phosphates, Sulphates, and Clay deposits. Uranium and Vanadium deposits and Non- Ferrous ores. Evaporation, Residual and Mechanical concentration, factors controlling residual concentration. Process of formation of residual deposits- Bauxite and Nickel.

UNIT-IV 11 Hours

Ore Deposits formed by Oxidation and Supergene enrichment-factors controllingsupergene enrichment. Mode of formation of placer deposits.

Ore deposits associated with metamorphism: Graphite, Asbestos, Talc, Soapstone,Andulasite, Sillimanite, Kyanite and Garnet.

Metallogenic epochs and provinces. Ore deposits related to plate tectonics, control of Ore localization.

Unit- V 12 Hour

Introduction to Ore Microscopy: Preparation of samples for Ore microscopic studies: Qualitative properties – Colour, Reflectance, Bireflectance and Reflection pleochroism. Isotropism and Anisotropism, Internal reflection, Rotation properties, Polishing hardness, Scratch hardness, Crystal form and habit, cleavage and parting, twinning etc. Quantitative properties – Micro indentation hardness and Reflectivity. Microchemical techniques, Modal analysis. Textures of Ore minerals, assemblages and paragenesis. Application of

Ore microscopic studies in mineral technology

Referenc Books :

1. Jensen and Bateman, A.M. - Economic Mineral Deposits
2. K.V.G.K. Gokhale & T.C.Rao - Ore Deposits of India
3. R.L.Stanton - Ore Petrology
4. C.F.Park (Jr) and Mac Diarmid - Ore Deposits
5. W. Lindgren - Mineral Deposits
6. E.N.Cameron - Ore Microscopy
7. J.R.Craig & Vaughan - Ore Microscopy and Ore Petrology
8. P.Ramdohr - The Ore Minerals and their Inter growths

Course outcome: After completion of this course students will be able toCO

	Statement
CO1	Know the various geological processes responsible for formation of ore and about textures and structures present in the ore.
CO2	Device the best way of separation of minerals with the knowledge of texture and structure
CO3	Operate the ore microscope to characterize the ore minerals.
CO4	Identify the minerals, textures, and structures present in the ore sample.

M.Sc./M.Tech (Mineral Processing) Second semester

Course: Comminution And Sizing	**Course Code: 21MNP2C6L**
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 30 Marks	**Semester End Examination:** 70 Marks

Objective: The objective is to study the size reduction operations in mineral processing. And also tounderstand the screening operations.

UNIT – I **10 Hours**

Definition, Scope and necessity of Mineral Processing, Historical developments and Economics. Physical Properties of Ores and their importance in Mineral Processing.

Sampling: Definition, purpose, types of sampling and measurements of accuracy of sampling. Definition of terms – Concentrate, Tailing, Middling, Recovery and Ratio of concentration. Unit operations. Simple problems on estimation of recovery and ratio of concentration. Efficiency and Selectivity index.

UNIT-II 09 Hours

Comminution: Definition and basic laws of Comminution, Simple problems on energy estimations. Crushing Purpose, Mechanism of crushing, types of crushers and their salient features, major parts and maintenance of crushers.

UNIT-III 09 Hours

Grinding: Tumbling mills, Importance of cascading and cataracting, estimation of critical speed of tumbling mills. Types of tumbling mills, grinding practice, open, closed circuit grinding operations, and related problems.

UNIT- IV 12 Hours

Laboratory Sizing: Definition of particle size, measurement of particle size, Sizing by screening and sub- sieve sizing. Definition of sieve, screen, mesh. Advantages of wet and dry sieving. Graphical representation of size analysis data, size distribution functions and their applications.

UNIT- V 12 Hours

Industrial screens and their efficiency. Liberation: Definition, importance and application of ore microscopy in liberation studies and its analysis. Methods of liberation and behavior of locked particles. Instrumental analysis of liberation of minerals. Working problems on screen performances.

Reference books:

1. A.M.Gaudin - Principles of Mineral Dressing
2. S.K.Jain - Ore Processing
3. A.K.Lynch - Crushing and Grinding Circuits
4. B.A.Wills - Mineral Processing Technology
5. E.J.Pryor - Mineral Processing
6. A.F.Taggart - Text Book of Ore Dressing
7. A.F.Taggart - Hand Book of Mineral Dressing
8. Robert.H.Richards, Charles Lock & R.Schumann - A Text Book of Ore Dressing
9. Pradeep & Rakesh Kumar - Selected Topics in Mineral Processing
10. S.P.Mehrotra & P.Sarkar - Mineral Processing – Recent advances and future trends. T.Allen - Practicle Size Measurement

Course Outcome: After completion of this course, students will be able to

CO	Statement
CO1	Perform the sampling of ore for various treatments
CO2	Demonstrate the crushing operation and produce products
CO3	Identify the various parts of crushers and grinding mills
CO4	Perform the sieve analysis of feed and products of any equipments used in mineral industries
CO5	Draw the separation curves and infer the results

M.Sc./M.Tech (Mineral Processing) Second semester

Course: CLASSIFICATION AND GRAVITY SEPARATION DSC7	**Course Code:** 21MNP2C7L
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 30 Marks	**Semester End Examination:** 70 Marks

Objective: The prime objective of this course is to acquire the knowledge for exploiting the differencesin physical properties of different minerals in different media in order to recover valuable minerals.

UNIT – I **09 Hours**

Movement of Solids in fluids : Free settling, Hindered settling , equal settling, Factors affecting the settling of particles, Laminar flow , Turbulent flow, Derivation of various laws , Reynolds number , Free settling ratio and Hindered settling ratio and numerical problems.

UNIT-II 10 Hours

Classification: Principles, Mechanism of classification, Types of sorting classifiers, Performance of hindered settling classifiers, Operation and efficiency of sorting hindered settling, classifiers as concentration devices and simple problems. Reflux classifiers, Stub cyclones, Autogenous media cyclones: Sorting classifiers; Principles, Operation and efficiency , types and their industrial application

UNIT- III 12 Hours

Introduction to Physical Methods of Separation: Principles, Types of processes and Ore characteristics.

Gravity Separation: Separation in Vertical currents–Jigging–Theory and principles, differenttypes of jigs, operation of jigs, performance and efficiency, Jig circuits. Separation in Streaming currents – Theory of thin film concentration and flowing film concentration. Tabling-factors affecting the performance of tables, different types of tables.

UNIT –IV 10 Hours

Spiral concentrators – principles, types of spirals, application of spiral concentrators, performance and their efficiency. Reichert cones, Enhanced Gravity concentration: Brief introduction of principles and operation – Multigravity separator, Floatex density separator, knelson concentrator, Falcon separator, Kelsey Jig, Apic Jig etc.

UNIT- V 11 Hours

Dense Medium separation : Principles, media preparation and stability of media, regeneration of media, Classification of DMS, types of dense medium separators and their Operation , typical DMS circuits efficiency and construction of partition curves.

Simple Problems on calculations of Recovery, Yield, Enrichment ratio and grade in gravity separation units. analysis of gravity separation flow sheets.

Reference books:

1. A.M.Gaudin - Principles of Mineral Dressing
2. S.K.Jain - Ore Processing
3. A.K.Lynch - Crushing and Grinding Circuits
4. B.A.Wills - Mineral Processing Technology
5. E.J.Pryor - Mineral Processing
6. A.F.Taggart - Text Book of Ore Dressing
7. A.F.Taggart - Hand Book of Mineral Dressing
8. Robert.H.Richards, Charles Lock & R.Schumann - A Text Book of Ore Dressing
9. Pradeep & Rakesh Kumar - Selected Topics in Mineral Processing
10. S.P.Mehrotra & P.Sarkar - Mineral Processing – Recent advances and future trends. T.Allen - Practicle Size Measurement.

Course Outcome: **After completion of this course, students will be able to**

CO	**Statement**
CO1	Differentiate the free settling and hindered settling phenomenon's
CO2	Identify the parts of mineral classifiers
CO3	Use classification as a method of concentrationCO4 Perform the gravity separation of minerals.
CO5	Draw the separation curves and appreciate the mineral separation by gravity methods

M.Sc./M.Tech (Mineral Processing) Second semester

Course: /INDIAN MINERAL DEPOSITS DSC8	**Course Code: 21MNP2C8L**
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 30 Marks	**Semester End Examination:** 70 Marks

Objective: The objective of this course is to impart knowledge on distribution of different mineraldeposits across India along with their contribution in national economy.

UNIT – I **10 Hours**

Importance of Mineral Resources for the Industry and Economy of a Nation. Mineral Resources, Expendable and Non-expendable minerals. Conservation of minerals. Metallic and non-metallic minerals, Essential, Critical and Strategic minerals.

UNIT-II 09 Hours

Study of important Metallic and Non-metallic Mineral Deposits of India with reference toOrigin, Mode of occurrence, Mineralogy, Distribution, Production, Process Flow-sheets,
Uses and Trades in India.

UNIT-III 09 Hours

Metallic deposits: Iron, Manganese, Chromium, Copper, Lead and Zinc, Bauxite, Gold and other precious metals

UNIT-IV 12 Hours

Refractory minerals, Diamond, Beach sands. Minerals used in Glass, Cement and Ceramic industries. Minerals used in fertilizer industry, Minerals used as insulators, Structural and Building materials including Pigments and Fillers, Minerals used in chemical industry, Abrasive minerals, Industrial and manufacturing materials

Unit- V 12 Hours

Fuel Minerals: Oil and Gas, Coal & Lignite. Definition, Composition, types and Ranksof Coals, Macerals and Lithotypes and their distribution. Distribution and Mode of Occurrence of Radioactive Minerals.

Reference Book:

1. K.V.G.K.Gokhale & T.C.Rao - Ore Deposits of India
2. S.Krishnaswamy - Indian Mineral Resources
3. S.Deb - Industrial Minerals and Rocks of India
4. W.Seely & S.Mudd Serie - Industrial Minerals and Rocks
5. B.P.Radhakrishna - Mineral Resources of Karnataka
6. R.N.P.Arogyaswamy - A Course in Mining Geology
7. Roshan Bappu & Mular - Mineral Processing Plant Design
8. Weiss (Editor)S.M.E. - Hand Book of Mineral Processing Vol. I & II.

Course Outcome: After completion of this course, students will be able toCO

	Statement
CO1	Discuss the Metallic and Non-metallic Mineral Deposits of India
CO2	Distinguish refractory minerals, Diamond, Beach sands. Minerals used in Glass, Cement andCeramic industries. Minerals used in fertilizer industry,
CO3	Locate the occurrence of Oil and Gas, Coal & Lignite deposits of India.

Course: / Computational Techniques in Mineral Processing SEC 2	**Course Code: 21MNP2S2LT**
Teaching Hours/Week (L-T-P): 1 - 2 - 0	**No. of Credits:** 02
Internal Assessment: 15 Marks	**Semester End Examination:** 35 Marks

Objective: The prime objective of this course is to develop the computational skills to optimize themineral beneficiation plants for effective utilization of resources.

Unit – I **13 Hours**

Introduction: Material balancing, simple problems on material balancing of closed circuit crushing and grinding.

Mass balancing of complex circuits: Mass balancing of complex circuits. Concepts of connection matrix and its applications. Estimation of recovery and separation efficiencies for beneficiation unit operations with multiple product streams with numerical examples.

Unit-II 13 Hours

Reconciliation of excess data for minimizing of errors involved in yield and recovery calculations.

Error analysis: Computation of errors involved in size and chemical analysis of feed and product streams for estimation of accurate yield in the plant operations. Application of Lagrangian Multipliers for error minimization. Use of machine learning algorithms for mineral processing plant optimizations

Course Outcome: after completion of this course the students can able to

CO	Statement
CO1	Perform the mass balancing of unit operations in mineral processing
CO2	Perform the reconciliation of data for minimizing the errors
CO3	Estimate the recovery and circuit efficiency

M.Sc./M.Tech (Mineral Processing) Second semester

Course: / Ore Microscopy LABDSCL	**Course Code:** 21MNP2C5P
Teaching Hours/Week (L-T-P): 0 - 0 - 4	**No. of Credits:** 02
Internal Assessment: 15 Marks	**Semester End Examination:** 35 Marks

Course Objectives: To identify the different ore minerals, gangue minerals and textures and their properties present in the hand specimen and polished sections of metallic and non-metallic ores using microscope.

List of Experiments:

- **Study of metallic and non-metallic ores: -** iron, manganese, copper, bauxite, lead and zinc oresetc.,
- **Microscopic studies of ores –** Important textures, Refletance, Bireflectance, Microhardnessandetch test.

Course Outcome: after completion of this course the students can able to

CO	**Statement**
CO1	To identify the different parts of microscope
CO2	Identify the different microscope setups
CO3	Operate the ore microscope
CO4	To identify the different ore minerals, gangue minerals and textures and their properties present in hand specimen and polished sections of metallic and non-metallic ores.

M.Sc./M.Tech (Mineral Processing) Second semester

Course: / COMMINUTION AND SIZING LAB DSCL	**Course Code:** 21MNP2C6P
Teaching Hours/Week (L-T-P): 0 - 0 - 4	**No. of Credits:** 02
Internal Assessment: 15 Marks	**Semester End Examination:** 35 Marks

Course Objectives: The objective of this course is to carryout different sampling, crushing and grinding techniques using different equipments.

List of Experiments:

- Experiments on Sampling techniques and error estimation.
- Verification of Gy's law of smapling
- Determination of physical characteristics of ore sample like specific gravity, bulk density, angleof repose.
- **Crushing experiments** – Jaw crusher, roll crusher. Verification of basic energy laws, Denvergrindability test. Work index, Bond and HGI work index.
- Demonstration of Ball Mill and Rod Mill Grinding.
- Determination of Particle Size by Size analysis, wet & dry sieve analysis, Sub-sieve analysis
  – Beaker decantation and Andresen Pipette method.
- Determination of Specific Gravity by pychnometer method.
- Separation of sample by size and calculation of head and distribution of values. Validation of datausing determinant methods.

Course Outcome: after completion of this course the students can able to

CO	**Statement**
CO1	Perform representative sample of the metallic and non-metallic ores.
CO2	Perform crushing and grinding operations to prepare the feed for subsequent mineral processing operations.

M.Sc./M.Tech (Mineral Processing) Second semester

Course: / Ore Classification and Gravity Separation Processes Lab DSCL	**Course Code:** 21MNP2C7P
Teaching Hours/Week (L-T-P): 0 - 0 - 4	**No. of Credits:** 02
Internal Assessment: 15 Marks	**Semester End Examination:** 35 Marks

Course Objectives : To classify and separate the ore and gangue minerals based onsize, shape and specific gravity using different classifiers and gravity separation equipments.

List of Experiments:

- Determination of terminal velocity - Free settling test, Hindered settling test
- Estimation of % solids both by weight and volume methods.
- Laboratory Screening Operations
- Sink and float tests
- Demonstration Experiments in Jigging.
- Shaking Table
- Demonstration of Hydrocyclone
- Demonstration of Air Classification
- Demonstration of Spiral concentrator
- Plotting of Tromp Curves

Course Outcome: after completion of this course the students can able to

CO	**Statement**
CO1	Separate different ore and gangue minerals from one another usingdifferent classifiers.
CO2	Demonstrate gravity separators and separate different ore and gangueminералbased on user requirements.
CO3	Estimate the pulp density and % Solids for any slurry samples.