VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY
BALLARI

M.Tech Mineral Processing

SYLLABUS

(Effective from 2016-17 onwards)

DEPARTMENT OF POST GRADUATE STUDIES AND RESEARCH IN MINERAL PROCESSING

VSKU POST GRADUATE CENTRE, NANDIHALLI – SANDUR
BALLARI (DIST.,) – 583119, KARNATAKA

Ph. No. (O) 08395 278260,Fax. No. 08395 278236, e-mail: vskubminpro@gmail.com

PREAMBLE

M.TECH (MINERAL PROCESSING) CBCS PROGRAMME

The backbone of the economy of any nation is its natural resources especially the land, water and mineral and their potential utilization. The water, forest and farm resources are renewable part and whereas the mineral resources are non-renewable part and get progressively exhausted as they are mined and removed. Therefore, it is imminent that greatest care has to be exercised in planning and judicious utilization of these precious, non-renewable mineral resources. India is bestowed with wide variety of minerals. India is not a poor country in mineral wealth, an increased attention has to be paid with respect to the proper utilization of these available natural resources.

The noted physicist and noble laureate Dr.C.V.Raman, has observed that "Unless we know the value of minerals, know-how to utilize them, promote the welfare of the country, we should let them lie in ground. The making use of a mineral is as important as finding it."

Resources are known. Socio-enviro-technological advances has to be evolved for the judicious utilization of these available resources. The high grade ores are on fast decline warranting the use of lean grade ores to meet the demands of the user industry. In this context mineral beneficiation is inevitable. Mineral processing also known as Ore dressing, Mineral dressing and better known as Mineral Processing Technology is a unique and multidisciplinary post graduate programme. The programme is potential enough to address the burning issues of the mineral industry ie from mine to metal. M.Tech (Mineral Processing) is 3 Year (6 Semester) post graduate programme structured with engineering and other allied subjects to harness the young talents of the country. 15 Hard Core papers, 10 Soft Core papers and 15 Hard Core Practicals are taught. 6^{th} semester (in III Year) is dedicated to project work (dissertation) of industrial related application or fundamental studies has to be carried out by the students. The duration of the project work is 4 months.

The syllabi is orderly structured and sequentialised with the needs of the mineral industry. The information and the contents of the programme and their industrial applications is continuously passed on to the students to keep them abreast of the present day developments in the mineral industry.

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M.Tech (MINERAL PROCESSING) CBCS PROGRAMME

STRUCTURE AND SYLLABUS

FIRST SEMESTER

SL. NO	SUBJECT CODE	TITLE OF THE PAPER	NO. OF CREDITS		EXAM HOURS	MARKS	
			L – T - P	TOTAL		IA	THEORY / LAB
Hard Core Papers - Theory							
1	MP HC - 1.1	Mineralogy	3 - 1 - 0	4	3	30	70
2	MP HC - 1.2	Petrology and Elements of Mining	3 - 1 - 0	4	3	30	70
3	MP HC - 1.3	Elements of Mechanical Engineering	3 - 1 - 0	4	3	30	70
Soft Core papers – Theory (Select any two)							
4	MP SC - 1.4	Elements of Electrical Engineering	3 - 0 - 0	3	3	25	50
5	MP SC - 1.5	Applied Mathematics & Applied Statistics	3 - 0 - 0	3	3	25	50
6	MP SC - 1.6	Mining Geology	3 - 0 - 0	3	3	25	50
Hard Core Papers - Practical							
7	MPL HC- 1.7	Mineralogy and Petrology Lab	0 - 0 - 2	2	4	-	50
8	MPL HC- 1.8	Mechanical Engineering Lab	0 - 0 - 2	2	4	-	50
9	MPL HC -1.9	Electrical Engineering Lab	0 - 0 - 2	2	4	-	50
			Total	**24**		**140**	**460**

Total marks for First Semester 600

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SECOND SEMESTER

SL. NO	SUBJECT CODE	TITLE OF THE PAPER	NO. OF CREDITS		EXAM HOURS	MARKS	
			L – T - P	TOTAL		IA	THEORY / LAB
Hard Core Papers - Theory							
1	MP HC -2.1	Ore Geology	3 - 1 - 0	4	3	30	70
2	MP HC -2.2	Assaying	3- 1 - 0	4	3	30	70
3	MP HC -2.3	Mineral Processing - I	3- 1 - 0	4	3	30	70
Soft Core papers – Theory (Select any two)							
4	MP SC -2.4	Testing of Materials & Transport Phenomenon	3 - 0 - 0	3	3	25	50
5	MP SC -2.5	Computer Basics and Programming in C & C++	3 - 0 - 0	3	3	25	50
6	MP SC -2.6	Heat and Mass Transfer	3 - 0 - 0	3	3	25	50
Hard Core Papers - Practical							
7	MPL HC -2.7	Assaying Lab – I	0 - 0 - 2	2	4	-	50
8	MPL HC -2.8	Mineral Processing Lab-I	0 - 0 - 2	2	4	-	50
9	MPL HC - 2.9	Computer Bascis and Programming in C & C++ Lab	0 - 0 - 2	2	4	-	50
Interdepartmental Elective paper(Select any one)							
1.	MP OE 1	Study of Minerals and Rocks	4-0-0	4	3	30	70
2.	MP OE 2	Mineral Resources of India	4-0-0	4	3	30	70
			Total	**28**		**170**	**530**

Total marks for Second Semester 700

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THIRD SEMESTER

SL. NO	SUBJECT CODE	TITLE OF THE PAPER	NO. OF CREDITS		EXAM HOURS	MARKS	
			L – T - P	TOTAL		IA	THEORY / LAB
Hard Core Papers - Theory							
1	MP HC - 3.1	Ore Microscopy & Research Methodology	3-1-0	4	3	30	70
2	MP HC - 3.2	Mineral Processing - II	3-1-0	4	3	30	70
3	MP HC - 3.3	Coal Preparation & Fuel Technology	3-1-0	4	3	30	70
Soft Core papers – Theory (Select any two)							
4	MP SC - 3.4	Surface Chemistry	3 - 0 - 0	3	3	25	50
5	MP SC - 3.5	Indian Mineral Deposits and Plant Flow Sheets	2 - 1 - 0	3	3	25	50
6	MP SC - 3.6	Bio Processing	3 - 0 - 0	3	3	25	50
		Hard Core Papers - Practical					
7	MPL HC 3.7	Ores and Ore Microscopy Lab	0 - 0 - 2	2	4	-	50
8	MPL HC 3.8	Mineral Processing Lab – II	0 - 0 - 2	2	4	-	50
9	MPL HC 3.9	Assaying Lab – II	0 - 0 - 2	2	4	-	50

Interdepartmental Elective paper (Select any one)							
1.	MP OE 3	Introduction to Mineral Processing	4-0-0	4	3	30	70
2.	MP OE 4	Iron and Steel Making	4-0-0	2	3	30	70
			Total	**28**		**170**	**530**

Total marks for Third Semester 700

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FOURTH SEMESTER

SL. NO	SUBJECT CODE	TITLE OF THE PAPER	NO. OF CREDITS		EXAM HOURS	MARKS	
			L – T - P	TOTAL		IA	THEORY / LAB
Hard Core Papers - Theory							
1	MP HC - 4.1	Mineral Processing – III	3-1-0	4	3	30	70
2	MP HC - 4.2	Non Ferrous Extractive Metallurgy	3-1-0	4	3	30	70
3	MP HC - 4.3	Mineral Processing-IV	3-1-0	4	3	30	70
Soft Core papers – Theory (Select any two)							
4	MP SC - 4.4	Mineral Processing Plant Design - I	3 - 0 - 0	3	3	25	50
5	MP SC - 4.5	Process Control & Automation	3 - 0 - 0	3	3	25	50
6	MP SC - 4.6	Industrial Management	3 - 0 - 0	3	3	25	50
Hard Core Papers - Practical							
7	MPL HC -4.7	Mineral Processing Lab – III	0 - 0 - 2	2	4	-	50
8	MPL HC -4.8	Metallurgy Lab	0 - 0 - 2	2	4	-	50
9	MPL HC -4.9	Coal Preparation Lab	0 - 0 - 2	2	4	-	50
	TOTAL			**24**		**140**	**460**

Total Marks for Fourth Semester 600

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FIFTH SEMESTER

SL. NO	SUBJECT CODE	TITLE OF THE PAPER	NO. OF CREDITS		EXAM HOURS	MARKS	
			L – T - P	TOTAL		IA	THEORY / LAB
Hard Core Papers - Theory							
1	MP HC - 5.1	Environmental Management & Mineral Processing Economics	3- 1 - 0	4	3	30	70
2	MP HC - 5.2	Agglomeration & Cement Making	3- 1 - 0	4	3	30	70
3	MP HC - 5.3	Ferrous Extractive Metallurgy	3- 1 - 0	4	3	30	70
Soft Core papers – Theory (Select any two)							
4	MP SC - 5.4	Mineral Processing Plant Design – II	3 - 0 - 0	3	3	25	50
5	MP SC - 5.5	Simulation & Modeling	3 - 0 - 0	3	3	25	50
6	MP SC - 5.6	Waste Recycling	3 - 0 - 0	3	3	25	50
Hard Core Papers - Practical							
7	MPL HC 5.7	Mineral Processing Lab – IV	0 - 0 - 2	2	4	-	50
8	MPL HC 5.8	Agglomeration	0 - 0 - 2	2	4	-	50
9	MPL HC 5.9	Simulation & Modeling Lab	0 - 0 - 2	2	4		50
	TOTAL			**24**		**140**	**460**

Total Marks for Fifth Semester 600

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SIXTH SEMESTER

SL. NO	SUBJECT CODE	TITLE OF THE PAPER	NO. OF CREDITS	EXAM HOURS	MARKS	
			TOTAL		IA	Theory Lab
Project Work						
1	MP HC - 6.1	Dissertation	10	-	-	250
2	MP HC - 6.2	Viva - Voce on Dissertation	2	-	-	50
3	MP HC - 6.3	Industrial Training	-	-	-	-
4	MP HC - 6.4	Industrial Tour Report	-	-	-	-
	TOTAL		**12**	**-**	**-**	**300**

Total Marks for Sixth Semester 350

The pattern of matrix for M.Tech Mineral Processing (Six Semesters)

No	COURSES	I SEM			II SEM			III SEM			IV SEM			V SEM			VI SEM		
		C	P	M	C	P	M	C	P	M	C	P	M	C	P	M	C	P	M
1	HARD CORE	18	6	450	18	6	450	18	6	450	18	6	450	18	6	450	12	2	300
2	SOFT CORE	6	2	150	6	2	150	6	2	150	6	2	150	6	2	200			
3	OPEN ELECTIVE	-	-	-	4	1	100	4	1	100	-	-	-	-	-				
	2	**24**	**8**	**600**	**28**	**9**	**700**	**28**	**9**	**700**	**24**	**8**	**600**	**24**	**8**	**600**	**12**	2	300

C- Credits P-Paper M-Marks

PAPER	C	P	M
HARD CORE	102	32	2550
SOFT CORE	30	10	750
OPEN ELECTIVE	08	2	200
TOTAL	140	44	3500

Note:-

1. A candidate with **B.Sc. or B.E.** degree in Mining Engineering, Chemical Engineering, Metallurgy , Materials Engineering, Mechanical Engineering, Industrial Production and Electrical Engineering are eligible for admission to I year M.Tech (Mineral Processing) CBCS Programme.
2. Hard Core Subjects are Compulsory. Candidates has to select any **two** soft-core subjects.
3. **One Open** Elective subject shall be chosen by the students of other Departments during **II & III semester**.
4. For practical examinations a batch shall consists of not more than **eight** students. Students are not permitted to take the practical examination without the submission of the Certified Laboratory records. 15 **marks** are allotted to**Viva-Voce** (**10Marks**) and **laboratory records** (**5Marks**).
5. After the completion of II **& IV Semester,** students are sent for Plant visits and Industrial Training respectively.. One or two Faculty members may accompany or visit the work place at least once during their training period for supervision. TA/DA may be paid for the faculty members for their visit as per the University rules.
6. During the V Semester Programme, the students have to undertake the Industrial Tour for a period of 15 days. Two Faculty members and one non teaching staff member have to accompany the students for tour..
7. During the VI semester programme each students has to undertake a Project Work in the Department or in any well established Mineral based organization / laboratory for a period of 4 months and has to submit the dissertation report. The **Project Report** has **10 Credits** and **Viva-Voce** has **2 Credits**.

8. Plant visits, Industrial training and Tour are compulsory. Candidate should present the dissertation work before the Viva-Voce Committee consisting of BOE Chairman and members, Chairman of the Department and their respective Guides.

9. All other conditions are as per the University rules and regulations promulgated from time to time. The grade and the grade point earned by the candidate in the subject will be as given below:

P	G	GP=V x G
90-100	9(A++)	VX9
80-89	8(A+)	VX8
70-79	7(A)	VX7
60-69	6(B+)	VX6
50-59	5(B)	VX5
0-49	0(C)	VX0

Here, P is the percentage of marks secured by a candidate in a course which is rounded to nearest integer. V is the credit value of the course. G is the grade and GP is the grade point.

9. If G=0(C), (GP=0) then the candidate is assumed to have automatically dropped the course. He/she is not said to have failed in the course.

10. **Theory Question paper format for Semester examinations**

10a. The format for Hardcore Theory Paper for 70Marks & 3 Hours duration consists of.

Question 1: Consists of 10 questions of 2 marks each covering all the units. (2 X 10 = 20 marks)
Questions 2: Consist of 4 Sub Questions with 5 marks each with choice; with total number of question not exceeding 6 covering all the units (5 X 4 = 20 marks)
Question 3: Consist of 3 Sub Questions with 10 marks each with choice, the total number of question not exceeding 4 covering all the units (10 X 3 = 30 marks)

10b. The format for Soft core theory paper for 50 marks & 3 Hours duration consist of.

Question 1 Consists of 10 questions of 1 mark each covering all the units. (1 X 10 = 10 marks)
Questions 2: Consist of 4 Sub Questions with 5 marks each with choice; with total number of question not exceeding 6 covering all the units (5 X 4 = 20 marks)
Question 3: Consist of 2 Sub Questions with 10 marks each with choice, the total number of question not exceeding 4 covering all the units (10 X 2 = 20 marks)

10c. The format for open elective theory paper for 35 marks & 2 Hours duration consist of.

Question 1 Consists of 10 questions of 1 mark each covering all the units. (1 X 10 = 10 marks)
Questions 2: Consist of 5 Sub Questions with 5 marks each with choice, with total number of question not exceeding 6 covering all the units (5 X 5 = 25marks)

FIRST SEMESTER

MP HC - 1.1 MINERALOGY (3-1-0)

Unit – I

Introduction, Elements of Crystals, Crystal morphology, Euler's formula. Goniometry: Interfacial angle, law of constancy of interfacial angles, Contact and Optical Goniometers. Symmetry characters– Plane of Symmetry, Axis of Symmetry and Centre of Symmetry. Crystallographic Axes, Parameters and Indices, Weiss and Muller's Notations. Classification of Crystals into six systems. Crystal

Forms: Simple, Open, Combination and Closed forms. Holohedrons, Hemihedrons, Tetrahedrons and Hemi morphs. Study of crystals of Normal classes. Twins: Definition, characters and types. A brief introduction to X-ray crystallography.

(14 Hours)

Unit-II

Definition of Mineral, crystalline and amorphous states, Crystalline aggregates – Columnar, Bladed, Acicular, Fibrous, Tabular, Foliated, Granular and Imitative forms. Properties depending upon light: Colour Pleochroism. Play of colours, Opalescence, Fluorescence, Phosphorescence, Streak, Luster and Diaphaneity. Properties depending upon cohesion and elasticity: Cleavage, Fracture, Hardness and Tenacity. Properties depending upon electricity: Electrical conductivity, Frictional and thermoelectricity, Pyroelectricity and Piezoelectricity. Properties depending upon Heat and Magnetism: Fusibility, Thermal conductivity, Specific heat, Para and Diamagnetism. Determination of specific gravity by balance, Pychnometer, Jolly's spring balance, Walker's steel yard and Heavy liquids. Solid solution, interstitial and defect solid solution. Isomorphism, Polymorphism and Pseudomorphism.

(14 Hours)

Unit- III

Classification of silicate structures: Brief study of feldspars, olivine, garnet, pyroxene, amphiboles, mica and silica group of minerals. Description of non-silicate group of minerals: Native elements, Carbonates, Oxides and Hydroxides , Sulfates and Sulfosalts.

(14 Hours)

Unit - IV

Optical Mineralogy: Preparation of thin sections of minerals and rocks. Petrological microscope: Its mechanical and optical parts. Nicol prism and its construction. Accessory plates – construction and use of Quartz wedge, Gypsum and Mica plates.Microscopic examination of minerals under plane polarized and crossed nicols-Colour, Pleochroism, Relief, Isotropism and Anisotropism, Interference colours, Birefringence, Extinction (causes and types only), and Optic sign (Types and determinations only).

(14 Hours)

BOOKS FOR REFERENCE :

1. H.H. Read : Rutley's Elements of Mineralogy
2. M.H.Battey : Mineralogy For students
3. E.S.Dana & W.E.Ford : A Text Book of Mineralogy
4. C.S.Hurlbut : Dana's Manual of Mineralogy.
5. William E. Ford : Dana's Textbook of Mineralogy
6. Pramod O Alexander : A Hand Book of Minerals, Crystals, Rocks and Ores

MP HC - 1.2 PETROLOGY AND ELEMENTS OF MINING (4-0-0)

PETROLOGY

Unit-I

Magma and its origin. Primary and Derivative magmas. Bowen's reaction principle. Diversity of Igneous rocks – Differentiation; Gravitational, Filter pressing, liquid immiscibility, fractional crystallization, role of volatiles in magmatic evolution and Assimilation. Igneous rocks: Forms, Structure and Textures of Igneous Rocks. Classification and types of igneous rocks.

(18 Hours)

Unit-II

Sedimentary and Metamorphic Rocks: Process of sedimentation, types and agents of weathering, transportation, deposition, diagenesis and lithification. Structures of sedimentary rocks: Bedding, Current bedding, Cross bedding, graded bedding, Ripple marks, Mud cracks etc. Classification of sedimentary rocks. Clastic and non-clastic sediments. Origin, occurrence and characteristics of common sedimentary rocks.Types and Agents of metamorphism. Textures and structures of metamorphic rocks. Metasomatism. Composition, origin and mode of occurrence of Gneisses, Amphibolites,Granulites, Schists and eclogites rocks.

(18 Hours)

Unit-III

ELEMENTS OF MINING:

Introduction and definition of mining terminology. Sampling: Sampling techniques. Mining Methods: Important methods of Open cast, underground and alluvial mining. Coal mining methods. Drilling: A brief introduction to different methods of drilling and their uses, Types and uses of explosives. Ventilation and illumination in underground mines. Mines support. Hazards in underground mines and their control. Impact of mining on environment.

(20 Hours)

BOOKS FOR REFERENCE :

1.G.W.Tyrrel	:	Principles of Petrology
2 J.F.Pettijohn	:	Sedimentary Rock
3.Turner and Verhoogan	:	Igneous and Metamorphic Petrology
4 A.Hrake	:	Petrology for Students
5.M.Best	:	Igneous and Metamorphic Petrology
6.R.N.P.Arogyaswamy	:	A Course in Mining Geology
7.Mackinstry	:	Mining Geology
8.D.J.Deshmukh	:	Elements of Mining Technology Vol. I & II
9.Peele Robert	:	Mining Engineers Hand Book Vol. I & II

MP HC - 1.3 ELEMENTS OF MECHANICAL ENGINEERING (3-1-0)

Unit-I

Energy – Introduction, Sources of energy,Fuels - Nuclear, Tidal, Wind, Solar etc.

Prime Movers: Types of prime movers. Definition of terms - Pressure, Work, Temperature, Heat, Power, Units of heat, Specific heat, Mechanical equivalent heat. Friction : Definition, Types of frictions, Limiting friction, limiting angle of friction, Coefficient of friction, Laws of solid friction and effects of friction. Lubrication : Definition, necessity, types and properties of lubricants. Methods of lubrication. Lubricators - Screw cap lubricator, Drop feed lubricator and Splash lubricator.

(14 Hours)

Unit-II

Couplings : Definition and types - Muff, Flange and Flexible. Clutches : Definition, Necessity, Single plate and multi plate clutch and cone clutches. Brakes: Types of brakes - Block and Bond brake, Internal expanding brake. Difference between brake and clutch. Bearings: Definition of Shaft, Spindle and Axle. Types of bearings – Journal bearing, Foot step bearing, Collar bearing, Antifriction bearing, Ball and Roller bearings. Power Transmission: Methods of Motion and Power transmission.

(14 Hours)

Unit-III

Belt Drive – Types - Open and Cross belt drive, Velocity ratio, Slip and creep, Guide Pulley, Jackey pulley, Stepped cone pulley, crowning of pulleys, Fast and Loose pulley. Belt Drive - Advantages of over Belt Drive. Chain Drive- elements of chain drive and advantages. Gear Drive – Advantages of gear drive. Types of Gears – Spur, Helical, Spiral, Bevel, Worm and Worm wheel, Rack and Pinion. Velocity ratio of Gear Drive, Gear train – Definition, types (simple and compound), Simple problems on Belt and GearDrive.Pumps : Definition, Classification of pumps, Reciprocating pump,Centrifugal pumps, Gear pump, Priming of pumps, Air vessels, Simple problems.

(14 Hours)

Unit-IV

Lathes : Types of lathes, description and functions of Lathe parts, Accessories and attachments, Lathe operations – Turning, Taper turning and their methods. Thread cutting, Knurling, Problems on taper cutting and thread cutting.Drilling Machine : Types of drilling machines, Drilling operations, Drill bits – types, cutting speed, feed and depth of cut.

Vibration : Introduction, Natural and forced vibrations. Effects of vibration. Remedies to avoid vibrations. Wear: Different types of wears – Abrasion, Corrosion, Scoring, Scuffing, Pitting, Scaling. Minimization of wear with examples. Metrology : Various height Gauges, Micrometer, Bourdan Tube Pressure Gauge.

(14 Hours)

BOOKS FOR REFERENCE :

1. K.P.Roy, S.K.Hazrachoudhary & A.K.Hazrachoudhary : Elements of Mechanical Engineering
2. K.P.Roy, S.K.Hazrachoudhary & A.K.Hazrachoudhary : Elements of Workshop Technology Vol.I & II
3. K.R.Gopalkrishna : Elements of Mechanical Engineering
4. N.D.Bhatt : Machine Drawing
5. K.R.Gopalkrishna : Machine Drawing

MPSC 1.4 ELEMENTS OF ELECTRICAL ENGINEEING (3-0-0)

Unit- I

D.C.Circuits: Ohm's law, Kirchoff's law, current division principle, solution of networks using C-Kirchoff's law. Principle of superposition. Electromagnetism: Basic definitions, solution of series and parallel magnetic circuits, Hysterisis, Faraday's laws of electromagnetic induction, Lenz's law, concept of self and mutual induction. Energy stored in a magnetic field. Rise and decay of currents in inductive circuits .A.C.Circuits: Generation of alternating emfs, average and effective values of sine wave. Form factor and peak factor, Phasor representation of alternating quantities, voltage, current and power relations in simple series circuits containing resistance, inductance and capacitance, Power in single phase circuits, Power factor.

(11 Hours)

Unit-II

Generation of 3 phase voltages. Advantages of 3 phase system, star and delta connections, Relationship between line and phase quantities, power in 3 phase circuits. Measurement of power using two watt meter method.D.C.Machines: Constructional features, principles of operation, generators and motors, e.m.f.equation, speed control of D.C. motors, starters. Efficiency of D.C.generators and motors.

(10 Hours)

Unit-III

Transformers: Constructional features, principles of operation. Transformers on no-load and on-load, regulation, losses and efficiency. OC and AC test to predetermine efficiency and regulation. Three phase transformers, star and delta connections. Auto transformers and welding transformers.Alternators : Constructional features, principles of operation, e.m.f. equation with distribution and coil spar factor. Three phase induction motors: Construction, types, principle of operation, output, losses and efficiency, torque, slip, characteristics of starting torque, starting speed control. Star-delta starters, applications.

(11 Hours)

Unit-IV

Measuring Instruments: Classification, essentials of Indicating instruments, construction and working principles of – Moving iron and moving coil Voltameter and Ammeter, Dynamometer type wattmeter, single phase energy meter, Megger and C.R.O.Fuse: Necessity of fuse, rewireble and H.R.C. cartridge fuse. Earthing: Purpose and methods of earthing.

(10 Hours)

BOOKS FOR REFERENCE :

1. B.L.Theraja : A Text book of Electrical Technology
2. S.L.Uppal : Electrical Engineering
3. S.K.Sahdev & D.S.Rana : Elements of Electrical Science
4. E.Hughes : Electrical Technology
5. H.Cotton : Electrical Technology

MP SC - 1.5 APPLIED MATHEMATICS AND APPLIED STATISTICS (3-0-0)

APPLIED MATHEMATICS:

Unit-I

Algebra : Matrices, Determinants, Progressions (arithmetic & geometric), Binomial theorem, Algorithms.

Equations: Linear equations of first degree, quadratic equations, solutions by factoring, system of simultaneous equations, analytical solution of a equation, reminder theorem and synthetic division.

Linear Differential Equations: Ordinary differential equations of second order, homogeneous, non homogeneous equations with constant and variable coefficients, solving technique of linear differential equations and an introduction to partial differential equations. **(10 Hours)**

Unit-II

Numerical solution of Algebraic equations: Method of successive bisection, method of false positions, Newton-Raphsson interactive method, The scant method.Finite differences: Definition of properties of delta, nibble and E, and the relations between them, the difference of a polynomial difference equations.Newton-Gregory forward and backward Interpolation formulae, Lagrange's interpolation formulae for unequal intervals. Numerical differentiation based on equal Interval and unequal interval and unequal interval interpolation formulae, computation of second derivatives. **(10 Hours)**

Unit-III

General quadrature formula, Trapezoidal rule, Simpson's ½ and 3/8 rules, Weddle's rule, problem theorem. Solutions of initial value problem for ordinary, linear first order equations by Picard's Euler's modified, Euler's fourth order Runge-Kutta methods.Solutions of boundary value problems, finite (difference method). **(10 Hours)**

APPLIED STATISTICS

Unit -IV

Frequency distribution : Construction of frequency distribution table and cumulative frequency table. Graphical representation : Histogram, frequency polygon and cumulative frequency curve. Measure of central tendency: Mean, Median, Partition values, Mode. Measurement of dispersion, Quartile deviation, mean deviation, standard deviation, skewness and Kurtosis. Curve fitting and method of least squares.

Correlation and regression : Correlation, Dot diagram, correlation table, Karl – Pearson's coefficient of correlation, Rank correlation and Regression. Theory of probability : Permutations and combinations, Addition theorem of probabilities, Multiplicative law of probability. Sampling :
Random and simple sampling. Tests of significance: chi square test, Students test, F-test, Z-test.

(12 Hours)

BOOKS FOR REFERENCE :

1. Kreyzic	:	Advanced Engineering Mathematics
2. Mallik and Gupta	:	Numerical Analysis
3. Mallik and Mallik	:	- do -
4. S.S.Sastry	:	- do -
5. M.Shantkumar	:	Computer based Numerical Analysis
6. F. Ayres (Schaum series)	:	Differential equations
7. P. Scield (Schaum series)	:	Numerical Analysis.

8. V.Rajaraman : Computer oriented Numerical Analysis
9. Samuel D.Counte & Carl : Elementary Numerical Analysis An algorithmic approach.
10. Ronald E, Walpol and Raymond H.Myers : Probability and Statistics for Engineers and Scientists
11. R.Lowell Wine : Statistics for Scientists and Engineers
12. Etwod.G.Kirkpatrick : Introductory Statistics and Probability for Engineering, Science and Technology
14. John.B.Kennedy and Adam.M. Neville : Basic Statistical Methods for Engineers and Scientists
15. Umargi : Probability and Statistical Methods.
16. A.Polland : Introductory Statistics.

MP SC: 1.6 MINING GEOLOGY (3-0-0)

Unit: I

Geological exploration: Geological mapping; its need, scope, technique and choice of the scale. Mineral exploration, its significance and objectives. Geological classification of the areas for mineral exploration. Collection of geological data. Exploration programme, selection of area, planning, organization and various stages of exploration. Geological parameters for mine planning and design. Methods of choice of sampling different geological formations. Concept of ore reserve, resource and methods of classification of ore reserves as proposed by various organizations. Methods of report writing and presentation of data.

Guides to Ore- Introduction: Targets and Loci**:** Ringed Targets. Intersecting Loci. Classification of Guides- Regional guides and guides of local imporatance. Physiographic Guides**:** Topographic Expressions of ore bodies: Deceptive outcrops. Physiographic environment of ore Deposits: Topography as a guide to iron ore. Physiographic relations of Placer Deposits: Guides to channels; Location of pay streaks. Physiographic in relation to oxidation and enrichment: Residual ores; Supergene sulphide zones**.** Geobotonical and Biogeochemcial guides. **(11 Hours)**

Unit II

Mineralogical Guides: Rock Alteration: Nature of alteration; Target rings of alteration, Mineralogical guides to solution-paths; Hypogene zoning as a guide. Oxidation products at depth; Unoxidized ore in outcrops; Minable oxidized ore; Surface oxidation products as indicators; Metals in the oxidized zone; Significance of gangue; Types of limonite derived from sulphides and other minerals. (**10 Hours**)

Unit III

Stratigraphic and lithologic guides in Syngenetic Deposits and in Epigenetic deposits, Reasons for favorability, Competent Vs. incompetent formations, Examples of favorable formations and Application. (**10Hours)**

Unit IV

Fracture patterns as guides: Mechanical Principles of Fracturing, Stress: Planes of principal stress, the pattern of principal stress, Relation of fractures to stress: Characteristics of shears and tension fractures, Forces causing fracturing. Vein patterns: typical vein patterns and their Applications, Vein structures within the pattern, Localization of ore shoots within the fracture pattern.Contacts and folds as guides: Contacts, Folds younger than the ore, Folds older than the ore **.(10 Hours)**

REFERENCES

1 Mackinstry Mining geology
2 RNP Aroga swamy Mining Geology

MPL HC - 1.7 MINERALOGY AND PETROLOGY LAB (0-0-2)

MINERALOGY **:** Megascopic and Microscopic identification of the following Minerals:

Quartz group	: Important varieties
Felslpars	: Orthoclase, Microcline, Plagioclase, Labradorite
Mica group	: Muscovite, Biotite
Pyroxenes	: Augite, Diopside, Hypersthene
Amphiboles	: Hornblende, Tremolite, Actinolite, Anthophyllite
Other Minerals	: Olivine, Serpentine, Chlorite, Garnet, Talc, Tourmaline, Sillimanite, Andalusite, Sillimanite, Kyanite, Corundum, Asbestos, Calcite, Dolomite, Baryte, Magnesite, Fluorite, Gypsum.

PETROLOGY **:** Megascopic Identification of following Rocks

Igneous	: Granite,Syenites,Pegmatites,Aplite,Diorite,Gabbro, Anorthosite, Dolerties,Rhyolites,Basalts, Ultramafic Rocks: Dunite, Pyroxenite, Peridotite, Komatiite
Sedimentary	: Conglomerates, Breccias, Sandstones, Limestones, Dolomite, Shale, Laterites and Bauxites.
Metamorphic	: Schists, Gneisses, Marble, Quartzite, Slate, Phyllite, Amphibolite and Charnockite,Banded Iron Formations

MPL HC - 1.8 MECHANICAL ENGINEERING LAB: (0-0-2)

Machine Shop: Jobs on plane turning, step turning, knurling and taper turning. Engineering Drawing: First angle projection, Orthographic projection of simple solids like prism, pyramid, cylinder, cone. Conversion of pictorial view into orthographic view involving sectional views. Isometric view of simple objects like cube, cylinder, cone, prism and the combinations.

MPL HC - 1.9 ELECTRICAL ENGINEERING LAB: (0-0-2)

Voltage and current relations & measurement of power using two wattmeters in Star and delta connected loads, Measurement of Inductance by VAW method, Calibration of single phase Energy meter, Determination of voltage, current and frequency with the help of CRO. Speed control of D.C. shunt motor by armature control and field control methods. Load test on D.C. shunt motor. Load test on single phase transformer.O.C. and S.C. tests on single phase transformer. Load test on three phase induction motor.

SECOND SEMESTER

MP HC - 2.1 ORE GEOLOGY **(3-1-0)**

Unit-I

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.

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.

(20 Hours)

Unit-II

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

(18 Hours)

Unit-III

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.

(18 Hours)

BOOKS FOR REFERENCE :

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

MP HC - 2.2 ASSAYING

(3-0-0)

Unit-I

Introduction, Sampling, Common apparatus and techniques, Accuracy and Precision. Separation techniques: Solvent extraction, Ion-exchange and brief idea about Chromatography.

(14 Hours)

Unit-II

Titrimetric Analysis: Theory and classification. Redox and Complexometric titrations. Gravimetry: Theory-methods-super saturation co-precipitation and post-precipitation. Precipitation from homogeneous solutions, Washing, drying and Ignition of the precipitate. Electrogravimetry: Principles and applications in the electrolytic separation of metals. Fire Assaying: Analysis of Gold and Silver. Proximate analysis of solid, liquid and gaseous fuels. **(14 Hours)**

Unit-III

Spectral Methods of Analysis: Principles, Instrumentation and application of Colorimetry and Spectro photometry, Flame photometry, Atomic Absorption Spectrometry and Flame emission spectroscopy.

(14 Hours)

Unit-IV

Thermal Analysis: Thermo Gravimetric Analysis (TGA) and Differential Thermal Analysis (DTA). A brief review of Electron Spectroscopy for Chemical Analysis (ESCA), X-ray diffraction, Electron Microprobe Analyser, (EMPA), X-ray Fluorescence and Inductively Coupled Plasma (ICP). Analysis of common ores like – Haematite, Pyrolusite, Magnetite, Chromite, Dolomite, Limestone, Bauxite, Magnesite, Chalcopyrite, Sphalerite, Baryte and Graphite.

(14 Hours)

BOOKS FOR REFERENCE :

1. Chatwal & Anand	:	Instrumental Methods of Chemical Analysis
2. G.W. Ewing	:	Instrumental Methods of Chemical Analysis
3. B.K.Sharma	:	Instrumental Methods of Chemical Analysis
4. P.J.Potts	:	A Hand book of Silicate Rock Analysis
5. F.J.Welcher	:	Standard Methods of Chemical Analysis
6. N.H.Furman	:	Standard Methods of Chemical Analysis
7. A.I.Vogel	:	Text Book of Quantitative Inorganic Analysis
8. Jain & Agarwal	:	Metallurgical Analysis

MP HC - 2.3 MINERAL PROCESSING - I (3-0-0)

UNIT – I

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.

Brief introduction of fundamentals of Mineral Processing techniques – Gravity methods, Physico-chemical methods and chemical processing.Analysis of separation processes- Thermodynamics, Kinetics, Determination of separatability curves, Separation efficiency **(14 Hours)**

UNIT - II

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. 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. **(14 Hours)**

UNIT-III

Classification : Principles, Mechanism of classification for sizing, Types ,Performance ,Operation and efficiency of sizing classifiers, problems on circulating load, classifier efficiency and performance curves. Hydrocyclones : Principles, Operation & efficiency of cyclones, types and their industrial application **(14 Hours)**

UNIT – IV

Comminution: Definition and basic laws of Comminution, Simple problems on energy estimations. Crushing: Purposes, Mechanism of crushing, types of crushers and their salient features and maintenance of crushers. Grinding: Tumbling mills, Importance of cascading and cataracting, estimation of critical speed of tumbling mills. Types of tumbling mills, grinding practice, open and closed circuit grinding operations and related problems. **14 Hours)**

BOOKS FOR REFERENCE :

1. K.V.G.K Gokhale & T.C.Rao : Ore Deposits of India
2. A.M.Gaudin : Principles of Mineral Dressing
3. B.A.Wills : Mineral Processing Technology
4. S.K.Jain : Ore Processing
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. Kelly & Spottiswood : Introduction to Mineral Processing
9. Robert.H.Richards, Charles Lock & R.Schumann : A Text Book of Ore Dressing
10. Pradeep & Rakesh Kumar : Selected Topics in Mineral Processing
11. S.P.Mehrotra & P.Sarkar : Mineral Processing – Recent advances and future trends
12. A.K.Lynch : Crushing and Grinding Circuits
13. A.M.Gaudin : Flotation

14. R.P.King : Flotation
15. A.K.Finch & G.S.Dobby : Column Flotation.
16. S.Venkatachalam & Degaleeson : Laboratory Experiments in Mineral Processing
17. A.Z.M. Abouzeid : Mineral Processing Laboratory Manual
18. T.Allen : Particle Size Measurement
19. A.K.Matis : Flotation Science and Engineering

MP SC – 2.4 TESTING OF MATERIALS & TRANSPORT PHENEMENON (3-0-0)

TESTING OF MATERIAL

Unit-I

Introduction to material properties:Tensile Test: Load, Stress, deformation, strain, Hook's law, Young's modulus, stress-strain diagram. Engineering stress-strain curve, yield point, percentage elongation, percentage reduction in area, proof stress, universal testing machine, Typical stress-strain curves. Compression Test: Compression test on brittle and ductile materials, nature of failure.Shear

Tests: Shear stress, shear strain, Hook's law applied to shear stress and strain, Rigidity modulus, single shear test and double shear test. Torsion Test: Torsion in solid and hollow circular shafts, torsion equation and torsion test. Wear Test: Introduction to pin on disc method. **(11 Hours)**

Unit-II

Hardness; Introduction, Micro Indentation Hardness, Brinnel hardness test, Vicker's hardness test, Rockwell hardness test, Rockwell superficial hardness test, Rebound hardness, shore's scleroscope.Impact Tests: Introduction, significance, Izod and charpy impact tests, effects of variables on impact test values.Fatigue: Introduction, Repeated loading, Fatigue strength and endurance limit, fatigue test, effect of variables on fatigue property.Testing of miscellaneous products: Introduction, testing of sheet, strip and pipes, ductility tests, bend test and reverse bend test, Testing of tubular products.Introduction to Non destructive testing; Visual examination, leakage testing, penetrant method, ultrasonic testing, X-ray testing, gamma ray testing, magnetic testing. **(11 Hours)**

TRANSPORT PHENOMENON

Unit-III

Fluid Mechanics: Fluid statics and its applications. Fluid flow phenomenon, Basic equations of fluid flow. Practical motion in fluids. Terminal velocity. Flow of incompressible fluids in conduits. Flow past immersed bodies. Transportation and metering of fluids. **(10 Hours)**

Unit-IV

Heat Transfer: Heat transfer by conduction in solids. Principles of heat flow in fluids. Heat transfer to fluids without phase change. Mass Transfer: Phase equilibria. Equilibrium stage operations. Leaching and extraction. Drying of solids. Gas absorption. Principles of diffusions and mass transfer between phases. Mass diffusion in liquids and solids. Convective mass transfer. **(10 Hours)**

BOOKS FOR REFERENCE :

1. A.V.K. Surayanarayana : Testing of metallic materials
2. Martyn.S. Ray : The Technology and Applications of Engineering materials.
3. Thomus Curtney : Mechanical Behaviour of materials.
4. H.W.Hayden, W.G.Muffatt and John Wulff : The Structure and Properties of Materials.
5. R.S.Khurni : Strength of Materials.
6. B.S.Bhavikatti : Strength of Materials.

7. R.B.Bird	:	Transport Phenomenon
8. Kern	:	Heat Transfer
9. Traybal	:	Mass Transfer Operations
10. Mc Cabe & Smith	:	Unit operations of Chemical Engineering
11. Christic.J.Geankoplis	:	Transport Process & Unit Operations.

MP SC - 2.5 COMPUTER BASICS AND PROGRAMMING IN C & C++ (3-0-0)

UNIT-I

Fundamentals of Computers: Organization of a computer, Parts of a personal computer, Input devices, Output devices, Computer storage devices.MS Office utilities, features, and facilities in MS Word, MS Power point. File handling, operations –opening, appending, cascading, closing and attribute control, storage and retrieval, sorting, merging, joining and dividing. Page layout formatting and editing.MS excel, data record, file, data structures, view, handling the data analysis and operations Data base concepts, operation, services, groups, tables graphs and objects. Measures of .dispersion. Statistical design of experiments, 1 and 2 way ANNOVA, Correlation coefficient and regression analysis, Linear and polynomial regression. Logarithm and sigmoid curves. **(12 hours)**

UNIT-II

Introduction to programming: Programming techniques, Algorithm, Flowchart. Fundamentals of C-language: Characters Used in C, Identifier, Keywords, Tokens, Constants, Variables, Variable declaration Basic Data types, Additional data types, Operators & Expressions, Additional operators, Structure of a C program(6 Hrs)Input /output Functions & Statements: Formatted Input/output functions, Escape sequences, Assignment statement, multiple assignment statement, writing user-friendly programs, Running a program using Turbo C **(10 hours)**

UNIT - III

Control statement in C: if –else statement, Nested if statement, switch statement ,Loop control structures in C: Loop control statements, for statement, Nested for statements, while statement, do-while statement, go to statement, break statement, continue statement' exit () function, nested for loop. Arrays and Subscripted Variables: One-dimensional array, Two-dimensional array, Array declaration. String manipulations in C: Reading /writing strings, String handling functions, Operations with characters. Pointers, Structures, Unions, enumerated data types, file handling, the C preprocessor, the C-standard library and header files. Introduction to Data Structures: Primitive and non primitive data types, Abstract data types, Definition and applications of Stacks, Queues, Linked Lists and Trees **(10 Hours)**

UNIT-IV

Introduction to Object Oriented Programming : Introduction, Characteristics of object oriented programming, Data Types. Functions using c++, Concepts of object oriented programming: Classes and Objects, Inheritance, Types of Inheritance : Single, Multiple, Multilevel and Hybrid Inheritance, Polymorphism, Data abstraction, Overloading : Function Overloading, Operator Overloading and Templates. **(10 Hours)**

BOOKS FOR REFERENCE :

1 Srivastav MS Office Complete
2. Udaya Kumar & Jeyapooyan : Computer Concepts & C-programming; 2008 Vikas Publishing
3. E.Balaguruswamy : Programming in C & C++,TMH 1990
4. Yashavant Kanitkar : Understanding Pointers in C &C++BPB Publications
5. Mullish Cooper : The Spirit of 'C' JAICO Publishing Hours
6. Bruce H.Hunter : Understanding 'C' BPB Pub. 1985

MP SC 2.6 HEAT AND MASS TRANSFER (3-0-0)

Unit I:

Introduction to Heat Transfer**:** Importance of heat transfer. Modes of heat transfer. Mechanism of thermal conduction in Solids, thermal conduction in Liquids and thermal conduction in gases. Thermal conductivity. Heat transfer at the interface of two solids. Convection and heat transfer coefficient. Radiation, study of conduction, convection and radiation.

Steady State Unidirectional Heat Conduction: Three –dimensional Fourier conduction equation. Transformation of Fourier equation into polar co-ordination. Derivation of Fourier equation in polar co-ordinates. Derivation of Fourier equation in spherical co- ordinate. Steady state unidirectional heat flow through Slab, Cylinder and sphere through at uniform and non uniform conductivity without heat generation. Electrical analogy for solving the conduction heat transfer problems. Heat flow through composite slabs, composite cylinders and composite spheres with consideration of heat transfer coefficients. Logmean area. **(11 Hours)**

Unit:II

Dimensional analysis and model testing: introduction, criteria of similitude .fundamental dimensions, Buckingham theorem, shear force in the flowing fluid. Frictional loss in pipes. Forced convection, natural or free convection. Advantages of dimensional analysis, Limitations of dimensional analysis physical significance of different non-dimensional numbers. Equivalent diameter. Model similitude

(10 Hours)

Unit:III

Introduction to radiation: introduction. Basic theories of radiant heat transfer. Spectrum of electromagnetic radiation. Reflection absorption and transmission of radiation. Emission of radiation. Black body and monochromatic Radiation. Planck law of radiation. Total emissive power and Stefan

Boltzmann law. Greybody and emissive power of greybody. Kirchhoff's law of radiation. Weins displacement law. Solid angle and intensity of radiation. Lambert cosine law radiation from real surfaces. (**10 Hours**)

Unit IV

Mass transfer: Introduction. Ficks law of diffusion .steady state diffusion of gases and liquids through solids. Equi molal diffusion. Isothermal evaporation of water into air. The mass transfer coefficient.

Thermometry: introductions. Fluid thermometers. Thermoelectric thermometers. Pyrometers. Possible errors in measurements. **(11 Hours)**

BOOKS FOR REFERENCE :

S.Domkundwar	-A course in Heat & mass transfer
Jacob & Hawkins	-Elements of Heat & mass transfer
ERG.Eckart & Robert,M	-Heat nad Mass Transfer
Brown	-Introduction to Heat Transfer

MPL HC- 2.7 ASSAYING LAB – I (0-0-2)

Analysis of various elements like Fe, Mn, Mg, Ca, Pb, Cu, Ni, Ti, V etc., by titrimetric, gravimetric and colorimetric methods

MPL HC - 2.8 MINERAL PROCESSING LAB - I (0-0-2)

Sampling techniques and error estimation.

Determination of physical characteristics of sample like specific gravity, bulk density, angle of repose. Size analysis, wet & dry sieve analysis, Sub-sieve analysis – Beaker decantation and Andreasen

Pipette method, specific surface by permeability method, Verification of Gy's law. Crushing experiments – Jaw, roll crusher. Verification of basic energy laws, Denver grindability test. Determination of pulp density by actual, and specific gravity method [PD scale/tables]. Estimation of % solids both by weight and volume methods.Separation of sample by size and calculation of head and distribution of values. Recheck the actual by determinant methods.

MPL HC - 2.9 COMPUTER BASCIS -PROGRAMMING IN C & C++ LAB (0-0-2)

Excel Math Basics: Writing Formulas and Expressions, Formatting Cells in Microsoft Excel , Locking Cells & Protecting Worksheets , Cell References in Microsoft Excel, Linking Worksheet Data in Excel, Microsoft Excel: Cool Keyboard Shortcuts , Using the Auto Fill Features of Excel, How to Create an Excel Chart , Chart Types: Pie, Column, Line, Bar, Area, Scatter Customizing Charts: A Comprehensive Guide, ANOVAs [1 and 2 way], F-Test, t-Test, Moving Average, Exponential Smoothing . Correlation and Regression

Programs in 'C' involving (Turbo C++ IDE):

1. Constants, Variable, Data type and Evaluation of arithmetic expressions.
2. Input /output Functions & Statements
3 Control statement in C & C++.
4 Loop Control structures *for, while, do- while, switch, if, if-else*
5 Arrays, sorting, searching and matrices operations
6 String progressing
7 Use of Pointers, Structures and Recursive functions.
8 Classes & Objects, Inheritance, Polymorphism, Templates.

THIRD SEMESTER

MP HC - 3.1: ORE MICROSCOPY & RESEARCH METHODOLOGY (3-1-0)

ORE MICROSCOPY

Unit-I

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. **(14 Hours)**

Unit-II

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.

(14 Hours)

RESEARCH METHODOLOGY

Unit III:

Definition and nature of Research, Motivation and Creativity in Research, Different types and Styles of Research in Sciences. Scientific temperament. Critical and Positive thinking, Research plan and design. Topic and formulation of Infrastructure for Research proposal, Problem, Objectives and Scope. Collection of literature, Sources of Information in Mineral Processing – INSDOC service. Classification systems used in libraries, Use of catalogue cards.

(14 Hours)

Unit IV :

Preparation and presentation of research report for various publications. Presentation of illustrations, reprography services and Dissertation writing. Modern Information Technology: E-mail, CD-ROM, Fax, INFLIBNET, INTERNET. Use of Computers in Research. Art of reading, understanding and writing of Scientific Papers, Impact Factors and Citation Index. Plagiarism and Ethical values in Research.

(14 Hours)

Books For Reference:-

1. E.N.Cameron : Ore Microscopy
2. J.R.Craig & Vaughan : Ore Microscopy and Ore Petrology
3. P.Ramdahr : The Ore Minerals and their Inter growths
4. A.S.Acharya : Guide to Thesis And Paper Writing
5. R.Ranganatha : Colon Classification
6. Henry & Sharp : Cataloging
7. M.N.Borse : Hand Book of Research Methodlogy. (Modern, Methods & New Technigues)
8. Deobold B.Van Dalen : Understanding Educational Research An Introduction

MP HC-3.2: MINERAL PROCESSING – II (3-1-0)

Unit I :

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.

(14 Hours)

Unit II:

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. Floatex density separators, Reflux classifiers, Stub cyclones Autogenousmedia cyclones : Sorting classifiers;Principles, Operation & efficiency of, types and their industrial application,

14 Hours)

Unit III:

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

Gravity Separation : Separation in Vertical currents – Jigging –Theory and principles, different types 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. 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.

(14 Hours)

Unit IV:

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.

(14 Hours)

BOOKS FOR REFERENCE

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. A.M.Gaudin	:	Flotation
9. R.P.King	:	Flotation
10. Kelley & Spottiswood	:	Introduction to Mineral Processing
11. Robert.H.Richards, Charles Lock & R.Schumann	:	A Text Book of Ore Dressing
12. Pradeep & Rakesh Kumar	:	Selected Topics in Mineral Processing
13. S.P.Mehrotra & P.Sarkar	:	Mineral Processing – Recent advances and future trends.

14. A.Z.M. Abouzeid : Mineral Processing Laboratory Manual
15. S.Venkatachalam & Degaleeson : Laboratory Experiments in Mineral Processing
16. T.Allen : Practicle Size Measurement
17. A.K.Matis : Flotation Science and Engineering
18. A.K.Finch & G.S.Dobby : Column Flotation.
19. SME HAND BOOK OF MINERAL PROCESSING : Weiss Vol I and II

MP HC - 3.3 COAL PREPARATIONS & FUEL TECHNOLOGY (3-1-0)

Unit-I

Fuel Technology: Scope, objectives, and applications. Types of fuels: solid, liquid, gaseous fuels with examples. Primary, secondary & tertiary fuels. Advantages of solid, liquid &gaseous fuels. Properties of fuels & their tests. Calorific value of fuels, Oxygen bomb calorimeter. Combustion of coal & their types. Boudward reactions and other relevant reactions.

(14 Hours)

Unit-II

Carbonization: Theory of carbonization, types of carbonization, advantages of carbonization, Gasification of coal, smelter gasifer and corex gas. standard metallurgical coke making process, properties of coke, Micum Test, Shatter Test, Haven test, Roga Index, Swelling Index, Gray king assay value, free swelling number. plastic properties of coals,High temperature properties of coke, byproducts of a coke oven, waste heat and flue gas recovery. Coal slurry injection to blast furnace.

(14 Hours)

Unit-III

Coal preparation: Scope, objectives and applications. Types and properties of coals in general, industrial uses, characteristics of coals, coking and non-coking coals. Washability studies sink and float analysis of coals. Standard washability curves, tromp Curves, Mayer curves, probable error, wash ability index. Efficiency of coal washing. **(14 Hours)**

Unit-IV

Gravity separation process**:** Jigging: jig types and applications. Comparision of mineral and coal jigs. Baum and Batac jigs. Heavy media Separation: Types, application and operation. Heavy Media (Commercial) , Media Recovery circuit. Heavy Media cyclones-operating principles ,applications, performance , efficiency and Design calculations. Preparation of non-coking coals. Modern developments in process and units.

Fine coal washing : Modern trends. Froth flotation , Oil agglomeration , Water only cyclone and their applications in coal washing Typical coal washing flow sheets with reference to Indian coal washeries, coal washery equipments and its selection. Factors of Designing a Modern coal washery.

(14 Hours)

BOOKS FOR REFERENCE :

1) Osborne : Coal Vol. I and II
2) Michel : Coal
3) G.G.Sarkar : Coal Preparation
4) Wilfred Francis : Fuel Technology
5) Samir Sarkar : Fuel and ombustion
6) Samir Sarkar : Elements of Fuel

7) Samir Sarkar : Utilization of Coal
8) James G Speight : Chemistry and Technology of Coal
9) Godfrey W.Humus : Fuel Technology
10) Wilfred Francis : Fuel Technology
11) James G Speight : Chemistry and Technology of Coal
12) Bernard R Cooper and Willim A Ellingson : The Science and Technology of Coal utilization
13) S. Venkatachalam & Degaleecan : Experiments in Mineral Engineering

MP SC - 3.4 SURFACE CHEMISTRY (3-0-0)

Unit-I

Chemical Bonding: Ionic bond- Properties of Ionic solids, Covalent bond- Properties of covalent compounds, Polarity in covalent bonds, Hydrogen bond, Metallic bond.
Colloids: Classification, Preparation, Properties and Application of colloids **(10 Hours)**

Unit-II

Adsorption: Types of adsorption and its characteristics. Thermodynamic models of isotherms. Fraundlich Adsorption Isotherm, Langmuir's Adsorption Isotherm, BET theory of multiplayer adsorption isotherm, Henry's law and Polany's potential theory, Mechanical effects of adsorption. Chemisorption. **(11 Hours)**

Unit-III

Physical Chemistry of Surface and Interfaces: Liquid-Gas Interface: Surface tension and its measurement, Surface tension values, surface tension and temperature and other properties. Surface tension and chemical composition. Thermodynamics of surface tension, surface tension of solutions, Monolayers and their effects.

Liquid-Liquid Interface: Interfacial tension and its values, Multicomponent system, Spreading of liquid over liquid, Films at interfaces, Emulsions.

Solid-Liquid Interface: Interfacial energy, Stagnant layer at solid-liquid interfaces, Adsorption of liquids, Heat of wetting, Adsorption from solutions, Importance of adsorption and its utilization, Corrosion by liquids.

Solid-Liquid-Gas Interface: Contact angle and its measurement and characteristics, Solid particles in liquid surface. **(11 Hours)**

Unit-IV

Electrical characteristics on Interfaces: Static electricity, Conductance of solid-gas interfaces, Electrokinetic phenomenon, theory and its measurements, Effects of composition of liquid phases and solid on electrokinetic phenomenon. Electrical Double Layer, mutual repulsion of EDL's, utilization of electrokinetic phenomenon. **(10 Hours)**

BOOKS FOR REFERENCE :

1. O.Kubaschewski and C.B.Alcoc	:	Metallurgical Thermodynamics
2. Jan Leja	:	Surface Chemistry of Froth Flotation
3. Puri & Sharma	:	Principles of Physical Chemistry
4. Maron & Prutton	:	Principles of Physical Chemistry
5. Samuel Glasstone	:	Physical Chemistry
6. J.J.Bikerman	:	Surface Chemistry, Theory and Applications
7. Lloyd.I.Osipov	:	Surface Chemistry, Theory & Industrial Applications.
8. Duncan.J.Shaw	:	Introduction to Colloid & Surface Chemistry.

MP SC - 3.5 INDIAN MINERAL DEPOSITS AND PLANT FLOW SHEETS (2-1-0)

Unit-I

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.

(10 Hours)

Unit-II

Study of important Metallic and Non-metallic Mineral Deposits of India with reference to Origin Mode of occurrence, Mineralogy, Distribution, Production, Process Flow-sheets, Uses and Trades in India. Metallic deposits: Iron, Manganese, Chromium, Copper, Lead and Zinc, Bauxite, Gold and other precious metals **(11 Hours)**

Unit-III

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. **(11 Hours)**

Unit-IV

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

(10 Hours)

Books for Reference:-

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.

(3-0-0)

MP SC - 3.6: BIO PROCESSING

Unit-I

Concept and scope of bio-mineral processing. Utility of Microbes for beneficiation and selective dissolution of minerals/metals. Types of microbes & their genesis. Culturing and identification of microbes with reference to bio-processing. Acid mine drainage its impact and control. Bio-flotation and flocculation. Application of Bio-processing and dissolution

(10 Hours)

Unit-II

Classification of microorganisms, Prokaryotic and Eukaryotic cells; general properties, distribution of microbes,applied fields of microbiology. Enumeration of microbes; microscopic techniques, staining. Bacteria - cell structure, spore, morphology, classifications and reproductions.Culture characteristics, growth, nutrition requirements, morphology and reproduction of Fungi, Algae, Protozoa and Actinomycetes**.**

(10 Hours)

Unit-III

Growth of microbes: batch culture, specific growth rate and doubling time; continuous culture; synchronous growth.Effects of environmental factors on growth.Microbial nutrition; culture media and culture characteristics.Handling of microbes; identification and staining.Control of microbes by physical agents and chemical methods.Microbial metabolisms -Anabolism/catabolism; Central metabolism: glycolysis and the TCA cycle; Metabolic pathways of contaminant biodegradation; Metabolic regulation Stoichiometry and Bacterial Energetics – Mass balances, Redox reactions: electron donor/electron acceptor; Redox half-reactions; Energy balances (_G) – Growth, Substrate Partitioning and theoretical yield, Electron acceptors, fermentation. Monod and Halden kinetics.

Bio processing of sulphides ore (bio-leaching and bio-oxidation). Mineral bio-processing mechanisms; engineering process. Degradation of natural substances.

(11 Hours)

Unit-IV

Concept and principles of bio leaching . Eh-pH diagrams and their importance in prediction of leaching systems. Common metals extracted through bio leaching and bio hydrometallurgy. Characteristics of different microbes used in mineral processing, Direct and indirect attachment of microbes on mineral surfaces, Variation of surface charges in presence and absence of microbes, Use of microbes in mineral operations, Bio flotation, Bio flocculation some case studies. Microbes and their utility in bio hydrometallurgy. Isolation and identification microbes used. Application of bio hydrometallurgy, some case studies.

(11 Hours)

BOOKS FOR REFERENCE :-

1. Agate. A.D., Basic principles of Geo-Chemistry
2. Venkatechalam. S., Hydrometallurgy
3. Ehrlich, H.L. and Brierley, C.L., Microbiological Mineral Recovery
4. Karavaiko. G.I and Kaznetsor, S.I., The Bactrial leaching of metals Iron Ores.
5. Murr, L.E., Torma, A.E and Brierly. A.J.(eds) Metallurgical applications of bacterial leaching and related microbiological phenomena.
6. Ross,G., Biohydrometallurgy.

MPL HC - 3.7: ORES AND ORE MICROSCOPY LAB (0-0-2)

Study of metallic and non-metallic ores: - iron, manganese, copper, bauxite, lead and zinc ores etc.,
Microscopic studies of ores – Important texture, Refletance, Bireflectance, Microhardness and etch test.

MPL HC - 3.8: MINERAL PROCESSING LAB – II (0-0-2)

Determination of terminal velocity - Free settling test, Hindered settling test,
Cyclone test rig experiments and classification [air and mechanical] experiments
Sink and float tests, preparation of washability cuves and reduced efficiency [tromp] curves
Experiments in Jigging, Tabling, Spiral – effect of machine parameters (profile, splitter position) and Material parameters like MOG, Percent solids.
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MPL HC - 3.9: ASSAYING LAB - II (0-0-2)

Separation of elements by Ion Exchange and Solvent Extraction methods.
Analysis of ores and Alloys. Experiments of Adsorption of liquids on solids.

FOURTH SEMESTER

MP HC-4.1: MINERAL PROCESSING- III (3-1-0)

UNIT - I

Flotation fundamentals **:** Introduction, History. Physical aspects of Flotation – Surface Energy and surface tension, Interfacial tension, Cohesion, adhesion and Contact angle. Types of interfaces, Electrokinetic Phenemenon, Electrical Double Layer at the Solid-Liquid interface. Alteration of Solid surfaces caused by mechanical forces. Adsorption and its characteristics, pH, Solid/Liquid ratio. Microflotation tests, Laboratory flotation tests, Flotation Kinetics and Factors affecting flotation

(14 Hours)

UNIT - II

Chemical Aspects – Flotation reagents and their Classification. Functions of each class of reagents. Dissociation and hydrolysis, Kraft point and Cloud point. Mechanism of Adsorption of reagents and Characteristics. Attachment of reagents to minerals as surface compounds, Attachment of reagents to Air bubble surface. Joint action of collectors and frothers. Mineralized froths and their stability. Types of flotation – Selective flotation, Skin flotation, Reverse flotation, Floc-flotation, Electro-flotation, ion flotation and Differential flotation.

(14 Hours)

UNIT - III

Flotation Machines**:** Basic machine features and function. Classification of flotation machines. Bubble generation. Design features of different machines. Like Denver flotation cell, Fagergren flotation cell,

flotation cell, Column flotation, Jameson cell and Dual Extraction Column etc,. Study of Flotation circuits like roughing, scavenging and cleaning etc,. **(14 Hours)**

UNIT - IV

Plant practices**:** Study of flotation of Copper, Copper- Lead-Zinc sulphides, Iron ore, Fluorspar, Rock phosphate, Lime stone, oxidized and mixed non-ferrous ores.

(14 Hours)

Books for Reference:-

1. Principles of Mineral Dressing - A.M.Gaudin.
2. Flotation - A.M.Gaudin.
3. Mineral Processing - E.J.Pryor
4. Text Book of Ore Dressing - A.F Taggart
5. Hand Book of Mineral Dressing - A.F Taggart
6. Will's Mineral Processing Technology - B.A. Wills
7. Introduction to Mineral Processing - Kelly and Spottiswood
7. Mineral Processing - S.K.Jain
8. Laboratory Experiments in Mineral Engineering - S.Venkatachalam & S.N.Degaleesan
9. Unit operations in Mineral Engineering - J.H.Brown
10. Mineral Processing Laboratory Manual - A-Z M Abouzeid.

11. Crushing and Grinding Circuits - A.J.Lynch
12. Flotation - R.P.King
13. A Text Book of Ore Dressing - Robert.H.Richards, Charles Lock & R.Schumann
14. Selected Topics in Mineral Processing - Pradeep & Rakesh Kumar
15. Mineral Processing – Recent advances and future trends. - S.P.Mehrotra & P.Sarkar
16. Practicle Size Measurement - T.Allen
17. Flotation Science and Engineering - A.K.Matis
18. Column Flotation. - A.J.Finch & G.S.Dobby
19. Flotation: Theory, Reagents and Testing - R.D.Crozier
20. Flotation of sulphide Minerals Developments in Mineral Processing Vol.6. - K.S.E. Forssberg (Ed)
21. Surface Chemistry of Froth Flotation - Jan Leja
22. Reagents in Mineral Flotation - P.Somasundaran & Brij Moudgil
23. Operational Hand Book of Mineral Processing - V.V.Ramana Murthy

MP HC - 4.2: NON FERROUS EXTRACTIVE METALLURGY (3 -1-0)

Unit-I

Thermodynamics and kinetics of metallurgical reactions.Sources of Metals.
Pyrometallurgy: Principles, Fuels and Combustion furnaces.

(14 Hours)

Unit-II

Unit processes of pyrometallurgy – Drying, Calcining, Roasting, Sintering, Smelting and Refining. Extraction of Copper, Nickel, Lead, Zinc, Aluminium, Gold, Silver, Titanium, Magnesium, Nuclear and Reactive metals. Use of Halides in non-ferrous extraction.

(14 Hours)

Unit-III

Hydrometallurgy: Principles, Chemical and Electrochemical Principles of Leaching, Precipitation, Solvent Extraction, Ion Exchange, Extraction, E_h -pH Diagrams, Metal Extraction under atmospheric pressure, high pressure and temperature. Extraction of metals-Gold, Silver, Uranium, Copper, Zinc and Nuclear metals. Bioleaching- Concepts and principles, E_h -pH Diagrams, Extraction of common metals, Microbes, Characteristics and utility.

(14 Hours)

Unit-IV

Electrometallurgy: Principles, Electrowinning and Electrorefining of metals like Copper, Nickel, Lead, Gold, Silver, Zinc etc., Electroplating. Powder Metallurgy: Principles and applications.

(14 Hours)

Books for Reference:-

1. Habashi.F., Principles of Extractive Metallurgy. Vol I - IV
2. Kubaschewski.O., Erons.E.L., and Alcock, C.B., Metallurgical Thermochemistry.
3. Phelke. R.D., Unit processing of Extractive Metallurgy
4. Rosenqvist.T., Principles of Extractive Metallurgy
5. Newton.J., Extractive Metallurgy
6. Gilchrist.J.d., Extraction Metallurgy
7. Bray.J.L., Non-ferrous production Metallurgy
8. Ray.H.S., Sridhar.R. and Abraham.K.P., Extraction of Non-ferrous Metals
9. Pryor.E.J., Mineral Processing
10. Kurt Meyer, Pelletization of Iron Ores
11. Venkatachalam.S., Hydo-metallurgy

MP HC - 4.3: MINERAL PROCESSING – IV (3-1-0)

Unit-I

Magnetic Separation: Principles, types of magnetic separators, wet and dry, low and high intensity, high gradient magnetic separators; performance, efficiency and their industrial applications Electrostatic separation: Principles, methods and application **(18 Hours)**

Unit-II

.Flocculation and Dispersion: Fundamental factors underlying flocculation and dispersion phenomenon,Effects of electrolytes, flocculants and dispersants **(10 Hours)**

Unit-III

Dewatering: Introduction and importance, Thickening – theoretical aspects, types of thickeners. Filtration – mechanism and types of filters.Centrifuging and drying: Thermal dryers, humidity calculations and sizing of rotary dryers, Fluidized bed dryers. Non-conventional methods of drying. Application and practice of dewatering processes in metallic and non-metallic slurry systems **(14 Hours)**

Unit-IV

Tailing Disposal: Tailing ponds and Design & construction, Types, Industrial applications and water reclamation **(14 Hours)**

MP SC - 4.4: MINERAL PROCESSING PLANT DESIGN – I (3-0-0)

UNIT -I

Sampling and Testing: Sampling a mineral deposit for feasibility studies and metallurgical testing. Metallurgical testing procedures. Metallurgical flow sheet development. **(10 Hours)**

UNIT-II

Selection and design features of Crushing and Grinding Equipments: Primary, Secondary & Tertiary Crushers. Rod and Ball mills. Autogenous grinding from Test work.

(11 Hours)

UNIT-III

Screening – Classification – Gravity Separation: Selection guidelines for size and types of Vibrating

Screens in Ore crushing plants. Application and selection of Spiral Classifiers, Selection of cyclone classifiers. Pumps and pump boxes for grinding circuits. **(11 Hours)**

UNIT-IV

Process and plant design for gravity concentration – examples with flow sheets. Dense media separation. Metallurgical, Operating and Economic characteristics. Flow sheet development.

(10 Hours)

MP SC - 4.5: PROCESS CONTROL AND AUTOMATION (3-0-0)

UNIT-I

Introduction – Static performance characteristics, Dynamic characteristics – Transducer elements – Intermediate elements. Temperature – Temperature measurements, various methods – column change – softening type. Instruments on expansion concept. Resistance thermometers, Thermocouples – Radiation type pyrometers, Ionization principle – recent methods. Liquid level measurement – various types. **(10 Hours)**

UNIT-II

Pressure – Pressure measurement – Manometers. Elastic properties utilization – Bourdon guage – Diaphragm guage. Force balancing concept. Bellow type – vaccum guage- McLead, Pirani Ionization gauge, High pressure measurements. Electrical type instruments. Density measurements – various types. **(10 Hours)**

UNIT-III

Flow: Flow measurement, both weight and volumetric flow measurements. Usage of Bernoulli's principle – orifice plates, venturi, elbow flow meter, nozzle – weirs – notch rotameters, laminar flow meter, obstructionless flow meter – positive displacement type – vane type. Viscosity measurements: various methods, Rheometers, Moisture and humidity measurements, various methods. Conductivity meter – pH meter. Particle size measurement using Image analysis.

(11 Hours)

UNIT-IV

Introduction to feed back control P, PI & PID controllers, Liquid level, mixing tank, interacting and non-interaction systems. Control of Crushing plants, wet grinding circuits, and Flotation columns: Control objectives, Disturbances, Sensing techniques, Case studies of various advanced automatic control systems for different mineral processing plants.

(11 Hours)

Books for Reference:

1) Process Control Instrumentation Technology –Curtis D.Johnson; 7th Edn
2) Industrial Automation and Process Control - Jon Stenerson,2003.
3) Process system and Control – F.G.Sainsky

MP SC - 4.6: INDUSTRIAL MANAGEMENT: (3-0-0)

Unit-I

Growth and concept of Industry: - Basic and scientific factory systems, types of ownership,

Principles of management. Organization- Types of organizations, role of executives, elements of co-ordination Functions of management: Planning, organizing directing, co-ordination, controlling and decision making

(10 Hours)

Unit-II

Personal Management:- Functions of personal management, recruitment, selection and training of Workers and supervisors. Production Management:- Plant location, layout of plants, depreciation and valuation of machinery, production planning and control. Quality productivity movement in India. Automation in India, its advantages and disadvantages. Functions of production control and planning control, material control.

(10 Hours)

Unit-III

Marketing: Functions of marketing, Market research, sales, organizational planning, advertising and sales
promotion, duties of sales personnel. **(11 Hours)**

Unit-IV

Human Relations: Job specification and morale, Employer and Employee relations, Health and Wealth of workers. Effects of physical conditions like noise, lighting, ventilation on output, fatigue and reduction of fatigue.
Industrial safety: Accidents and their reduction. Settlement of individual disputes, ILO, workers participation in management. **(11 Hours)**

Books for Reference:

1. Barthwal. B.R. **:** Industrial Economics- An introductory Text
   Wiley Eastern Ltd., New Delhi, 1984.
2. Mehta.P.L. **:** Managerial Economics
   Sultan Chand & Sons, New Delhi – 1988.
3. Dwivedi **:** Text book of Managerial Economics
   Vikas Publihsing House, New Delhi 1998.
4. Minor.J.B. & Miner.M.G. **:** Personnel and Industrial Relations:
   A Managerial approach
   Mac Millan Publihsing Co.1997
5. Promod Verma & Surya Mokkerjee **:** Trade Unions of India
   Oxford & IBH Publishing Co. 1982
6. Banga.T.R. & Sharma.S.C. **:** Industrial Organisation and Engineering Economics
   Khanna Publications, Delhi.

MPL HC - 4.7: MINERAL PROCESSING LAB – III (0-0-2)

Flocculation and dispersion. Oil agglomeration.

Experiments on Flotation – measurement of contact angle, surface tension and frothing, flotation of oxides, sulphides, salts and natural floatable minerals, differential flotation, flotation kinetics Circuit configuration, locked cycle test etc. Adsorption,

MPL HC - 4.8: METALLURGY LAB: (0-0-2)

Process diagnostic metallurgical tests, Experiments on Reduction and Oxidation roasting, Thermal

decomposition, Leaching [aqueous, acidic, alkaline, oxidative, reductive and complexing] [heap, agitational]

and Phase rule.

MPL HC - 4.9: COAL PREPARATION LAB : (0-0-2)

Sampling of coal, Study of washability curves, sink and float analysis. Preparation of Laboratory liquids, Study of washability index . Ash analysis, Proximate analysis of coal, Hard grove grindability index. calorific value of coals using oxygen bomb calorimeter.

Study of typical Indian coal washery flow sheets. Solving of washability problems and other calculations. Experiments on Jigging, H.M.Separation, froth flotation and oil agglomeration of coal. Study of coking and non-coking coals. Carbonization of coking coals, experiment on classification of fine coal using cyclone.

FIFTH SEMESTER

MP HC - 5.1 ENVIRONMENTAL MANAGEMENT & MINERAL PROCESSING ECONOMICS

(3-1-0)

Unit-I

Introduction: Impact on environment and Ecology due to mining and mineral processing, Biosphere, Natural cycle, Concept of sustainable development, Life Cycle Assessment, Environmental Impact Assessment, Environmental management Plan, Objectives of Environmental Plan.Environmental pollution, definition of Pollution, Origin of Pollution, Pollutants, Classification of Pollutants, Types of Pollution, Source of Pollution, Effects of Pollution on the Environment.

(14 Hours)

Unit-II

Air Pollution: Introduction, composition of air, Origin of Atmosphere, Structure of Atmosphere, (Troposphere, Stratosphere, Mesosphere, Thermosphere, and Exosphere), Sources of Air pollution, Classification of Air Pollution and Pollutants, according to air origin and state of materials. Effects of Air Pollution (Effects on Human health, animals,Plants, material and climate).Air pollution laws, analysis of air pollutants, measurement of air quality, units, sampling devices and methods of sampling, control of air pollution and equipments.

(14 Hours)

Unit-III

Water Pollution: Characteristics of water, Types of water pollution, sources of water pollution, Classification of water pollutants, Waste water sampling and analysis, Waste water treatment, control of water pollution, water management – Industrial wastes and treatment processes.

Soil pollution: Introduction to soil chemistry, soil pollution, soil erosion, control of land degradation, control of soil pollution, solid waste management. Soil pollution by Industrial wastes, Soil pollution by, Chemical and metallic pollutants, Radioactive pollution. Soil pollution by industrial waste and remedial measures.

Noise Pollution: Definition, Sources and Classification of Noise pollution, Measurement of Noise, Units of sound, Noise level, Measuring noise level, Industrial noise pollution, Prevention and control of noise pollution.

(14 Hours)

Unit-IV

Role of mineral industry in National Economy. Economics- Definition, Wealth, cost, prices, Elements of economic activities – production and Productivity. Demand, Supply and Distribution of Income. Economic organization of industry, Private and Public sector, Costs and cost accounting. Capital interest and annual charges, obsolescence, depreciation and valuation. International Trade related to Mineral Industry. Economic selection of equipment, estimating the cost of equipment. Capital and operative cost. Milling calculations and Mill reports.

(14 Hours)

BOOKS FOR REFERENCE:

1.	C.S.Rao	: Environmental Pollution Control Engineering
2.	Suresh K.Dhameja	: Environmental Engineering and Management
3.	M.N.Rao, H.V.N.Rao	: Air Pollution
4.	Fred & Bell	: Environmental Geology, Principles and practices
5.	Willium P.Cunningham and Barbara Wood worth Saigo	: Environmental Science – A Global Concern
6.	Herbert.F.Lund	: Industrial Pollution Control Hand book.
7.	B.K.Sharma	: Environmental Chemistry
8.	Anil Kumar De	: Environmental Chemistry
9.	Amitava Bandopadhyay, N.G.Goswami P.Ramachandra Rao.	: Environmental West management in Iron and steel Industries.
10.	P.S.Jaiswal and Nistha Jaiswal	: Environmental Law See Add-2003
11.	Barthwal. B.R.	: Industrial Economics- An introductory Text Wiley Eastern Ltd., New Delhi, 1984.
12.	Dwivedi	: Text book of Managerial Economics Vikas Publihsing House, New Delhi 1998.
13.	Banga.T.R. & Sharma.S.C.	: Industrial Organisation and Engineering Economics Khanna Publications, Delhi.

MP HC - 5.2 AGGLOMERATION AND CEMENT MAKING (3-1-0)

AGGLOMERATION

Unit – I

Agglormeration: Principles, mechanisms and importance of size enlargement process. Sintering of iron ores: effect of fluxes, fuel and moisture content. Briquetting and Nodulizing.

(14Hours)

Unit-II

Pelletization – principles, mechanisms, fundamental forces of cohesion between particles, surface tension, forces between microassemblies, pore size distribution, additives, pre-heating & indurations, quality of agglomerates, effect of parameters, like, size, moisture, binder concentration, effect of drying and autoclave curing, fluxed pellets, composite pre -reduced pellets and cold bonded pellets.Compaction by piston/ roll press – effect of machine and material parameters.

(14 Hours)

CEMENT MAKING

Unit –II

Introduction to cement making, chemical composition and physical properties of raw materials, general types of Portland cement, special types of cements. Major components, critical impurities chemical analysis, raw material requirement and proportionating Types of process, product fineness, reclaiming and proportionating. **(14 Hours)**

Unit –IV

Crushing: - Grinding Circuits for raw materilas, additives, beneficiation, operating costs. Mixing: - dry and wet processes. Burning and cooling: - chemistry of kiln process, kiln capacity, rotary kiln design , fuels, clinker cooling , kiln exhaust gas and dust handling systems. Cement storage and handling systems. **(14 Hours)**

Books For Reference

1. H.S.Ray, R.Sridhar& K.P.Abraham, Extraction of Non Ferrous Metals
2. T.Rosenqvist, :Principles of Extractive Metallurgy
3. H.S.Ray & A.Ghosh, :Principles of Extractive Metallurgy
4. R.H.Tupkari, :Introduction to Modern Iron Making
5. McHarry, Jan, :Reuse Repair Recycle, Gaia Books Ltd. 1993.
6. Lardinois, I., and Klundert, A van de, Organic Waste – Options for Small-scale Resource Recovery, Urban Solid Waste Series, TOOL / WASTE Consultants, 1993..
7. Franceys, R., A guide to the development of on-site sanitation. WHO 1992.
8. Karekezi, S. and Ranja, T., Renewable Energy Technologies in Africa, AFREPEN, 1997.
9. Vogler, Jon, Work from Waste – Recycling Wastes to Create Employment, Intermediate Technology Publications, 1981. A classic text full of practical ideas for recycling and re-use of waste.
10. Pollock, Cynthia, Worldwatch paper – Mining Urban Wastes: The Potential for Recycling, Worldwatch Institute 1987.
11. S.Ramachandra Rao (Ed):- Waste processing and recycling in mineral and metallurgical industries Vol. II: proceedings of the International Symposium on Waste Processing and Recycling in Mineral and Metallurgical Industries II, Vancouver, British Columbia, August 20-24, 1995
12. Hand Book of Mineral Dressing - A.F Taggart
13. SME HAND BOOK OF MINERAL PROCESSING : vol I and II
14. Kurt Meyer, Pelletising of Iron Ores

MP HC -5.3 FERROUS EXTRACTIVE METALLURGY (3-1-0)

Unit-I

Iron Making: The blast furnace plant and its accessories. Raw material and their preparation. Sintering and Pelletization. Blast furnace reactions. **(14 Hours)**

Unit-II

Modern trend in blast furnace practice – High top pressure, Oxygen enrichment of blast, Humidification of blast. Auxiliary fuel and lime dust injection through the tuyers. Laddle desilicanization, External desulfurization. Direct reduction process – Rotary Kiln, Gaseous reduction (Hyl, Midrex), Electric Dig iron (Tysland, hole process), Corex Technology. **(14 Hours)**

Unit-III

Steel Making: Thermodynamics of refining – Carbon, Silicon, Manganese, Phosphorous and Sulphur reactions. Deoxidization of steel – Raw materials for steel making. Steel making by L.D.Process .

(14 Hours)

Unit-IV

Steel making by Oxygen bottom blowing and combined blowing. Other recent processes. Secondary steel making processes. Electric arc furnace process, Casting pit practice , continuous casting of steel, Production of ferro alloys. **(14 Hours)**

Books for Reference:

1. Biswas. A.K., principles of Blast Furnace Iron making
2. Tupkary.R.H., Introduction to Modern Iron Making.
3. Tupkary.R.H., and Tupkary.V.R., An Introduction to Modern Steel Making.
4. Kurt Meyer, Pelletising of Iron Ores
5. Ghosh.A and Chatterjee.A., Iron making and Steel making
6. Ghosh.A., Text book of Material and Metallurgical thermodynamics

MP SC 5.4 MINERAL PROCESSING PLANT DESIGN – II (3-0-0)

UNIT -I

Flotation: Basic functions and sizing and Selection of flotation machines, Flotation machine families, Selection of chemical reagents, Conceptual design of flotation circuits. **(9 Hours)**

UNIT-II

Magnetic and Electrostatic separation: Types, Process and Plant design of Magnetic and Electrostatic separators. Flow sheets. (**6 Hours)**

UNIT - III

Solid-Liquid separation: Thickeners – Mill design for thickeners, thickener tanks, Mechanism of operation and control. Filters – Types and theory of continuous filtration, Concentrate drying, Handling and storage. **(9 Hours)**

UNIT -IV

Belt conveyers: Design, Selection, Stackers and Reclaimers. Slurry transportation Operations: Design and Application of a Centrifugal slurry pump, Design and construction of Tailing ponds and water Reclamation facilities. Environmental considerations in mill sites. Dust collection systems – Electrostatic system design and Equipment applications. Design and construction of Modern Mineral Processing Plant and Flow Sheets.

(18 Hours)

MP SC - 5.5 SIMULATION AND MODELING (3-0-0)

UNIT-I

Particle population and distribution functions: Distribution functions- Empirical distribution functions, Truncated size distributions, distribution density function, distribution by number, the representative size and population averages.

Distributions based on particle composition, Joint distribution functions. Mineral liberation: beta distribution for mineral liberation.

(10 Hours)

UNIT-II

Size classification: Models based on screen capacity, Karra model and Kinetic Model.
General principles of operation of the Hydrocyclone, Empirical performance models for hydrocyclones, The Plitt model for the hydrocyclone.

(10 Hours)

UNIT-III

Comminution operations: Crushing machines, Jaw and gyratory crushers, Cone crushers, Crushing mechanisms and product size distributions. Magnetic separation machines, Dry Magnetic separation, Hopstock Model. **(11Hours)**

UNIT-IV

Flotation: A kinetic approach to flotation modeling, Pulp phase, Bubble phase, Froth phase, Entrained phase. A kinetic model for flotation, Particle–bubble collisions.

Simplified kinetic models for flotation, Application to flotation cells in complex flow sheets.

(11 Hours)

B**OOKS FOR REFERENCE:**

Modeling & simulation of
Mineral Processing Systems : R.P.King; Butterwort Heinemann 2001
Particulate technology : Bennette (Barrol)
Grinding Hand book : Prasher.

MP SC - 5.6: WASTE RECYCLING (3-0-0)

Unit-I

Mining wastes: Types of waste, utilization of waste dumps, separation of valuable metals from waste products of mining using primary separation methods, recovery of iron ore, manganese ore, coal and other ferrous metals from mining wastes, recovery of radioactive minerals from gold mining wastes, a case study of individual metals collection of mining waste model check dams and dumps

(11 Hours)

Unit-II

Processing waste: Types of processing waste, waste slurry treatment using thickners , cyclones, sedimentation, settling techniques , solid waste recovery of valuable metals by simple separation methods, waste disposal , tailing dumps , ponds. **(10 Hours)**

Unit-III

Metallurgical waste: Types of metallurgical wastes, iron ore fines, coal fines, coke breeze, dolomite fines, sinter fines, pellet fines and sludge etc.Uses of fines in pellet plants , coke fines , sinter plants , briquette making & recycling using sinter plants Sludge treatment , segregation and separation of sludge constituents using primary separation methods , iron ore , coke, and coal fines separation

(11 Hours)

Unit-IV

Sludge: Sludge types, granulated slag reuse in cement plants. Sludge used in construction of roads and metal recovery from Sludge. Environment control and bio leaching techniques. Injection of iron ore and coke fines to blast furnaces and its advantages and disadvantages **(10 Hours)**

BOOK FOR REFERENCE:

1. McHarry, Jan, *Reuse Repair Recycle,* Gaia Books Ltd. 1993. A valuable source book aimed at reducing wastage by thrift. Aimed mainly at a western audience but with many references applicable to the developing world.
2. Lardinois, I., and Klundert, A van de, *Organic Waste – Options for Small-scale Resource Recovery,* Urban Solid Waste Series, TOOL / WASTE Consultants, 1993. The focus of this book is on the recovery of urban organic waste, in developing countries, through activities such as animal raising, composting, the production of biogas and briquetting.

3. Franceys, R., *A guide to the development of on-site sanitation.* WHO 1992. Provides in-depth technical information about the design, construction, operation and maintenance of on-site sanitation facilities, with numerous practical design examples.
4. Karekezi, S. and Ranja, T., *Renewable Energy Technologies in Africa*, AFREPEN, 1997.
5. Vogler, Jon, *Work from Waste – Recycling Wastes to Create Employment*, Intermediate Technology Publications, 1981. A classic text full of practical ideas for recycling and re-use of waste.
6. Pollock, Cynthia, *Worldwatch paper – Mining Urban Wastes: The Potential for Recycling*, Worldwatch Institute 1987.
7. S.Ramachandra Road(Ed):- Waste processing and recycling in mineral and metallurgical industries Vol. II: proceedings of the International Symposium on Waste Processing and Recycling in Mineral and Metallurgical Industries II, Vancouver, British Columbia, August 20-24, 1995

MPL HC- 5.7: MINERAL PROCESSING LAB – IV (0-0-2)

Dry Magnetic separation experiments – Size, Intensity and Gradient, Davies tube experiments, Amenability tests,

Thickening tests, selection of flocculants, Filtration vacuum and pressure filtration tests

Locked cycle test configuration, Effect of circuit configuration and effect of reclaimed water, Preparation of material and metallurgical balance..

MPL HC - 5.8: AGGLOMERATION (0-0-2)

Pelletization studies : effect of size, moisture and binder concentration, drying, preheating and induration.

Sintering of iron ores – effect of fluxes, moisture and fuel. Roast sintering of pyrite concentrate. Compaction by piston / roll press.

Study of processing and development of flow sheets for Iron Ores, Manganese ores, Copper, Lead & Zinc ,Bauxite, Graphite, Limestone & Dolerite, Baryte, Magnesite and Clays.
Each student should carry out experiments and develop flowsheets for any 3 of the above minerals.

MPL HC - 5.9: SIMULATION & MODELING LAB (0-0-2)

Simulation Exercises using Ore Dressing Plant Simulator (e.g. MODSIM) on:

(Not less than 14 Exercises from the following)

1. Drawing Flow-sheet of Ore Dressing Plants
2. Simulation of crushing and grinding plants, Models for vibrating screens.
3. Simulation of gravity separation plants.
4. Dense medium separations - baths and cyclones.
5. Autogenous gravity separations - jigs, sluices, Riechert cones, water-only cyclones and spiral concentrators.
6. Simulation of flotation plants.
7. Models for flotation systems.
8. Comminution plants.
9. Models for SAG and FAG mills.
10. Models for ball and rod mills.
11. Models for classifiers.
12. Simulation of open and closed loop milling circuits.
13. Mineral liberation and comminution.

14. Simulation of combined comminution and concentration plants including regrinding.
15. Simulating complex plants.
16. Designing new plants.
17. Assessment of existing plants.
18. Calibration of models against plant data.

SIXTH SEMESTER

MPHC 6.1 DISSERTATION (0-0-10)

The student has to undertake a Project Work in the Department or in any well established Mineral based organization / laboratory for a period of 4 months and has to submit the dissertation report.

MPHC 6.2 VIVA-VOCE (0-0-2)

The student has to face Viva-Voce examination and has to defend his dissertation thesis submitted.

MPHC 6.3 INDUSTRIAL TRAINING (0-0-0)

After the completion of II and IV semester, the student has to undergo plant visit and plant respectively. The industrial visit report and industrial training report has to be submitted along with dissertation for evaluation.

MPHC 6.4 INDUSTRIAL TOUR (0-0-0)

During the V semester programme, the students have to undertake the Industrial tour accompanied by 2 teaching faculty and 1 non teaching staff member for a period of 15 days. The detailed industrial tour report has to be submitted along with dissertation, industrial training reports for evaluation.

SYLLABUS FOR OPEN ELECTIVE PAPERS
(For Inter-Department Students Only)

Paper	Subject	L	P	T	C
For II Semester non mineral processing students only					
MP OE1	Study of Minerals and Rocks fo	4	--	--	4
MP OE2	Mineral Resources of India	4	--	--	4
For III Semester non mineral processing students only					
MP OE3	Introduction to Mineral Processing	4	--	--	4
MP OE4	Iron Making and Steel Making	4	--	--	4

MP OE1: STUDY OF MINERAL AND ROCKS [For II Semester] (4-0-0)

Unit I:

Mineral – Definition, Physical properties, Properties depending upon light, Cohesion and elasticity, Electrical conductivity, Heat and Magnetism. Classification of silicate and non-silicate minerals and their properties. **(14 Hours)**

Unit-II :

Rock- Definition, magma and its origin. Bowen's reaction principle, Classification of rocks. Process of formation of igneous rocks, structure and texture of igneous rocks. Origin and mode of occurrence of igneous rocks. Process and formation of sedimentary rocks. Classification of sedimentary rocks, structure of sedimentary rocks. Definition of metamorphism, types and agents of metamorphism. Structure and texture of metamorphic rocks. **(42 Hours)**

MP OE2: MINERAL RESOURCES OF INDIA [For II Semester] (4-0-0)

Unit –I:

Role of Mineral industry in National Economy. Strategic, critical and essential minerals. Renewable and non-renewable resources, Conservation of minerals, Metallic and non-metallic minerals. National Mineral policy, Study of the following mineral deposits of India with reference to mineralogy, Mode of occurrence, distribution and production: Iron, Manganese Chromium, Copper, Bauxite and Gold. **(28 Hours)**

Unit –II:

Study of minerals used in glass, cement, ceramic, fertilizer industries. Minerals used as insulators, minerals used in Chemical industry. Abrasive minerals. Pigments and fillers, Fuels: Coal and Petroleum. **(28 Hours)**

MP OE3: INTRODUCTION TO MINERAL PROCESSING [For III semester] (4-0-0)

Unit –I

Definition, Scope and necessity of Mineral Beneficiation, Historical developments and Economics. Physical Properties of Ores and their importance in Mineral beneficiation.
Definition of terms – Concentrate, Tailing, Middling, Recovery and Ratio of concentration. Unit operations. Sampling: Definition, purpose, methods, measurements of accuracy of sampling.
Crushing: Purposes, Mechanism of crushing, types of crushers and their salient features. Grinding: Tumbling mills, Types of tumbling mills, open and closed circuit grinding operation. Liberation: Definition and importance of liberation studies and its analysis. Laboratory sizing, Industrial screens.

(28 Hours)

Unit –II:

Different techniques used in Mineral Processing –Brief study on Gravity Concentration, Floatation, Magnetic Separation, Electro static Separation and Agglomeration.

(28 Hours)

MP OE4: IRON AND STEEL MAKING [for III semester] (4-0-0)

Unit- I:

Iron Ore: Definition of ore, mineral, rock, gangue, tenor and grade of ore. Brief studies on Origin, occurrence and Distribution of iron ore deposits of the world, India, and Karnataka. Types of Iron Ores, Mineralogy of Iron Ore and banded iron formations, Liberation Studies.
Iron Ore Processing: Iron Ore washing, Gravity methods, jigging, H.M.S, Spiral, Classification, magnetic separation and flotation. Recent trends in iron ore processing including Iron Ore fines and slimes. Agglomeration of Iron Ore fines.

(14 Hours)

Unit-II

Iron Making: Raw Materials for iron making, Stoichiometry. Conventional blast furnace iron making, temperature profiles of blast furnace. Iron making, sponge iron making.
Steel Making: Raw materials for steel making, liquid iron refining. Impurities of liquid iron & and removal of carbon, silica, manganese, phosphorous, sulphur etc B.O.F.

(42 Hours)