# DEPARTMENT OF FUEL & MINERAL ENGINEERING ISM - DHANBAD

## COURSE STRUCTURE & COURSE CONTENTS OF THE B TECH 4-YEAR MINERAL ENGINEERING DISCIPLINE



#### **ISM - Dhanbad**

(Established under section 3 of the UGC Act, 1956, vide notification No. F. 11-4/67-U3, dated 18<sup>th</sup> September 1967 of the Government of India)

More than two-and-half decades of excellence: from 1984 - 2011

#### **COURSE STRUCTURE For the 4-Year B Tech MLE & Dual Degree Programmes**

# **I SEMESTER**

SUBJECT CODE	SUBJECT NAME	L-T-P =CH	
		(Hours per week)	
THEORY			
HS C-11101	English for Science & Technology	3-1-0=07	
AM C-11101	Mathematics-I	3-1-0=07	
AP C-11101	Physics-I	4-0-0=08	
AC C-11101	Chemistry	4-0-0=08	
FM D-11101 &	Engineering Materials (Section A)	2-0-0=04	
AC D-11102	Engineering Materials (Section B)	1-0-0=02	
MM C-11101	Engineering Graphics	1-6-0=08	
CM C-11301	Earth System Science /Global Energy	2.0.0-06	
ES C -11301	Scenario & Energy Security of India	5-0-0-00	
	Total	21-8-0=50	
PRACTICALS			
MM C-11201	Workshop Practice	0-0-03 = 03	
AC C-11251	Chemistry Practical	0-0-3/2=1.5	
AP C-11201	Physics Practical-I	0-0-3/2=1.5	
	OTHERS		
SW C-11001	Counseling Special Classes	0-0-0 = (04)	
	Total	0-0-06=06	
		21-8-6 =56	

L- Lecture, T-Tutorial, P-Practical, CH- Credit Hours

# **II SEMESTER**

SUBJECT CODE		L-T-P=CH	
	SUBJECT NAME	(Hours per week)	
	THEORY		
AM C-12101	Mathematics-II	3-1-0=07	
AP C-12101	Physics -II	3-0-0=06	
AM D-12102 &	Computer Programming &	3-0-0=06	
CS D-12101	Information Technology	1-1-0=03	
MM C-12101	Electrical Technology	3-0-0=06	
EI C-12101	Electronics & Instrumentation	3-0-0=06	
MM C-12102	Engineering Mechanics	3-0-0=06	
HS C-12305	Value Education, H R & Legislation	3-0-0=06	
	Total	22-2-0=46	
PRACTICAL			
AM D12202	Computer Programming	0 - 0 - 2/2 = 01	
AP C12201	Physics Practical - II	0 - 0 - 2/2 = 01	
MM C12301	Workshop Practice - II	0 - 0 - 02 = 02	
MM C12202	Electrical Technology	0 - 0 - 2/2 = 01	
EI C12201	Electronics & Instrumentation	0 - 0 - 2/2 = 01	
MM C12203	Engineering Mechanics	0 - 0 - 2/2 = 01	
OTHERS			
SW C12701	Co-Curricular Activity	0-0-00 =(03)	
	Total	0-0-07 =07	
Total		22-2-07=53	

L- Lecture, T-Tutorial, P-Practical, CH- Credit Hours

# **III SEMESTER**

SUBJECT	SUBJECT NAME	L-T-P=CH		
CODE		(Hours per week)		
THEORY				
FM D-13101	Sec-A: Introdn. to Mineral Processing & Metallurgy	2-0-0=04		
GL D-13152	Sec-B: Economic Geology	2-0-0=04		
FM C-13102	Particle Technology	3-0-0=06		
GL R-13151	Geology - I: Mineralogy, Petrology & Stratigraphy	3-0-0=06		
AM R-13101	Methods of Applied Mathematics	4-1-0=09		
MM R-13101	Mechanical Engineering – 1 (Sec A: Mechanics of Solids & Sec B: Theory of Machines)	3-1-0=07		
	HSS Electives (Any One)			
HS E-13302	i) Philosophy of Science			
HS E-13303	ii) Gandhian Studies	3-0-0=06		
HS E-13304	iii) Oral Communication Skills			
HS E-13305	iv) Oral Presentation Skills			
	Total	20-2-0=42		
	PRACTICALS			
FM C-13201	Particle Technology	0-0-3=03		
GL R-13251	Geology –1: Mineralogy, Petrology & Stratigraphy	0-0-3=03		
	Total	0-0-6=06		
Total		20-2-6=48		

L- Lecture, T-Tutorial, P-Practical, CH- Credit Hours, R – Code for Capsule Course

# **IV SEMESTER**

SUBJECT CODE		L-T-P =CH	
	SUBJECT NAME	(Hours per week)	
	THEORY		
FM C-14101	Comminution & Classification	3-0-0=06	
ME C-14101	Mining Methods & Unit Operations	3-0-0=06	
AM R-14101	Numerical & Statistical Methods	4-0-0=08	
MM R-14101	Mechanical Engineering – II	3-1-0=07	
HS R -14306	English for Professional Communication	3-0-0=06	
	Total	16-1-0=33	
PRACTICAL			
FM R-13201	Comminution & Classification	0-0-3=03	
AM R-14202	Numerical & Statistical Methods	0-0-3=03	
OTHERS			
FM C-14505	Composite Viva-voce	0-0-0=(04)	
SW C-14701	Co-Curricular activity	0-0-0=(03)	
	Total	0-0-3=03	
Total		16-1-3=36	

L- Lecture, T-Tutorial, P-Practical, CH- Credit Hours, R – Code for Capsule Course

# **V SEMESTER**

SUBJECT	SUBJECT NAME	L-T-P=CH	
		(Hours per week)	
CODE			
	THEORY		
FM C-15101	Physical Separation Processes	3-0-0=06	
FM C-15102	Transport Phenomenon	3-0-0=06	
FM C-15103	Extractive Metallurgy	3-0-0=06	
MM C-15154	Material Handling Systems	3-0-0=06	
M S C-15153	Managerial Economics	3-0-0=06	
	Total	15-0-0=30	
	PRACTICALS		
FM C-15201	Physical Separation Processes	0-0-3/2=3/2	
FM C-15302	Analytical Techniques in Mineral Engg.	0-0-3=03	
MM C-15254	Material Handling Systems	0-0-3/2=3/2	
OTHERS			
FM C-15601	Plant Visits	0-0-0=(05)	
FM C-15401	Seminar Presentations	0-0-0=(04)	
FM C-15001	Vocational Training*	0-0-0=(05)	
	Total	0-0-6=06	
Total		15-0-6=36	

L- Lecture, T-Tutorial, P-Practical, CH- Credit Hours

\* Vocational training taken at the end of IV Semester is credited for marks in V Semester

# **VI SEMESTER**

SUBJECT	SUBJECT NAME	L-T-P=CH	
CODE		(Hours per week)	
THEORY			
FM C-16101	Coal Preparation	3-0-0 = 06	
FM C-16102	Fuel Technology	3-0-0 = 06	
FM C-16103	Surface Phenomenon & Froth Flotation	3-0-0 = 06	
EE R- 16101	Applied Electrical Engineering	3-1-0 = 07	
ES C- 16106	Pollution Control & Envir. Management	3-0-0 = 06	
	Total	15-1-0=31	
PRACTICALS			
FM C-16201	Coal Preparation	0-0-3/2=3/2	
FM C-16202	Fuel Technology	0-0-3/2=3/2	
FM C-16203	Surface Phenomenon & Froth Flotation	0-0-3/2=3/2	
ES C-16206	Pollution Control & Envir management	0-0-3/2=3/2	
OTHERS			
FM C-16501	Comprehensive Viva-voice	0-0-0=(04)	
FM C-16601	Industrial Tour	0-0-0=(05)	
	Total	0-0-6 =06	
Total		15-1-6=37	

L- Lecture, T-Tutorial, P-Practical, CH- Credit Hours

## **VII SEMESTER**

SUBJECT	SUBJECT NAME	L-T-P=CH	
CODE		(Hours per week)	
	THEORY		
FM C-17101	Computational Techniques in Mineral Engg.	2-1-0=05	
FM C-17102	Process Equipment Selection	3-0-0=06	
FM C-17103	Dewatering & Drying	3-0-0=06	
FM C-17104	Elements of Material Engineering	3-0-0=06	
MS C-17152	Industrial Engineering & Management *	3-0-0=06	
	Total	14-1-0=29	
PRACTICALS			
FM C-17201	Dewatering & Drying	0-0-3=03	
FM C-17801	Project Work	0-0-6=06	
OTHERS			
FM C-17601	Plant visits	0-0-0=(05)	
FM C-17001	Vocational Training**	0-0-0=(05)	
	Total	0-0-9=09	
Total		14-1-9=38	

L- Lecture, T-Tutorial, P-Practical, CH- Credit Hours \* Only of 4 year dual degree students \*\* Vocational training taken at the end of VI Semester is credited for marks in VII Semester

# **VIII SEMESTER**

SUBJECT	SUBJECT NAME	L-T-P =CH	
CODE		(Hours per week)	
	THEORY		
FM C-18101	Modeling and Simulation	3-2-0=08	
FM C-18102	Flow-sheet Design and Plant Layout	3-2-0=08	
FM C-18103	Agglomeration Techniques	3-0-0=06	
MM R-18104	Maintenance Engineering	3-0-0=06	
FM C-18104 (S)	Beneficiation Process Control	2-0-0=04	
	Electives (Any one)		
FM E-18101	Clean Coal Technology		
FM E-18102	Bio-Mineral Processing	3-0-0=06	
FM E-18103	Open Elective of student's choice*		
	Total	17-4-0=38	
PRACTICALS			
FM C-18801	Dissertation	0-0-6=06	
OTHERS			
FM C-18401	Term paper & Seminar	0-0-0=(03)	
FM C-18501	Comprehensive Viva-voice	0-0-0=(04)	
FM C-18601	Industrial Tour	0-0-0=(05)	
	Total	0 -0 -6=06	
Total		15-4-6=40	

\* This subject student can adopt from the capsule courses of the any of the other departments, which is of his interest and can help him in carrying out his dissertation/project work.

L- Lecture, T-Tutorial, P-Practical, CH- Credit Hours

#### COURSE CONTENT OF 4-YEAR B TECH MINERAL ENGINEERING

#### **III SEMESTER**

# FM D-13101INTRODUCTION TO MINERAL PROCESSING & METALLURGY 2-0-0=04GL D-13152ECONOMIC GEOLOGY2-0-0=04

FM D-13101 Section - A: Introduction to Mineral Processing and Metallurgy

Introduction to Mineral Processing, scope and importance; liberation and its importancedegree of liberation, optimum degree of liberation. Brief introduction to different types of unit operations; Quantification of Mineral Engineering unit processes: recovery, ratio of concentration, enrichment ratio and separation efficiency etc. Economics of mineral processing.

Basic concepts of metallurgy, different types of metallurgical processes (pyro, hydro and electro metallurgy). Roasting, smelting, converting, leaching, precipitation processes. Faraday's laws, electro winning and refining.

GL D-13152 Section –B: Economic Geology

Classification of common ore forming minerals, chemical and physical and optical properties of common sulphide, oxide and complex ore minerals, Introduction to ore microscopy, detailed study of association, texture and structure of ores, process mineralogy, specifications for different industrial applications. Mode of occurrences of common ores with lithology and structure, geographical distribution of some important mineral deposits.

#### FM C-13102PARTICLE TECHNOLOGY3-0-0=06

Sampling of solids and slurries- principle, methods, sampling theories, sampling for different applications, Indian standards. Production of fine particles and their characterization, Concept of equivalent diameter for small particles.

Particle size distribution and quantification: Gaudin-schumann, Gaudin-Meloy equations, Rosin-Rammler, Broadbent and Calcott equation. ,Methods of particle size measurement: Sieving, sedimentation and elutriation , Optical methods, On-line particle size measurement, Computer analysis of size distribution data, Particle shape characterization – different methods, image analyzers, Surface area measurement - direct and indirect methods, permeability, gas adsorption., Volume and porosity measurements, Bulk solids packing density and ratio, Bulk solids properties – bulk density, true density abrasivity, voidage, friability and flowability. Fundamentals of blending.

#### GL R-13151 GEOLOGY – I (Mineralogy, Petrology & Stratigraphy) 3-0-0=06

#### Mineralogy

Minerals: Physical and chemical properties; Crystal, crystal classes and systems; Classification of minerals and properties of common silicate minerals (Quartz, Feldspar, Pyroxene, Amphibole, Garnet, Olivine, Mica), Sulphides (Pyrite, Chalcopyrite, Galena, Sphalerite) and oxides (Haematite, Magnetite, Chromite, Pyrolusite, Psilomalene).

#### Petrology

Igneous rocks: Magma and lava, extrusive and intrusive forms, textures; Classification and description of some common igneous rocks (Granite, Dolerite, Basalt, Rhyolite, Pegmatite).

Sedimentary Rocks: Sedimentation processes; Classification and description of some common sedimentary rocks (Conglomerate, Limestone, Shale, Sandstone).

Metamorphic rocks: Processes of metamorphism, textures and structures of metamorphic rocks; Classification and description of some metamorphic rocks (Slate, Schist, Gneiss, Quartzite, Marble).

#### Stratigraphy

Principles of stratigraphy; Concepts of palaeontology; Fossils, their mode of preservation and significance as indices of age and climate; Concept of index fossils; Broad stratigraphic subdivisions and associated rock types of important ore provinces, coal belts and oil fields of India.

#### AM R-13101 METHODS OF APPLIED MATHEMATICS 4-1-0=09

**Section**–A: Analysis of Complex variables: Limit, continuity and differentiability of function of complex variables. Analytic functions. Cauchy-Riemann's and Cauchy's integral theorem, Morera's theorem. Cauchy's integral formula, Expansion of function of complex variables in Taylor's and Laurent's series, singularities and poles. Residue theorem, contour integration, conformal mappings and its application, Bilinear Transformation.

**Section–B:** Special Functions: Solution in series of ordinary differential equations, Solution of Bessel and Legendre equations, recurrence relations and generating function for  $J_n(X)$ , orthogonal property and integral representation of  $J_n(X)$ . Legendre polynomial, Rodrigues formula, orthogonality properties and generating function for  $P_n(X)$ . Elliptical integrals and Error function and their properties.

**Section–C:** Laplace transform and PDE: Laplace transform of simple functions first and second shifting theorems, t- multiplication and t- division theorems; Laplace transforms of derivatives, integrals and periodic functions. Inverse Laplace transform and convolution property. Use of Laplace transform in evaluating complicated and improper integrals and solution of ordinary differential equations related to engineering problems.

Partial Differential Equations: Classification of partial differential equations, solution of one dimensional wave equation, one dimensional unsteady heat flow equation and two dimensional steady heat flow equation in Cartesian and polar coordinates by variable separable method with reference to Fourier trigonometric series and by Laplace transform technique.

#### MM R-13101 MECHANICAL ENGINEERING – 1 3-1-0=07

#### Section–A: Mechanics of Solids

Stress-strain diagram; Elastic constants and their relations; Thermal stresses and strains; Principal stresses and principal planes.

Deflection of beams, Analysis of stresses in pressure vessels, Torsion of circular sections. Basic concepts: Degees of freedom, kinematic constraints, Linkages, mechanisms.

#### **Section-B: Theory of Machines**

Different types of gears, gear trains, reduction ratio and torque assessment, application of gearboxes. Basic principles and constructions of Governors, Flywheels, Brakes, Clutches and dynamometers. Case study based on laboratory setups on the above broad areas.

#### HSS – Electives or Optional (Any One)

#### HS E-13302 OPTIONAL-I: Philosophy of Science 3-0-0=06

**Introduction:** Rationale for study of philosophy of science, prevalence of imbalances; General approach, nature scope and relation of the subject with historical development; Science and philosophy vis-à-vis need for intellectual and moral balance. Scientific and philosophical approaches to knowledge development and knowledge application (emphasis on earth and mineral sciences).

Foundations of philosophy: Nature, concept, scope, methodology, divisions and implications.

**Concept and Nature of Science**: Origin/aim, methodology, scope and development; nature of scientific methods; Movements, scientific thought; Divisions of science; scientific laws and scientific explanations.

**Convergence of science and philosophy:** Unified theory; Space-time relationship, patterns, of change; Deeper issues and broad involvements of science; status of scientific proposition and concepts of entities, epistle mic and ontological aspects.

**Philosophical Analysis and Scientific Practice**: Philosophic base of Eastern Thought and their parallel in science; The essential of unity between Eastern Thought pattern and Western science, Need for harmony between intuitive thought and rational knowledge; philosophers or science with reference to Western thought philosophers of science – Western and Eastern.

Inter-relationship of Science and Culture: Science and aesthetics, science and human values, science in the full tradition, science vis-a vis human conduct and social affairs;

social significance of science; Implications of philosophy of science for a new peaceful social order, synthesis of eastern 'Work View' and Western 'Materialism'.

#### HS E-13303 OPTIONAL-II: Gandhian Studies 3-0-0=06

Introduction to Gandhi's life and philosophy; Fundamentals of Gandhian economics; Gandhi's concept of human nature, perfectibility of man; Ethical ideas of Gandhi – truth, Ahimsa, Brahmacharya, Non-stealing, Non-possession and Voluntary poverty. Gandhi's interpretation of history and society.

Public welfare and Sarvodaya philosophy: Antyodaya; Sarvodaya socialism and capitalism; Nature of Sarvodaya economy from Gandhi to Vinoba; Concept of production and distribution in Sarvodaya economy and its utility in our socioeconomic and scientific/technical development; Non-violent economy vis-a vis centralized industrial economy and rural economy.

Study of the current industrial problems and priorities as against the Gandhian ideology.

Gandhian approach to manpower management, prospects, cooperative production and consumption, rural entrepreneurship, finance, planned changes for helping the disadvantaged sections of the society.

Man and machine – problems of automation and Gandhi's views.

Gandhi's political views: The state as a organ of violence, political sovereignty of the people, decentralization of political power, concept of freedom, the ideal political condition – Ram Rajya.

Satyagraha, the importance of truth force, self-suffering, winning over the opponent by love. Relevance of Gandhian ideas in the contemporary economic and political situation.

#### HS E-13304 OPTIONAL-III: Oral Communication Skills 3-0-0=06

- a. The nature, purpose and characteristics of good conversation.
- b. Phonological forms to use in speech
- c. Developing conversation skills with a sense of stress, intonation land meaning
- d. Use of question of tags
- e. Starting, maintaining and finishing conversations
- f. Standard conversational exchanges
- g. Spoken language idioms
- h. Effective listening and attention to others
- i. Gestures and body language
- j. Do's and Don'ts in conversation
- k. Telephone conversation

- m. Participating in informal discussions and situations
- n. Using information to make some decision i.e. making social arrangement with friends
- o. Reproducing information in some form (question/answer, summarizing, orally, reporting etc.).

#### HS E-13305 OPTIONAL-1V: Oral Presentation Skills 3-0-0=06

- a. Characteristics of a good presentation
- b. Assessing the audience and its needs
- c. Planning a presentation
- d. Different presentation styles
- e. Using the presentation Matrix
- f. The Informative Presentation
- g. The Demonstration Presentation
- h. The Persuasive Presentation
- i. Presentation structure and design
- j. Materials and logistics
- k. Visual aids and their developments
- 1. Rehearsing land delivering
- m. Using performance techniques
- n. Overcoming anxiety and stress
- o. Openings and closings
- p. Getting and maintaining audience attention
- q. Using language to optimal effect
- r. Body language and gestures
- s. Linguistic aspects; introducing, sequencing, signaling, quoting, clarifying and summarizing.
- t. Handling questions.

#### **Practicals**

#### FM C-13201PARTICLE TECHNOLOGY0-0-3=03

Methods of sampling, accuracy and precision of sampling. Determination particle size distribution of powder by Dry sieving, Comparison of wet and dry sieving efficiencies for fine powders, Sieving by Alpine air jet sieve sizer, Sub sieve sizing by: Warman cyclosizer, beaker decantation techniques, , Andersen Pipette method. Surface area

determination. Bulk density, true density and apparent density, porosity, friability determination.

GL R-13251 GEOLOGY – I: MINERALOGY, PETROLOGY & STRATIGRAPHY 0-0-3=03

#### **Study of physical properties of minerals**

- (A) Rock forming minerals: Talc, Gypsum, Calcite, Fluorite, Feldspar (Orthoclase, Microcline, Plagioclase), Muscovite, Biotite, Quartz, Beryl, Tourmaline, Corundum, Kyanite, Serpentine, Garnet and Sillimanite.
- (B) Ore minerals: Haematite, Magnetite, Chalcopyrite, Malachite, Azurite, Chromite, Bauxite, Pyrolusite, Psilomalene, Sphalerite, Galena

#### Petrology

Study of common rocks with reference to their structures, mineral composition and uses:

- (A) Igneous Rocks: Granite, Syenite, Gabbro, Basalt, Dolerite, Lamprophyre, Aplite, Pegmatite
- (B) Metamorphic Rocks: Slate, Schists, Gneisses, Quartzite, Marble, Amphibolite, Charnockite.
- (C) Sedimetary Rocks: Conglomerate, Sandstone, Shale, Carbonaceous Shale, Coal, Limestone.

#### **IV SEMESTER**

#### **Theory**

#### FM C-14101COMMINUTION AND CLASSIFICATION3-0-0=06

Mining and its effect on rock size distribution, Fundamentals of size reduction, Comminution laws; Liberation studies- effect of size on liberation; drop shatter tests and shatter index, single particle breakage and packed bed breakage.

**Crushing**: Jaw, Gyratory, Cone, Roll crushers, Hammer mills and Rotary breakers, High compression rolls: their construction, operation maintenance and performance aspects. In-pit and portable crushers.

**Grinding:** Grinding mills principles, construction and their operation, Mill liners, Feed entry, and product discharge mechanisms. Open and closed circuit grinding; Ball, Rod, Pebble, Autogenous and Fluid energy mills. Application of these mills for specific processing requirements: Effect of process parameters on mill performance.

**Industrial screening:** Fundamentals of screening, Dry and wet screening, Classification of screens, operation and maintenance of different types of industrial screens. Prescrubbing and other processes to improve screening efficiency.

**Classification:** Introduction to different types of classifiers used in mineral industry; Hydrocyclones; construction, operation, maintenance. Efficiency of classifiers, solid and water balance calculations.

#### ME C-14101 MINING METHODS AND UNIT OPERATIONS 3-0-0=06

Mining Methods, Drilling, Blasting: Methods of short hole drilling in surface and underground mines. Explosives and accessories used in blasting in opencast and underground mines. Opencast Mining: Development of deposits, box cut and open trenches, development of benches.

Underground coal mining methods: Modes of entry, board and pillar and longwall methods, their applicability, merits and demerits, general description of the methods. Underground Metalliferous Mining methods. Modes of entry, development, drives, cross-cuts, raises and winches, general description of stoping methods.

#### AM R-14101 NUMERICAL & STATISTICAL METHODS 4-0-0=08

#### A. Numerical methods

Solution of algebraic and transcendental equations by bisection, iteration, false position, secant and Newton Raphson methods, generalized Newtons method for multiple roots.

Solution of a system of linear simultaneous equations by Gauss elimination, Gauss-Jordan, Crout's triangularisation, Jacobi and Gauss Seidel methods. Finite differences, Symbolic relations, differences and factorial notation of a polynomial, data smoothing, interpolation and extrapolation, Newton-Gregory forward and backward, Gauss forward and backward, Stirling, Bessel, Everett, Lagrange and iterative methods, Cubic splines, Numerical differentiation and integration, Trapezoidal, Simpson's 1/3<sup>rd</sup>, Simpson's 3/8<sup>th</sup>, Weddle and Gaussian quadrature formulae.

Numerical solution of first order ordinary differential equation by Taylor's series, Picard's, Euler's, Modified Euler's, Runge-Kutta, Adams-Moulton and Milne's methods. Solution of simultaneous first order and second order ordinary differential equations with initial conditions by Taylors series, Runge-Kutta and Milne's methods. Numerical solution of boundary value problems by finite difference and shooting methods.

#### **B.** Statistical Methods

Concept of frequency distribution: Moments, skewness and kurtosis.

Probability: various approaches of probability-classical, frequency (statistical), subjective and axiomatic. Theorems on probability, conditional probability, independence, Bayes Theorem.

Random variable-discrete and continuous. Distribution function and their properties, probability, mass and density functions, Mathematical expectation, Moment generating function and its properties.

Probability distributions; Bernoulli, binomial, negative binomial, Poisson and normal distributions.

Theory of least squares and curve fitting. Correlation- Simple, multiple and partial, Regression lines and regression coefficients, Multiple and partial regression.

Tests of Significance; Normal test, t-test, Chi-square and F-test.

#### MM R-14101 MECHANICAL ENGINEERING - II 3-1-0=07

Analysis of various thermodynamic processes, P-V and T-S diagrams. Analysis of Air Standard Cycle

Classifications, applications and performance estimation of Internal Combustion engines, Gas turbines and Compressors, Basic maintenance steps.

Performance study and power estimation based on laboratory experimental data. Properties of fluid; classifications; Ideal fluid, Newtonian and Non-Newtonial fluids; Newtons law of viscosity.

Fluid Statics: fluid pressure and its measurement.

Fluid Kinetics: Continuity equation, types of flow.

Fluid dynamics: One dimensional equation of motion; Bernoulli's equation; applications of Bernoulli's equation; venturimeter.

Flow through pipes – Darcy-Weisbach's equation.

Classification, basic construction and applications of different types of pumps and water turbines. Performance study and power estimation based on laboratory experimental data.

#### HS C-14306 ENGLISH FOR PROFESSIONAL COMMUNICATION 3-0-0=06

English for Professional Communication (EPC) provides the student with an overview of the fundamentals of written and oral communication as they apply to the professional world. It introduces students to critical professional communication skills along with their applications in real – world situations. This course is the last in a sequence of four HSS courses designed to develop skills in oral and written English. The course combines the fundamentals of the professional and business writing with the elements of professional speaking. There are four major areas which the course addresses: oral communication in collaborative, small-group situations; facing the job interview; report and project writing; and understanding of the basic business correspondence process, involving the sender, the message, and the receiver. The course attempts to integrate all four areas to provide an increased comprehension of how information is transmitted in the professional world.

#### **Practicals**

#### FM C-13201 COMMINUTION AND CLASSIFICATION 0-0-3=03

Estimation of reduction ratios, capacities and efficiencies for various size reduction units such as Jaw crushers, Roll Crushers, Ball mills etc. Determination of Bond and HGI work index values for the given samples. Performance analysis of laboratory model continuous screen. Calculation of settling velocity of particle.

#### AM R-14202 NUMERICAL & STATISTICAL METHODS 0-0-3=03

#### A. Numerical Methods

Numerical solution of non-linear algebraic and transcendental equation by bisection, iteration, false position, secant and Newton Raphson methods.

Numerical solution of a system of linear simultaneous equation by Gauss elimination and Gauss Seidel methods.

Interpolation by Lagrange's interpolation formula.

Numerical evaluation of definite integral by Trapezoidal, Simpson's  $1/3^{rd}$ , Simpson's  $3/8^{th}$ , Weddle and Gaussian quadrature formulae.

Numerical solution of first order ordinary differential equation by Euler's, Modified Euler's, second and fourth order Runge-Kutta, Adams-Moulton and Milne's methods.

#### **B.** Scope of practice sessions:

Computation of raw moments, central moments, coefficient of variation, coefficients of skewness and kurtosis; Fitting of straight line, second degree polynomial (parabola), power curve and exponential curve; Computation of product moment correlation, multiple and partial correlation coefficients; Regression coefficients and regression lines, plane of regression. Application of tests of significance based on numerical data.

#### **V SEMESTER**

# <u>Theory</u>FM C-15101PHYSICAL SEPARATION PROCESSES3-0-0=06

Basic principles, processes, Ore characteristics required for applying gravity separation techniques, main applications and related problems.

Basic principles of jigging, Types of jigs and their relative merits and demerits for beneficiation of metallic and non metallic ores. Variables affecting Jigging, Jigging practice, operation and maintenance of jigs.

Principles of heavy media separation, types of media solids, characteristics and specifications, stability of the media suspension, stability index, preparation, recovery and regeneration of media solids, typical media recovery circuits, Separation characteristics of different types of dynamic and static heavy media separators for beneficiation of metallic and non-metallic minerals.

Introduction to flowing Film gravity separation techniques, principles involved, Separation characteristics of various units such as pinched sluice, Bucharts, slime tables and shaking tables including influence of various design of riffles. Spiral concentration, application of modern spiral concentrators for beneficiation of minerals. Reichert cones and multigravity separator.

Magnetic Separation: Introduction to Magnetic separation; Dia-magnetic minerals, paramagnetic minerals, ferro-magnetic minerals, remnance, induction, intensity of magnetization, field intensity. Design of magnetic separators, Types of magnetic separators; Low intensity magnetic separator, high intensity magnetic separator, high gradient magnetic separator, Super conductivity separators, high-tension separation and their application.

Principles of electrostatic separation of conductive and non-conductive materials using different electrostatic separators, its main applications in beach placer mineral industries with flow sheets as typical examples.

#### FM E-15102

#### TRANSPORT PHENOMENA

3-0-0=06

#### Introduction

Transport Processes, Dimensional Analysis.

**Momentum Transfer :** Steady and Unsteady Flows; Overall mass, energy and momentum balance; Navier Stokes equation; Newton's Law, Non-Newtonian Fluids; Laminar flow in falling film, flow through conduits etc; Inviscid fluid flow, Viscous flow, Laminar and Turbulent Boundary Layer Theory, Friction Factor; Flow past immersed objects, packed and fluidized bed.

**Mass Transfer:** Steady state mass transfer and diffusion; molecular diffusion in gases, liquids, biological gels and solids; Unsteady state mass transfer under different conditions, mass transfer coefficient, diffusion through porous medium and capillaries;

Boundary layer flow and turbulence in mass transfer, Simultaneous heat, mass and momentum transfer.

#### Heat Transfer:

<u>Conduction</u>: Steady State: One Dimensional – Composite wall and cylinder; Multidimensional- Differential heat balance, shape factor, graphical and numerical methods.

Unsteady State: Analytical solutions of one dimensional lumped heat capacity system, heat flow in semi-infinite solid, convection boundary conditions, Heisler chart solutions.

<u>Convection</u>: Natural and forced convection, overall heat transfer coefficient, fouling factor, types of heat exchanges.

<u>Radiation:</u> Physical mechanism, radiation properties, shape factor, heat exchange between non-black bodies, infinite parallel planes, radiation shields, gas radiation.

#### FM C-15103EXTRACTIVE METALLURGY3-0-0=06

Iron Making – Raw Material preparation, Blast Furnace (BF) construction & accessories, BF iron making, slag-metal reactions, BF aerodynamics, BF irregularities and solutions. Alternative routes of iron making – low shaft furnace & charcoal furnaces, S-R processes such as Corex, Romelt, etc. Sponge iron technology – Rotary Kiln, Shaft Fluidized bed, Steel Making – Principles, different methods of steel making such as acid & basic open hearth, basic oxygen, electric arc & induction furnace.

#### FM C-15301(S) ANALYTICAL TECHNIQUES IN MINERAL ENGG. 0-0-3=03

Wet assaying of ores of iron, copper, lead – zinc and manganese, complexometric methods (EDTA titration) of analysis of lime stone, dolomite, principle of dry assaying processes, fire assay methods of gold & silver.

Instrumental methods of investigation: X-ray, DTA/TGA, Spectroscopy – atomic absorption, flame photometry, UV and IR spectrophotometry and colorimetry Zeta potential measurement, SEM, TEM.

Application of chemical characterization for beneficiation of minerals, application of modern instruments of analysis of minerals, difference between modern and conventional method for analysis of minerals, estimation of Mn in pyrolusite or its ore, difference between Iodometry and Idimetry. Estimation of Cu, in copper ore by Iodometry method. Estimation of Zn, in zinc ore, Compleximetry estimation for analysis of Ca and Mg in their and the ore containing both of them., complete analysis of mineral, Use of AAS and IR for analysis of the chemical constitute present even in traces, TGA and DTA analysis of dolomite.

#### MM C-15154 MATERIAL HANDLING SYSTEMS 3-0-0=06

Size reduction equipment in coal and ore processing plants, crushers and mills – different types, design features, operation and application. Constructional features of various screens for coal and ore processing systems, operation and selection.

Mechanical feeders for different subsystems of coal and ore processing plants – types, design features and operation.

Belt conveyors – different components, design features, operation and care.

Chain conveyors – types, design features and operation, bucket elevators.

Silos, bins and bunkers – constructional details and application.

#### MS C-15153 MANAGERIAL ECONOMICS 3-0-0=06

Different areas of micro-economics and macro-economics; marginal utility analysis; Law of demand- its factors and exceptions; demand curve, elasticity of demand and its classification; Indifference curve and its properties – consumer's equilibrium with the help of indifference curve.

Law of supply and supply curve; Concept of elasticity of supply; total revenue, marginal revenue and average revenue; Different types of returns to scale; Concept of production function and its significance. Different cost concepts and their behaviour, different cost curves; Significance and measures of cost-control.

Features of perfect competition, equilibrium of a firm under perfect competition in short run and long run; equilibrium of monopoly; Conditions of price-discrimination, equilibrium of discriminating monopoly; Features of monopolistic competition, equilibrium of a firm under monopolistic competition in short run and long run. Different theories of wage-determination; Different theories of interest-determination; Sources of profit.

Different components of consumption function and investment function; Relationship between money supply and price level; Concepts of demand pull and cost push inflation, effects of inflation, steps to control inflation. Criteria of economic development; Features of capitalism; Socialism and mixed economy; characteristics of developed and underdeveloped/developing economy. Economic planning and its types: Significance of economic planning in developed and underdeveloped/developing economy.

Labour intensive strategy and capital intensive strategy; Small unit strategy and big unit strategy; Public sector strategy and private sector strategy. Areas of public finance; Merits; and demerits of direct and indirect taxes. Nature of the problem of investment decision; Methods of investment decision for selecting the best project.

#### **Practicals**

#### FM C-15201PHYSICAL SEPARATION PROCESSES0-0-3/2=3/2

Separation of particles using Wilfley Table. Performance analysis of a laboratory size mineral Jig, laboratory concentration table treating synthetic mixture samples. Effect of irrigation water, inclination, angle on the performance of a Mozely Mineral Separator treating various minerals. Demonstration on Multi-gravity separator, Determination of

magnetic content of a given sample using Davis tube magnetic separator, Effect of feed rate, current intensity on separation of magnetic and non-magnetic particles with Low and high intensity magnetic separators. Recovery of minerals by using Electrostatic separator.

#### MM R-15254 MATERIAL HANDLING SYSTEMS 0-0-3/2=3/2

Laboratory classes related to various material handling systems.

#### **VI SEMESTER**

**Theory** 

#### FM C-16101COAL PREPARATION3-0-0=06

Coal characteristics, Necessity, scope and application of coal preparation, washability characteristics of coal, effect of mining methods on size, quality and washability.

Crushing of coal: various types of coal size reduction process and their significance. Screening of coal: Classification of coal using various screens and their efficiency.

Coarse coal cleaning: Jigs, heavy media baths and heavy media cyclones. Use of Spirals and tables for coal processing. Performance analysis of different coal cleaning unit operations(Partition curves, misplacement, Meyers curve) and their merits and demerits.

Fine coal cleaning: Challenges in fine coal cleaning, Froth-Flotation, water-only cyclone, Vorsyl separators, oil – agglomeration.

Product disposal and Miscellaneous methods, coal preparation economics, coal preparation flowsheets, modern developments.

#### FM C-16102 FUEL TECHNOLOGY 3-0-0=06

Introduction: Types of fuels

Solid Fuels: types of solid fuel, origin of coal, coal petrography, mineral matter in coal, classification and grading of coal, chemical and physical properties of coal, plastic/coking properties of coal, thermal decomposition of coal, selection, testing utilization of coking and Non-coking coal.

Coal carbonization: Fundamentals of coal carbonization, types of carbonization processes, by product recovery and coke properties; non-recovery coke ovens.

Liquid Fuels: Classification of petroleum, characterization of petroleum and their products. Coal liquefaction.

Gaseous Fuels: Classification of gas, production of gaseous fuel such as producer gas, water gas, natural gas coal bed methane.

#### FM C-16103 SURFACE PHENOMENON & FROTH FLOTATION 3-0-0=06

Physics and Chemistry of interfaces: Types of interfaces, surface energy and surface defects, surface tension applications, interfacial tension, cohesion, adhesion. Surface tension as applied to mineral beneficiation, double layer at solid liquid interface, electrokinetic phenomena. Basics of electrochemical adsorption of particle surface in flotation. Correlation between structure and adsorption for organic reagents in flotation, Chemistry of flotation reagents.

Flotation fundamentals, Flotation theory including kinetics, classification and functions of flotation reagents, laboratory flotation tests; types of flotation: carrier flotation, selective flotation, floc-flotation, skin flotation, reverse flotation, electro flotation etc.

Flotation machines – Basic machine features and functions, Design features of different flotation machines, selection and sizing of flotation machine based on kinetic data. Modern Flotation machines like Column Flotation, Jameson Cell etc. Flotation circuits – Roughing, Scavenging, cleaning etc.

Flotation practice for coal, copper, lead-zinc sulphide, fluorspar, rock phosphate, limestone etc.

#### EE R-16101APPLIED ELECTRICAL ENGINEERING3-1-0=07

Operation characteristics of three phase induction motors; Methods of starting and speed control of DC motor; Ward-Leonard method of speed control of DC motor; Basic principles of Thyristor controlled variable speed AC and DC motors; Principles of rate making of electricity and power factor improvement; Substation arrangement; Circuit breaker; Protective relays: - Inductions pattern over current relay, Thermal overload relay, Earth fault relay; Lightening arrester, Fuses:- Types and selection. Power cables:-Types and selection, Types of motor enclosure, FLP enclosures for hazardous area equipment, intrinsically safe circuit.

Industrial application and control of electrical motors:- Types of electric motors and their application in industry; Controllers for the speed control of DC and AC motors.

Diesel – Electrical oil rigs.

I.E rules applied to mines and oil fields.

#### ES C-16106 POLLUTION CONTROL & ENVIR. MANAGEMENT 3-0-0=06

Mineral exploitation and its environmental impact, source of pollution and magnitude of the problem. Ecological cycles, Socio-economic consideration. Hazardous substances and chemical management. Air and noise pollution due to coal and mineral processing. Generation of dust, noise and vibration and associated problems. Methods of abatement of dust and noise pollution.

Water pollution, problem and control, discharge of effluents to running streams and consequent health hazard, waste water treatment, Zero-discharge concepts. Solid waste: Problem of disposal, design and stability of tailing ponds. Vegetation and cosmetic treatment. Utilization of tailing rejects and fly ash. By-products and value added products.

Environmental management and audit: legal aspects.

#### **Practicals**

#### FM C-16201 COAL PREPARATION 0-0-3/2=3/2

Comparative crushing characteristics of coal in a conventional high speed roll-crusher and a slow speed roll-crusher (sizer). Sink –float test including ash analysis and plotting of washability curves. Bench scale washing of coal in a static bath and calculation of probable error and imperfection in separation. Effect of frother dosage on collector less flotation of coking coal. Effect of frother dosage on collector aided flotation of a coking coal at a fixed diesel oil dosage. Effect of diesel dosage on collector aided flotation of a coking coal at a fixed frother dosage. Determination of size and density profile of stratified jig bed. Demonstration of centrifugal separators such as Water-only cyclone, Heavy media Cyclone/Separator, Vorsyl separator.

#### FM C-16202 FUEL TECHNOLOGY 0-0-3/2=3/2

Proximate and ultimate analysis of coal, calorific value of coal. Free swelling index, caking index, GKLT, sulphur determination, petrography, aniline point, flash point, ash fusion temperature of coal. Penetration index of Bitumen & Wax, Viscosity of coal slurry, Viscosity of oil by Redwood viscometer, Crossing point of a coal sample.

#### FMC-16203SURFACE PHENOMENON & FROTH FLOTATION0-0-3/2=3/2

Selective flotation of complex sulphide ores: flotation of chalcopyrite, lead and zinc. Flotation of lime stone / flotation of dolomite, Reverse flotation of silica. Effects of reagents dosages on flotation, effect of pH, effect of collection time etc.

#### ES C-16206 POLLUTION CONTROL & ENVIR. MANAGEMENT 0-0-3/2=3/2

Mineral exploitation and its environmental impact, source of pollution and magnitude of the problem. Ecological cycles, Socio-economic consideration. Hazardous substances and chemical management. Air and noise pollution due to coal and mineral processing. Generation of dust, noise and vibration and associated problems. Methods of abatement of dust and noise pollution.

Water pollution, problem and control, discharge of effluents to running streams and consequent health hazard, waste water treatment, Zero-discharge concepts. Solid waste:

Problem of disposal, design and stability of tailing ponds. Vegetation and cosmetic treatment. Utilisation of tailing, rejects and flyash. By-products and value added products.

Environmental management and audit: legal aspects.

#### **VII SEMESTER**

#### FM C-17101 COMPUTATIONAL TECHNIQUES IN MINERAL ENGG. 2-1-0 = 05

Application of mass balance techniques for various unit operations in mineral engineering. Optimization of yield, recovery and grade of the product streams.

Minimization of errors involved in size assay analysis. Computation of efficiencies of various separation processes in mineral processing operations.

Calculations related to material balancing of simple and complex circuits. Estimation of grade and recovery values for two/three product separation systems.

Computation of recovery and grade of the products through kinetic behaviour of the individual species for batch and continuous flotation operations. Use of RTD theorems: their applications and limitations.

#### FM C -17102PROCESS EQUIPMENT SELECTION3-0-0=06

Brief review of mineral engineering unit operations. Introduction, various methodologies involved in selection and sizing of various mineral processing units.

Selection and sizing of reciprocating and non-reciprocating crushers. Selection and sizing of rod and ball mills.

Selection and sizing of various size separators such as screens and hydraulic classifiers including limitations involved.

Capacity and Selection of various mineral beneficiation equipments for treating coal and minerals such as jigs, flotation machines, and heavy media separators.

General overview of magnetic and electrostatic separator selection.

#### FM C-17103 DEWATERING & DRYING 3-0-0=06

Introduction to dewatering and drying Flocculation and Dispersion – Fundamental factors underlying flocculation and dispersion phenomena. Mechanism of reagent adsorption, factors affecting flocculation and dispersion, selective flocculation.

Dewatering by gravity sedimentation (thickening) principles and practices. Sizing and selection of thickeners, Different types of thickeners and their use in mineral industries.

Filtration: Principles of filtration, Flow through packed beds, factors affecting the filtration. Different types of filters and their design features.

Centrifuging & Drying: Different types of thermal dryers and their applications, centrifugal sedimentation. Application and practice of dewatering processes in mineral industries.

#### FM C -17104ELEMENTS OF MATERIAL ENGINEERING3-0-0=06

Introduction to structure and properties of materials crystal imperfection. Review of Engineering materials-like steel, cast iron, brass, bronze. Mechanical properties of metals – Elastic & Plastic deformation. Strengthening mechanism Fracture, Fatigue, creep, recovery, recrystallization & grain growth. Electrical properties – Electrical conduction, semi conductivity, dielectric behaviour, Ferro electricity, piezoelectricity. Magnetic properties: Diamagnetism, Paramagnetism, Ferromagnetism, Ferrimagnetism, soft & hard magnetic materials. Composite materials: Particle – reinforced fibre – reinforced & structural composites. Powder metallurgy – Production of metallic powder, compaction of powder & sintering. Composite materials, carbides & ferrites.

#### MS C-17152 INDUSTRIAL ENGG & MANAGEMENT 3-0-0=06

Basic functions of Management – Planning, organizing, staffing, directing and controlling. Introduction to Industrial Engineering techniques. Productivity: definition, measurement. Work study and its role in improving productivity of an organization. Types of production systems. Introduction to production planning and control. Concepts of Human Resource Management – Selection, Training & Development.

Finance Management – Capital Budgeting Techniques. Pay-back period, ARR, NPV, IRR, PI, Sources of capital: Cost concepts and Break even analysis;

Project Management – Introduction, Network construction & identification of critical activities in CPM & PERT

#### **Practicals**

#### FM C-17201DEWATERING & DRYING0-0-3=03

Comparison of pressure and vacuum filter using coal of same size, Effect of coal particle size in vacuum filtration, Effect of coal particle size in pressure filtration, comparison of pressure and vacuum filter using a mineral of same size, Dewatering of coal fines using hydrocyclone, Estimation of filtration rate constant for (coal and mineral) using vacuum filter, Estimation of filtration rate constant (coal and mineral) using pressure filter, Estimation of rate of sedimentation of solid from a suspension with or without flocculants, Estimation of rate of sedimentation of solid from a suspension with or without dispersants, Estimation of rate of drying using a dryer.

#### **VIII SEMESTER**

#### Theory

#### FM C-18101MODELLING & SIMULATION3-2-0=08

Introduction to mathematical modeling, Stochastics and deterministic models, Modelling of size reduction, Matrix and Kinetic models for crushers and grinding mills.

Application for the computation of size distribution of the products of crushers and grinding mills from the size distribution of the feeds to the units. Review of computer techniques for handling multidimensional arrays. Computation and representation of assay factor matrices by arrays of variables. Writing computer programmes incorporating the algorithms, Extension of the algorithms to incorporate assay values and mineralogical compositions. Evaluation of the performance of the comminution circuits.

Introduction to computation of partition value equations. Use of partition value curves and equations for the modeling of screening, classification and density separation processes. Modelling of electrical and magnetic separation processes using distribution factors.

Recycle calculation by iterative methods using direct substitution and Wegestein's techniques. Writing of computer programs incorporating the use of partition values, Use of computer programs and packages for the modeling of separation processes and iterative recycle calculations. Simulation of stochastic and deterministic phenomena, Monte Carlo Simulation. Matrix form representation of beneficiation plant flow sheets.

Mineral characterization files, feed composition files and other data bases required for the plant flow sheet, computations. Software for the development of the flow sheet matrices; simulation of unit operations and recycle calculations. Graphic display and error traps for computer program to simulate beneficiation plant flow sheets.

#### FM C-18102FLOWSHEET DESIGN & PLANT LAYOUT3-2-0=08

Solid and water balance calculations for the estimation of flow rates in beneficiation circuits.

General guidelines for plant design. Size selection for a mineral beneficiation plant and for a coal preparation plant: Broad criteria.

Flow sheet development for a coking coal and non-coking coal washery on individual and blended feed basis.

Flow sheet development for Iron ore, copper and beach sand beneficiation plants.

Rated capacity and peak load capacity of the plants. Material flow diagram, general equipment arrangement. General guidelines on plant layout for a coal, iron ore, copper, lead-zinc and beach sand beneficiation.

#### FM E-18103AGGLOMERATION TECHNIQUES3-0-0=06

Necessity and scope of agglomeration, Raw material preparation, Green ball formation,

Drying of green balls, Firing of pellets, Types of pellets, DISC & DRUM pelletizer, Constructional & operational features, Firing systems – Shaft furnace, Grate, Kiln & Grate-Kiln combination for pellet firing.

Mechanism of Sintering, types of Sinter and properties of Sinter. Briquetting.

#### MM C-18104 MAINTENANCE ENGINEERING 3-0-0=04

#### Sec A:

Maintenance – Key to equipment control. Basic definitions, preventive, operating and shutdown maintenance; level of maintenance; factor influencing the level of preventive maintenance; evaluating PM data processing techniques for upgrading PM program, focus on implementing with examples; measuring maintenance effectiveness and maintenance control. Application of preventive maintenance for system of equipments. Maintenance associated with inspection, condition monitoring technique, diagnostic, maintenance techniques; Modern testing techniques; vibration and signature analysis; causes; remedy in rotating machinery.

Non-destructive testing as an aid to maintenance, principle methods, such as dyepenetrant, magnetic particle testing and ultrasonic tests, Tero-technological approach to maintenance.

Lubrication: Introduction to lubrication engineering, type , classification of lubricants with their properties and characteristics. Science of friction and wear; theories of lubrication; Bearing lubrication technique for minimization of friction and wear.

Wear: Different types of wear, such as abrasive, corrosive, seizure, scoring, scuffing, pitting, spalling, adhesive, etc. and techniques for minimization of wear with examples.

General layout of a coal preparation plants, iron ore beneficiation and a copper ore beneficiation plants. Location of equipment

#### FME-18104(S)BENEFICIATION PROCESS CONTROL2-0-0=04

Introduction: Importance of control systems, General layout of a coal/ mineral beneficiation plants, types control systems adopted, basic principles, definition and description feed forward and back-ward control systems, application and uses of different control systems for pressure control, level control, density measurements and controls used in coal and mineral processing plants with examples and case studies.

#### **Electives (Any One)**

# FM E-18101CLEAN COAL TECHNOLOGY3-0-0=06Introduction to clean coal technology, effect of enhanced coal combustion on<br/>environment, pre-combustion coal cleaning methods including biological and chemical<br/>cleaning methods.3-0-0=06

Clean coal combustion technology, Atmospheric fluids bed combustion, circulating fluidized bed combustion. Pressurized fluidized bed combustors.

Post combustion technology: SOx, NOx ,  $H_2S$  and other toxic gases emission and control methods, SPM and its control methods and equipment.

Integrated coal gasification combined cycle and coal combustion combine cycle methods.

# FM E-18102BIO-MINERAL PROCESSING3-0-0=06

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.

#### FM E-18103OPEN ELECTIVE OF STUDENTS CHOICE\*3-0-0=06