INFORMATION BROCHURE

ISM-JRF Admission
2014-15, Phase-2

Indian School of Mines

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Online Application for ISM-JRF Admission, 2014-15 Phase-2 Commences from 25th September, 2014

Contents

1. ABOUT ISM

Indian School of Mines, Dhanbad, popularly known as ISM, is one of the prestigious institutes of the country, built on the pattern of the Royal School of Mines, England, UK in the year 1926. ISM focuses its education on various engineering, science and management disciplines. The institute offers B.Tech, M.Sc., M.Sc. Tech., M.Tech, M.Phil, MBA, M.Tech. Dual Degrees, Integrated M.Tech./M.Sc. Tech. programmes, besides awarding Ph.D. and D.Sc. in almost all disciplines. ISM, a Deemed to be University, since 1967, started its programmes initially by offering degrees specialised in different earth sciences and engineering disciplines. Today it enjoys the status of an autonomous institute fully funded by the Ministry of HRD, Govt of India. ISM, while administering its programmes through various Departments and Centres of excellence, offers its services to several industries especially in mining, mineral, petroleum and metallurgy sectors.

Institute that aims at excellence in teaching and research, benefits both academia and industry through 18 departments in various research areas of **Engineering:** Civil, Computer Science & Engineering, Chemical, Electrical, Electronics, Environment Science & Engineering, Fuel, Mechanical, Mineral, Mining, Mining Machinery and Petroleum; **Science:** Applied Physics, Applied Chemistry, Applied Mathematics, Applied Geology, Applied Geophysics, besides **Management and Humanities & Social Sciences.** It has been focusing its academic and research activities on various aspects of industry ever since its inception.

ISM has maintained its all-India character, drawing faculty and students from all-over the country. It occupies a unique position, not only in India but also globally, and has contributed to the development of mineral and petroleum sector substantially. The institute possesses state-of-the-art facilities for advanced studies in almost all the areas of Engineering, Sciences, Management and Humanities & Social Sciences research, situated within a sprawling campus spread over an area of 218 acres (+170 acres under acquisition).

1.1 Location of the institute
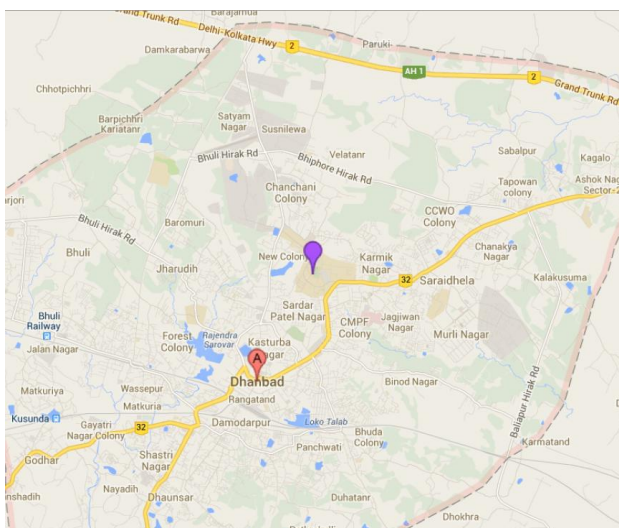
Dhanbad   Indian School of Mines
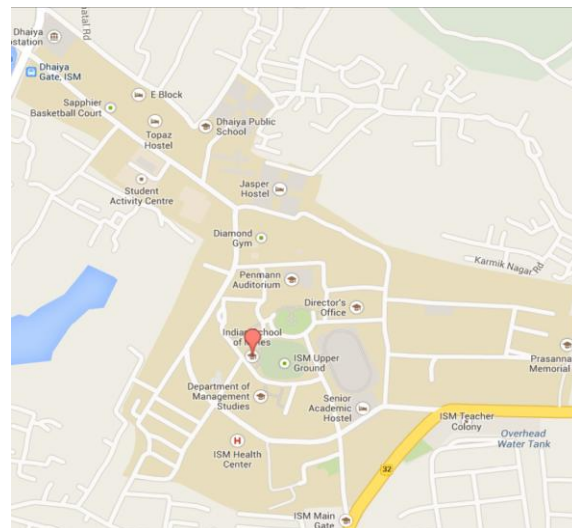
ISM is located in the city of Dhanbad, the Coal Capital of India. One can reach Dhanbad by rail and road. It is 259 kms from Kolkata, 155 kms from Ranchi, 67 kms from Bokaro Steel city and about 180 kms from Jamshedpur. Trains are available from all parts of the country to reach via Kolkata, Delhi and Bombay. Ranchi and Kolkata are nearest cities connected by air. Deluxe and Express buses ply from Kolkata, Ranchi, Jamshedpur and Bokaro. ISM campus is just 2.5 kms from the Dhanbad railway station where taxis and autos ply round the clock. It should be noted that people arriving by train should exit from the main gate located near platform No.1 to avail the taxis / autos.

2.   ABOUT ISM-JRF 2014-15, Phase-2 ADMISSION

Indian School of Mines, Dhanbad provides Junior Research Fellowship (ISM-JRF) to the deserving and eligible candidates qualified through national level tests and thus providing ample opportunities for carrying out research leading to Ph.D. degree.

ISM JRF is open to candidates, below the age of 30 years (35 years for women, PC, SC, ST & OBC) as on **the last date of application [24th October, 2014],** who have obtained **FIRST CLASS OR OGPA 7.0 and above (In case of class not mentioned)** in their qualifying degree of relevant discipline of **Science / Engineering and Management**. The cut-off for those candidates applying in the discipline of **Humanities is 55% marks or equivalent grade**. Physically Challenged (PC) / colour blind candidates may not be considered for field related or some research areas (See section 5 for details). The medium of instruction, publication of research paper and reporting will be in English. Therefore, the scholars are required to possess adequate knowledge of English.

The total number of seats for the 2014-15 phase-2 admission depends on the availability of fund and vacancy for the academic year 2014-15. The discipline-wise distribution of seats will be as per the requirement of respective departments. The Government of India reservation policy will be followed and the number of seats to each category is fixed at the institute level and not for each discipline.

2.1   Disciplines

This scheme is currently available to all the listed disciplines given in Table 1, with an emphasis on inter-disciplinary research in various engineering, science and management departments.

Besides the above, ISM encourages registration for Ph.D. in the interdisciplinary area which may be offered to the successful candidates. Please see annexure – I for details.

Table 1: List of disciplines

Engineering Streams			
Sl. No.	**Discipline**	**Code**	**Department**
1	Chemical Engg.	CHE	Chemical Engg.
2	Computer Science & Engg.	CSE	Computer Science & Engg.
3	Civil Engg.	CVL	Civil Engg.
4	Electronics Engg.	ECE	Electronics Engg.
5	Electrical Engg.	ELE	Electrical Engg.
6	Environmental Science & Engg.	ESE	Environmental Science & Engg.
7	Fuel Engg.	FLE	Fuel & Mineral Engg.
8	Industrial Engg. & Management	IEM	Management Studies
9	Mechanical Engg	MEC	Mechanical Engg
10	Mineral Engg	MLE	Fuel & Mineral Engg.
11	Mining Machinery Engg.	MME	Mining Machinery Engg.
12	Mining Engg.	MNE	Mining Engg.
13	Petroleum Engg.	PET	Petroleum Engg.

Science/Management/HSS Streams			
1	Applied Geology	AGL	Applied Geology
2	Applied Geophysics	AGP	Applied Geophysics
3	Chemistry	CHY	Applied Chemistry
4	English Language/Literature	ENG	Humanities & Social Sciences
5	Environmental Science	ENS	Environmental Science & Engg
6	Management	MAN	Management Studies
7	Mathematics	MAT	Applied Mathematics
8	Philosophy	PLY	Humanities & Social Sciences
9	Physics	PHY	Applied Physics
10	Statistics	STA	Applied Mathematics

2.2   Fellowship

The selected candidates will get a consolidated research fellowship as given in Table 2.

Table 2: Fellowship

Sl. No.	Qualifying Degree	Consolidated Fellowship per month	
		First 2 years	**3rd year onwards**
1	M.Tech. / M.Phil. / MBA	₹18,000.00	₹20,000.00
2	B.Tech. / M.Sc. Tech / M.Sc.	₹16,000.00	₹18,000.00

Any change in fellowship will be intimated to the candidate. **Contingency grant of ₹30000.00 per annum** are allowed with prior approval from Guide & Head of the Department.

At the end of each year the work performance of the JRFs would be assessed as per the institute rules. The fellowship may be withdrawn at any time if the research carried out is found unsatisfactory. Extension of fellowship shall not be given in any case.

2.3   Rules and Regulations

The details are given in ISM website (www.ismdhanbad.ac.in) hosted under '**Rules'**. Also, candidates are required to adhere to the prescribed rules and regulations issued through various orders by the ISM authorities from time to time.

2.4   Programme Fee

The fees to be paid at the time of **admission** for Ph.D. programmes are given in Table 3. The fee should be paid by **SEPARATE** demand drafts drawn in favour of **Registrar, Indian School of Mines, payable at Dhanbad** as per the institute's fees structure.

Table 3: Fee structure

Sl. No.	Particulars	Fee (INR)
1	Fee payable at the time of admission	₹30,500.00
2	Hostel mess fee advance (Annual)	₹30,000.00

In addition to above, the students are required to pay an additional amount towards accidental insurance and institute blazer etc., as per actuals, at the time of admission. The fee structure is subject to change from time to time. The exact fee structure will be notified at the time of admission.

3.   ADMISSION

3.1   General Information

Interested candidates should submit their application **online ONLY**, between 25.09.2014 to 20.10.2014. The following information can also be downloaded from the ISM website http://www.ismdhanbad.ac.in/phd-jrf:

a.   Advertisement for ISM-JRF 2014-15, Phase-2
b.   Details on application
c.   Information brochure
d.   Important dates
e.   Online registration and application
f.   Other notifications viz. Important dates, details on Entrance Exam, Interview, Admission, Results, etc.

The last date for the submission of online application is 20.10.2014. The hard copy of the application form should reach "Assistant Registrar (Academic), Indian School of Mines, Dhanbad – 826004" on or before 24.10.2014. Please write "**ISM JRF 2014-15, Phase-2**" on the top of the envelope. Applications received after the due date will not be considered.

3.2   Application Fee

The application fees for ISM JRF are given in Table 4. The application fee is to be paid only by **Bank Challan of SBI**, along with online application. Application fee once paid will not be refunded under any circumstances.

Table 4: Application fee for ISM-JRF

Sl. No.	Category	Fee
1	General/OBC	₹2,000.00
2	SC/ST/PD	₹1,000.00

3.3   Eligibility Criteria

a. The disciplines for ISM JRF admission are given in Table 1.
b. For the admission in Science, Engineering and Management disciplines, only the candidates with **FIRST CLASS** in their qualifying degree are eligible to apply. If class is not mentioned in the **candidate's certificate**, then an **OGPA of 7.0** or above will be considered as FIRST CLASS.
c. For the admission in Humanities disciplines, candidates with **55% marks or equivalent grade** in their qualifying examination are eligible to apply**.**
d. The candidates' qualifying degree and subject should match as per details mentioned in Table 5 with respect to discipline, degree and specialisation.
e. Candidates appearing for their final/pre-final semester exams are **NOT ELIGIBLE** to apply.

Table 5: Eligibility Criteria

3.3.1   Engineering Streams

Sl	Discipline	Eligibility qualifications#
1	Chemical Engg.	M Tech/B Tech/B.E in Chemical Engineering with specialization in Petroleum, Petrochemical, Environmental, Polymer Technology, Fuel & Energy or M Sc Chemistry with Mathematics at B Sc level with minimum.
2	Computer Science & Engg.	M.Tech. and/or B.Tech. or equivalent in Computer Science & Engg. / IT / Electronics Engg. / Electronics and Communication Engg. / Electrical Engg. / Computer Application.
3	Civil Engg.	B.Tech. in Civil Engg. / M.Tech. in Civil Engg. with specialization in Structural / Geotechnical / Water Resources / Environmental / Transportation Engg.
4	Electronics Engg.	M.Tech. / B.Tech. or Equivalent in Electronics and Communication Engg./Electronics and Instrumentation Engg.
5	Electrical Engg.	M.Tech./B.Tech. or equivalent in Electrical/Electrical & Electronics Engg.
6	Environmental Science & Engg.	M.Tech. / B.Tech. or equivalent in Agriculture / Biotechnology / Civil / Chemical / Environmental / Mechanical / Mining / Mineral / Petroleum / Material Science / Textile/Leather Technology/Water Resource Engg./Environmental Science & Engg.
7	Fuel Engg.	M.Tech. / B.Tech. or equivalent in Mineral / Fuel / Chemical / Metallurgical / Mining Engg.; B.Tech. Mechanical Engg. with M.Tech. in Fuel Engg.
8	Industrial Engg. & Management	Postgraduate / Bachelors Degree in Industrial Engg. and Management / Industrial Engg. / Production Engineering / Mechanical Engg. / Electrical Engg. / Civil Engg. or equivalent.

9	Mechanical Engg	M.Tech. / B.Tech. or equivalent in Mechanical / Production / CAD-CAM / Thermal / Mechatronics / Energy / Power Plant / Industrial / Manufacturing / Automobile / Mining Machinery Engg. / Maintenance Engg. & Tribology
10	Mineral Engg	M.Tech. / B.Tech. or equivalent in Mineral / Chemical / Metallurgical / Mining Engg; B.Tech. Mechanical Engg. with M.Tech. in Mineral Engg.
11	Mining Machinery Engg.	B. Tech in Mechanical / Electrical / Mining Machinery Engg. with M. Tech in Mining Machinery / Mechanical / Electrical Engg. **Specialisation**: Machine Design/ CAD/ Fluid Mechanics & Fluid Machines / Maintenance Engg. & Tribology / Automobile Engineering / Electrical Machines / Power Electronics & Drives / Instrumentation & Control.
12	Mining Engg.	M.Tech. or equivalent in Mining Engg. / Opencast Mining / Mine Planning & Design / Rock Excavation Engg. / Geomatics / Underground Space Technology / Rock Mechanics / Civil Engg. / Engineering Geology; B.Tech or equivalent in Mining Engg. / Civil Engg. / Opencast Mining / Mining Machinery/Environmental Engg.; M.Sc. Tech. (Applied Geology); M.Sc. (Geospatial Science).
13	Petroleum Engg.	M.Tech. / B.Tech. or equivalent in Petroleum Engg. / Petroleum Management; M.Tech. in Petrochemical / Chemical / Mechanical Engg. / M.Sc. in Chemistry.

Equivalence degrees for B.Tech will be BE/BSc Engg. (4 years) and for M.Tech. will be ME/M.Sc. Engg.

3.3.2 Science/Management/Humanities and Social Sciences Streams

SI	Discipline	Eligibility qualifications
1	Applied Geology	M.Sc. / M.Sc. Tech in Geology / Applied Geology or M.Sc./M.Sc. Tech. In Geology/ Applied Geology with specialisation in Marine Geology / Oceanography / Hydrogeology / Geochemistry/ Applied Geochemistry / Environmental Science / Geoinformatics / Natural Hazards & Disaster Risk Management / Remote Sensing and GIS / Geophysics / Petroleum Geosciences. **OR** M.Tech in Mineral Exploration / Engineering Geology / Petroleum Exploration / Geo-exploration / Exploration Geosciences / Remote Sensing and GIS applications / Geoinformatics / Petroleum Geosciences / Marine Geosciences having M.Sc. / M.Sc. Tech. in Geology/ Applied Geology or M. Tech in Geological Technology. **OR** B. Tech. / M. Tech in Mining Engg. / Mineral Engg. / Civil Engg.
2	Applied Geophysics	M.Sc/ M.Sc. Tech/Integrated M. Sc/Integrated M. Sc. Tech. in Applied Geophysics/ Exploration Geophysics/ Geophysics or M.Sc. Tech in Marine Geophysics or M.Tech in Geophysical Technology or M. Tech (Petroleum Exploration).
3	Chemistry	M.Tech. / M.Phil. / M.Sc. or equivalent in Chemistry / Applied Chemistry / Industrial Chemistry.
4	English Language/ Literature	M.A. / M.Sc. / M.Litt. / M.Phil. or equivalent in English Language & Literature / Applied Linguistics & Language Teaching / English Language Teaching
5	Environmental Science	M.Phil. / M.Sc. / M.Sc. Tech. or equivalent in Atmospheric Science / Botany / Zoology / Microbiology / Biotechnology / Chemistry / Physics / Environmental Science / Environmental Science & Management / Geology / Hydrology / Statistics / Soil Science / Remote sensing and GIS / Forestry
6	Management	MBA Degree / Postgraduate Degree or Diploma recognized as equivalent to Postgraduate in Management by AICTE / UGC / AIU / Postgraduate Degree in Economics / Commerce / Psychology / Professional qualifications like CA / CS / ICWA / Postgraduate Degree in Industrial Engg. and Management / Industrial Management / Industrial Engg. / Production Engg.
7	Mathematics	M.Phil/ M. Tech. / M.Sc. or equivalent in Mathematics/ Applied Mathematics/ Mathematics & Computing.

8	Philosophy	M.A. / M.Sc. / M.Com / MBA or equivalent degree or Master's in Engg. / Technology or equivalent degree or M.A. / M.Phil. in Philosophy or equivalent.
9	Physics	M.Sc./Integrated M.Sc./M. Phil or equivalent in Physics/Applied Physics or B.Tech./M. Tech./ Integrated M. Tech. or equivalent in Engineering Physics/Material Science/Nanoscience and Technology/Optoelectronics or equivalent.
10	Statistics	M.Phil. / M.Sc. or equivalent in Statistics / Applied Statistics.

3.4   Reservation Policy

- Reservation for PC/SC/ST/OBC-NC candidates will be as per Government of India directive/guidelines.
- For Physically Challenged (PC) candidates, a maximum of 3% within the respective category.
- For Other Backward Classes non-creamy layer (OBC-NC) category candidates the certificate in the format given in Annexure II is to be produced during the interview and submitted (in original) at the time of admission by as per the admission to Central Educational Institutions (CEIS), under the Government of India. The certificate should be issued **on or after 1st September, 2014**. Candidates not having OBC-NC certificate issued on or after this date will not be considered for selection.

3.5   Medical Fitness

A candidate selected for a programme will be offered admission, only if he/she is found fit as per the norms & standards of medical fitness set by ISM. An overview of the standards of medical fitness set by ISM is presented below. Female candidates are **NOT ELIGIBLE** for admission in Mining Engineering discipline.

A candidate should have good general physique with:

- Chest measurement: Not less than 70cms with satisfactory limit of expansion and contraction.
- Vision: Should be normal. In case of defective vision, it should be corrected to 6/9 in both eyes or 6/6 in the better eye. Colour blind candidates are not eligible for admission in Applied Geology, Mining and Petroleum Engineering disciplines.
- Hearing: Should be normal. Defective hearing should be corrected.
- Heart & Lungs: Should not have any abnormality and no history of mental diseases or epileptic fits.
- The candidate shall submit the medical certificate in the prescribed proforma at the time of admission. However, the candidates to be admitted will be examined by a medical board set by ISM before admission, whose decision for medical fitness will be final.
- Physically Challenged: Candidates with any form of physical disability is not considered for Mining and Petroleum Engineering disciplines.

3.6   Application Procedure

3.6.1   Registration and online application

Interested candidates should register their name using valid email id and phone number up to 16.10.2014 and submit their application online from 25.09.2014 to 20.10.2014. Details on application along with information brochure containing eligibility criteria may be downloaded from the ISM website http://www.ismdhanbad.ac.in/phd-jrf from 25.09.2014 onwards. The last date for the registration of online applications is 16.10.2014. The application fee of Rs. **2000/-** (Rs.**1000/-** for SC/ST/PD candidates) for the ISM-JRF programme to be paid through online bank challan of SBI. The candidates will be guided through the application process while registration and online application. Please feel free to contact ISM JRF Admission office through ism.jrf@gmail.com.

3.6.2   Submission of hard copy of application form

A hard copy of the completed application form along with requisite bank challan should reach **Assistant Registrar (Academic), Indian School of Mines, Dhanbad – 826004**, latest by 24.10.2014. Please write/type clearly "**ISM JRF 2014-15, Phase-2**" on the top of the envelope.

3.6.3   Admit card for ISM JRF-EE

After due verification, admit cards will be generated automatically using your login credentials through the website.

3.7   Selection process

3.7.1   For candidates appearing for ISM-JRF EE (Non-NET LS/Non-GATE).

a. The applicants have to qualify the ISM-JRF Entrance Examination (ISM-JRF EE) 2014-15 (Phase-2).

b. **ISM-JRF EE will adopt objective type questions with NEGATIVE marking for wrong answers.**

c. Only the successful candidates who qualify in the written test will be called for the interview on the scheduled date

d. The weightage for ISM-JRF EE and interview would be in the ratio of 50:50

   o For candidates with **M Tech/M Phil with first class,** a weightage of 10 marks will be given and the interview would be held out of 40 marks.

3.7.2 For GATE or NET LS qualified candidates:

a. All those candidates with valid GATE score as on the last date of online application (**20.10.2014**) / NET LS (Lectureship) qualified candidates are eligible for direct interview with the following distribution of marks :

- o GATE: Gate score (out of 100) will be converted out of 50 marks.
- o NET (Lectureship) qualified candidates will get 50 marks.
- o Interview will be held out of 50 marks
  - For candidates with **M Tech/M Phil with first class** a weightage of 10 marks will be given and the interview would be held for 40 marks.

3.7.3 For NET (Junior Research Fellowship) qualified candidates:

These candidates can directly apply through respective departments.

3.7.4 Option for appearing in ISM-JRF Written Test

GATE/NET qualified candidates who are desirous to take the ISM-JRF Entrance Examination will be allowed. In such cases the ISM-JRF Entrance Examination marks will be taken into consideration with due weightages as mentioned (item 'a' above).

3.7.5 ISM-JRF Entrance Examination (ISMJRF-EE)

All applicants other than GATE/NET qualified candidates have to qualify the ISM-JRF Entrance Examination to be called for the interview. **ISMJRF-EE will adopt objective type questions with NEGATIVE marking for wrong answers.** The National wide, ISMJRF-EE will be held on **30.11.2014 (SUNDAY)** at the centres given in Table 6 from **9.00 AM - 12.00 Noon.**

Table 6: List of centres for ISMJRF EE

Sl. No.	Centre	Code
1	Bhubaneswar	BBS
2	Chennai	CHN
3	Dhanbad	DHN
4	Kolkata	KOL
5	New Delhi	NDL
6	Varanasi	VAR

Important points to be noted:

- If the number of candidates appearing for ISMJRF-EE in a particular centre falls below a feasible number, ISM reserves the right to shift the exam for the candidates to the nearest centre.
- The medium of examination will be English.
- The syllabus for the ISMJRF-EE is given in section 3.6.

3.7.6   ISM JRF Interview

All the GATE/NET qualified candidates and those who qualify the ISMJRF-EE will be called for the interview on the scheduled date. The weightage for NET/ISMJRF-EE and interview would be in the ratio of 50:50. A weightage of 10 marks will be given and the interview would be held for 40 marks for those candidates having **M.Tech. / M.Phil. with first class.**

3.7.7   Final Admission

From the qualified candidates after the interview, a merit list will be prepared and will be called to take admission on a scheduled date. If there is any vacancy after the admission of merit list candidates an extended merit list will be prepared from the remaining qualified candidates and will be called for taking admission subsequently.

Up on selection the candidates are required to submit necessary undertakings in the prescribed format given in **<u>Annexure I</u>** for carrying out Ph.D. in interdisciplinary areas during admission and before joining the programme. Before signing of the undertaking they should ensure that they have gone through the rules and regulations of ISM Ph.D. programme and admission procedures given in the ISM website.

The selected JRFs are required to register for Ph.D. programme within three months of their joining by paying the requisite tuition fees and other charges on the date of their registration, failing which the selection will stand, cancelled.

All JRFs will be governed by the ISM's Ph. D. rules (full-time) prevailing at that time.

ISMJRF-EE Syllabus

3.8 Engineering Streams

3.8.1 Chemical Engineering (Code: CHE)

Fluid Mechanics: Fluid statics; fundamental concepts of fluid flow, Newtonian and non-Newtonian fluids, incompressible and compressible fluid flow, Bernoulli's equation, macroscopic friction factors, transportation and metering of fluids, pump characteristics, basics of packed and fluidized beds.

Chemical Process Calculation: Steady-state and dynamic processes, lumped and distributed processes, single and multi-phase systems; equilibrium relations, correlations for physical and transport properties, behaviour of ideal and real gases and gaseous mixtures, vapor pressure, humidity and saturation, mass and energy balance with and without recycle, bypass and purge, heat of reaction and laws of thermochemistry; combustion calculations.

Heat transfer: Basic modes of heat transfer, heat transfer coefficients, boiling, condensation and evaporation, and their applications, types of heat exchangers and evaporators and their design.

Mechanical Operations: Types of mechanical operations, characteristics of particulate solids: sampling techniques, specification and screen analysis, particle size distribution; principles of size reduction, crushing and grinding efficiency, laws of crushing, pulverization and ultrafine grinding, theory and applications of filtration.

Chemical Engineering Thermodynamics: Basic concepts of thermodynamics, extensive and intensive properties, state and path functions, laws of thermodynamics and their applications, equation of state, thermodynamic properties of fluids, vapour-liquid equilibria, chemical reaction equilibria.

Mass Transfer: Fundamentals of mass transfer: molecular diffusion, mass transfer coefficients and interface mass transfer, steady and unsteady state theories of mass transfer, heat and mass transfer analogies, single and multi-stage contact operations, distillation, absorption and stripping, humidification, drying, liquid–liquid extraction, leaching, adsorption.

Chemical Reaction Engineering: Theories of reaction rates, kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal and non-ideal reactors, residence time distribution, single parameter models, non-isothermal reactors, diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables, sensors, transducers and their dynamics, transfer functions and dynamic responses of simple systems, feedback controllers, analysis of closed loop control systems including stability, frequency response and controller tuning, process reaction curve, feed forward control, control valves and their characteristics.

General Chemical Technology: Inorganic and organic process industries, sulphuric acid, sodium hydroxide fertilizers (ammonia, urea, phosphatic fertilizers), pulp and paper, sugar, oil and fats industries, petroleum refining and petrochemicals, polymerization industries, polyethylene, polypropylene, PVC and polyester synthetic fibres.

Fuel & Energy: Solid, liquid and gaseous fuel; and their utilisation, renewable energy sources.

3.8.2 Computer Science and Engineering (Code: CSE)

Programming Skill: Programming proficiency in C/C++/Java

Discrete Mathematics: Counting Techniques, Generating Functions, Recurrence Relations, Formal Logic, Propositional and Predicate Calculus, Boolean Algebra.

Computer Organization and Architecture: Logic Functions, Minimization, Design and Synthesis of Combinational and Sequential Circuits, Data Representation, Machine Instructions, Addressing Modes, ALU, CPU, Control Unit Design, Cache and Main Memory, I/O Interface, Pipelining Multiprocessors.

Data Structures and Algorithms: Arrays, Stacks, Queues, Linked Lists, Binary Trees, Height Balanced Trees, Graphs, Sorting, Searching, Algorithm Analysis, Space and Time Complexity,

Algorithm Design: Divide and Conquer, Greedy Approach, Dynamic Programming, Back Tracking, Complexity Classes: P, NP-hard and NP-complete.

Operating Systems: Processes, Threads, Inter-Process Communication, Synchronization, Deadlocks, CPU Scheduling, Memory Management, File Systems, I/O Systems.

Database: ER-Model, Relational Algebra, Tuple Calculus, Database Design, Query Languages, Transactions and concurrency Control.

Compiler Design: Lexical Analysis, Parsing, Syntax Directed Translation, Runtime Environments, Intermediate Code Generation, Code Optimization, Code Generation.

Computer Networks and Security: OSI and TCP/IP Architectures, Flow and Error Control, MAC Algorithms, Routing Algorithms, TCP and UDP, Sockets, Application Layer Protocols: SMTP, HTTP, DNS, WWW; Security: Symmetric and Asymmetric-Key Cryptography, Authentication, Hash Functions, SSL / TLS.

Software Engineering: Software Development Life Cycle, Software Requirement Specifications, System Design, Coding, Testing, Software Project Management.

3.8.3   Civil Engineering (Code: CVL)

Structural Engineering: Bending moment and shear force in statically determinate beams. Simple stress and strain relationship: Stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle. Simple bending theory, flexural and shear stresses, shear centre. Analysis of statically determinate trusses, arches, beams, cables and frames, displacements in statically determinate structures and analysis of statically indeterminate structures by force/ energy methods, analysis by displacement methods (slope deflection and moment distribution methods), influence lines for determinate and indeterminate structures.

Concrete Structures: Concrete Technology- properties of concrete, basics of mix design. Concrete design- basic working stress and limit state design concepts, analysis of ultimate load capacity and design of members subjected to flexure, shear, compression and torsion by limit state methods. Basic elements of prestressed concrete.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases. Connections- simple and eccentric, beam-column connections, plate girders and trusses.

Geotechnical Engineering: Origin of soils, soil classification, three-phase system, fundamental definitions, relationship and interrelationships, permeability & seepage, effective stress principle, consolidation, compaction, shear strength. Sub-surface investigations- scope, drilling bore holes, sampling, penetration tests, plate load test. Earth pressure theories, effect of water table, layered soils. Stability of slopes. Foundation types-foundation design requirements. Shallow foundations-bearing capacity, effect of shape, water table and other factors.

Water Resources Engineering: Properties of fluids, principle of conservation of mass, momentum, energy and corresponding equations, potential flow, applications of momentum and Bernoulli's equation, laminar and turbulent flow, flow in pipes, pipe networks. Concept of boundary layer and its growth. Uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump. Forces on immersed bodies, flow measurements in channels, tanks and pipes. Dimensional analysis and hydraulic modeling. Hydrologic cycle, rainfall, evaporation, infiltration, stage discharge relationships, unit hydrographs, reservoir capacity**.** Duty, delta, estimation of evapo-transpiration. Crop water requirements. Types of irrigation system, irrigation methods. Water logging and drainage, sodic soils.

Environmental Engineering: Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, sludge disposal, effluent discharge standards. Domestic wastewater treatment, quantity of characteristics of domestic wastewater, primary and secondary treatment Unit operations and unit processes of domestic wastewater, sludge disposal. Types of air pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits. Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste

management (reuse/ recycle, energy recovery, treatment and disposal). Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

Transportation Engineering: Geometric design of highways, testing and specifications of paving materials, design of flexible and rigid pavements. Traffic characteristics, theory of traffic flow, intersection design, traffic signs and signal design, highway capacity.

Surveying: Importance of surveying, principles and classifications, mapping concepts, coordinate system, map projections, measurements of distance and directions, leveling, theodolite traversing, Total Station, errors and adjustments, curves.

3.8.4   Electronics Engineering (Code: ECE)

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Nortons maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, and resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, Basics of LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Small Signal Equivalent circuits of diodes, BJTs, MOSFETs and analog CMOS. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential and operational, feedback, and power. Frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits, 555 Timers. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinatorial circuits: arithmetic circuits, code converters, multiplexers, decoders, PROMs and PLAs. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, DFT and FFT, z-transform. Sampling theorem. Linear Time-Invariant (LTI) Systems: definitions and properties; causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay. Signal transmission through LTI systems.

Control Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative (PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density. Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Fundamentals of information theory and channel capacity theorem. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), digital modulation schemes: amplitude, phase and frequency shift keying schemes

(ASK, PSK, FSK), matched filter receivers, bandwidth consideration and probability of error calculations for these schemes. Basics of TDMA, FDMA and CDMA and GSM.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss and Stokes theorems, Maxwells equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; S parameters, pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Basics of propagation in dielectric waveguide and optical fibers. Basics of Antennas: Dipole antennas; radiation pattern; antenna gain.

Instrumentation and Measurements: Principle of measurements and error analysis. Instruments: DC & AC voltage and current meters, power and energy meters, meter for measuring speed, potentiometer and bridges; estimation of instrument ranges. Amplifiers in instrumentation, Digital display in instruments. Principle of oscilloscope and recorders, Passive (resistive, inductive, capacitive) and active (thermoelectric, piezoelectric, photoelectric etc.) transducers.

3.8.5   Electrical Engineering (Code: ELE)

Electric Circuits and Fields: Network graph, KCL, KVL, node and mesh analysis, transient response of DC and AC networks; sinusoidal Steady-state analysis, resonance, basic filter concepts; ideal current and voltage sources, Thevenin's, Norton's and Superposition and

Maximum Power Transfer theorems, two-port networks, three phase circuits; Gauss Theorem, electric field and potential due to point, plane and spherical charge distributions;

Ampere's and Biot-Savart's laws; inductance; dielectrics; capacitance.

Signals and Systems: Representation of continuous and discrete-time signals; shifting and scaling operation; liner, time-invariant and casual system; Fourier series representation of continuous periodic signals; sampling theorem; Fourier, Laplace and Z transforms.

Electrical Machines: Single phase transformer- equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers – connections, parallel operation; auto-transformer; energy conversion principles; DC machines – type, winding, generator characteristics, armature reaction and commutation, stating and speed control of motors; three phase induction motor – principles, types, performance characteristics, starting and speed control; single phase induction motors; synchronous machines – performance, regulation and parallel operation of generators, motor starting, characteristics and applications; servo and stepper motors.

Power Systems: Basic power generation concepts; transmission line models and performance; cable performance, insulation; corona and radio interference; distribution systems; per-unit quantities; bus impedance and admittance matrices; load flow; voltage control; power factor correction; economic operation; symmetrical components; fault analysis; principles of over-current. Differential and distance protection; solid state relay and digital protection; circuit breakers; systems stability concepts, swing curves and equal area criterion; HVDC transmission and FACTS concepts.

Control Systems: Principles of feedback; transfer function; block diagrams; steady-state errors; Routh and Nyquist techniques; Bode plots; root loci; lag, lead-lag compensation; state space model; state transition matrix, controllability and observability.

Electrical and Electronic Measurements: Bridges and potentiometers; PMMC, moving iron, dynamometer and induction type instruments; measurements of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meters; oscilloscopes; potentiometric recorders; error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET; amplifier-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifier characteristics and application; simple active filter; VCOs and timers; combinational and sequential logic circuits; multiplexer; Schmitt trigger; multi-vibrators; sample and hold circuits; A/D and D/A converters; 8-bit microprocessor basics, architecture, programming and interfacing.

Power Electronics and Drives: Semiconductor power diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs – static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters – fully controlled and half controlled; principles of choppers and inverters; basic concepts of adjustable speed dc and ac drives.

3.8.6 Environmental Science and Engineering (Code: ESE)

Global & Regional Environmental issues: Green House Effect, Global Warming, Acid Rain, Ozone layer depletion, Climate Change, Carbon Foot Printing, Environmental impacts of particulates and gaseous pollutants like Photo chemical smog, haze, secondary pollutant formation etc.

Air Pollution: Introduction to atmosphere, physical and chemical properties of atmosphere, thermodynamics of atmosphere, meteorology, global circulation, stability class, lapse rate, inversion, wind rose diagram, types of stack plume behaviour, types of air pollution & pollutants, Its natural & anthropogenic sources, impacts of air pollutants on environment, health & material, air quality monitoring and standards, Concept of dispersion, diffusion and advection, fate and transport of pollutants, Gaussian plume model, box model, emission factor and emission inventory, plume rise calculation, vehicular pollution, indoor air pollution, air pollution by combustion activities.

Air Pollution Control: Particle size and number, aerodynamic diameter, particle size distribution, gravity settling chamber design, derivation of plug flow and mixed flow model to design gravity settling chambers, design of cyclone, design of fabric filter and Electro Static Precipitator. Control of gaseous pollutants by absorption, adsorption, thermal incineration and condensation, clean coal combustion technologies for thermal power plants, control of SOx and NOx before, during and after combustion, control of vehicular pollution, alternative fuels, synthetic fuels, green fuels, control of incomplete combustion products, control of CO_2, Carbon Sequestration and indoor air pollution control.

Water: Water pollution-Sources & effects, Water born diseases, Water quality parameters, Drinking water quality standards, Stream Standards, Water treatment methods – aeration, coagulation, flocculation, filtration and chlorination.

Waste Water Engineering: Waste Water Characteristics, Preliminary and Secondary treatment, Design of unit operations, Screening, Grit Chamber, Sedimentation Tank, Activated Sludge Process, Oxidation Ditch, Trickling Filter, Aerated Lagoons & Stabilisation Pond, and Anaerobic Treatment, Treatment Technology- Anaerobic filter, Anaerobic Contact Process, UASB, Sludge Management- Treatment and Disposal, Common Effluent Treatment Plant (CETP).

Land: Land use changes due to human and industrial activities, land use planning and development, soil conservation, Solid waste (domestic & industrial) management and disposal.

Ecology and Microbiology: Ecology & Ecosystem; function and structure, Resilience & Inertia, Biodiversity & Hot spots; Red data Books; Population & Fragile ecosystem Community ecology, Aquatic Ecology, Ecology Succession, Biotic Indices, Carbon & Nitrogen Cycle, Eutrophication, Ecotoxicology, Bio-magnification, Microbes- Importance, Enumeration & Application, Bacterial Nutrition, Metabolisms & Growth, Control of Microbes, Bacteriological Contamination, Coliforms.

Hydrology: Ground water pollution, Movements of grounds, Conservation of ground resources.

Noise: Sound Pressure Level, Sound Power Level, Noise Standards, Physiological effects and abatement measures.

Environmental Legislation: Water Act, Air Act, Environmental Protection Act, Forest Conservation Act, Wild Life Protection Act.

Environmental Administration: Environmental Impact Assessment (EIA), Environmental Management Plan, Environmental Auditing.

3.8.7 Fuel Engineering (Code: FLE)

Origin and Classification of coal;

Coal Characterisation: Chemical, Physical, Plastic and Petrographic composition;

Coal Carbonisation: Fundamental of coal carbonisation, Low Temperature, High Temperature Carbonisation, Design of coke oven, By-product , Formed coke and Briquetting.;

Coal Combustion: Fundamental of coal combustion, Stoichiomentry, Design of Furnaces and Boiler, Atmospheric Fluidized bed Combustion (AFBC), Circulating Fluidized bed Combustion (CFBC), Pressurised Fluidized bed Combustion (PFBC).;

Coal Gasification: Fundamental of coal gasification, Kinetics of Coal Gasification and Different types of gasifiers, Different Gaseous Fuels;

Clean Coal Technology: Pre-combustion cleaning, Integrated Coal Gasification Combined cycle etc.; Modelling and Simulation of some energy systems like, Integrated Coal Gasification Combined Cycle, AFBC, CFBC, and PFBC.;

Liquid Fuels: Characteristics of liquid fuels like gasoline, diesel and kerosene etc.;

Non-conventional Energy sources: Wind, Solar, Biomass, Hydroelectricity etc.;

Heat Transfer: Fundamentals of heat transfer and its application in energy related systems. ;
Mechanical Operation: Types of Mechanical Operations, Characteristics of particulate solids: sampling techniques, specification and screen analysis, and particle size distribution.;

Principles of size reduction: Specific properties of solids for size reduction. Energy required for size reduction. Crushing and grinding efficiency. Laws of crushing, pulverization and ultrafine grinding.

3.8.8 Industrial Engineering & Management (Code: IEM)

Principles and Practices of Management:

Management: concept and basic features ; Functions of Management: Planning, Organizing, Staffing, Directing and Controlling; Organisation structure; Basic theories of Management

Research Methodology and Statistics:

Scientific Research: Definition, problems, types of variables; Measures of Central Tendency and Dispersion, Probability, Sampling, and Randomness; Statistics: Purpose, Approach, and Method: Binomial Statistics, Normal Probability; Correlation and Regression

Human Resource Management:

Training and Development, Motivation, Leadership, Job Satisfaction, Recruitment and Selection, Performance Appraisal

Quantitative Techniques

Role of quantitative techniques in managerial decision making; Optimization techniques: Classification and Applications; Linear Programming: Features, Modelling, Simplex method of solution, Transportation model, and Assignment problem; Queuing theory: its role in decision making

Concept of Information System, Basics of MIS and DSS

Operations Management and Industrial Engineering

Concept and measurement of Productivity; Work Study techniques; Productivity improvement through Incentive Planning, Job Evaluation, and Merit Rating; Inventory Management: ABC analysis and EOQ model ; Demand Forecasting: Time series analysis ; Concept of Quality, application of Quality Control techniques in improving product quality; Basics of Production Scheduling, Facility Location, and Plant Layout

Project Management

Concept of a Project, Project breakdown structure; Project Scheduling: time estimates, CPM/PERT

Economics

Managerial Economics: Basic Philosophy; Demand and Supply function: Elasticity of Demand

Nature and behaviour of different types of revenue and costs; Pricing under monopoly and oligopoly

Financial Management

Concept and Basic understanding on: Working Capital Management, Capital Budgeting decisions

3.8.9 Mechanical Engineering (Code: MEC)

Mechanics of Solids: Complex stress and strains combined bending and axial torsion, Shear force and bending moment diagrams. Deflection of beams, fixed and continuous. Thick and thin cylinders, columns, springs.

Theory of Machines: Velocity & acceleration diagrams. Fly wheel and governors, gear profile and gear trains, balancing and vibrations.

Machine design: Engineering and computer graphics, basic concepts of design, CAD, design of mechanical component i.e. shaft, coupling, pulleys, gears, bearings, Engineering materials.

Thermal engineering: Laws of thermodynamics, entropy, enthalpy, Internal combustion engines –

two-four stroke, boilers, steam turbine, mode of heat transfer, heat exchangers, refrigeration, cycles and air conditioning.

Hydraulics in Industrial applications: Properties of fluid, Bernoulli's equation, Euler's equation, Reynolds's equation, Navierstoke's equation flow of fluid, reciprocating and centrifugal pumps, hydraulic turbines.

Production Technology: Theory of metal cutting, conventional, non-conventional machining methods. Welding, foundry and forging practices, Computer integrated manufacturing, CPM and PERT

3.8.10 Mineral Engineering (Code: MLE)

Introduction: Definition of Ore, Mineral and gangue, Classification of common ore forming minerals, Chemical and physical and optical properties of different ores and minerals, scope and necessity of beneficiation of Ores and Minerals, Definition of liberation, Measurement of degree of liberation.

Sampling: Definition, principles and methods, sampling theories, measurement of necessary of sampling.

Particle Sizing: Particle characterization and measurement, Definition and shape and size and their measurements, Equivalent diameters, Measurement of particle size by sieving, sedimentation, elutriation and optical methods.

Comminution: Fundamentals of size reduction, comminution laws, various types of crushers, Band work index and HGI. Grinding mill principles, design construction and their operation in open and closed circuit with classifiers, Principles involved in industrial screening and wet classification of ores and minerals.

Gravity Separation: Basic principles, application criteria for gravity concentration techniques.

Jigging: Basic principles, types of jigs and their relative merits and demerits, operation and maintenance of jigs.

Flowing Film Gravity Concentration: Introduction to flowing film gravity concentration principles involved derivation of various coal and minerals, including tabs and spi

Band work index and HGI.

3.8.11 Mining Machinery Engineering (Code: MME)

Mechanics of Solids: Complex stress and strains combined bending and axial torsion, Thick and thin cylinder. Deflection of beams, columns, springs, Theories of failure.

Theory of Machine: Velocity & acceleration diagrams. Fly wheel, governors, gear train balancing, cam and follower, gyroscope, vibrations, mechanism of lower pair.

Machine design: Basic concept of design, CAD, design of mechanical components pulleys, shafts, couplings, gears, Engineering materials, selection of bearings applied to mining equipments.

Thermal engineering: Laws of thermodynamics, entropy, enthalpy, I.C. engines, heat exchanger.

Hydraulics in Industrial applications: Properties of fluid, Navierstoke's equation, Bernoulli's and Euler's equation, Hydrostatic pumps, motors, valves and other components, hydrostatic systems used in industrial applications. Design of hydrostatic drives. Fluid flow machines such as pumps, fan and compressors.

Mining Equipments: Construction, operation and maintenance of underground and opencast equipment (coal and metal), selection and capacity calculation of mining equipment, safety aspects of mining equipment, Design and capacity estimation of mine winder, hydraulics use in mining equipment, condition monitoring of mining equipment. Construction, operation and selection of mineral beneficiation equipment – such as crushers, mills, feeders, classifiers, etc.

Automobile Engineering: Power transmission, gearboxes, engines, suspensions, differentials.

3.8.12 Mining Engineering (Code: MNE)

Drilling and Blasting: Exploratory drilling techniques; Types of blast hole drills, and their applicability, advantages and disadvantages; Different types of explosives, their applicability and selection; Blasting: blast design, patterns of blasting and controlled blasting.

Mine Construction: Vertical and inclined shafts: Location, shape and size, organization of sinking and construction of shaft collar, insets; Shaft sinking operations; Drilling and blasting, lining, mucking, dewatering, ventilation, surveying and lighting. Mechanized sinking; Main haulage drifts and tunnels: Purpose, shape, size and location, Tunnelling operations; Excavation, mucking, supporting and ventilation; Introduction to mine systems engineering. Methods of technological forecasting and its relevance in mine planning; Planning, scheduling and cost control of projects through network, analysis; Optimisation in production planning; project selection, blending and quality control using linear programming; sensitivity analysis.

Underground Coal Mining: Choice of mining methods: Bord & pillar mining and longwall mining methods. Design of bord and pillar workings: methods of driving development galleries; sequence and manner of extraction; strata control and support in bord and pillar workings. Design of longwall workings: development of longwall panels; equipment on a longwall face; strata behaviour and support requirement; production, manpower, productivity and cost; exploitation of thick seams, thin seams and contiguous seams. Working coal seams under water bodies and surface structures.

Underground Metalliferous Mining: Ore deposit characteristics, losses and dilution of ore in mining, net-smelter return to mine. Opening of deposits by adit, shaft, decline and ramp. Mine development - main horizon, raises, ore passes, discharge and haulage of ore in mine. Classification and selection of stoping method; Stoping methods: Shrinkage, Cut and Fill, Sub-level, Open stoping, Vertical Crater Retreat, Sub-level Caving, Block Caving. Recent trends in mechanization of development and stoping methods.

Surface Mining: Classification of mining systems; Application and working of cyclic and continuous mining systems. Inpit-crushing - conveying systems, Cyclic and continuous excavation & loading systems; Dumper and belt conveyor (shiftable, modular and high angle) transport systems. Waste dump formation methods and corresponding equipment. Method and criteria for selection of equipment. Planning inputs and methodology. Determination of ultimate pit configuration. Design of haul roads. Analysis and design of highwall and waste dumps slopes.

Rock Mechanics: Basic Rock Mechanics - Are rocks Elastic, homogeneous and isotropic? Definition of basic terminology - E_s E_t & E_o. Major Rock Mass classifications. Failure theories - their comparative study. Uniaxial compressive strength, tensile strength and shear strength, and their time dependent characteristics. Variation of UCS. In-situ stresses and their measurement. Stress around circular, elliptical and rectangular openings in elastic and homogeneous and non-homogeneous rocks. Mishaps in openings and remedial measures. Causes and precautions for subsidence. N.E.W. (Non Effective Width). Grouting and Shotcreting, Rock reinforcement, Rock Bursts. Instrumentation.

Mine Ventilation: Mine gases; Heat and humidity problems in mines and ventilation thermodynamics; Natural ventilation - Air flow through mine openings; Mechanical ventilation; Ventilation Survey and Planning; Ventilation network analysis for incompressible and compressible flows; Mine fires; Mine explosions; Mine dust; Mine illumination; Controlled recirculation and Environmental monitoring.

Mine Surveying: Meridian: True and Magnetic; Magnetic compass and Gyrocompass; Theodolite traverse and adjustment of the figure; Triangulation and EDM traversing; correlation - the latest trend; Determination of azimuth of reference line; Modern surveying equipment: Total station and GPS; Geological reading.

3.8.13 Petroleum Engineering (Code: PET)

Concept of worldwide Hydrocarbon exploration, General energy scenario (national and worldwide), History of Petroleum Production on-land and offshore, Petroleum Exploration organizations, Basic

concepts of Fluid Mechanics, Basic Thermodynamics of single and multi-component system, Composition & Characteristics of hydrocarbons, Rheology of non-Newtonian fluids, Types & characteristics of engineering materials and their strength.

Basics of Well planning, Design & selection of drilling fluid, rheology of drilling fluid, cement slurry & crude oil. Operating system of drilling rigs, Factors affecting rate of penetration. Various drilling hazards. Development of oil & gas fields, Well Completion, well equipment, workover & stimulation, design and selection of artificial lift, Surface operations & transportation for oil & gas.

Petrophysical properties of reservoir rocks, Fluid flow through porous media. Reservoir fluid characteristics, Phase behavior, Reserve estimates, Reservoir drive mechanisms, Well Test, Analysis Petroleum Formation Evaluation. Environment management in Petroleum Operations. Characteristics of sea wave, wind and current forces, Basic concept of Offshore Drilling and Production system.

Occurrence of Petroleum, Various methods of petroleum exploration, Multicomponent distillation, adsorpson, dehydration, desorption & evaporation, solvent extraction, desulphurization, Heat exchangers. Theory of emulsions, Refinery products & their specifications, Coking, Cracding reforming & blending of products. Lube oil production including dewaxing process. Petrochemical feed stocks, ethylene & propylene based petrochemicals, Environmental management in Hydrocarbon industry.

Selection and application of different types of pumps, flow meter, fluid couplings, torque conversions, hydraulic clutches and brakes. Operations and Regulations of Air Compressors and Air Motors. Different types of hydraulic and pneumatic valves and their use in control circuits of Drilling rigs. Power plants, Tractors, Excavators and Crancs. Different types of loading and basic parts like shafts, pulleys, columns, frames, gears. Design of different types of pressure vessels. Preventive and Schedule maintenance procedures, Selection criteria of machine tools and equipment of general maintenance.

3.9   Science/Management/HSS Streams

3.9.1   Applied Geology (Code: AGL)

Geomorphology and Remote Sensing: Methods of geomorphic investigations, evolution of different land forms, applications of geomorphology in different geological investigations. Principles of remote sensing, photogeology and applications of remote sensing. Geographic information system and its applications. Global positioning system.

Stratigraphy: Principles of stratigraphy, stratigraphic classification, stratigraphy and tectonics of Precambrian rocks of India, Phonerozoic stratigraphy of peninsular and extra peninsular India.

Palenontology: Theories of organic evolution, causes of extinction, morphology of common invertebrate and vertebrate fossils, Micropalentology and its applications, Paleobotany for exploration.

Mineralogy and Geochemistry: Crystal chemistry, phase stability and properties of different mineral groups, chemical evolution of the earth, geochemical classification and distribution of elements, geochemistry of important elements.

Sedimentary Petrology: Textures and structures of igneous rocks, petrology of important sedimentary rocks, paleocurrent analysis, provenance studies, sedimentary basins in India.

Igneous Petrology: Textures and structures of igneous rocks, crystallization of magma and representations in phase diagrams, representations of chemical analysis of igneous rocks and their applications and limitations, petrology of different types of igneous rocks magmatism in relation to plate tectonics.

Metamorphic Petrology: Metamorphic textures, kinetics of metamorphic reactions, stability of common metamorphic minerals, geothermometry and geobarometry, different types of projection diagrams, metamorphism of different rocks, plate tectonics and metamorphism.

Structural Geology: Stress, strain, strain analysis, structural analysis, poly-deformed terrains, shear zones and migmatites; analysis of thrust belts, mechanisms of folding and fracturing. Introduction to petrofabrics.

Geotectonics: Variations of physical properties in the earth, crustal types and their evolution, evolution of ocean basins, concept of plate tectonics and tectonics of different types of plate boundaries with special reference to India.

Economic Geology: Classification of ore deposits, evolution of different types of ore deposits, origin, migration and accumulation of petroleum; coal geology and nuclear geology. National mineral policy, conservation and utilization of mineral resources.

Exploration Geology: Concepts of mineral exploration, methods of geological and geochemical prospecting drilling techniques, sampling, estimation of reserves, geophysical prospecting, mineral beneficiation, Marine mineral resources.

Engineering Geology: Engineering properties of rocks and soil, geotechnical investigations for dams, reservoirs, tunnels, and mass movements. Rocks as construction materials, landslides.

Hydrogeology and Environmental Geology: Hydrological characters of different rocks, aquifer evaluation, groundwater flow, characteristics of groundwater for different use, groundwater development and management, groundwater provinces of India; Groundwater recharge, Rainwater harvesting, environmental problems of mineral exploration, low temperature geochemistry, environmental planning and management.

3.9.2 Applied Geophysics (Code: AGP)

Solid Earth Geophysics: Earth: its rotation and figure. Gravity and its variation over the earth, Earth: surface features, continents, continental margins, oceans. Thermal history and its characteristics over various earth surface features. Earth's interior: physics status; variation of physical quantities and seismic wave velocity inside the earth, major sub divisions. Composition and structure of upper and lower continental crust, layering in oceanic crust, crustal structure studies for mountains, plateau, basins in India, Gravity and DSS studies for the Himalayas. Oceanic magnetic anomalies and their interpretations, magneto stratigraphic time scale, paleomagnetic evidences from continental drift, APWP for different continents-their main results, seismological evidences for lithospheric deformation, concept of sea floor spreading and plate tectonics, plate margins and processes at plate margins, triple junction, Characteristic movement of Indian plate and formation of the Himalayas.

Seismology: Phenomena of earthquake and its effects. Elastic rebound theory. Intra and inter plate earthquakes, classification of earthquakes. Monitoring rockmass performance: purpose and nature; Monitoring systems including seismic and microseismic methods. Magnitude and intensity scales, impacts and assessment of earthquakes and related hazard, risk and their mitigation. Different types of elastic waves and their propagation characteristics, Attenuation and dispersion of seismic waves. **Strong motion seismology:** displacement, velocity and acceleration response spectra, Seismic damping, Strong motion instrument. Ray characteristics and related parameters for horizontally and spherically stratified earth. Fault plane solutions and related interpretation, moment tensors for different fault patterns, earthquake characteristics along constructive, conservative and destructive boundaries. Seismic networks and arrays, stand-alone and telemetry systems. Earthquake prediction: dilatancy theory, short-term, middle-term and long-term prediction

Signal Analysis: Signals, noise and their classification, continuous and discrete signals. Complex exponential Fourier series, Fourier integral, Fourier transform and its properties, energy and phase spectra, Fourier transforms of some commonly used functions, utility of domain transformation; inverse Fourier transform; use of one and two dimensional Fourier transforms in solving geophysical problems, radial and angular spectra.

Seismic Methods: Travel time relation for direct, reflected and head waves over multi layered earth. Land and marine energy sources, electromagnetic pulse and Accelerated Weight Drop. Basic theory and working principle of seismic transducers, Various refraction/transmission shooting techniques: reduction of refraction data. Seismic attenuation, reflection and transmission coefficients, Knott and Zoeppritz equations. Geometry of reflection ray path and time distance relationship, seismic noise and their cause. Methodology for 2D reflection Survey: Different kinds of spread geometries, end on, split spread, crooked lined profiling, linear and tapered geophone arrays, effect of arrays on the seismic response, optimization of spread geometry, offset matching, source arrays. Common depth point shooting and its advantages. 3D survey designing: Different 3D geometries, swath, MESA, GEOLAND, GX-III, 3D survey design shooting-in line,

slant and orthogonal, optimization of source and receiver lines in a swath, optimization of different offsets. **Offshore survey:** Single, streamer and multiple streamer. Processing sequences-preparation of processing geometry, quality checks, true amplitude recovery, deconvolution, filtering, velocity analysis, statics, noise elimination through multichannel filtering, parameter optimization for generation final stacked section. DMO and migration, 3D Processing techniques-generation of time slice and stacked sections.

Resistivity and IP methods: Fundamental relation between potential, apparent resistivity, transform and layer distribution of a stratified earth. Applications of linear filter theory; determination of filter coefficients, sinc response- filter length. Potential due to a point source in an anisotropic medium, triangle of anisotropy. Partial curve matching of three layer and four layer curves, Dar Zarrouk parameters, principle of equivalence, Resistivity modeling. Mise-a-la-masse method. Sources of IP, membrane and electrode polarizations, time domain and frequency domain measurement of IP, chargeability, percent frequency effect and metal factors, apparent chargeability over layered earth, electromagnetic coupling.

Electromagnetic Method: Principle of electromagnetic induction; magnetic field due to a current carrying loop, elliptical polarization, plane of polarization, dip and tilt angles, nomograms for quantitative determination of parameters by dip angle method, VLF and AFMAG methods TURAM method. Response of a single closed conducting circuit by using a fixed horizontal transmitter-receiver system. Analysis of response function with frequency and different ranges of conductivities, amplitude and phase relations, vector diagrams and their significance. Maxwell's equations, propagation of electrical and magnetic field as a dissipative wave, diffusion equation, propagation constant.

Gravity and Magnetic method: A review of land gravimetry; gravity measurements in land, air and sea, reduction of data and interpretation of free air and Bouger anomaly maps; ambiguity in gravity interpretation and conditions for unique interpretation; use of gravity survey in mineral and hydrocarbon exploration programs, search for metallic and nonmetallic ores, coal and lignite; mapping faults, exploring for salt domes, stratigraphic traps, uplifted horst and graben, use of gravity in regional geological studies including granitic plutons, thrust belts, accreted terrains.

Measurement of earth's magnetic field and its gradient for land, air and sea, instrument mounting and stability of platforms, reduction of data, preparation and interpretation of anomaly maps, Interpretation of magnetic anomaly and total magnetic field maps.

Remote Sensing and Image Processing: Sources of EMR and governing laws; interaction of EMR with atmosphere and surface of the earth. Atmospheric windows; spectral signature and spectral reflectance, spectral responses of vegetation, water, soil etc. Types of sensors-photographic, single and multi band opto mechanical, thermal sensors, LISS and sensor array: their principle and operations; spectro-radiometers, microwave sensors: SLAR and SAR Systems. Structure of Remote Sensing Images, Data format BIL, BSQ and BIP, type of data products. Image Processing technique as applied to satellite image data. Image restoration, reduction, magnification, contrast enhancement (linear and non linear), histogram equalization, rationing, filtering and edge enhancement.

Well logging: Borehole environment, Logging tools: Basic principles, calibration, environment corrections, computation of reservoir parameters and their simple applications: Resistivity: focused (SFL), micro resistivity devices, conventional induction logging tools. Self potential: electrical analogue of SP, effects of bed thickness, hole diameter, shaliness, irregular invasion on SP response. SP in tight formations, bimetallism and bimagnetism effects on SP. Natural gamma ray: Effects of borehole environment, logging speed, time constant and formation density on log response, corrections for caving and casing etc.; measurement of porosity using neutron sources: CNL SNP; compensated density and sonic tools for porosity measurements.

3.9.3 Chemistry (Code: CHY)

Structure and bonding: Atomic structure and periodic properties: Bonding types of bonds Structure of solid, crystal defects, properties dependent on defects, lattice energy.

Quantum Chemistry: Schrodinger equation of free particle, particle in a box degeneracy, harmonic oscillator, rigid rotor and hydrogen atom. Angular Momentum including spin. Coupling of angular momenta including spin-orbit coupling.

Spectroscopy: Spectroscopic selection rules for vibrational, electronic vibronic and Raman Spectroscopy. Theoretical treatment of rotational, vibrational & electronic spectroscopy. Principles

of Magnetic resonance and photoelectron spectroscopy. Term Symbols and spectroscopic states. Application of mass. UV-VIS. IR and NMR spectroscopy for the structure elucidation of compounds.

Thermodynamics: First law of thermodynamics, relation between C_p and C_v, enthalpies of physical and chemical changes, temperature dependence of enthalpies. Second law of thermodynamics, entropy, free energy, Gibbs-Helmholtz equation. Third law of thermodynamics and calculation of entropy.

Chemical Equilibrium: Free energy and entropy of mixing partial molar quantities, Gibbs-Duhem equation, Equilibrium Constant. Temperature dependence of equilibrium constants phase diagram of one and two component system. Free energy and equilibrium constant, phase rule and phase equilibrium.

Solutions: Ideal and non-ideal solutions. Colligative properties of solutions. Debye-Huckel treatment of dilute electrolyte solutions. Molecular weight determination.

Acid and Bases: Bronsted and Lewis acids bases. pH and pKa acid concept in non-aqueous media. HSAB concept.

Electrochemistry: Electrochemical cell reactions. Nernst Equation. Electrode kinetics, electrical double layer, Batteries, primary, secondary and fuel cells. Corrosion and its prevention.

Reaction Kinetics: First, second and third order reactions, Collision theory of reaction rates. Theory of absolute reaction rates.

Macromolecules: Number average and weight average molecular weight. Determination of molecular weights. Types of polymerization reactions, Kinetics and mechanism of polymerizations.

Organic Reaction mechanism: Nucleophilic, Electrophilic, free radical substitution , addition and elimination reactions. Aldol, Perkin, Stobbe, Dieckmann condensations. Hoffmann, Schmidt, Lossen, Curtis, Beckmann and Fries rearrangements. Reimer-Tiemann, Reformatsky and Grignard reactions. Diels-Alder reactions; Claisen rearrangements. Friedel-Crafts reactions: Fittig reaction and Robinson annulations Hydroboration. Oppenaur Oxidation, MPV, Clemmensen and Birch reductions.

Stereochemistry and conformational analysis: Recognition of symmetry elements and chiral structures. R, S nomenclature, diastereoisomerism in acyclic and cyclic systems E-Z isomers, Conformational analysis of cyclic (chair and boat) and acyclic systems, Interconversion of Fischer, Newman and Sawhorse projections. Asymmetric synthesis. Stereoselective and stereospecefic reactions.

Aromaticity: Huckel's rules and concept of aromaticity (n) annulenes and hetero annulenes.

Pericyclic reactions: Selection rules and stereochemistry of electrocyclic reactions, cycloadditions and sigmatropic shifts.

Synthetic methods in Organic Chemistry.

Photochemistry: Cis-trans isomerisation, Paterno-Buchi reaction, Norrish type I and II reactions of structure of compounds.

Chemistry of Transition Elements: Coordination Chemistry of transition metal ions, stabilization of unusual oxidation states, stereochemistry of coordination compounds, Ligand Field theory, Crystal Field Theory and Molecular orbital theory of coordination compounds.

Organometallic Chemistry: Synthesis, Structure and bonding in organometallic compounds. Organometallic reagents in organic synthesis and in homogeneous catalysis (Hydrogenation, hydroforrmylation, isomerization and polymerizations) P-acid metal complexes, Fluxional molecules, Metallocenes (Synthesis, reactions and structure).

Nuclear Chemistry: Radioactive decay & equilibrium, Chemical effects of Nuclear transformations, fission & fusion, Radioactive techniques, tracer techniques, neutron activation analysis.

Chemistry of Lanthanides & Actinides: Electronic configuration, Lanthanide contraction, isolation, application of lanthanide compounds as shift reagents, spectral and magnetic properties.

Chemistry of non-Transition Elements: Properties of non-transition elements, synthesis, structure and properties of their halides and oxides, polymorphism of Carbon, phosphorous and sulphur, synthesis, structure and properties of boranes, carboranes; borazines, silicates, carbides, silicones, phosphazenes, pseudohalides and nobel gas compounds.

3.9.4 English (Code: ENG)

British Literature Since 1900: Poetry, Drama, Fiction, Science Fiction, Short Stories, War Poetry, Autobiography, Film Studies from 1900 till present.

ELT and Linguistics: General and descriptive linguistics, Socio-linguistics, Psycholinguistics, Psychology of second language learning, the sociology of language in education; Language use, Register, dialects, Style; Principles of language Teaching, Language teaching methodology, Language teaching technology, CALL; English for specific purposes, Academic discourse and style; Language and Literature Testing.

Indian and Commonwealth Literature: Pre and post Independence Poetry, Drama, Fiction, Science Fiction, Short Stories, Autobiography, Diaspora, Translation and film studies / Literature.

Contemporary Literary Theory and Criticism: From New Criticism to After Theory.

Contemporary American and Afro-American Literature: American and Black–American Poetry, Drama, Fiction, Short Stories, Autobiography, Films / Literature and Cultural Studies.

3.9.5 Environmental Science (Code: ENS)

Global & Regional Environmental issues: Green House Effect, Global Warming, Acid Rain, Ozone layer depletion, Climate Change, Carbon Foot Printing, Environmental impacts of particulates and gaseous pollutants like Photo chemical smog, haze, secondary pollutant formation etc.

Air Pollution: Introduction to atmosphere, physical and chemical properties of atmosphere, thermodynamics of atmosphere, meteorology, global circulation, stability class, lapse rate, inversion, wind rose diagram, types of stack plume behaviour, types of air pollution & pollutants, Its natural & anthropogenic sources, impacts of air pollutants on environment, health & material, air quality monitoring and standards, Concept of dispersion, diffusion and advection, emission factor and emission inventory, plume rise calculation, vehicular pollution, air pollution by combustion activities.

Air Pollution Control: Particle size and number, aerodynamic diameter, particle size distribution, working principles of gravity settling chamber, cyclone, fabric filter and Electro Static Precipitator. Control of gaseous pollutants by absorption, adsorption, thermal incineration and condensation, clean coal combustion technologies for thermal power plants, control of SOx and NOx before, during and after combustion, control of vehicular pollution, alternative fuels, synthetic fuels, green fuels, control of incomplete combustion products, control of CO_2, Carbon Sequestration and indoor air pollution control.

Water: Water pollution–Sources & Effects, Water quality standards, Self purification of natural water, Global Hydrological Cycle, Water Treatment Methods - Coagulation & Flocculation, Filtration, Softening, Deflouridation, Denitrification, Chlorination.

Ecology and Microbiology: Ecology & Ecosystem; function and structure, Resilience & Inertia, Biodiversity & Hot spots; Red data Books; Population & Fragile ecosystem Community ecology, Aquatic Ecology, Ecology Succession, Biotic Indices, Carbon & Nitrogen Cycle, Eutrophication, Ecotoxicology, Bio-magnification, Microbes- Importance, Enumeration & Application, Bacterial Nutrition, Metabolisms & Growth, Control of Microbes, Bacteriological Contamination, Coliforms.

Land: Land use patterns, Land use changes due to human and industrial activities, Land use planning and development, Soil characteristics, Soil Erosion.

Noise: Sound Pressure Level, Sound Power Level, Noise Standards, Physiological effects and abatement measures.

Geology: Earth's interior, important minerals and rocks, Rock classification.

Hydrology: Ground water resources assessment, Aquifers–its types and parameters, Rainwater harvesting.

Environmental Legislation: Water Act, Air Act, Environmental Protection Act, Forest Conservation Act, Wild Life Protection Act.

Environmental Administration: Environmental Impact Assessment (EIA), Environmental Management Plan, Environmental Auditing.

3.9.6 Management (Code: MAN)

Principles and Practices of Management: Management – Concept and basic features, Functions of Management – Planning, Organising, Staffing Directing & Controlling, Organisation Structure, Basic Theories of Management

Research Methodology and Statistics: Scientific Research – Definition, Problems, Types of variables, Measures of Central Tendency and Dispersion, Probability, Sampling and Randomness, Statistics – Purpose, Approach and Method: Binomial Statistic: The normal probability; Correlation & Regression.

HRM: Meaning of Industrial Relations, Worker's Participation in Management, Training and

Development Motivation, Leadership, Group Dynamics, Conflict, Job Satisfaction, Organistional Communication, Human Resource Development, Recruitment and Selection, Performance Appraisal.

Quantitative Techniques: Role of quantitative techniques in managerial decision making, Optimisation Techniques – Classification and applications, Liner Programming in Features, Modelling, Simplex Method of solution, Queuing theory – Concepts and its role in decision making, MIS – Concept and general form

Operations Management: Concept & Measurement of Productivity, Work Study Techniques and efficiency improvement, Inventory Management – ABC Analysis and EOQ model, Demand Forecasting – time series analysis Concept of Quality, Application of Quality Control Techniques in Improving Product Quality.

Economics: Managerial Economics – Basic Philosophy, Demand and Supply Function – Elasticity of Demand Five – Year Plans of India, Nature and Behaviour of Different types of revenue and Nature and Behaviour of Different types of revenue and costs. Pricing under Monopoly & Oligopoly, Criteria of Economic Development, Foreign Direct Investment, Liberalisation and its effect on Indian Economy. International Monetary Economics: Exchange Rates, Balance of payment.

Finance: Concept and Basic Understanding on: Financial Statement Analysis, Long term & Short term financing, Working capital management Capital budgeting decisions, Capital Markets and Financial Institutions.

Marketing Management: Concept of Marketing, Current Trends and Practices, Issues in Consumer Behaviour The marketing Mix, Marketing Research: Methods & Practices, International Marketing.

3.9.7 Mathematics (Code: MAT)

Complex Variables: Algebra of complex numbers, Reimann sphere and Stereographic projections, Continuity and differentiability of complex functions, Analytic functions and Cauchy-Reimann equation, Cauchy's theorem, Morera's theorem, Cauchy's integral formula, Taylor's and Laurent's series, Residues and Residue Theorem, Contour Integration, Conformal Mapping, Bilinear Transformation, Schwarz-Christofell Transformation.

Real Analysis: Reimann's integral, improper integrals, convergency and divergency of series, Binary operations, Boolean algebra, Fourier series, Concept of linear algebra, Linear dependence and independence of vectors, basis, quadratic forms, canonical forms, rank of matrix, Eigen values and Eigen vectors.

Vector and Tensor Calculus: Gradient, Divergence and Curl, Recurrence relations, Line, surface and volume integrals, Stokes' and Gauss theorems, Curvilinear coordinates and expressions for vector operations. Notion of Tensors, covariant and contravariant Tensors, Christofell's symbols and differentiation of tensors.

Differential Equations: First order ODE, Singular Solution, General theory of homogeneous and non-homogeneous linear ODE, Variation of parameters, Solution of second order ODE in series form, ordinary simultaneous differential equations, Partial differential equations of first order, Lagrange and Charpit's method. Classification of PDE, Solution of PDE: Solution of Laplace, Poisson, Heat conduction and Wave equations.

Special functions: Beta, Gamma and Error functions, Bessel and Legendre functions, Hypergeometric functions, Hermite, Laguerre and Chebyshev Polynomials.

Mechanics: Generalized coordinates, Lagrange's Equations, Hamilton's Canonical equations,

variational principles, Hamilton's principles and principles of least action, Two dimensional equations of rigid bodies, Euler's dynamical equations for the motion of rigid bodies, Motion about an axis.

Numerical Analysis: Finite difference operators, interpolation and extrapolation, Numerical solution of algebraic and transcendental equations. Solution of simultaneous linear equations, matrix inversion, Numerical integration and differentiation. Numerical solution of ordinary differential equations: Initial and Boundary value problems, Numerical solution of Laplace, Heat conduction and Wave equations.

Integral Transforms: Laplace transform and its inverse transform, convolution theorem, Fourier transform, sine and cosine transforms, inverse Fourier transform, Hankel transform and its inverse transform, Application of all the three transforms in solving ordinary and partial differential equations.

Operation Research: Linear Programming, simplex method, Assignment problems, Transportation problems, Game theory.

3.9.8   Philosophy (Code: PLY)

Ethics and Applied Ethics: Ethics and Ethos, Morality, Social Values and Individual Attitudes, The Problem of Relativism, Egoism and Altruism, Self Interest, Motivation, and Justification, Acting for Reasons, The History of Ethics, Standards and Principles, Value Judgment, Ethical Theories and Principles, Kant and Deontology, Emotivism, The Virtues and the Good Life, Justice, Equality, Right and the Social Contract.

Duty and Responsibility of Individual for his Work, Characteristic Attitude of a Group towards the Morality of Work, Human Rights, Ethics and Environment, Responsibilities to the Natural World, Bio-centric Ethics and the Value of Life, Inter-relationship of Science and Culture, Science and Human Values.

Classical and Contemporary Indian Philosophy: Nature and Central Concepts of Indian Philosophy, Vedas, Upanishads, Concept of Purusharthas, Concept of Dharma, Bhagavat Gita, Nyaya, Vaisesika, Samkhya,Yoga, Purva Mimamsa, Vedanta, Buddhism, Jainism, Carvaka, Contemporary Indian Thinkers (Rabindranath Tagore, Sri Aurobindo, Mahatma Gandhi, Swami Vivekananda, Jiddu Krishnamurthi and Radhakrishan).

Classical and Contemporary Western Philosophy: Plato, Aristotle, St. Anslem, St. Aquinas, St. Augustine, Descartes, Spinoza, Berkeley, Lebnitz, Hume, Kant, Hegel, John Locke, Marx, Nietzsche, Frege, Russell, Wittgenstein, Ryle, Husserl, Heidegger, Logical Positivism, Pragmatic Theory and Post-modernism.

Philosophical Analysis and Logic: The Principles of Logic, Analytic Truth and Logical Possibility, The A Priori, Concepts, Truth, Sources of knowledge, Meaning and Definition, Theories of Truth.

3.9.9   Physics (Code: PHY)

Classical Mechanics: Generalized co-ordinates, Lagrange's equations, Hamiltonian equations, variational principle, Symmetries and conservation laws, central forces, collisions and scattering, Rotating co-ordinate system, Rigid body kinematics and dynamics. Euler equations - symmetrical & Assymetrical top, canonical transformations, Hamilton -Jacobi theory.

Special Theory of Relativity: Frames of reference, Lorentz transformations, Doppler shift, velocity addition, time dilation, Minkowski space – four vectors, Proper time, Energy - momentum four Vector, Mass-energy equivalence, Relativistic force equation, Four tensors – Lorentz covariant & contra-variant equations.

Condensed Matter Physics: Crystal classes and systems, Bonding of common crystals, Crystal structure, Symmetries, reciprocal lattice, X-ray and neutron diffraction, structure factor, point defects and dislocations. Lattice vibrations, specific heat of solids, heat capacity. Free electron theory of metals, Periodic potentials, energy bands in metals, insulators and semiconductors, tight binding approximation, impurity levels in doped semiconductors, Electronic transport, electrical and thermal conductivity, Hall Effect. Dielectrics – Polarisation mechanisms, Clausius-Mossotti equation, Piezo, Pyro and Ferro-electricity. Dia, Para, Ferro-magnetism, Ferri- and Antiferro

magnetism. Superconductivity – Phenomenology, Meissner effect, Type I and Type II super conductors, BCS theory.

Nuclear Physics: General properties of nuclei, size, shape, charge distribution, spin & parity, nature of nuclear forces, nuclear models-liquid drop model, shell model and collective model. Interaction of charged particles and photons with matter, Nuclear detectors – Ionization chamber, Gas proportional counter, GM counter, Scintillation and Semi-conductor detectors. Radioactive decays – theoretical understanding, Nuclear reactions, nuclear fission and fusion. Classification of fundamental forces and elementary particles, iso-spar strangeness, parity, symmetry and conservation laws, accelerators.

Quantum Mechanics: Wave-particle duality, Heisenberg's uncertainty principle, the Schrodinger wave equation, particle in a box, Harmonic oscillator, potential barrier and tunnelling , Motion in a central potential, Hydrogen atom, commutation relations, symmetries in quantum mechanics, spin, addition of angular momenta, Pauli's exclusion principle. Time independent perturbation theory, Fermi Golden rule, Approximation methods for bound states, WKB approximation, Time-dependent perturbation theory, scattering theory, Relativistic wave equations, second quantization.

Statistical Mechanics: Phase space, microstates and macrostates, partition function, Free energy connection with thermo dynamical quantities, canonical and grand canonical ensembles, applications, kinetic theory, MB, BE, and FD statistics of ideal gas, Black body radiation and Planck's distribution law, Bose-Einstein's condensation, Einstein – Debye's theory of specific heat.

Atomic and Molecular Physics: Hydrogen atom spectrum, spin-orbit coupling , fine structure, LS & JJ coupling, Zeeman, Paschen-Back and Stark effects, X-rays and Auger transitions, Compton effect, Brief idea of molecular spectra, Rotational and Rotational-Vibrational spectra of simple molecules, Frank-Condon Principle, Raman spectra. Lasers – spontaneous and stimulated emission, population inversion, optical pumping, description of He-Ne, CO_2 and Ruby Lasers.

Mathematical Physics: Vector analysis, Tensor analysis, Linear vector space, Matrix theory, Functions of a complex variable, differential equations, special functions, Fourier integral and transforms, Laplace transforms.

3.9.10 Statistics (Code: STA)

Random variables and distribution functions, probability mass function, probability density function, joint probability distribution, expectation and moments, independent random variables, marginal and conditional distribution, moment generating function, characteristic function, moment inequalities (Chebyshev, Markov, Jensen). Convergence in probability and in distribution, weak and strong laws of large numbers and central limit theorem for independent, identically distributed random variables with finite variance.

Probability distributions: Bernoulli, binomial, multinomial, hypergeometric, Poisson, geometric and negative binomial distributions, uniform, exponential, Cauchy, beta, gamma, normal and bivariate normal distributions, functions of random variables. Sampling distributions, Chi square, t, and F distributions, standard errors and large sample distributions, distribution of order statistics and range.

Correlation and regression analysis: Product moment correlation, regression lines, multiple and partial correlations, multiple and partial regressions, plane of regression, rank correlation and intra-class correlation.

Estimation: Unbiasedness, consistency, efficiency, sufficiency, minimal sufficiency, completeness, factorization theorem, exponential family of distribution and its properties, uniformly minimum variance unbiased (UMVU) estimation, Rao-Blackwell theorem, Cramer Rao inequality, minimum variance bound estimator and its properties, Estimation by methods of moments, maximum likelihood, least squares and minimum chi-square, Interval estimation.

Test of hypotheses: Simple and composite hypotheses, two types of errors, critical region, power function, most powerful and uniformly most powerful tests, Neyman-Pearson's lemma, likelihood ratio tests. Tests for mean and variance in normal distribution: one population and two population cases, Tests for correlation and regression coefficients, paired t-test, chi-square test for goodness of fit, contingency tables, large sample tests through normal approximations and test of independence.

Sequential Analysis: Sequential probability ratio test (SPRT), Operating Characteristic function of SPRT and Average Sample Number (ASN).

Non-Parametric tests: Sign test, run test, median test, Mann-Whitency Wilcoxon test.

Finite population sampling: Basic principles of sample surveys, simple random sampling with and without replacement, probability proportional to size sampling, Hurwitz-Thompson estimator, ordered and unordered estimates, stratified random sampling, allocation problems, post-stratification, ratio, regression and product methods of estimation, double sampling, cluster sampling, two-stage sampling and systematic sampling, Non-sampling errors, non-response problems, Warner's randomized response technique for sensitive characteristics, measurement errors in sample surveys.

Design of experiments: Analysis of variance, basic principles of design of experiments, completely randomized design (CRD), randomized block design (RBD) and latin square design (LSD). Estimation of missing observations in RBD and LSD, incomplete block design and balanced incomplete block design (BIBD). Factorial experiments: 2^2, 2^3, 3^2 and 3^2 factorial experiments, Split-plot and simple lattice designs.

4. Frequently asked questions (FAQ)

4.1 Application

1. **Will the application forms received after the due date be considered?**
    Application forms received after the DUE DATE will not be considered and no query/communication is entertained in this regard.

2. **What happens if I make a mistake while filling the application form?**
    The candidates have to ensure their eligibility and other requirements (age, qualification, class obtained etc.) while applying. ISM will not be held responsible for mistakes identified at any stage and the candidature is liable to be rejected. Take utmost care while filling your claims in the online application. No correspondence will be entertained in this regard.

3. **Will ISM accept DD as application fee?**
    No. The mode of payment of application fee is through bank challan of SBI ONLY.

4. **Where can I find the information regarding ISM JRF admission?**
    Candidates are instructed to regularly check the ISM Website, http://www.ismdhanbad.ac.in/phd-jrf for announcements, results or any other information regarding ISM-JRF 2014-15, Phase-2.

4.2 ISMJRF EE

1. **What are the documents to be carried for the ISMJRF EE?**
    Candidates called for exam should bring with them Admit Card and Photo-id card issued by recognized institute/govt agencies.

2. **Where I can find the address of the exam centres?**
    The address will be notified through ISM website prior to the exam.

3. **What is the pattern of written exam?**
    The ISM-JRF EE will adopt multiple choice objective type questions for a total of maximum 100 marks. There will be four choices with one correct answer for each question. The entire question paper will be divided into three sections: (1) 30 questions of 1 mark each, (2) 20 questions of 2 marks each, and (3) 10 questions of 3 marks each.

4. **Is there negative marking for the wrong answers? If so, how much will be deducted?**
    There is a negative mark for each wrong answer. The deduction will be 1/3rd of the corresponding marks of the respective section. For example: if the wrong answer is in the

section with 1 mark each, then 1/3 will be deducted; if the wrong answer is in the section with 2 mark each, then 2/3 will be deducted; and if the wrong answer is in the section with 3 mark each, then 3/3=1 will be deducted.

5. **What is the qualifying score in the exam or in the interview?**
   The ISM has the authority to decide the qualifying score for each discipline and for each admission.

6. **Do we receive personal Exam/Interview/Admission Letters?**
   No. Personal letters will not be sent to each candidate. The name of the short-listed candidates will be posted on ISM website http://www.ismdhanbad.ac.in/phd-jrf at least 2 weeks in advance. Such candidates can take a print-out of the notice from the website and make necessary arrangements for attending the interview. **No separate communication will be sent by post**.

7. **Will ISM pay for the TA/DA for the candidates coming for Exam / Interview / Admission?**
   Candidates called for Exam/Interview/Admission will have to make their own arrangements for travel, accommodation etc. NO TA/DA will be paid by ISM.

4.3 Interview

1. **What are the documents to be carried for the Interview?**
   Candidates called for interview should bring with them attested copies along with original of all the transcripts (marks cards from SSLC or equivalent onwards, degree certificate of the qualifying examination, NET/GATE card, category certificate, etc.) and produce them before the scrutiny committee for verification, failing which they will not be interviewed.

2. **What if my OBC-NC certificate is not valid at the time of interview?**
   Candidates without valid OBC-NC certificate will not be interviewed. The certificate should be issued on or after 1st September, 2014. No relaxation or communication will be entertained.

3. **If my OBC-NC certificate is not valid or if I could not bring my original OBC-NC certificate, will I be considered as general candidate?**
   NO. Candidates without valid OBC-NC certificate will not be interviewed.

4.4 Admission

1. **Do I need to submit original certificates at the time of admission?**
   Original certificates along with self attested copies of the certificates, mark sheets valid NET/GATE certificate, etc. starting from matriculation/school final examination are to be produced at the time of interview and admission. The original GATE / NET Card and Migration Certificate are to be submitted at the time of admission.

2. **What are the documents to be carried for the Admission?**
   Candidates called for admission should bring with them all the transcripts/certificate in **ORIGINAL** (like marks cards from SSLC or equivalent onwards, degree certificate of the qualifying examination, migration certificate, NET/GATE card, category certificate for SC/ST/PH/OBC-NC, etc.) and produce them before the admission committee, failing which their admission will cancelled.

3. **When will the admission take place?**
   Candidates, who are provisionally selected to ISM-JRF, should report to the Institute for completing admission formalities on 06.02.2015. Any change in the date will be notified on ISM website

4.5   General

1. **When should I pay the fees?**
    Programme fee for the first semester and Hostel mess advance fee for the first year has to be paid at the time admission. Caution money and security deposits are refundable only after successful completion of the programme. Fees for subsequent semesters are to be paid before the commencement of the each semester.

2. **What is the format for OBC-NC certificate? What is the validity of OBC-NC certificate?**
    Certificate in the format given in Annexure II to be produced during interview and submitted (in original) at the time of admission by Other Backward Classes non-creamy layer (OBC-NC) category candidates as per the admission to Central Educational Institutions (CEIS), under the Government of India. The certificate should be issued on or after 1st September, 2014. Candidates not having OBC-NC certificate issued on or after on or after 1st September, 2014 will not be considered for selection.

3. **Will the offer letter be sent to the candidates by post?**
    The offer letter for the selected candidates will be posted on ISM website http://www.ismdhanbad.ac.in/phd-jrf within two months after the interview (date will be notified later). They can download the offer letter and make necessary arrangements to take admission along with requisite fees etc. No separate communication will be sent by post.

4. **When do we join the department after admission?**
    All the admitted candidates are required to join their respective departments and report to the Head of the Department on 09.02.2015.

5. **Will ISM allow the selected candidate to take extension for completing the examinations/dissertation projects/viva-voce of the qualifying degree, if it's not completed?**
    NO. At the time of joining, candidates should have completed all the requirements for the award of the qualifying degree including all examinations, dissertation projects, viva-voce, etc. Otherwise their admission will be cancelled.

6. **I have completed the course, but the degree is not awarded, then will ISM allow me to take an extension for submission of original documents of that exam?**
    No. Candidates pursuing the qualifying degree are **NOT ALLOWED** to take admission for the 2014-15 Phase-2 of admission to ISM JRF.

5.   DISCLAIMER

The website mentioned in this document has been launched to provide the candidates and public-at-large, information about the ISM Ph. D. Admission. If you do not agree to the terms and conditions below, do not access this site or any pages thereof.

5.1   Terms and Conditions

5.1.1 No Warranty

The information and materials contained in the site, including text, graphics, links or other items - are provided on an "As Is" and "As Available" basis. Although, ISM-JRF Admission Committee which organizes and conducts examination tries to provide information accurately, it disclaims liability for errors or omissions in this information and materials. No warranty of any kind, implied, expressed or statutory, including but not limited to the

warranty of fitness for a particular purpose and freedom from computer virus, is given in conjunction with the information and materials.

5.1.2 Limitation of Liability

In no event, ISM will be liable for any damages, including without limitation, direct or indirect, special, incidental, or consequential damages, losses, or expenses arising in connection with this site or use thereof or inability to use by any person, or in connection with any failure of performance, error, omission, interruption, defect, delay of operation or transmission, computer virus or line or system failure, even if ISM, or representative thereof, are advised of the possibility of such damages, losses or expenses.

5.1.3 Network Services

The ISM-JRF Admission committee cannot be held responsible for reduced access speeds due to bandwidth overloads especially close to the application submission date.

6.   JURISDICTION

In case of any claim or dispute arises in respect of JRF Admission, it is hereby made absolutely clear that the Courts in Dhanbad and Dhanbad alone shall have the exclusive jurisdiction to entertain and settle any such dispute or claim.

INDIAN SCHOOL OF MINES
DHANBAD 826004

Dated: _____

UNDERTAKING TO CARRY OUT RESEARCH
IN THE INTER-DISCIPLINARY AREA AT ISM-DHANBAD

I, the undersigned Mr / Ms / Mrs _____

Son / Daughter / Wife of _____bearing

Registration No./Form No._____ and possessing basic degree/qualifying

degree in the discipline of _____,

agree to carry out my research in the inter-disciplinary area of any discipline in the event of

my selection to ISM JRF research scheme conducted for the year 2014-15 [Phase-2].

I opt the above mentioned choice on my own and agree to abide by the rules and

regulations stipulated by the institute / department. I will also extend my full cooperation to

my guide / guides during my course of my research in its successful completion. This

undertaking is being submitted by me to ISM Dhanbad after having given sufficient thought

and having become familiar to the norms of the research schemes to do my research in the

inter-disciplinary area at ISM Dhanbad.

Signature of the Candidate

Name in Capital: _____

Registration No: _____

Dated:_____

ANNEXURE-II

FORM OF CERTIFICATE TO BE PRODUCED BY OTHER BACKWARD CLASSES (NON-CREAMY LAYER) APPLYING FOR ADMISSION TO CENTRAL EDUCATIONAL INSTITUTIONS (CEIs), UNDER THE GOVERNMENT OF INDIA

This is to certify that Shri/Smt./Kum. _____ Son/Daughter of Shri/Smt._____ of Village/Town _____ District/Division _____ in the _____ State belongs to the _____ Community which is recognized as a backward class under:

(i) Resolution No. 12011/68/93-BCC(C) dated 10/09/93 published in the Gazette of India Extraordinary Part I Section I No. 186 dated 13/09/93.
(ii) Resolution No. 12011/9/94-BCC dated 19/10/94 published in the Gazette of India Extraordinary Part I Section I No. 163 dated 20/10/94.
(iii) Resolution No. 12011/7/95-BCC dated 24/05/95 published in the Gazette of India Extraordinary Part I Section I No. 88 dated 25/05/95.
(iv) Resolution No. 12011/96/94-BCC dated 9/03/96.
(v) Resolution No. 12011/44/96-BCC dated 6/12/96 published in the Gazette of India Extraordinary Part I Section I No. 210 dated 11/12/96.
(vi) Resolution No. 12011/13/97-BCC dated 03/12/97.
(vii) Resolution No. 12011/99/94-BCC dated 11/12/97.
(viii) Resolution No. 12011/68/98-BCC dated 27/10/99.
(ix) Resolution No. 12011/88/98-BCC dated 6/12/99 published in the Gazette of India Extraordinary Part I Section I No. 270 dated 06/12/99.
(x) Resolution No. 12011/36/99-BCC dated 04/04/2000 published in the Gazette of India Extraordinary Part I Section I No. 71 dated 04/04/2000.
(xi) Resolution No. 12011/44/99-BCC dated 21/09/2000 published in the Gazette of India Extraordinary Part I Section I No. 210 dated 21/09/2000.
(xii) Resolution No. 12015/9/2000-BCC dated 06/09/2001.
(xiii) Resolution No. 12011/1/2001-BCC dated 19/06/2003.
(xiv) Resolution No. 12011/4/2002-BCC dated 13/01/2004.
(xv) Resolution No. 12011/9/2004-BCC dated 16/01/2006 published in the Gazette of India Extraordinary Part I Section I No. 210 dated 16/01/2006.

Shri/Smt./Kum._____ and/or his family ordinarily reside(s) in the _____ District/Division of _____ State. This is also to certify that he/she does not belong to the persons/sections (Creamy Layer) mentioned in Column 3 of the Schedule to the Government of India, Department of Personnel & Training O.M. No. 36012/22/93-Estt.(SCT) dated 08/09/93 which is modified vide OM No. 36033/3/2004 Estt.(Res.) dated 09/03/2004.

Dated: District Magistrate/
Seal   Deputy Commissioner, etc.

NOTE:
a) The term 'Ordinarily' used here will have the same meaning as in Section 20 of the Representation of the People Act, 1950.
b) The authorities competent to issue Caste Certificates are indicated below:
(i) District Magistrate / Additional Magistrate / Collector / Deputy Commissioner / Additional Deputy Commissioner / Deputy Collector / Ist Class Stipendiary Magistrate / Sub-Divisional magistrate / Taluka Magistrate / Executive Magistrate / Extra Assistant Commissioner (not below the rank of Ist Class Stipendiary Magistrate).
(ii) Chief Presidency Magistrate / Additional Chief Presidency Magistrate/ Presidency Magistrate.
(iii) Revenue Officer not below the rank of Tehsildar and
(iv) Sub-Divisional Officer of the area where the candidate and / or his family resides.