RRB JE Syllabus

13.0. RECRUITMENT PROCESS:

(a) Candidates should apply only through online mode through the official websites of any RRBs. Candidates can apply to only one RRB and only one common online application (in order of preference for any or all the notified posts). **The selection of RRB once exercised shall be final. Application to more than one RRB by a candidate will lead to rejection of all the applications.**

(b) The recruitment process shall comprise of the following stages:

(i) 1st Stage Computer Based Test (CBT-I)

(ii) 2nd Stage Computer Based Test (CBT-II)

(iii) Document Verification (DV)

(iv) Medical Examination (ME)

(c) Information on examination schedule and venues will be given to eligible candidates in due course through RRB websites, SMS and/or email.

(d) Request for postponement of any of the stages or for change of venue, date and shift will not be entertained under any circumstances.

(e) **NOTE-I: -** Candidates are not permitted to use calculators and other electronic gadgets. They should not, therefore, bring the same inside the Examination Premises. If any candidate is found to possess mobile phone, Bluetooth or any other means of wireless communication, in working or switched off mode, his/her candidature shall be cancelled forthwith and he/she will be debarred from RRB examinations besides legal action as deemed fit.

(f) Candidates will have to download the city and date intimations, e-call letters and travel authority (wherever applicable) from the links provided on the official web-sites of RRBs. Candidates should read the instructions on the e-Call Letter carefully and follow them scrupulously. Failure to comply with the instructions may lead to cancellation of their candidature.

(g) Mock/Practice tests will also be made available on RRBs official website to the candidates to acquire familiarity with the online examination process.

13.1 1st Stage CBT (Common for all notified posts of this CEN) :

Duration : 90 minutes (120 Minutes for candidates who are eligible for use of a Scribe)

No. of Questions: 100

The 1st stage CBT is of screening nature and the standard of questions for the CBT will be generally in conformity with the educational standards and/or minimum technical qualifications prescribed for the posts. The normalized score of 1st stage exam shall be used only for short listing of candidates for 2nd stage exam as per their merit. ***Candidates who are shortlisted for 2nd stage CBT availing the reservation benefits of a community, PwBD and ExSM shall continue to be considered only against that community for all subsequent stages of recruitment process.*** The Questions will be of objective type with multiple choices and are likely to include questions pertaining to:

a. **Mathematics:**

Number systems, BODMAS, Decimals, Fractions, LCM and HCF, Ratio and Proportion, Percentages, Mensuration, Time and Work, Time and Distance, Simple and Compound Interest, Profit and Loss, Algebra, Geometry, Trigonometry, Elementary Statistics, Square Root, Age Calculations, Calendar & Clock, Pipes & Cistern.

b. **General Intelligence and Reasoning:**

Analogies, Alphabetical and Number Series, Coding and Decoding, Mathematical operations, Relationships, Syllogism, Jumbling, Venn Diagram, Data Interpretation and Sufficiency, Conclusions and Decision Making, Similarities and Differences, Analytical reasoning, Classification, Directions, Statement – Arguments and Assumptions etc.

c. **General Awareness:**

Knowledge of Current affairs, Indian geography, culture and history of India including freedom struggle, Indian Polity and constitution, Indian Economy, Environmental issues concerning India and the World, Sports, General Scientific and technological developments etc.

d. **General Science:**

Physics, Chemistry and Life Sciences (up to 10th Standard CBSE syllabus).

The section wise Number of questions and marks are as below:

Subjects	No. of Questions	Marks for each Section
	CBT-I	CBT-I
Mathematics	30	30
General Intelligence & Reasoning	25	25
General Awareness	15	15
General Science	30	30
Total	**100**	**100**
Time in Minutes	90	

i. . The section wise distribution given in the above table is only indicative and there may be some variations in the actual question papers.

ii. There shall be negative marking in CBT (Computer Based Test/Examination) and marks shall be deducted for each wrong answer @ 1/3 of the marks allotted for each question.

iii. **Minimum percentage of marks for eligibility in various categories:** UR -40%, EWS-40%, OBC(NCL)-30%, SC-30%, ST -25%. This is also applicable to Ex-servicemen candidates, as per their community. These percentage of marks for eligibility may be relaxed by 2 marks for PwBD candidates in case of shortage of PwBD candidates against vacancies reserved for them.

13.2 2nd Stage CBT:

Short listing of Candidates for the 2nd Stage CBT exam shall be based on the normalized marks obtained by them in the 1st Stage CBT Exam. Total number of candidates to be shortlisted for 2nd Stage shall be **15 times** the community wise total vacancy of Posts notified against the RRB as per their merit in 1st Stage CBT. However, Railways reserve the right to increase/decrease this limit in total or for any specific category(s) as required to ensure availability of adequate candidates for all the notified posts.

Duration : 120 minutes (160 Minutes for candidates who are eligible for use of a Scribe)

No of Questions: 150

Syllabus: The Questions will be of objective type with multiple choices and are likely to include questions pertaining to General Awareness, Physics and Chemistry, Basics of Computers and Applications, Basics of Environment and Pollution Control and Technical abilities for the post. The syllabus for General Awareness, Physics and Chemistry, Basics of Computers and Applications, Basics of Environment and Pollution Control is common for all notified posts under this CEN as detailed below:

a) **General Awareness:**

Knowledge of Current affairs, Indian geography, culture and history of India including freedom struggle, Indian Polity and Constitution, Indian Economy, Environmental issues concerning India and the World, Sports, General Scientific and Technological Developments etc.

b) **Physics and Chemistry: Up to 10th standard CBSE syllabus.**

c) **Basics of Computers and Applications:**

Architecture of Computers; input and Output devices; Storage devices, Networking, Operating System like Windows, Unix, Linux; MS Office; Various data representation; Internet and Email; Websites & Web Browsers; Computer Virus.

d) **Basics of Environment and Pollution Control:**

Basics of Environment; Adverse effect of environmental pollution and control strategies; Air, water and Noise pollution, their effect and control; Waste Management, Global warming; Acid rain; Ozone depletion.

e) **Technical Abilities:**

The educational qualifications mentioned against each post shown in Annexure-A, have been grouped into different exam groups as below. Questions on the Technical abilities will be framed in the syllabus defined for various Exam Groups given at Annexure-VII-A, B, C, D,& E.

The section wise Number of questions and marks are as below:

Subjects	**No. of Questions**	**Marks for each Section**
	CBT-II	CBT-II
General Awareness	15	15
Physics & Chemistry	15	15
Basics of Computers and Applications	10	10
Basics of Environment and Pollution Control	10	10
Technical Abilities	100	100
Total	**150**	**150**
Time in Minutes	120	

i. The section wise distribution given in the above table is only indicative and there may be some variations in the actual question papers.

ii. There shall be negative marking in CBT (Computer Based Test/Examination) and marks shall be

deducted for each wrong answer @ 1/3 of the marks allotted for each question.

iii. **Minimum percentage of marks for eligibility in various categories:** UR-40%, EWS-40%, OBC(NCL)-30%, SC-30%, ST-25%. This is also applicable to Ex-servicemen candidates, as per their community. This percentage of marks for eligibility may be relaxed by 2 marks for PwBD candidates, in case of shortage of PwBD candidates against vacancies reserved for them.

iv. Virtual calculator will be made available on the Computer Monitor during 2nd Stage CBT.

13.3 Discipline Mapping Table

Table One

S. N.	Three years Diploma in Engineering or Bachelor's degree in Engineering/Technology	Exam Group
1	Mechanical Engineering	Mechanical and Allied Engineering
	Production Engineering	
	Automobile Engineering	
	Manufacturing Engineering	
	Mechatronics Engineering	
	Industrial Engineering	
	Machining Engineering	
	Tools and Machining Engineering	
	Tools and Die Making Engineering	
	Combination of any sub stream of basic streams of above disciplines	
2	Electrical Engineering	Electrical and Allied Engineering
	Combination of any sub stream of basic streams of Electrical Engineering	
3	Electronics Engineering	Electronics and Allied Engineering
	Instrumentation and Control Engineering	
	Communication Engineering	
	Computer Science and Engineering	
	Computer Engineering	
	Computer Science	
	Information Technology	
	Combination of sub streams of basic streams of above disciplines.	
4	Civil Engineering	Civil and Allied Engineering
	Combination of any sub stream of basic streams of Civil Engineering	
	B.Sc., in Civil Engineering of 3years duration	

Table Two

S. N.	Educational Qualifications	Exam Group
1	B.Sc., Chemistry and Physics	CMA

Note:

a) All the candidates with the above qualification shall be tested in the Exam Group mapped as per the above chart. A candidate possessing more than one minimum educational qualification, mapped to different Exam Groups, can choose any one Exam Group, provided he/she opts for the post(s) whose educational qualification is mapped to the chosen exam group. However, these candidates would be eligible for all the opted posts as per educational qualification.

b) The educational qualification for the post of DMS (Depot Material Superintendent) is Three Years Diploma in Engineering i.e., a candidate with Three Years Diploma in any of Engineering disciplines, can apply for these posts as applicable. Candidates with educational qualifications not figuring in the above chart and eligible for DMS posts have to choose any one of the above listed Exam Groups other than CMA Exam Group, during the

registration for online applications of this CEN.

13.4 SHORTLISTING OF CANDIDATES FOR 2nd STAGE CBT, DV AND EMPANELMENT:

Short listing of Candidates for the DV shall be based on the normalized marks obtained by them in 2nd Stage CBT. The normalization scheme to be adopted for short listing the candidates from 1st Stage CBT to 2nd Stage CBT and for DV on the basis of performance in 2nd Stage CBT is detailed below:

13.4.1 NORMALISATION OF MARKS:

a) Whenever CBT is conducted in multiple sessions for the same syllabus, the raw marks obtained by the candidates in different sessions will be converted to normalized marks.

b) The raw marks for a **single session CBT** and normalized marks for **multi-session CBTs** will be used for computing **Merit Index**, which is a common benchmark for generating merit for candidates from different Exam Groups.

13.4.2 CALCULATION OF MERIT INDEX FOR ALL PAPERS:

(a) In order to generate a common merit list of comprising of candidates who are from different Exam Groups, but are eligible for a common post, a **Merit Index** will be computed.

(b) For all papers for which there is only one CBT session, the **actual marks** obtained by the candidates will be used for calculating the Merit Index, while for papers in multiple sessions, **normalized marks** will be calculated corresponding to the raw marks obtained by a candidate. Accordingly, the Merit Index will be prepared based on these normalized marks.

The Merit Index will be computed using the formula given below:

$$\text{Merit Index} = S_q + (S_t - S_q)\,\frac{M - M_q}{\overline{M_t} - M_q}$$

(Merit Index is the relative score of a candidate within the discipline.)

M: Marks obtained by the candidate (actual/raw marks for single session exam and normalized marks for multi session exam).

M_q: The qualifying marks for general category candidate in the paper (40).

$\overline{M_t}$: The mean marks of top 0.1% or top 10 whichever is larger of the candidates who appeared in the paper (in case of multi session exam including all sessions)

S_q: 350 is the score assigned to M_q.

S_t: 900 is the score assigned to $\overline{M_t}$.

The qualifying marks (M_q) for general category candidate is 40.

The Merit Index will be calculated for UR, EWS, OBC(NCL), SC and ST candidates whose actual marks for single session exam and normalized marks for multi-session exam are equal or above the community qualifying marks prescribed in Para 13.2. Based on the Merit Index generated, a combined merit list of the candidates of different disciplines/Exam Groups will be prepared in the descending order of merit and the allotment of the preference will be done on the basis of this merit list.

13.4.3 DOCUMENT VERIFICATION (DV):

(a) Candidates will be shortlisted for Document Verification based on their marks and merit in the 2nd stage CBT and options. The number of shortlisted candidates will be **equal to the number of vacancies**.

(b) In case two or more candidates secure equal marks, their merit position shall be determined by age criteria i.e., the older candidate shall be given higher merit than the younger candidate and in case age being same, then alphabetical order (A to Z) of the name (Given name, not surname) shall be taken into account to break the tie.

(c) During document verification, candidates will have to produce their original certificates. No additional time will be given and the candidature of the candidates not producing their original certificates on the date of verification is liable to be forfeited.

(d) Empanelment of candidates will be based on merit and subject to successful completion of document verification and passing prescribed medical examination.

(e) Appointment of selected candidates is subject to their passing requisite Medical Fitness Test to be conducted by the Railway Administration/RRB, final verification of educational and community certificates and verification of antecedents/character of the candidates.

(f) On completion of all stages of recruitment process, RRB will allot Railway zone/Production unit as per the option of eligible candidates, subject to merit, medical standard and vacancy position. Once candidates are empanelled, as per their merit and choice, they will forfeit the right to be considered for their preference in the next priority zone/unit. However, RRBs also reserve the right to allot Railway zone/unit, which is/are not opted by the candidate, if considered in administrative interest, subject to the candidates' meeting eligibility requirements.

(g) Candidates may please note that RRBs only recommend names of empanelled candidates to the Railway Administrations concerned. The offer of appointment is issued only by the respective Railway Administrations.

(h) In case of any shortfall in empanelment or other exigencies, RRBs reserve the right to utilise the candidates down in the merit list if required, as per merit and options of such candidates. This however, will not confer any vested right on such candidates to be considered for appointment.

Annexure-VII A	
Syllabus for Civil & Allied Engineering Exam Group– JE	
S.N.	**Subject**
1	**Engineering Mechanics**- Force (resolution of force, moment of force, force system, composition of forces), Equilibrium, Friction, Centroid and Center of gravity, Simple machines.
2	**Building Construction**- Building components (substructure, superstructure), type of structure (load bearing, framed and composite structures).
3	**Building materials**- Masonry materials (stones, bricks, and mortars), Timber and miscellaneous materials (glass, plastic, fiber, aluminium steel, galvanized iron, bitumen, PVC, CPVC, and PPF).
4	**Construction of substructure**- job layout, earthwork, foundation (types, dewatering, coffer dams, bearing capacity).
5	**Construction of superstructure**- stone masonry, brick masonry, Hollow concrete block masonry, composite masonry, cavity wall, doors and windows, vertical communication (stairs, lifts, escalators), scaffolding and shoring.
6	**Building finishes**- Floors (finishes, process of laying), walls (plastering, pointing, painting) and roofs (roofing materials including RCC).
7	**Building maintenance**- Cracks (causes, type, repairs- grouting, guniting, epoxy etc.), settlement (causes and remedial measures), and re-baring techniques.
8	**Building drawing**- Conventions (type of lines, symbols), planning of building (principles of planning for residential and public buildings, rules and byelaws), drawings (plan, elevation, section, site plan, location plan, foundation plan, working drawing), perspective drawing.
9	**Concrete Technology**- Properties of various types/grades of cement, properties of coarse and fine aggregates, properties of concrete (water cement ratio, properties of fresh and hardened concrete), Concrete mix design, testing of concrete, quality control of concrete (batching, formwork, transportation, placing, compaction, curing, waterproofing), extreme weather concreting and chemical admixtures, properties of special concrete (ready mix, RCC, pre-stressed, fiber reinforced, precast, high performance).
10	**Surveying**- Types of survey, chain and cross staff survey (principle, ranging, triangulation, chaining, errors, finding area), compass survey (principle, bearing of line, prismatic compass, traversing, local attraction, calculation of bearings, angles and local attraction) leveling (dumpy level, recording in level book, temporary adjustment, methods of reduction of levels, classification of leveling, tilting level, auto level, sources of errors, precautions and difficulties in leveling), contouring (contour interval, characteristics, method of locating, interpolation, establishing grade contours, uses of contour maps), area and volume measurements, plane table survey (principles, setting, method), theodolite survey (components, adjustments, measurements, traversing), Tacheometric survey, curves (types, setting out), advanced survey equipment, aerial survey and remote sensing.
11	**Computer Aided Design**- CAD Software (AutoCAD, Auto Civil, 3D Max etc.), CAD commands, generation of plan, elevation, section, site plan, area statement, 3D view.
12	**Geo Technical Engineering**- Application of Geo Technical Engineering in design of foundation, pavement, earth retaining structures, earthen dams etc., physical properties of soil, permeability of soil and seepage analysis, shear strength of soil, bearing capacity of soil, compaction and stabilization of soil, site investigation and sub soil exploration.
13	**Hydraulics**- properties of fluid, hydrostatic pressure, measurement of liquid pressure in pipes, fundamentals of fluid flow, flow of liquid through pipes, flow through open channel, flow measuring devices, hydraulic machines.
14	**Irrigation Engineering**- Hydrology, investigation and reservoir planning, percolation tanks, diversion head works.
15	**Mechanics of Structures**- Stress and strain, shear force and bending moment, moment of inertia, stresses in beams, analysis of trusses, strain energy.
16	**Theory of structures**- Direct and bending stresses, slope and deflection, fixed beam, continuous beam, moment distribution method, columns.
17	**Design of Concrete Structures**- Working Stress method, Limit State method, analysis and design of singly reinforced and doubly reinforced sections, shear, bond and development length, analysis and design of T Beam, slab, axially loaded column and footings.
18	**Design of Steel Structures**- Types of sections, grades of steel, strength characteristics, IS Code, Connections, Design of tension and compression members, steel roof truss, beams, column bases.
19	**Transportation Engineering**- Railway Engineering (alignment and gauges, permanent way, railway track geometrics, branching of tracks, stations and yards, track maintenance), Bridge engineering (site selection, investigation, component parts of bridge, permanent and temporary bridges, inspection and maintenance), Tunnel engineering (classification, shape and sizes, tunnel investigation and surveying, method of tunneling in various strata, precautions, equipment, explosives, lining and ventilation).
20	**Highway Engineering**- Road Engineering, investigation for road project, geometric design of highways, construction of road pavements and materials, traffic engineering, hill roads, drainage of roads, maintenance and repair of roads.

21	**Environmental Engineering**- Environmental pollution and control, public water supply, domestic sewage, solid waste management, environmental sanitation, and plumbing.
22	**Advanced Construction Techniques and Equipment**- Fibers and plastics, artificial timber, advanced concreting methods (under water concreting, ready mix concrete, tremix concreting, special concretes), formwork, pre-fabricated construction, soil reinforcing techniques, hoisting and conveying equipment, earth moving machinery (exaction and compaction equipment), concrete mixers, stone crushers, pile driving equipment, working of hot mix bitumen plant, bitumen paver, floor polishing machines.
23	**Estimating and Costing**- Types of estimates (approximate, detailed), mode of measurements and rate analysis.
24	**Contracts and Accounts**- Types of engineering contracts, Tender and tender documents, payment, specifications.

Annexure-VII B	
Syllabus for Electrical & Allied Engineering Exam Group– JE	
S. N.	**Subject**
1	**Basic concepts**: Concepts of resistance, inductance, capacitance, and various factors affecting them. Concepts of current, voltage, power, energy and their units.
2	**Circuit law:** Kirchhoff's law, Simple Circuit solution using network theorems.
3	**Magnetic Circuit:** Concepts of flux, mmf, reluctance, Different kinds of magnetic materials, Magnetic calculations for conductors of different configuration e.g. straight, circular, solenoidal, etc. Electromagnetic induction, self and mutual induction.
4	**AC Fundamentals:** Instantaneous, peak, R.M.S. and average values of alternating waves, Representation of sinusoidal wave form, simple series and parallel AC Circuits consisting of R.L. and C, Resonance, Tank Circuit. Poly Phase system – star and delta connection, 3 phase power, DC and sinusoidal response of R-Land R-C circuit.
5	**Measurement and measuring instruments:** Measurement of power (1 phase and 3 phase, both active and re-active) and energy, 2 wattmeter method of 3 phase power measurement. Measurement of frequency and phase angle. Ammeter and voltmeter (both moving oil and moving iron type), extension of range wattmeter, Multimeters, Megger, Energy meter AC Bridges. Use of CRO, Signal Generator, CT, PT and their uses. Earth Fault detection.
6	**Electrical Machines:** (a) D.C. Machine – Construction, Basic Principles of D.C. motors and generators, their characteristics, speed control and starting of D.C. Motors. Method of braking motor, Losses and efficiency of D.C. Machines. (b) 1 phase and 3 phase transformers – Construction, Principles of operation, equivalent circuit, voltage regulation, O.C. and S.C. Tests, Losses and efficiency. Effect of voltage, frequency and wave form on losses. Parallel operation of 1 phase /3 phase transformers. Auto transformers. (c) 3 phase induction motors, rotating magnetic field, principle of operation, equivalent circuit, torque-speed characteristics, starting and speed control of 3 phase induction motors. Methods of braking, effect of voltage and frequency variation on torque speed characteristics, Fractional Kilowatt Motors and Single Phase Induction Motors: Characteristics and applications.
7	**Synchronous Machines:** Generation of 3-phase e.m.f. armature reaction, voltage regulation, parallel operation of two alternators, synchronizing, control of active and reactive power. Starting and applications of synchronous motors.
8	**Generation, Transmission and Distribution:** Different types of power stations, Load factor, diversity factor, demand factor, cost of generation, inter-connection of power stations. Power factor improvement, various types of tariffs, types of faults, short circuit current for symmetrical faults. Switchgears and Protection: Rating of circuit breakers, Principles of arc extinction by oil and air, H.R.C. Fuses, Protection against earth leakage / over current, etc. Buchholz relay, Merz-Price system of protection of generators & transformers, protection of feeders and bus bars. Lightning arresters, various transmission and distribution system, comparison of conductor materials, efficiency of different system. Cable – Different type of cables, cable rating and derating factor.
9	**Estimation and costing:** Estimation of lighting scheme, electric installation of machines and relevant IE rules. Earthing practices and IE Rules.
10	**Utilization of Electrical Energy:** Illumination, Electric heating, Electric welding, Electroplating, Electric drives and motors.
11	**Basic Electronics:** Working of various electronic devices e.g. P N Junction diodes, Transistors (NPN and PNP type), BJT and JFET. Simple circuits using these devices.

Annexure-VII C	
Syllabus for Electronics & Allied Engineering Exam Group– JE	
S.N.	**Subject**
1	**Electronic Components & Materials**: Conductors, Semi conductor & Insulators; Magnetic materials; Jointing & Cleaning materials for U/G copper cable & OFC; Cells and Batteries (chargeable and non chargeable); Relays, Switches, MCB & Connectors.
2	**Electronic Devices and circuits:** PN Junction diodes, thyristor; Diode and triode circuits; Junction Transistors; Amplifiers; Oscillator; Multivibrator, counters; Rectifiers; Inverter and UPS.
3	**Digital Electronics:** Number System & Binary codes; Boolean Algebra & Logic gates; Combinational & Sequential logic circuits; A/D & D/A converter, counters; Memories
4	**Linear Integrated Circuit:** Introduction to operational Amplifier; Linear applications; Non Linear applications; Voltage regulators; Timers; Phase lock loop.
5	**Microprocessor and Microcontroller:** Introduction to microprocessor, 8085 microprocessor working; Assembly Language programming; Peripherals & other microprocessors; Microcontrollers
6	**Electronic Measurements:** Measuring systems; Basic principles of measurement; Range Extension methods; Cathode ray oscilloscope, LCD, LED panel; Transducers
7	**Communication Engineering:** Introduction to communication; Modulation techniques; Multiplexing Techniques; Wave Propagation, Transmission line characteristics, OFC; Fundamentals of Public Address systems, Electronic exchange, Radar, Cellular and Satellite Communication.
8	Data communication and Network: Introduction to data communication; Hardware and interface; Introduction to Networks and Networking devices; Local Area Network and Wide area network; Internet working.
9	**Computer Programming:** Programming concepts; Fundamentals of 'C' and C ++; Operators in 'C' and C ++; Control Statements; Functions, Array String & Pointers, File Structure; Data Structure and DBMS
10	**Basic Electrical Engg.:** DC Circuits; AC fundamentals; Magnetic, Thermal and Chemical effects of Electric current; Earthing - Installation, Maintenance, Testing,

Annexure-VII D	
Syllabus for Mechanical & Allied Engineering Exam Group– JE	
S. N.	**Subject**
1	**Engineering Mechanics:** Resolution of forces, Equilibrium and Equilibrant, parallelogram law of forces, triangle law of forces, polygon law of forces and Lami's theorem, couple and moment of a couple, condition for equilibrium of rigid body subjected to number of coplanar non-concurrent forces, definition of static friction, dynamic friction, derivation of limiting angle of friction and angle of repose, resolution of forces considering friction when a body moves on horizontal plane and inclined plane, calculation of moment of inertia and radius of gyration of : (a) I-Section (b) channel section (c) T-Section (d) L-Section (Equal & unequal lengths) (e) Z-Section (f) Built up sections (simple cases only), Newton's laws of motion (without derivation), motion of projectile, D'Alembert's principle, definition law of conservation of energy, law of conservation of momentum.
2	**Material Science:** Mechanical properties of engineering materials – tensile strength, compressive strength, ductility, malleability, hardness, toughness, brittleness, impact strength, fatigue, creep resistance. Classification of steels, mild steel and alloy steels. Importance of heat treatment. Heat treatment processes – annealing, normalizing, hardening, tempering, carburizing, nitriding and cyaniding.
3	**Strength of Materials:** Stress, strain, stress strain diagram, factor of safety, thermal stresses, strain energy, proof resilience and modules of resilience. Shear force and bending moment diagram – cant leaver beam, simply supported beam, continuous beam, fixed beam. Torsion in shafts and springs, thin cylinder shells.
4	**Machining:** Working principle of lathe. Types of lathes – Engine lathe – construction details and specifications. Nomenclature of single point cutting tool, geometry, tool signature, functions of tool angles. General and special operations – (Turning, facing, taper turning thread cutting, knurling, forming, drilling, boring, reaming, key way cutting), cutting fluids, coolants and lubricants. Introduction to shaper, slotter, plainer, broaching, milling and manufacture of gears, heat treatment process applied to gears.

5	**Welding –** Introduction, classification of welding processes, advantages and limitations of welding, principles of arc welding, arc welding equipment, choice of electrodes for different metals, principle of gas (oxy-acetylene) welding, equipment of gas welding, welding procedures (arc & gas), soldering and brazing techniques, types and applications of solders and fluxes, various flame cutting processes, advantages and limitations of flame cutting, defects in welding, testing and inspection modern welding methods, (submerged, CO2, atomic – hydrogen, ultrasonic welding), brief description of MIG & TIG welding.
6	**Grinding & Finishing Process:** Principles of metal removal by grinding, abrasives, natural and artificial, bonds and binding processes, vitrified, silicate, shellac rubber, grinding machines, classification: cylindrical, surface, tool & cutter grinding machine, construction details, relative merits, principles of centreless grinding, advantages & limitations of centreless grinding work, holding devices, wheel maintenance, balancing of wheels, coolants used, finishing by grinding, honing, lapping, super finishing, electroplating, basic principles – plating metals, applications, hot dipping, galvanizing tin coating, parkerising, anodizing, metal spraying, wire process, powder process and applications, organic coatings, oil base paint, lacquer base enamels, bituminous paints, rubber base coating.
7	**Metrology:** Linear measurement – Slip gauges and dial indicators, angle measurements, bevel protractor, sine bar, angle slip gauges, comparators (a) mechanical (b) electrical (c) optical (d) pneumatic. Measurement of surface roughness; methods of measurements by comparison, tracer instruments and by interferometry, collimators, measuring microscope, interferometer, inspection of machine parts using the concepts of shadow projection and profile projection.
8	**Fluid Mechanics & Hydraulic Machinery:** Properties of fluid, density, specific weight, specific gravity, viscosity, surface tension, compressibility capillarity, Pascal's law, measurement of pressures, concept of buoyancy. Concept of Reynold's number, pressure, potential and kinetic energy of liquids, total energy, laws of conservation, mass, energy and momentum, velocity of liquids and discharge, Bernoulli's equation and assumptions, venturi meters, pitot-tube, current meters. Working principle & constructional details of centrifugal pump, efficiencies – manometric efficiency, volumetric efficiency, mechanical efficiency and overall efficiency, cavitation and its effect, working principle of jet & submersible pumps with line diagrams.
9	**Industrial Management:** Job analysis, motivation, different theories, satisfaction, performance reward systems, production, planning and control, relation with other departments, routing, scheduling, dispatching, PERT and CPM, simple problems. Materials in industry, inventory control model, ABC Analysis, Safety stock, re-order, level, economic ordering quantity, break even analysis, stores layout, stores equipment, stores records, purchasing procedures, purchase records, Bin card, Cardex, Material handling, Manual lifting, hoist, cranes, conveyors, trucks, fork trucks.
10	**Thermal Engineering:** Laws of thermo dynamics, conversion of heat into work vice versa , laws of perfect gases, thermo dynamic processes – isochoric, isobaric, isothermal hyperbolic, isentropic, polytrophic and throttling, modes of heat transfer, thermal conductivity, convective heat transfer coefficient, Stefan Boltzman law by radiation and overall heat transfer coefficient. Air standards cycles – Carnot cycle, Otto cycle, Diesel cycle, construction and working of internal combustion engines, comparison of diesel engine and petrol engine. Systems of internal combustion engine, performance of internal combustion engines. Air compressors their cycles refrigeration cycles, principle of a refrigeration plant.

Annexure-VII E

Syllabus for CMA Exam Group

S.N.	Subject
1	Measurements, Units and Dimensions, Types of errors in measurements, Significance of accuracy in measurement.
2	**Light:** Basic principles of light - reflection, refraction, laws of reflection, total internal reflection, interference, diffraction and polarization. Formula for magnification of microscope, telescope. Electro Magnetic spectra.
3	**Heat:** Heat as energy- sources of heat, Transmission of heat, Expansion of solids, liquids and gases. Temperature (based on thermal equilibrium), Different Scales of Temperature. Calorimetry, Applications of Specific heat, Latent heat. Anomalous expansion of water and its significance in nature. Combustion, Calorific value, specific heat of gases.

4	S**ound**: Sources of sound. Propagation of sound. Velocity of sound in different media / substances. Characteristics of sound. Reflection of sound, echo, Resonance, Sonar and Doppler effect.
5	**Mechanics:** Scalars and Vectors. All types of motion. Friction. Newton's laws of motion. Momentum. Equations of motion (under gravity and freely falling), projectile. Range. Laws of Floatation. Work, Power and Energy. Conservation of energy. Center of mass. Centre of gravity. Stability and Equilibrium. Universal law of Gravitation. Relation between 'g' and 'G'. Circular motion, Kepler's Laws. Elasticity and Hooke's Law.
6	**Magnetism:** Magnetic field, Uniform and non uniform magnetic fields. Magnetic induction. Magnetic lines of force. Magnetic pole strength, Magnetic moment. Inverse square law of magnetism. Magnetic properties of materials and their classification.
7	**Electricity & Electro Magnetism**: Electric charge, field, electric intensity, electric potential, potential difference. Simple Electric Circuits. Conductors, Non conductors / Insulators, Coulomb's inverse square law. Primary and secondary Cells. Ohm's Law - its limitations. Resistances in series and parallel, Emf of a circuit; Specific resistance. Kirchhoff's laws. Relation between electric potential and Electric energy, electric Power (wattage). Heating effect of electric current, and Joule's law. Ampere's law, circular loop and Solenoid. Magnetic force on moving charged particle and long straight conductors. Fleming's left hand rule, Electric motor. Electromagnetic induction – Faraday's law Electromagnetic flux. Lentz law, Generators and Alternating Currents. Inductance – self, mutual inductance and principles of transformer.
8	**Modern Physics:** Discharge of Electricity through gases, Cathode rays, Anode rays and their properties; X-rays; Atomic models: JJ Thomson, Rutherford and Bohr's models. Atomic nucleus and its structure. Atomic models: Mass defect; Radio Activity- Discovery, properties of alpha, beta, and gamma radiations. Applications of alpha, beta, and gamma radiations, alpha, beta decays, Half life period, Isotopes, Isobars, and Isotones. Artificial radioactivity; radio isotopes and their uses in different fields; radioactive series; Chain and controlled nuclear reactions; Fission and fusion of nuclei - atomic bomb and hydrogen bomb.
9	**Electronics and Communications**: Semi conductors, diode, p-n junction characteristics. Transistor – pnp & npn characteristics and uses. Zener Diode characteristics. Simple electronic circuits, Logic gates – applications, modulation and demodulation.
10	**Matter:** States of matter. Elements, Compounds and Mixtures. Methods of separation of mixtures. Chromatography. Behavior of gases; measurable properties of gases; gas laws. Mole concept. Dalton, Avogadro, Berzelius laws.
11	**Chemical Reactions:** Physical and chemical changes. Types of Chemical reactions; Physical and Chemical properties of various compounds. Chemical calculations. NaOH, Bleaching powder, baking soda, washing soda, and their uses, Plaster of Paris.
12	**Acids and Bases, Salts**: Strength and uses of Acids & Bases. Neutralization. Nature and uses of different Salts. Water of crystallization. Complex, Neutral and double salts. Oxidation and Reduction, Rancidity. Identification of Acids, Bases– Indicators: Natural, Chemical. PH Scale - Role of PH in daily life-agriculture, medicine. Classification of salts based on affinity to water Examples of Acidic, Basic, Mixed, Complex, Neutral and double salts. Solutions - Types of solutions; solubility, ionization, Concentration; Oxidation number concept. Balancing of Redox reactions, Calculation of Concentrations. Stoichiometry.
13	**Atomic Structure:** Electromagnetic spectrum, Atomic spectrum, Characteristics of electron, proton and neutron, Rutherford's model of an atom, nature of electromagnetic radiation, Plank's quantum mechanics, explanation of photo electric effect, features of atomic spectra, characteristics of hydrogen spectrum, Bohr's theory of structure of atom, Bohr's explanation of spectral lines, failure of Bohr's theory, wave particle nature of electrons, de Broglie's hypothesis, Heisenberg's uncertainty principle, important features of the Quantum mechanical model of an atom, Quantum numbers, concept of orbitals, define an atomic orbital in terms of quantum numbers-shapes of s, p and d orbitals, n l x rule, Energies of electronic energy levels (n+l) rule state Auffbau principle, Pauli's exclusive principle and Hund's rule of maximum multiplicity, electronic configuration of atom, explanation of stability of half filled and completely filled orbital.
14	**Periodic Classification of Elements**: Characteristics of elements in groups and periods. Signification of atomic number and electronic configuration as the basis per periodic classification. Classification of elements into s-block, p-block, d-block, f-block and their main characteristics. Periodic trends in physical and chemical properties of elements. Study of different Groups of periodic table.
15	**Chemical Bonding**: Ionic and Covalent bonds: Introduction of chemical bonding. Electronic Configuration of Noble gases. sigma, pi bond with examples. Shapes of molecules bond lengths and bond angles in molecules. Hybridization and explanation of H2O, BF3, CH4, NH3 etc. molecules. Hydrogen bonding and types of H bonds.

16	**Carbon and its Compounds**: Need to study of carbon compounds separately. Classification of Organic compounds Hydro carbons - Alkanes, alkenes, alkynes aromatic and aliphatic compounds with examples. Bonding in Carbon including Hybridization. Allotropes of Carbon. Versatile nature of carbon. Tetravalency, Chains, branches and rings. Catenation, Isomerism. Saturated and Unsaturated carbon compounds. Bonding of carbon with other elements. Functional groups in carbon compounds. Homologous series. Chemical properties of carbon compounds Combustion and Oxidation. Addition reactions. Substitution reaction. Important carbon compounds. Nomenclature organic compounds. Carbohydrates and their classification. Proteins-examples, Oils and fats examples Polythene - Nylon, PVC, Polyvinyl alcohol; Rubber – uses in daily life. Polymers, and other important organic compounds.
17	**Environmental Chemistry**: Different types of pollutions, acid rains, Ozone and its reactions, effects of depletion of ozone layer, Green house effect and global warming, Green Chemistry as an alternative tool for reducing pollution.
18	**Metallurgy:** Occurrence of Metals. Minerals, Ores - Examples. Extractions of metals – activity series and related metallurgy, flow chart of steps involved in the extraction of metals from ore. Refining metals, Electrolytic refining, Corrosion – Prevention of Corrosion. Alloys and their uses.