

ANNEXURE

SYLLABUS FOR DIRECT RECRUITMENT TO THE POST OF JUNIOR ENGINEER (ELECTRICAL)

PAPER	SUBJECT	MARKS	DURATION
	Part-A		
Paper - I	General Knowledge (50 questions)	100	3 hours with compensatory time of 20 minutes per hour for persons with benchmarked disabilities
	General English (25 questions)	50	
	Part- B		
	Precis writing	10	
	Essay Writing	20	
	English Comprehension- (Conventional)	20	
	Total	200	
Paper - II	Basic Computer Knowledge (35 questions)	70	3 hours with compensatory time of 20 minutes per hour for persons with benchmarked disabilities
	Simple Arithmetic (30 questions)	60	
	General Intelligence & Reasoning (35 questions)	70	
	Total	200	
Paper - III (Electrical) (Technical Paper)	1. Power System-I I. Generation of Electrical Power (1) Thermal Power Plants (2) Hydro Electric Generation Unit II. Power Planning Economic and Tariff III. Sub-Station	60	3 hours with compensatory time of 20 minutes per hour for persons with benchmarked disabilities
	2. Power System-II I. Principle of Distribution System/Principle of Transmission and Distribution II. Material of Overhead Lines III. Concept on Line Design, Construction and L.A. IV. Detail of Service Connection V. Construction Details of Under Ground Cable VI. CEA Safety Regulations	60	
	3. Switch Gear and Protection-I I. Protective Relays II. Relay Application and Characteristics III. Feeder Protection IV. Generator Protection V. Motor Protection VI. Circuit Breakers	30	
	4. Instrumentation and Control-I I. Overview of Instrumentation and Control System II. Pressure Measurement III. Transducers IV. Signal Conditioning	30	
	5. High Voltage Engineering (E)-I I. Overview of the Power Generation, Transmission and Distribution II. Measurement of High Voltages III. Over Voltage	20	
	Total	200	

Paper - III (Electronics) (Technical Paper)	1. Electronic Devices and Circuits Unit-I : Semiconductor and Diodes Unit-II : Bipolar Junction Transistor Unit-III : Transistor Oscillators and FET and UJT Unit-IV : SCR, TRIAC, DIAC, MOSFET Unit-V : Opto Electronics Devices and Waveshaping Circuits	60	3 hours with compensatory time of 20 minutes per hour for persons with benchmarked disabilities
	2. Digital Electronics Unit-I : Number System and Boolean Algebra Unit-II : Combinational Circuits Unit-III : Sequential Circuits Unit-IV : Memory Devices Unit-V : Microprocessor-8085	40	
	3. Linear Integrated Circuits Unit-I : Introduction to Operational Amplifiers Unit-II : Opamp Applications Unit-III : PLL & Applications Unit-IV : D/A and A/D Converters Unit-V : Special Function ICs (qualitative treatment only)	40	
	4. Microcontroller Unit-I : Architecture & Instruction Set of 8051 Unit-II : Programming Examples Unit-III : I/P and Timer	30	
	5. Electronic System Design Unit-I : Design of Power Supply Unit-II : Design of Small Amplifiers Unit-III : Data Acquisition System Unit-IV : Design of Function Generator Unit-V : High Voltage/High Current Driver	30	
	Total	200	
Paper - III (Mechanical) (Technical Paper)	Unit-I : Mechanics of Materials	36	3 hours with compensatory time of 20 minutes per hour for persons with benchmarked disabilities
	Unit-II : Designed of Machined Elements	24	
	Unit-III : Theory of Machines	34	
	Unit-IV : Machine Tools	26	
	Unit-V : Manufacturing Processes	36	
	Unit-VI : Production Management	34	
	Unit-VII : Mechanical Measurement	10	
	Total	200	

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Paper – IV (Electrical) (Technical Paper)	1. Electrical Machine-I I. Transformer II. Storage Batteries	40	3 hours with compensatory time of 20 minutes per hour for persons with benchmarked disabilities
	2. Electrical Machine-II I. Induction Motor II. Three Phase Synchronous Machine III. Single	30	
	3. Power Electronics/Electronic Devices & Circuits-II I. The Thyristor and their Characteristics II. Power Diodes & Power Transistors III. Line Cumulated Converters IV. A.C. Voltage Controllers V. D.C. Chopper & Switch Mode Power Supply VI. Power Supplies VII. A.C. Drivers VIII. A.C. Voltage Control	30	
	4. Repairing of Household Equipment-II I. Ceiling Fan/Exhaust Fan II. Fluorescent Lamp/Sodium Vapour Lamp III. Split Type/Window Air-Conditioning	20	
	5. Non-Conventional Sources of Energy I. Solar Radiation II. Wind Energy III. Solar Cell	80	
	Total	200	
Paper – IV (Electronics) (Technical Paper)	1. Electrical Circuits and Instrumentation Unit-I : D.C Circuits and theorems Unit-II : A.C Circuits and resonance Unit-III : Transformer and Machines Unit-IV : Measuring Instrument and CRO Unit-V : Transducers and Test Instruments	60	3 hours with compensatory time of 20 minutes per hour for persons with benchmarked disabilities
	2. Industrial Electronics Unit-I : Power Devices and Trigger Circuits Unit-II : Converters and Choppers (Qualitative Treatment Only) Unit-III : Inverters & Applications Unit-IV : Programmable Logic Controller Unit-V : Numerical Control Systems	60	
	3. Communication Engineering Unit-I : Networks, Antenna and Propagation Unit-II : Amplitude Modulation Unit-III : Angle and Pulse Modulation Unit-IV : Audio Systems Unit-V : Video Systems	30	
	4. Computer Hardware and Networks Unit-I : Motherboard Components and Memory Storage Devices Unit-II : I/O Devices and Interface Unit-III : Maintenance and Trouble Shooting of Desktop and Laptops Unit-IV : Computer Network Devices and OSI Layers	30	
	5. Embedded System Unit-I : Arm Processor Architecture, Arm Processor Fundamentals Unit-II : Arm Instructions Sets Arm Unit-III : Cache Mechanism Unit-IV : Memory Protection and Management Unit Unit-V : Embedded OS and RTOS	20	

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Paper - IV (Mechanical) (Technical Paper)	Total	200	3 hours with compensatory time of 20 minutes per hour for persons with benchmarked disabilities
	Unit-I : Fluid Mechanics	20	
	Unit-II : Fluid Machines	30	
	Unit-III : Thermal Engineering	36	
	Unit-IV : I.C. Engines	34	
	Unit-V : Automobile Engineering	30	
	Unit-VI : Refrigeration and Air-Conditioning	30	
	Unit-VII : Mechanical Estimation	20	
	Total	200	

Notes:

1. Questions in Paper-I and Paper-II shall be set and answered in English only and of Multiple Choice Question patterns only except for précis writing, essay writing and English comprehension under Paper-I (Part- B), each question in Multiple Choice Question will carry two marks. The candidates will be given probable questions at least four wherein the candidate has to choose the correct answer for every objective type question.
2. 50 percent of the questions in Paper-III and Paper-IV (Technical Papers) shall be set in multiple choice questions pattern, the remaining 50 percent shall be set in conventional type questions.
3. Detailed description of syllabus are highlighted in the following pages.



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PAPER - I

General Knowledge: Questions will be designed to test the candidate's knowledge of current events and of such matters of everyday observation and experience as may be expected of an educated person. The test will also include questions relating to Indian history and culture, Indian polity including the Constitution of India, geography, economy and general science. Questions on Mizo history and culture will also form part of the syllabus.

General English: Questions will be designed to test the candidate's understanding and knowledge of English language, vocabulary, spelling, grammar, sentence structure, synonyms, antonyms, sentence completion, phrases and idiomatic use of words etc. There will be questions on comprehension of a passage also.

Essay Writing: Question on essay writing will be designed to test the candidate's grasp of his material, its relevance to the subject chosen, and to his ability to think constructively and to present his ideas logically, constructively and concisely.

English Comprehension: There will be questions on comprehension of passages also to test the vocabulary, grammar, logical thought ability and overall grasp of the candidate's over English language.

PAPER - II

Basic Computer knowledge: Introduction to Computers, introduction to Graphical user interface based Operating System, elements of Word Processing, Spreadsheets, Power point presentations, Computer communication and internet, world wide web and web browser, communication and collaboration.

Simple Arithmetic: Number system, simplification, roots, averages, discounts, percentages, profit & loss, ratio and proportion, partnership, chain rule, time & work, time & distance, simple & compound interest, mensuration, permutations & combinations, heights & distances, line graphs, bar graphs, pie charts and tabulation.

General Intelligence & Reasoning: It would include questions of both verbal and non-verbal type. This component may include questions on analogies, similarities and differences, spatial visualization, spatial orientation, problem solving, analysis, judgement, decision making, visual memory, discrimination, observation, relationship concepts, arithmetical reasoning and figural classification, arithmetic number series, non-verbal series, coding and decoding, statement conclusion, syllogistic reasoning etc.

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Syllabus for Junior Engineer (Electrical)

ELECTRICAL ENGINEERING -Paper-III

(Full.Marks : 200)

1. Power System – I

(60 Marks)

I. Generation of Electrical Power

(1) Thermal Power Plants:-

- i. Detail layout of thermal power station.
- ii. Site selection and furnish the list of thermal power plants.
- iii. Generating capacity of the thermal power plants.
- iv. Working principle of the following (a) Coal handling Plant (b) Alternators (c) Condensing plant (d) Water treatment plant (e) Ash handling system (f) Station auxiliaries (g) Pulverising system (h) Steam system (i) Turbine system.

(2) Hydro Electric Generation Unit :-

- i. Developing a Hydro Electric reasons for developing a Hydro Electric Project.
- ii. Type of hydro electric project.
- iii. List of hydro electric projects and their capacities.
- iv. Detail layout of the hydro electric project.
- v. The Alternator, the Computing system and turbine of the hydro-electric project.
- vi. The station auxiliaries of the hydro electric projects.

II. Power Planning Economic and Tariff.

- i. To define –
(a) Demand (b) Load Curve (c) Maximum Demand or Peak Load (d) Connected Load (e) Demand factors (f) Load factor (g) Diversity factor (h) Plant factor.

III. Sub-Station

- i. To define sub-station.
- ii. To prepare the list of equipment of a sub-station.
- iii. To design the layout of a transmitting sub-station.

2. Power System – I

(60 Marks)

I. Principle of Distribution System/Principles of Transmission and Distribution

- i. The transmission system and Distribution system.
- ii. Transmission efficiency with the variation of system voltage/The principle of choice of voltages in generation, transmission & distribution.
- iii. Compare the overhead and underground distribution.
- iv. To describe (a) 2 Wire DC System (b) 3 wire DC system (c) Single phase AC (d) Three phase AC system.

II. Material of Overhead Lines

- i. Characteristics and their application of (a) Poles and wood poles (b) Treatment of wood poles (c) Concrete Poles (d) Steel tubular poles (e) Rail poles (f) Steel towers with cross arms brackets (g) Stays struts and other line accessories like arcing Home etc. suspension clamp, strain clamp, snail clamp, tubular compression dead end etc and binding wires dampers etc.
- ii. Characteristics & field of application of (a) Shackle Insulators (b) Pin Insulators (c) Post Insulators (d) Distributors (e) String Insulators.

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Syllabus for Junior Engineer (Electrical)

III. Concept on Line Design, Construction and L.A.

- i. To describe the rules & practices on (a) Selection of conductors size (b) Arrangement and spacing of conductor (c) Selection of height of poles or Towers (d) Clearances between power lines (e) Selection of span (f) Maintaining the clearance from building (vertical & Horizontal) (g) Earthing and counterpoise of transmission and distribution line.

IV. Detail of Service Connection

- i. Layout of the low and Medium voltage Distribution System.
- ii. The detail of service connection of overhead line (low and medium voltage).
- iii. The relevant IE Rules IS specification regarding the tests before giving service connections.
- iv. Insulation testing & earth testing.

V. Construction Details of Underground cable

- i. Types of cables.
- ii. Standard size of cables & their field of applications (To write the specification of underground cable).
- iii. The method of cable laying.
- iv. To describe the method of cable joints for (a) PILC cable (b) XLPE cable (c) PVC cable.
- v. Type of tests for commissioning of cables.

VI. CEA Safety Regulations :

- i. To state the CEA Safety regulations related to (a) Overhead lines (b) Conductors at different voltages on same supports (c) Erection of or alternation to building structure flood banks and elevation of roads (d) Clearance (e) Routes (f) Maximum intervals between supports (g) Same structure-carrying the Telecommunication lines (h) Lines crossing or approaching each other (i) Guarding (j) Service from OH Line (k) Earthing (l) Metallic bearer wire used for supporting insulated cables (m) Protection against.

3. Switch Gear and Protection – I

(30 Marks)

I. Protective Relays

- i. To describe the following (a) causes of faults (b) consequences of faults (c) relay protection (d) zones of protections.

II. Relay Application and characteristics

- i. To describe the functions and operating principle of (a) over current relays (b) instantaneous over current relay (c) application of time current relays (d) time-graded protection with over current relays (e) directional relays (f) directional over current relays and their connections (g) distance relays (h) Impedance relay (i) Ohm relay (j) differential relays.

III. Feeder Protection

- i. To describe the protection and their selection
- ii. To explain the principle of over current protection in respect of (a) non-directional time and current grading (b) directional time and current grading (c) over current earth fault protection (d) directional earth fault relays (e) Earth-fault detection in systems earth through A.C. suppression oil.

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Syllabus for Junior Engineer (Electrical)

iii. Apparatus protection.

(i) Transformer protection.

(ii) To describe (a) the nature of transformer faults (b) faults in auxiliary equipment (c) winding faults (d) overloads and external start-circuits (e) differential protection of transformers (f) problems encountered in differential protection of transformers.

IV. Generator Protection

i. To describe type of generator faults e.g. (a) stator fault (b) Rotor fault (c) Abnormal running conditions.

ii. To describe (a) the stator protection systems (b) the rotor protection systems (c) the field feature protection (d) unbalanced load up protection (e) over load protection (f) prime mover protection (g) over speed protection (h) over voltage protection.

iii. To describe (a) the protection of generator transformer unit (b) relay tripping functions.

V. Motor Protection

i. To describe different type of motor faults.

ii. To describe the protection systems of (a) stator (b) Rotor (c) over load (d) unbalance and single phasing (e) under-voltage (f) Reverse phase protection (g) loss of synchronism.

VI. Circuit breakers

i. Theory of circuit interruption.

ii. To state the rating of a circuit breaker.

iii. To define the effect of re-striking voltage transients.

iv. To describe this interaction between the breaker and circuit.

v. To classify (a) current dropping (b) duties of switch gear.

vi. To describe (a) automatic switch (b) air circuit breakers (c) oil circuit breakers (single break and multi-break construction) (d) Air blast circuit breaker (e) performance of circuit breakers and system requirements (f) terminal start air unit, and R.R.R.V. (g) interruption of small inductive and capacitive currents (h) modification of circuit breaker duty by shunt resistors.

vii. To state the recent developments in circuit breakers.

4. Instrumentation and Control – I

(30 Marks)

I. Overview of Instrumentation and control system

i. To list the basic components of instrumentation system such as -

(a) Measurement system.

(b) Information signals and system.

(c) Intelligent versus dumb instrumentation.

ii. To discuss the basic idea of the control systems such as -

(a) Automatic control systems.

(b) Types of control system.

(c) Definition of controller.

II. Pressure Measurement

i. To describe the concepts of pressure measurement in (a) mechanics (b) mechanics (b) hydraulics (c) kinetics (d) thermodynamics.

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III Transducers

- i. To describe the characteristics of Electrical Transducers.
- ii. To describe the criterion for the selection of Transducers.
- iii. To describe (a) the principles of different type of resistive transducer (b) different type of inductive transducer (c) capacitive transducer (d) photoelectric transducers (e) thermoelectric transducers (f) ultrasonic temperature transducers (g) magnetic flow meters (i) measurement of thickness by beta gauge.

IV. Signal Conditioning

- i. To describe the basic principle (a) D.C. (b) A.C. signal conditioning (c) Data Acquisition and conversion system.
- ii. To describe the basic instrumentation Amplifier.

5. High Voltage Engineering (E) – I

(20 Marks)

I Over view of the power generation, transmission and Distribution

- i. To describe the generation & Transmission of Electrical Energy.
- ii. Define (a) voltage stresses (b) Testing voltages.

II Measurement of High Voltages

- i. Type of voltages to be measured & their wave shapes.
- ii. The measurement of (a) peak voltage by spark gap (b) state the effect of nearby earthed objects (c) state the effect of humidity (d) effect of radiation & of polarity (e) influence of dust particles (f) effect of rod gaps.
- iii. The working principle of Electrostatic Voltmeters.
- iv. High voltage measurement by ammeter in series with high resistance method.
- v. The generating or rotating voltmeters.
- vi. Suppression of disturbances.
- vii. Calibration of PD – Detectors in a Test Arrangement.

III Over voltage

- i. The lightning mechanism.
- ii. To state the (a) Energy in Lightning (b) Nature of Danger.
- iii. The simulated lightning surges for testing.
- iv. The switching surges test voltage characteristics.

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Syllabus for Junior Engineer (Electronics)

ELECTRONICS ENGINEERING Paper-III (Full Marks : 200)

1. ELECTRONIC DEVICES AND CIRCUITS

60 Marks

Unit-I Semiconductor and Diodes:

Semiconductor – Classification - Intrinsic and Extrinsic - N type & P type - Drift current & Diffusion

current – Diodes - PN junction diode - Forward and Reverse bias characteristics – Specification - Zener diode - Construction & working principle – Characteristics - Zener break down – Avalanche break down - Zener diode as a voltage regulator – Applications - Specifications.

Rectifier – Classification of Rectifiers - Half wave rectifier - Fullwave rectifier (Center tapped, Bridge) – Efficiency – Ripple factor – Applications – Filters – C, LC, and PI Filters.

Unit-II Bipolar Junction Transistor:

Transistor – NPN and PNP transistor – operation -- Transistor as an amplifier – Transistor biasing – Fixed bias, Collector base bias, Self bias – CB, CE, CC Configurations – Characteristics – Comparison between three configurations in terms of input impedance, output impedance, Current gain, Voltage gain – RC coupled amplifier – Load characteristic analysis – Emitter follower and its application – Negative feedback – Basic concept, effect of negative feedback, Types of Negative feedback connections – Transistor as a switch.

Unit-III Transistor Oscillators and FET and UJT:

Transistor oscillator – Classifications – Condition for oscillations (Barkhausen criterion) – Hartley Oscillator – Colpitts Oscillator – RC Phase shift oscillator, Crystal oscillator. **Field Effect Transistor** – Construction – Working principle of FET – Difference between FET and BJT – Characteristics of FET – Applications – FET amplifier (Common source amplifier).

Uni Junction Transistor – Construction – Equivalent circuit – Operation – Characteristics – UJT as a relaxation oscillator.

Unit-IV : SCR, TRIAC, DIAC, MOSFET:

SCR – Working principle – Characteristics – SCR as a switch, Controlled rectifier – Specifications.

TRIAC – Working principle – Characteristics – Speed control of fan using DIAC and TRIAC.

DIAC – Working principle – Characteristics – DIAC as bi-directional switch.

MOSFET – Working principle – characteristics – MOSFET as a switch.

Unit-V Opto Electronics Devices and waveshaping circuits:

LDR, LED, Segment LED, LCD, Opto coupler, Opto interrupter – Infrared transmitter and receiver – Laser diode (Simple treatment) – Solar cell – Avalanche Photo diode – Photo transistor. Clipper, Clamper – Voltage doubler, Astablemultivibrator, Monostable and Bistable Multivibrators using Transistor.

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Syllabus for Junior Engineer (Electronics)

2. DIGITAL ELECTRONICS

- 40 Marks

Unit-I: Number System and Boolean Algebra:-

LOGIC GATES AND DIGITAL LOGIC FAMILIES : GATES - AND, OR, NOT, NAND, NOR, EXOR, EX-NOR. Implementation of logic function using gates, Realization of gates using universal gates - Simplification of expression using Boolean techniques, Boolean expression for outputs - Digital logic families-TTL, CMOS, Logics and their characteristics - comparison and applications, Tristate logic.

Unit-II: Combinational Circuits:

Arithmetic circuits - Binary-Addition, subtraction, 1's and 2's complement - Signed binary numbers - Half Adder and Full Adder - half Subtractor and Full Subtractor - Encoder, Decoder, Multiplexer, Demultiplexer - BCD adder, parity checker and generator.

Unit-III: Sequential Circuits

FLIP-FLOPS - SR, JK, T, D Flip-flops, Triggering of FF - edge & level - Counters -Asynchronous/ ripple counter, Decade counter, Up-Down counter (4 bit Synchronous counter). REGISTERS - 4- bit shift register - Serial IN Serial OUT, Serial IN parallel OUT, Parallel IN Serial OUT, Parallel IN Parallel OUT.

Unit-IV : Memory Devices

Classification of memories, RAM organization - Address Lines and Memory Size - Read/write operations - Static RAM - Dynamic RAM - SAD RAM - DDR RAM - ROM - Expanding memory - PROM - EPROM - EEPROM - Flash memory.

Unit-V: Microprocessor-8085

Evolution of microprocessor - 8085: Architecture, Instruction sets, Addressing modes, memory mapped I/O and I/O mapped I/O and its Comparison, Machine cycle-Opcode fetch, memory read, memory write, I/O read, I/O write.

3. LINEAR INTEGRATED CIRCUITS

- 40 Marks

Unit-I: Introduction to Operational Amplifiers

Integrated circuit - Classification of IC-Advantages of IC over discrete components-Operational amplifier IC 741 - Schematic symbol for opamp - pin diagram of IC 741-Block diagram of an opamp-Characteristics of an Ideal opamp-Basic linear circuits-Inverting Amplifier, Non Inverting amplifier-Differential Amplifier.

Unit-II: Opamp Applications

Summing amplifier-Multiplier-Divider-Voltage follower-comparator-Integrator-Differentiator-Instrumentation amplifier - Waveform generators-square wave, triangular wave, sine wave, saw tooth wave generators. (Qualitative treatment only)

Unit-III: PLL & Applications

PLL-Basic principles and application of PLL - Basic components of PLL

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Syllabus for Junior Engineer (Electronics)

Unit-IV: D/A and A/D Converters

Digital to analog converter – Basics of D/A conversion-R-2R Ladder D/A Converter Analog to digital converter-Basics of A/D Conversion-sampling-Sample and hold circuit quantization - Types of A/D converter.

Unit-V: Spécial Function ICs (qualitative treatment only)

IC 555 Timer Applications-Astable multivibrator-monostable multivibrator-Schmitt trigger.

4. MICROCONTROLLER

- 30 Marks

Unit-I: Architecture & Instruction set of 8051:

Comparison of Microprocessor and Microcontroller – Block diagram of Microcontroller – Functions of each block. Pin details of 8051 – ALU – ROM – RAM – Memory Organization of 8051-Special function registers-Program Counter-PSW register-Stack-I/O Ports-Timer-Interrupt-Serial Port-Oscillator and Clock-Clock Cycle-State-Machine Cycle-Instruction cycle-Reset-Power on Reset-Overview 8051 family.

Instruction set of 8051-Classification of 8051 Instructions-Data transfer instructions-Arithmetic Instructions-Logical instructions.

Unit-II: Programming Examples:

Structure of Assembly Language - Different addressing modes of 8051.

Unit-III: I/P and Timer:

Bit addresses for I/O and RAM-I/O programming-Programming 8051 Timers-Different modes of Timer.

5. ELECTRONIC SYSTEM DESIGN - 30 Marks

UNIT-I:

Design of Power Supply : DC power supply with filters, regulators & protection circuits, Multi output and variable power supply design.

UNIT-II:

Design of small signal amplifiers : Emitter follower, two stage direct coupled amplifiers.

UNIT-III:

Data acquisition system: ADC, DAC, Design of Instrumentation amplifier. Design of Electronic voltmeter and ammeter.

UNIT-IV

Design of function generator : Design of AM signal using multiplier IC, AM signal demodulation using envelope detector, Design of FM signal using VCO (using IC NE566).

UNIT-V:

High voltage/high current driver : Circuit for Relay and motor control applications. Microcontroller based closed loop system, security systems, Microcontroller based stepper motor control system.

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Syllabus for Junior Engineer (Mechanical)

MECHANICAL ENGINEERING Paper-III

(Full Marks : 200)

Unit I : Mechanics of Materials :

- 36 Marks

Hooke's law, Young's modulus, Shear modulus of rigidity, Poisson's ratio, generalized Hooke's law for two dimensional stress, relation among the elastic constants for an isotropic material determination of principle stresses and strains. Stresses in welded joints: butt weld and fillet weld. Determination of principal stresses and strains, thin walled cylindrical and spherical pressure vessels. Simple bending of beams, torsion of shaft, columns and struts

Unit II Design of machined elements :

- 24 Marks

Material behaviour and design factors for dynamic load; design of circular shafts for bending and torsional load only; design of screwed joints; design of belts and gears for transmission of power.

Unit III : Theory of Machines :

- 34 Marks

Kinematic and dynamic analysis of plane mechanisms. Cams, Gears and epicyclic gear trains, flywheels, governors, balancing of rigid rotors, balancing of single and multicylinder engines. Ropes, belts and chain drives. Functions of Brakes, clutches and dynamometers.

Unit IV : Machine Tools :

- 26 Marks

Metal cutting and cutting tools- Metal cutting by chip forming process, drives and mechanisms in machine tools--Machine tool motions, Lathe- types of lathe tools and their uses; drilling machine- Operations, classification, specifications. Shaper, Planer, Slotter and broaching - Operations, classification, specifications. Operations, classifications, specifications of Milling machine, Boring machine, Grinding machine, Gear hobbing machine, Capstan & Turret lathe. Principles of numerical control; operation of NC, CNC and DNC systems: point-to-point, continuous path / contour system.

Unit V : Manufacturing Processes :

- 36 Marks

Mechanical properties of metals and alloys, manufacturing of iron and steel, carbon and alloy steels. Metallurgy in manufacturing, Microstructure of Metals, Equilibrium diagram of alloys. Heat treatment of steel, Casting processes. Fabrication processes- mechanical joining, adhesive joining, welding, brazing and soldering. Gas welding and cutting, electric Arc welding and cutting. Metal working processes - Forging and rolling.

Non-conventional machining : Chemical Machining, Electrochemical Machining, Electro Discharge Machining (EDM), Laser Beam Machining, Electron Beam Machining, Water Jet Machining, Abrasive Jet Machining.

Unit VI : Production Management :

- 34 Marks

Plant location and layout, material handling- Factors affecting plant location; necessity of plant layout; process and product layout; work station design; procedural steps for making a plant layout ; Demand forecasting, Production planning and control measures. Product inspection and quality control; raw materials management and inventory control.

Work study - Concept and objectives of work study; method study procedure! flow process chart, flow diagram; principles of product design for mass production, and simple operations research (OR) models.

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Syllabus for Junior Engineer (Mechanical)

Unit VII Mechanical Measurement :

- 10 Marks

Concept of fits and tolerances; tools and gauges; comparators; inspection of length; position, profile and surface finish. Linear measurement, angular measurement; measurement of screw threads and gears.

Machine tool metrology - Tests for level of installation of machine in horizontal and vertical planes.

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Syllabus for Junior Engineer (Electrical)

ELECTRICAL ENGINEERING Paper-IV

(Full Marks : 200)

1 Electrical Machine – I

-40 marks

(a) Transformer :-

- i. Basic principle.
- ii. Classification of transformer based on.
- iii. Application.
- iv. Construction.
- v. Construction of transformer.
- vi. List of components used.
- vii. Type and nature of cooling of transformer.
- viii. Working principle of transformer.
- ix. Describe transformer on (a) no-load (b) full load.
- x. Derive the emf equation of transformer.
- xi. Effect of leakage flux and leakage reactance of transformer.
- xii. Phase and diagram on no load (specify whether ideal or actual).
- xiii. Percentage resistance, reactance and impedance of transformer.
- xiv. Different type of losses in transformer.
- xv. Calculate the losses and efficiencies of transformer.
- xvi. Condition for maximum efficiency of transformer.
- xvii. Procedure for testing of transformer.
- xviii. Open circuit test and short circuit test.
- xix. The voltage regulation of a transformer.
- xx. Construction of Auto transformer.
- xxi. Working principle of Auto transformer.

(b) Storage Batteries :-

- i. Type of storage batteries.
- ii. Construction of Lead Acid battery.
- iii. Working principle of Lead Acid battery.
- iv. Special feature of maintenance free battery.
- v. Defects in storage batteries.
- vi. The method of battery maintenance.
- vii. Different method of battery charging.
- viii. Different battery charging circuit for (a) Constant voltage (b) Constant current charging.
- ix. Method of testing, fault diagnosis and repair of batteries.
- x. Safety procedure for battery.
- xi. Method for prevention of environmental pollution.

2. Electrical Machine – II

-30 Marks

I. Induction Motor

- i. Explain the constructional features of three phase induction motor.
- ii. Explain the method of the production of rotating magnetic fields produced in a three phase stator winding when three phase supply is applied in it.
- iii. To define slip, synchronous speed.
- iv. Working principle of an three phase induction motor.

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Syllabus for Junior Engineer (Electrical)

- v. To develop an expression for torque in three phase induction motor.
- vi. Method of achieving high starting torque of an three phase induction motor.
- vii. Explain various methods starting induction motor.
- viii. The modern techniques of starting different types of induction motor.
- ix. Explain different method of speed control in three phase induction motor (conventional method).
- x. The modern method of speed control of three phase induction motor.
- xi. State and enumerate different losses in three phase induction motor.
- xii. To determine the efficiency of three phase induction motor considering the losses in the motor.
- xiii. The various methods for testing of induction motor.
- xiv. The various components in Test Report.
- xv. State various factors involved in installation of a three phase induction motor.
- xvi. The various step for the maintenance of induction motor.
- xvii. The working principle of single & three phase induction regulator.

II. Three phase synchronous Machine

- i. Constructional detail of three phase synchronous machine.
- ii. Basic principle of developing three phase armature windings.
- iii. Voltage regulation by synchronous impedance method.
- iv. Method of synchronise the incoming alternator with three phase bus bar.
- v. Local sharing between two alternators in synchronized mode.
- vi. Why synchronous motor is not self-starting.
- vii. Change in excitation of a synchronous motor on armature current.
- viii. Application of synchronous machine.
- ix. Condition/factors for the application of synchronous machine.
- x. Testing the synchronous machines and to determine their performance characteristics.

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III. Single

- i. Type of single phase motors.
- ii. Construction of various type of induction motor (split phase type).
- iii. Construction & working principles of single phase synchronous motor.
- iv. Construction & working principles of single phase commutator motor.
- v. Testing procedure of single phase induction motor measurement of (i) speed (2) power consumption (3) torque.
- vi. Selecting a specific type of single phase induction motor for a particular purpose.

3. Power Electronics / Electronic Devices & Circuits – II

-30 Marks

I. The Thyristor and their characteristics

- i. The construction, working principle, characteristics and rating of (a) Power diode (b) Silicon controlled rectifier (c) Power Transistor (d) Gate turn off Thyristor (GTC) (e) Triac (f) Disc.
- ii. To classify thyristors.
- iii. To explain the basic principle of selection of Thyristors a) Overloads & fault current b) Voltage rating c) Di/dt behavior of thyristor d) Series parallel operation e) Current sharing during switching.

II. Power Diodes & Power Transistors

- i. To classify power diodes & state their characteristics and field of application.
- ii. To describe (a) forward recovery (b) Reverse recovery characteristics of power diode.
- iii. To describe (a) the static characteristics of transistor (b) Turn-on & Turn off times of transistor (c) Second break down in transistor (d) Breakdown voltage of transistor.

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(e) Base drive circuit of transistor.

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III. Line Commutated Converters

- To define (a) Converter (b) Inverter.
- Line commutated converter in terms of quadrant of conversion.
- The equation for output voltage (a) Three phase half wave converter (b) Three phase semi-converters (c) Three phase full controller (d) Three phase dual converter.
- The method of power factor improvement for phase controller converters.
- Basic considerations for designing converter circuits.

IV. A.C. Voltage Controllers

- The principle of AC voltage control.
- Describe the principle of (a) ON/OFF control and (b) Phase control for single phase loads (Star/Delta connected loads).
- Single phase tap changer circuits.

V. D.C. Chopper and Switch Mode Power Supply

- Define the DC Chopper and their field of application.
- The principle of step down and step up operation.
- Voltage control in single phase inverters.

VI. Power supplies

- Purpose for developing AC & DC power supply (in industries).
- The principle of operation of a) Switched mode DC power supply b) AC power supplies & VPS configuration.

VII. A.C. Drivers

- To list different method of AC motor control.
- To draw the schematic diagram of (a) Stator voltage control (b) Rotor voltage control (c) Frequency control (d) Stator voltage and frequency control (e) Stator current control (f) Voltage current and frequency control.

VIII. A.C. Voltage Control

- To list Describe operating principle of (a) constant voltage transformer (b) Servo controlled voltage stabilizer.
- Describe the working principles of different type of Electro Magnetic Interface suppressor.
- Dielectric and induction heating.

4. Repairing of Household Equipment – II

-20 Marks

I. Ceiling fan/Exhaust Fan

- To describe and draw the diagram of a ceiling/exhaust fan.
- To describe the electrical circuits of ceiling/exhaust fan.
- To describe the fastening of the components of ceiling/exhaust fan.
- To describe the dismantling procedure of a ceiling/exhaust fan.
- To state the precautions required to dismantle the ceiling/exhaust fan.
- To state the procedure for repair of the ceiling/exhaust fan.
- To describe the process of preventive maintenance.

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Syllabus for Junior Engineer (Electrical)**II. Fluorescent Lamp/Sodium Vapour Lamp**

- i. To draw and describe the circuit of the lamp fitting.
- ii. To explain the function of each components.
- iii. To state the procedure for dismantling.
- iv. To enlist the probable faults in the fitting.
- v. To state the procedure for repair of the circuit.
- vi. To perform the repair work.
- vii. To state the assembly procedure.
- viii. To suggest testing procedure.

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III. Split type/Window Air-conditioning

- i. The function of control terminals on the remote control unit.
- ii. The electrical (in some cases block diagram/functional diagram) for checking the operation.
- iii. The procedure for testing without dismantling for detecting or isolating the fault.
- iv. The procedure for testing after dismantling for detecting or isolating the fault.
- v. To describe the procedure for the repair replacement of defective components.
- vi. The testing procedure for the compressor or costing unit/without dismantling.
- vii. The procedure for commissioning of the Air Conditioner of the repair.

5. Non-Conventional Sources of Energy (E) – II**-80 Marks****I. Solar radiation****-30 Marks**

- i. To describe (a) Global, direct and diffused radiation (b) Spectral distribution of direct solar radiation through four types of curves (c) Radiation measuring Instruments (d) Data from a radiation measurement network.
- ii. Water & Air heating application – To describe the construction and uses of water heating system through – (a) flat plate collector (b) spiral or 'sea shell' collector (c) heat pipe collector (d) Cylindrical heater/storage system.
- iii. To describe three types of air heaters used to dry crop in lower latitude or space heating in higher latitude.
- iv. To describe the integration of an air collector into a heating and cooling system.
- v. To know some storage units.
- vi. Space heating application: To describe the utilization of air heater and thermal energy storage in space heating application.
- vii. Thermal Power & other applications (a) Heat Engine (b) Large scale power Generation (c) Furnaces (d) cookers (e) refrigeration & cooling (f) Heat pumps (g) solar ponds. (h) distillation (i) industrial application of process heat and transport.
- viii. Photovoltaic Technology: (a) Principle of solar cells (b) Solar cells & modules (c) Applications of photovoltaic system (d) Photovoltaic Power Generation.

II. Wind Energy**-25 Marks**

- i. To state the historical development of wind generated Electricity in the following countries (a) Denmark (b) USA (c) United Kingdom.
- ii. To enumerate the wind energy potential.
To state the annual velocity & power duration curves.
To describe the windmill.
To describe the use of wind energy as (a) power generation (b) water pumping system.
To describe the method of wind Energy conservation, distribution & utilization system.

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III. Solar Cell

-25 Marks

i. Photo voltaic systems components and application.

The principle of energy storage system.

The principle of power condition system.

The principle of voltaic applications.,

ii. Design of stand Alone system.

Describe (a) The solar module performance (b) Battery performance (performance of lead Acid Battery, Nickel cadmium Batteries) (c) Power control system (d) The method of regulation & system sizing (e) To state the application in water pumping.

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Syllabus for Junior Engineer (Electronics)**ELECTRONICS ENGINEERING Paper-IV****(Full Marks : 200)****ELECTRICAL CIRCUITS AND INSTRUMENTATION****60****Marks****Unit-I : D.C. CIRCUITS AND THEOREMS**

Definition and unit for voltage, current, power, resistance, conductance, resistivity – Ohm's law – Kirchoff's current law and voltage law. Series circuits – parallel circuits – series parallel circuits – Thevenin's, Norton's, super position and maximum power transfer theorem – Statement and explanation.

UNIT-II : A.C. CIRCUITS AND RESONANCE

AC through single pure resistance, pure inductance, pure capacitance – voltage and current relationship – the equation for power and power factor in each case - Definition for impedance, reactance, admittance, conductance, impedance, phase angle, power factor and power. Resonance - series resonance – parallel resonance – condition for resonance – resonant frequency – Q factor – resonance curve – bandwidth.

UNIT-III : TRANSFORMERS AND MACHINES

Transformer – Ideal transformer – Construction – Working principle – EMF equation – Losses in transformer – core loss, copper loss – Efficiency – Regulation – Open Circuit, Short Circuit test on transformer – List of applications.

D.C. Machines – DC – Generator – Working principle – Applications – DC motor – working principle.

Single phase Induction motor – Types - construction & principle of operation of capacitor start induction motor - Applications-stepper motor-working principle-uses.

UNIT-IV : MEASURING INSTRUMENTS AND CRO

Indicating instruments - Basic forces for indicating instruments - construction and operation of permanent magnet moving coil Instrument – Advantages - Disadvantages of PMMC - Shunts and Multipliers - DC ammeter - DC volt meter - volt meter sensitivity principle of operation of CRO - operation of CRT Applications of CRO - Types of CRO.

UNIT-V : TRANSDUCERS & TEST INSTRUMENTS

Transducers – classification of transducer – Types - uses. Construction, operation and application of photo electric transducer, LVDT and Load cell. Principle of working of Thermocouple - Temperature measurement using thermocouple - list of applications - Principle of working of Thermistor - Temperature measurement using thermistors – types (NTC, PTC) – List of applications. Digital voltmeter – Types (to list only) Advantages over analog instruments.

2. INDUSTRIAL ELECTRONICS**Marks****UNIT-I: POWER DEVICES AND TRIGGER CIRCUITS**

Thyristor family – Working principle, VI characteristics and applications of SCR – Definitions for holding current, latching current, dv/dt rating - Insulated gate bipolar transistor (IGBT), MOSFET and GTO – Symbol - principle of working, VI characteristics and applications - Triggering of SCR –

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Gate triggering - Types - Concepts of DC triggering, AC triggering, Pulse gate triggering - Pulse transformer in trigger circuit- Electrical isolation by opto isolator - Resistance capacitor firing circuit and waveform, Synchronized UJT triggering (ramp triggering) circuit and waveform.

UNIT-II: CONVERTERS AND CHOPPERS (Qualitative treatment only)

Converters - Definition - Single phase Half controlled bridge converter with R load and RL load - importance of flywheel diode - Single phase fully controlled bridge converter with resistive load - voltage and current waveforms - Single phase fully controlled bridge converter with RL load - voltage and current waveforms. Commutation - Natural commutation - Forced commutation - Type of forced commutation. Chopper - Definition - principle of DC chopper operation - Applications of DC chopper - Principle of working of single phase AC chopper.

UNIT-III INVERTERS & APPLICATIONS

Inverter - Definition - Requirement of an inverter - Single phase inverter with resistive load - Single phase inverter with RL load - Methods to obtain sine wave output from an inverter - Output voltage control in inverters - Parallel inverter using IGBT. HVDC Transmission - principle - advantages - drawbacks SMPS - Block diagram of SMPS - Working principle - advantages and disadvantages. UPS - Working principle - Type (ON Line, OFF Line), Comparison.

UNIT-IV: PROGRAMMABLE LOGIC CONTROLLER

Relays - Basics of Input and Output module (digital input and output module) - Logic functions - AND logic, OR logic, NAND logic, EX-OR logic - Star delta starter - Conveyor control and Lift control.

UNIT-V NUMERICAL CONTROL SYSTEMS

Basic concepts of numerical control - advantages, disadvantages - applications of numerical control system - Programming systems (mention the names only) - Data processing unit.

3. COMMUNICATION ENGINEERING

marks

30

Unit-I: Networks, Antenna and Propagation

Networks - Symmetrical and asymmetrical networks - Equaliser - types, applications - Attenuator - types - Filters - types and definitions - circuit elements and cutoff frequencies of LPF, HPF and BPF- Antennas - Basic antenna principle - Propagation (short theory only) Ground wave propagation, sky wave, space wave propagation.

Unit-II: Amplitude Modulation

Modulations - Frequency spectrum - Relationship between wavelength and frequency, types of modulation - Amplitude modulation - Expression - AM Transmitter - Types of transmitters - AM Receiver - TRF receiver - super heterodyne radio receiver.

Unit-III: Angle and Pulse Modulation

Frequency modulation - Frequency spectrum - effects of noise in FM - comparison of AM and FM - FM Transmitters & Receiver - Direct and Indirect methods - Phase Modulation Principles Pulse Modulation types - Generation and detection of PA, PWM, PPM, PCM, DPCM, Delta modulation.

Unit-IV : Audio systems

Principles, types, classifications, advantages and disadvantages of Microphones, Loud speakers, Audio recording and reproduction

Unit-V : Video systems

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Colours TV : Principles of colour transmission and reception - LCD, LED display unit - plasma display.

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Syllabus for Junior Engineer (Electronics)**4. COMPUTER HARDWARE AND NETWORKS****30****Marks****Unit-I: MOTHERBOARD COMPONENTS AND MEMORY STORAGE DEVICES**

Introduction : Parts – Mother board, expansion slots, memory, power supply, drives and front panel and rear panel connectors-Hardware, Software and Firmware.

Processors : Architecture and block diagram of multicore Processor

Bus Standards Overview and features of USB

Primary Memory : Introduction-Main Memory, Cache memory-DDR2-DDR3, RAM versions-1TB RAM

Secondary Storage : Hard Disk – Construction-Working Principle-Serial ATA; HDD Partition-Formatting, Troubleshooting hard disk drives.

Removable Storage : CD&DVD construction-reading & writing operations; CD-R, CD-RW; DVD ROM,

DVD-RW; construction and working of DVD Reader/Writer.

Blue-ray: Introduction

Unit-II: I/O DEVICES AND INTERFACE

Keyboard and Mouse : Keyboard : Signals – operation of membrane and mechanical keyboards – troubleshooting ; wireless Keyboard. Mouse-types, connectors, operation of Optical mouse and Troubleshooting.

Printers : Introduction – Types of printers-Operation-Construction-Features and Troubleshooting. I/O

Ports : Serial, Parallel, USB, Game Port, Bluetooth interface, IR connector, fire ware.

Displays and Graphic Cards : Panel Displays-Principles of LED, LCD and TFT Displays. SVGA Port Signals-common problems and solutions.

Modem: Working principles-common problems and solutions.

Power Supply: online and offline UPS – Working principles; Surge suppressors and spike isolators.

SMPS : Principles of Operation.

Unit-III: MAINTENANCE AND TROUBLE SHOOTING OF DESKTOP AND LAPTOPS

Standard CMOS setup, Advanced BIOS setup, Power management, beep codes and error messages.

Diagnostic Software and Viruses : Computer Viruses-Precautions-Anti-Virus Software-identify the signature of viruses-Firewalls and latest diagnostic software's.

Laptop : Difference between laptop and desktop-Types of laptop-working principles-configuring laptops and power settings.

Laptop components : Adapter-types, Battery-types and basic problems, RAM-types, CPU-types,

Laptop Mother Board-Laptop Keyboard-Mouse and Touchpad-Ports.

Installation and Troubleshooting : Formatting, Partitioning and Installation of OS-Trouble Shooting

Laptop Hardware problems-Preventive maintenance techniques for laptops.

Unit-IV: COMPUTER NETWORK DEVICES AND OSI LAYERS

Data Communication : Components of a data communication-Networks-Definition-Types of

Connections : Point to point-multipoint; Topologies : Star, Bus, Ring, Mesh, Hybrid-Advantages and Disadvantages of each topology. Internet-Intranet-Extranet-Guided-Twisted pair, Coaxial, Fiber optic; Unguided-Radio waves-Infrared.

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5. EMBEDDED SYSTEM

20

marks

Unit-I:

ARM PROCESSOR ARCHITECTURE : The RISC and ARM design philosophy, Embedded System Hardware.

ARM PROCESSOR FUNDAMENTALS : Data Flow Model, registers, modes of operation.

ARM Nomenclature and families.

Unit-II:

ARM INSTRUCTIONS SETS ARM and Thumb Instruction Sets, Data Processing Instructions, Branch Instructions, Load-Store Instructions, Software Interrupt Instruction, Program Status Register Instructions.

Unit-III:

CACHE MECHANISM : Introduction to cache memory, memory hierarchy and cache memory.

Unit-IV:

MEMORY PROTECTION AND MANAGEMENT UNIT : Introduction to protection unit.

Unit-V:

EMBEDDED OS AND RTOS : Fundamental Components to Embedded OS.

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Syllabus for Junior Engineer (Mechanical)

MECHANICAL ENGINEERING. Paper-IV

(Full Marks : 200)

**Unit I : Fluid Mechanics :
Marks**

20

Fluid and properties of fluid. Pressure and its measurement -Intensity of pressure; pressure head; Pascal's Law. Equilibrium of floating bodies- Archimedes' principle; buoyancy and principle of floatation. Flow of fluid and flow through pipes- Chezy's equation and Dancy's equation of head loss, Reynold's number and its effect on pipe friction; open channel flow and flow measurement.

**Unit II : Fluid Machines :
Marks**

30

Various types of pumps, reciprocating pump; centrifugal pump; axial flow pump and jet pump. Classification of water turbines- Impulse turbine (Pelton wheel); inward flow reaction turbine (Francis turbine) and axial flow reaction turbine (Kaplan turbine)

**Unit III : Thermal Engineering :
Marks**

36

Basic concept of First law and second law of Thermodynamics; concept of entropy and reversibility; availability and unavailability and irreversibility. Steam generation- modified Rankine cycle analysis. Modern steam boilers properties of steam, Steam engine- Classification of steam engines; Function and use of steam turbines, Function of a steam condenser, elements of a condensing plant. Type and size of a steam power plant; essential equipment of a steam power plant; coal handling system; pulverized coal firing system. Function and use of gas turbines- Principle of operation, closed cycle and open cycle, constant pressure and constant volume gas turbine.

**Unit IV : I.C. Engines :
Marks**

34

IC engines - Classification of IC engines; working principle of 2-stroke and 4-stroke cycles IC engines; SI engine and CI engine; Otto cycle; Diesel cycle; dual-combustion cycle. Firing order of multi cylinder engine; Types of Fuels- additives; knocking, compression ratio, octave rating; cetane rating; Governing of SI and CI engines. Super-charging and turbo-charging of IC engines.

**Unit V : Automobile Engineering:
Marks**

30

Automobile components, automobile engines-classification and components, petrol and diesel engine. Fuel system- Working principle of different types of modern carburetors. Different types of engine cooling systems. Principles of different types of lubrication system- petrol, splash, semipressure, pressure, wet-sump, dry sump. Power train- transmission, clutch and gear boxes and function of propeller shaft. Principle of braking system; functions of Suspension system and Steering system; types of commercial vehicle wheels.

**Unit VI : Refrigeration and air-conditioning
Marks**

30

Concepts of refrigeration and air-conditioning system. Thermal principles- heat transfer by conduction, convection and radiation, heat exchangers, vapour compression system and vapour absorption system.

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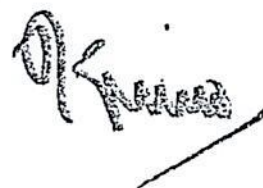
Psychrometry - properties; processes; charts; sensible heating and cooling; humidification and dehumidification effective temperature; air-conditioning load calculation. Determination for comfort condition and simple load calculations. Concept of an air-conditioning and distribution system

Unit VII : Mechanical Estimation
Marks

20

Elements of cost, Components of cost, Indirect expenses. Forms of materials, procedural steps for calculating material cost of a product. Estimation in machine shop, forging, welding and sheet metal shop.

Calculation for machining time, machining cost of machined items.



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