

**DETAILED SYLLABUS FOR THE POST OF JUNIOR INSTRUCTOR (TECHNICIAN
MECHATRONICS) IN INDUSTRIAL TRAINING DEPARTMENT**

CAT NO: 654/2023

TOTAL : 100 MARKS

MODULE 1 (7 marks)

Introduction of First aid. Operation of electrical mains and electrical safety. Introduction of PPEs. Response to emergencies e.g.; power failure, fire, and system failure. Importance of housekeeping & good shop floor practices. Introduction to 5S concept & its application. Occupational Safety & Health: Health, Safety and Environment guidelines, legislations & regulations as applicable. Bench work – Metal working hand tools and devices –Work bench – vices – files – hacksaw – hammer – chisels – spanners – screw drivers – scrapers. Linear measurements- its units, steel rule dividers, calipers – types and uses, Punch – types and uses. Description, use and care of marking table. Vernier caliper – its parts, principles, reading, uses and care. Outside micrometer – its parts, principles, reading, uses and care, vernier height gauge. Marking tools – scribe, Dividers, Dot punch, Centre punch. Marking out – Coordinates system, Rectangular – Polar – Rules for marking Bevel protractor, combination set- their components, uses and cares. Pedestal grinder, star wheel dresser, safety precautions, care and maintenance. Marking media, marking blue, Prussian blue, chalk and their special application, description. Surface plate and auxiliary marking equipment, ‘V’ block, angle plates, parallel block, description, types, uses, accuracy, care and maintenance. Bevel protractor, combination set-their components, uses and cares.

MODULE 2 (10 marks)

Measuring Instruments – purpose –Function- types – Calculation of Least count of: - Vernier Caliper, Micro meter, height gauge, Vernier bevel protector and Sine bar. Drill- Purpose- Function types and tool geometry, nomenclature, Control Angle and Tool Life. Reamers -Purpose –types. Hand Tap and Die- Purpose- types. Drilling Machine - Constructional features-working principle-Purpose, functions, Types - Accessories and uses. Drill, Tap, Die-types & application. Determination of tap drill size. Reamer- material, types (Hand and machine reamer), parts and their uses, determining hole size for reaming, Reaming procedure. Drilling machines-types &their application, construction of Pillar & Radial drilling machine. Countersunk, counter bore and spot facing-tools and nomenclature. Cutting Speed, feed, depth of cut and Drilling time calculations

MODULE 3 (12 marks)

. Introduction to metals, difference between metal and non-metal, properties of metal, Classification of metals and its applications, pig – iron, cast iron, wrought iron, steel-plain carbon steel(Low carbon steel, medium and high carbon steels, high speed steel, stainless steel, carbides, etc..)

Limit and Fits – Limit, Fits -Types and Tolerances and allowances with IS 919 Interpretation of ISO system of limits and fits.

Lathe Machine - Constructional features, Specification -working principle-Purpose - functions - Types , Lathe machine elements and uses of accessories Lathe mechanism -Function and importance of -driving mechanism-gear box mechanism, Lathe cutting tool - Purpose- function-types, tool elements and its applications and Cutting tool geometry, Nomenclature, Control angle and tool life. Lathe Operations- Facing, plain turning, Step turning, chamfering, taper Turning and calculations, knurling, boring and step boring, Die passing. Cutting speed, Feed, depth of cut and time calculations.

Pedestal Grinding Machine- Constructional features, working principle –Purpose, function – uses and applications. Grinding- Surface grinding machine-Constructional features-working principle-Purpose -functions, types, machine elements and uses of accessories, machine time calculation and method of Surface Grinding operations. Cylindrical grinding machine - Constructional features- working principle- Purpose-functions, types, machine elements and uses of accessories, machining calculations and Method of Cylindrical Grinding operations. Grinding Wheel- specification – Grit-Grain size-Structure-Bond, Grades and selection of Grinding wheel - Dressing – Truing and balancing of grinding wheel.

Milling Machine - Constructional features-working principle-Purpose- functions, Types and uses of accessories. Milling Operations- methods of milling, Plain milling, Step milling, end milling, machine time calculation. Milling Cutter- Purpose- types, cutting tool Geometry, Nomenclature and Tool Life.

Selection of coolants / cutting fluids for different materials. Cutting speed, Feed, depth of cut and time calculations. Fasteners: - Types- purpose and its Application.

Explanation of gas welding, arc welding and MIG welding techniques description of welding equipment and welding joints. Knowledge about flux, filler rod material. Die welding techniques.

MODULE 4 (7 marks)

Basic blocks of a computer, Components of desktop and motherboard. Hardware and software, I/O devices, and their working. Different types of printers, HDD, DVD. Various ports in the computer. Windows OS MS widows: Starting windows and its operation, file management using explorer, Display & sound properties, screen savers, font management, installation of program, setting and using of control panel, application of accessories, various IT tools and applications. Concept of word processing: MS word – Menu bar, standard tool bar, editing, formatting, printing of document etc. Word Processing Software Introduction to the various applications in MS office. Introduction to Word features, Office button, toolbars. Creating, saving and formatting and printing documents using Word. Working with objects, macro, mail merge, templates and other tools in Word. Excel – Worksheet basics, data entry and formulae. Moving data in worksheet using tool bars and menu bars, Formatting and calculations, printing worksheet, creating multiple work sheets, creating charts.

MODULE 5 (10 marks)

Basic Electrical Engineering Concept of current, voltage, resistance, electric charge, current density and Power and energy. Ohms law and Kirchoff's Laws. Primary and secondary cells. Measurement of voltage and current in networks. AC parameters for sine and Square wave forms. Electromagnetic theory: - Flux, Flux density, magnetic effect, magnetic field, electromagnetic force, concepts of coil (electromagnetic). Solenoids and relays. Instrument used for Measuring electrical parameters:- Measurements of electrical quantities using voltmeter , Ammeter, Multimeter , Megger. Power supply units and Stabilizers. Electromagnetic induction, Motor and Generator effect. Types of AC and DC Motors, Construction and its working principles, Speed control of AC/DC Motors. Principle and Operation of servo motor, Stepper motor and its applications. Concepts of AC/DC Drives. Principle and operation of single phase, three phase transformer and Auto transformer. Winding details of three phase transformer. Tacho Generator. Instrument transformers (CT and PT), clamp meter, Phase sequence meter, Power factor meter. Concepts of open loop and closed loop systems, feedback devices used in Mechatronics, Principle and Operation of tacho-generator, Encoder, and linear scale. Electrical cables and connectors: Color code of cables, cable joints (straight joints and T Joints), wiring layout diagrams, Types of cables and its specifications: co-axial cables, Fiber optical cables. Types of connectors and its specifications: Power connectors, Flat cables, RJ45 Connector, BNC, TNC, Audio Video, D-Shell and Edge connector. Cable termination methods, cable layout diagrams, electrical control panel wiring and electrical bus systems. Purpose of using protective devices, Fuses, Contactor ,Relays, Timers, Circuit Breakers, MCBs, ELCBs, DOL ,Star - Delta Starters, Push buttons, Limit switches, Micro switches, Float switches, Solenoids, Float switch, OLRs, Photo electric relay, Importance of earthing, Types of earthing techniques. Importance on electrical safety, safety marking and symbols, Risk management, Electric hazards, Prevention of accidents and Personal safety aspects. Environment safety and safety precautions while handling electrical equipment. Classification of fires, Different type of firefighting equipment.

MODULE 6 (10 marks)

Electronic components: Basic Electronic components (active and passive) and its symbols. Reading of electronic circuit drawing. Types of Resistors, capacitors and its identification. Working and operation of Diodes. Rectifier circuits. Zener voltage Regulator. Transistors and its applications. CRO-Block diagram and its functions. DC Regulated power supplies. Introduction to Op-Amp, characteristics, Configuration and its applications. Introduction to Optoelectronics, LED, LDR, Photo diode, opto-coupler. Study of Power Electronic Devices: Power diodes, power transistors, SCR, DIAC, TRIAC, UJT IGBT, phase control rectifiers, Converters. Soldering Techniques: -. Describe Soldering and Desoldering process, Do and Don'ts of soldering. Concepts of SMD.

Number System: Binary, Decimal, Octal, Hexa Decimal Number systems and its Conversions. Binary Arithmetic and logical operations. Digital Logic: Boolean

algebra. Logic gates: AND, OR, NOT, NAND, NOR, XOR. Encoder and Decoders. Concepts of Flip-Flop: SR, JK, T, D. Counters, Multiplexers and De-Multiplexers. Memories: Discs, RAM, ROM, Semiconductor memories.

Distinguish between System Software and Application Software. Differentiate between Linux and Windows OS Windows 32 bit, and 64 bit System FDISK, Format, Scandisk, FAT System, NTFS and Directories, Fragmentation and defragmentation disk Familiarization of MS-office or equivalent tools for creating documents, spread sheet and presentation Explain and apply common prevention methods, Explain Service Flow Sequence (SFS) and Trouble Shooting Chart (TSC) of PC. Concept and need of - Digitalization - Concept of Industry 4.0 Introduction, working and Applications of - RFID (Identification, system and application) - Bus (Binary unit system) Control - Information Security - GPS services

Basic block diagram of computer system. Block diagram of Microprocessor and its functionality. Difference between Microprocessor and Microcontroller. 8051 Microcontroller-features, Block diagram and pin configuration. Assembler directives, Instruction set of 8051. Assembly language Programming.

Introduction to maintenance, Importance of maintenance and types. Guidelines for trouble shooting of electrical, electronic systems and PLC.

MODULE 7 (10 marks)

Introduction to Sensors & transducers Sensors - Classifications & Operation Proximity Sensor -Classifications & Operation, Sensors for Temperature measurements Sensors for Distance and Displacement Sensor characteristics and interface technique.

Introduction to NC /CNC Technology, Importance and applications in industry. Difference among NC, CNC and FMS (Flexible Manufacturing System). Working principle and Construction details of CNC System-Functional Block Diagram and its Features Measuring /Feedback System. Main Elements of CNC machine (Turning/Milling)-CNC Control Panel-feedback devices-encoders. Introduction to coordinate System, Axes Designation - CNC Codes-G and M (Siemens and Fanuc control) -calculation of Spindle speed, feed, depth of Cut. Modes of operation of CNC machine. Absolute and Incremental coordinate system. Procedure for simulating tool path program. Offsets, types of offsets and importance of offset for work and tool. Procedure for setting offset and recording offset parameters in CNC system. Calculations: Cutting speed, Feed, Depth of cut and machining time calculations. Tools and Tool holders for turning operations and milling, operations. Simple programming for facing, plain turning, step turning operations and milling operations.

MODULE 8 (10 marks)

Definition and history of Pneumatics. Pneumatic system: Basic components, Comparison to pneumatic systems, Advantages and limitations, Application of pneumatics. Compressible fluids - types, properties of air, applicable gas laws (Boyle's, Charles', Gay-Lussac' laws). ISO symbols used in pneumatic circuits

Transducer, Types and Classification, Principle and operation of Temperature, Pressure, Flow, Level transducers. Process transmitter for temperature, magnetic, pressure, flow and Level. Process Controller – PI&D Concept. Function and applications of LVDT, Ultrasonic sensors, Load cell, Micro switch, Float switch, Proximity sensor, Limit Switch. Functional plan and application of sorting Transmission, multiple Sensors in Automation System.

Types, constructions, designations, working, applications and selection criteria of following: Directional control valves, Flow control valves, Pressure control valves, Special valves- quick exhaust valve and time delay valve, Logic valves- shuttle valve and twin pressure valve. Other fittings and access of Simulation Software for construction of Pneumatic circuits. Types of pneumatic fitting and their selections. Construction of pneumatic circuits using simulation software. Pneumatic cylinders- types, construction, working, materials, specifications, mounting and cushioning. Pneumatic motors- types, construction, working, specifications and applications. Referring machine manual and manufacturer's catalogue. Pneumatic devices – concept and Importance. Pneumatic Drives –I/P converter and P/I converter. Electro-pneumatic circuits: Reciprocation of cylinder using pressure switches, Control of a cylinder using a single limit switch, Automatic dual cylinder sequencing circuits, Pressure dependent control of a double acting cylinder. Construction, working, principle, major elements, performance variables and applications of following devices: Automotive pneumatic brake, Automotive air suspension, Pneumatic drill, Pneumatic gun (tools).

Basic of pneumatic elements and system. Types, construction, working, specifications and selection criteria of following air preparation and conditioning elements: Air compressors, Air receivers, Air dryers, Air filters, regulators and lubricators (FRL unit). Bearing and its functions Lubrication and their selections. Installation of pneumatic systems. Causes, remedies and Troubleshooting in pneumatic elements. Maintenance of pneumatic systems: Maintenance schedule and Inspection Check Sheet preparation, Maintenance of different application of Pneumatic system.

MODULE 9 (10 marks)

Introduction and Definitions of important terms like Hydraulics, Pressure, Force, Vacuum etc. Pascal's Law and its Application of hydraulics- Bernoulli's Principle, Hydraulic Jacks, Hydraulic Symbols and Circuit Building as per Standards DIN/ISO, Advantages and Disadvantages of Hydraulic System, Hydraulic Oil and Types, Importance of Hydraulic Oil, Ideal Characteristics of Hydraulic Oil, Properties of hydraulic oil e.g. viscosity, ageing stability, Grades of hydraulic oil, Maintenance of Hydraulic Oil, Reading, understanding of Hydraulic Symbols for construction of circuit diagrams.

Types and Function of Components and Connectors - Steel pipe, Tubing, Hose Gauges, Packing and Seals, Filters and Strainers, Hydraulic Tank

Construction, Types and working of Directional Control Valves, Pressure Control Valves, Flow Control Valves, Pressure Intensifiers, Accumulators, Cartridge Valves and Cylinder

Construction and Working, Specifications: Gear Pump, Vane Pump, Radial Piston Pump, Pump Maintenance and Troubleshooting, Hydraulic Motor Specifications, Construction and Working of Gear Motor, Vane Motor, Radial Piston Motor

Construction of circuits and operation of Clamp Control Circuit, Injection Control Circuit, Reciprocating Screw Circuit, Oil Filtration Circuit, Deceleration Circuit, Prefill Circuit, Hydraulic Motor Circuit , Hi-Low Pump Circuit

MODULE 10 (8 marks)

PLC: Overview of different control systems. Introduction about PLC. Block diagram of PLC. Different types of PLC, PLC Architectures (Fixed and Modular). Selection of PLC. Advantages of PLC. Applications of PLC. Various types of modules used in PLC. Familiarization of AND, OR and NOT logics with examples. Registers, Basics. Timer Functions. Counter Functions. Introduction and importance of Sequential Control Systems. Communication protocols used in PLC: RS-232, RS-485, Ethernet, Profibus. Different programming languages of PLC: LDR, STL, FBD, CSF. Basic ladder programming of PLC. Configuration of PLC and its modules. Wiring of PLC. Interfacing of PLC with other devices. Safety aspects. Introduction to HMI configuration.

MODULE 11 (6 marks)

Anatomy of robots: Overview of a robot manipulator system – basic components of robot, overview of robot applications in industrial automation. Types of end effectors: Grippers and tools. Robot Drives & Control, Robot Programming Languages, Robot Application in Manufacturing.

Advantages of Simulator Software. Develop simple Electrical circuit Develop Industrial application based Electrical circuit Trouble shooting techniques and mechanism.

Advantages of Simulator Software. Develop simple Electronics circuit- Develop Industrial application based Electronics circuit, Troubleshooting techniques and mechanism. Advantages of Simulator Software. Develop simple Hydraulic circuit, Develop simple pneumatic circuit Troubleshooting techniques and mechanism. Application of Pick and Place robot, project Function of each part, Explanation of the drawings (Mechanical, Hydraulic, Pneumatic, Electrical), Assembling Techniques Safety precautions in each stage, Testing procedure, Common faults and their rectification.

NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper.