सं.No.A1(644)89-Rct.   दि.Dated: 20.02.2026

अधिसूचना NOTIFICATION

विषय Sub: Recruitment to the posts of Technician (1) (Post Code: TECH-SMSL, TECH-BKMD, TECH-TTRS & TECH-EW&S) and (Post Code: TECHN-AML, TECHN-EW&S, TECHN-FFL1, TECHN-FFL2, TECHN-TTRS & TECHN-WEL) against CSIR-SERC Advt. No. SE-1/2021 & SE-3/2021 respectively – Syllabus for Trade Test & Competitive Written Examination (CWE) - reg.

In continuation of CSIR-SERC notification of even number dated 07.02.2026 notifying the tentative dates for holding of Trade Test & Competitive Written Examination (CWE), the mode of selection, scheme/syllabus for Trade Test and Competitive Written Examination (CWE) for recruitment to the aforesaid posts of Technician are as follows:-

Mode of Selection:

The candidates fulfilling all necessary eligibility criteria as recommended by the Screening Committee will be invited for Trade Test and those who qualify in the Trade Test will be called for Competitive Written Examination (CWE) consisting of three papers. The second and third paper will be evaluated only for those candidates who secure the minimum threshold marks (to be determined by the Selection Committee) in the first paper. The final merit list will be prepared on the basis of the performance of the candidates in the written examination.

Scheme & Syllabus of Examination:

Competitive Written Examination (CWE)	
Mode of examination	OMR based or Computer based objective type multiple-choice examination.
Medium of Questions	The questions will be set both in English and Hindi except the questions on English Language.
Standard of exam	SSC + ITI/XIIth standard
Total No. of Questions	150
Total Time Allotted	2 hours 30 minutes

Paper I (Time allotted – 1 hour)

Subject	No. of Questions	Maximum Marks	Negative Marks
Mental ability test*	50	100 (two marks for every correct answer)	There will be no negative marks in this paper.

* Mental Ability Test will be so devised so as to include General Intelligence, Quantitative Aptitude, Reasoning, Problem Solving, Situational Judgment, etc.

Paper II (Time allotted – 30 minutes)

Subject	No. of Questions	Maximum Marks	Negative Marks
General Awareness	25	75 (three marks for every correct answer)	One negative mark for every wrong answer.
English language	25	75 (three marks for every correct answer)	One negative mark for every wrong answer.

Paper III (Time allotted – 1 hour)

Subject	No. of Questions	Maximum Marks	Negative Marks
Concerned subject	50	150 (three marks for every correct answer)	One negative mark for every wrong answer.

The syllabus for Trade Test and CWE (i.e. Paper III) related to respective trade is enclosed as follows:

S.NO	Name of the Trade	Annexure for Trade Test	Annexure for CWE (Paper-III)
1.	Electronics Mechanic	I	I A
2.	Machinist	II	II A
3.	Fitter	III	III A
4.	Instrument Mechanic	IV	IV A
5.	Welder	V	V A
6.	Electrician	VI	VI A
7.	Refrigeration & Air Conditioning Mechanic	VII	VII A
8.	Computer Operator and Programming Assistant	VIII	VIII A
9.	Draughtsman Civil	IX	IX A
10.	CAD-CAM Operator cum Programmer	X	X A
11.	Turner	XI	
12.	Mechanic / Machine Tool Maintenance	XII	

The date, time & venue of holding Trade Test & Competitive Written Examination will be notified shortly. Candidates are advised to visit the CSIR-SERC website www.serc.res.in for updates.

(लोकनाथ पटनायक Lokanath Patnayak)
प्रशासनिक अधिकारी Administrative Officer
20.02.26

TRADE: ELECTRONICS MECHANIC
SYLLABUS FOR TRADE TEST

1. **Trade and Orientation**
   - List of tools & Machinery used in the trade.
   - Identify safety signs for danger, warning, caution & personal safety message.
   - Use of personal protective equipment (PPE). Practice elementary first aid.
   - Preventive measures for electrical accidents & steps to be taken in such accidents. Use of Fire extinguishers.

2. **Hand tools and their uses**
   - Identify the different hand tools. Selection of proper tools for operation and precautions in operation. Care & maintenance of trade tools. Practice safety precautions while working in fitting jobs.
   - Workshop practice on filing and hacks awing. Practice simple sheet metal works, fitting and drilling.
   - Make an open box from metal sheet.

3. **Basics of AC and Electrical Cables**
   - Identify the Phase, Neutral and Earth on power socket, use a tester to monitor AC power.
   - Construct a test lamp and use it to check mains healthiness.
   - Measure the voltage between phase and ground and rectify earthing.
   - Identify and test different AC mains cables. Prepare terminations, skin the electrical wires /cables using wire stripper and cutter. Measure the gauge of the wire using SWG and outside micrometer.
   - Refer table and find current carrying capacity of wires. Crimp the lugs to wire end.
   - Measure AC and DC voltages using multi meter. Identify the type of meters by dial and scale marking/ symbols.
   - Demonstrate various analog measuring Instruments. Find the minimum and maximum measurable range of the meter. Carryout mechanical zero setting of a meter. Check the continuity of wires, meter probes and fuse etc. Measure voltage and current using clamp meter.

4. **Cells & Batteries**
   - Identify the +ve and -ve terminals of the battery. Identify the rated output voltage and Ah capacity of given battery. Measure the voltages of the given cells/battery using analog/ digital multimeter.
   - Charge and discharge the battery through load resistor. Maintain the secondary cells.
   - Measure the specific gravity of the electrolyte using hydrometer.
   - Test a battery and verify whether the battery is ready for use of needs recharging.

5. **AC & DC measurements**
   - Use the multi meter to measure the various functions (AC V, DC V, DC I, AC I, R)
   - Identify the different types of meter for measuring AC & DC parameters
   - Identify the different controls on the CRO front panel and observe the function of each control
   - Measure DC voltage, AC voltage, time period using CRO sine wave parameters
   - Identify the different controls on the function generator front panel and observe the function of each controls

6. **Soldering/ De-soldering and Various Switches**
   - Practice soldering on different electronic components, small transformer and lugs.
   - Practice soldering on IC bases and PCBs and de-soldering using pump and wick
   - Join the broken PCB track and test
   - Identify and use SPST, SPDT, DPST, DPDT, tumbler, push button, toggle, piano switches used in electronic industries. Make a panel board using different types of switches for a given application.

7. **Active and Passive Components**
   - Identify the different types of active electronic components.
   - Measure the resistor value by colour code and verify the same by measuring with multimeter
   - Identify resistors by their appearance and check physical defects
   - Identify the power rating of carbon resistors by their size.
   - Practice on measurement of parameters in combinational electrical circuit by applying Ohm's Law for different resistor values and voltage sources. Measurement of current and voltage in electrical circuits to verify Kirchhoff's Law. Verify laws of series and parallel circuits with voltage source in different combinations.
   - Measure the resistance, Voltage, Current through series and parallel connected networks using multi meter
   - Identify different inductors and measure the values using LCR meter
   - Identify the different capacitors and measure capacitance of various capacitors using LCR meter
   - Identify and test the circuit breaker and other protecting devices.
   - Dismantle and identify the different parts of a relay.
   - Connect a timer relay in a circuit and test for its working. Connect a contactor in a circuit and test for its working. Construct and test RC time constant circuit
   - Construct a RC differentiator circuit and convert triangular wave into square wave
   - Construct and test series and parallel resonance circuit.

8. **Power Supply Circuits**
   - Identify different types of diodes, diode modules and their specifications.
   - Test the given diode using multi meter and determine forward to reverse resistance ratio.
   - Measure the voltage and current through a diode in a circuit and verify its forward characteristic.
   - Identify different types of transformers and test.
   - Identify the primary and secondary transformer windings and test the polarity
   - Construct and test a half wave, full wave and Bridge rectifier circuit.
   - Measure ripple voltage, ripple frequency and ripple factor of rectifiers for different load and filter capacitors.
   - Identify and test Zener diode and Construct and test Zener based voltage regulator circuit.
   - Calculate the percentage regulation of regulated power supply.

9. **Computer Hardware, OS, MS office and Networking**
   - Identify various indicators, cables, connectors and ports on the computer cabinet.
   - Demonstrate various parts of the system unit and motherboard components.
   - Identify various computer peripherals and connect it to the system.
   - Disable certain functionality by disconnecting the concerned cables SATA/ PATA
   - Replace the CMOS battery and extend a memory module.
   - Test and Replace the SMPS. Replace the given DVD and HDD on the system
   - Dismantle and assemble the desktop computer system.
   - Boot the system from Different options
   - Install OS in a desktop computer, Printer driver software and test for print outs, antivirus software, scan the system and explore the options in the antivirus software, MS office software
   - Create folder and files, draw pictures using paint. Explore different menu/ tool/ format/ status bars of MS word and practice the options. Explore different menu/ tool/ format/ status bars of MS excel and practice the options. Prepare power point presentation on any three known topics with various design, animation and visual effects. Convert the given PDF File into Word file using suitable software.
   - Browse search engines, create email accounts, practice sending and receiving of mails and configuration of email clients. Identify different types of cables and network components e.g. Hub, switch, router, modem etc.
   - Prepare terminations, make UTP and STP cable connectors and test. Connect network connectivity hardware and check for its functioning. Configure a wireless Wi-Fi network

10. **IC Regulators**
    - Construct and test a +12V fixed voltage regulator.
    - Identify the different types of fixed +ve and –ve regulator ICs and the different current ratings (78/79 series)
    - Identify different heat sinks for IC based regulators.
    - Observe the output voltage of different IC 723 metal/ plastic type and IC 78540 regulators by varying the input voltage with fixed load.
    - Construct and test a 1.2V – 30V variable output regulated power supply using IC LM317T.

11. **Transistor**
    - Identify different transistors with respect to different package type, BE-C pins, power, switching transistor, heat sinks etc.
    - Test the condition of a given transistor using ohm-meter.
    - Measure and plot input and output characteristics of a CE amplifier.
    - Construct and test a transistor based switching circuit to control a relay (use Relays of different coil voltages and Transistors of different β)

12. **Amplifier**
    - Construct and test fixedbias, emitter-bias and voltage devider-bias transistor amplifier.
    - Construct and Test a common emitter amplifier with and without bypass capacitors and common base amplifier. Construct and Test common collector/emitter follower amplifier / Test Darlington amplifier/ two stage RC Coupled amplifier. Construct and test a Class B complementary push pull amplifier & test class C Tuned amplifier.

13. **Oscillators**
    - Demonstrate Colpitts oscillator, Hartley oscillator circuits and compare the output frequency of the oscillator by CRO. Construct and test a RC phase shift oscillator circuits and crystal oscillator circuits. Demonstrate Astable, monostable, bistable circuits using transistors.

14. **Wave shaping circuits**
    - Construct and test shunt clipper. Construct and test series and dual clipper circuit using diodes.
    - Construct and test clamper circuit using diodes. Construct and test Zener diode as a peak clipper

15. Power Electronic Components

- Identify different power electronic components, their specification and terminals.
- Construct and test a FET Amplifier. Construct a test circuit of SCR using UJT triggering.
- Identify different heat sinks used in SCRs.
- Construct a snubber circuit for protecting SCR use freewheeling diode to reduce back emf.
- Construct a jig circuit to test DIAC.
- Construct a simple dimmer circuit using TRIAC.
- Construct UJT based free running oscillator and change its frequency.

16. MOSFET & IGBT

- Identify various Power MOSFET by its number and test by using multimeter. Identify different heat sinks used with various power MOSFET devices. Construct MOSFET test circuit with a small load.
- Identify IGBTs by their numbers and test by using multimeter. Construct IGBT test circuit with a small load.

17. Opto Electronics

- Test LEDs with DC supply and measure voltage drop and current using multimeter.
- Construct a circuit to test photo voltaic cell. Construct a circuit to switch a lamp load using photo diode / transistor.
- Identify opto coupler input and output terminals and measure the quantum of isolation between input/output terminals and operate a relay by connecting a switch.

18. Basic Gates

- Identify different Logic Gates (AND, OR, NAND, NOR, EX-OR, EX-NOR, NOT ICs) by the number printed on them. Verify the truth tables of all Logic Gate ICs by connecting switches and LEDs.
- Construct and verify the truth table of all the gates using NAND and NOR gates. Use digital IC tester to test the various digital ICs (TTL and CMOS).

19. Combinational Circuits

- Construct Half Adder circuit using ICs and verify the truth table and Construct Full adder with two Half adder circuit using ICs and verify the truth table. Construct the adder cum subtractor circuit and verify the result.
- Construct and Test a 2 to 4 Decoder , 4 to 2 Encoder, 4 to 1 Multiplexer, 1 to 4 De Multiplexer.

20. Flip Flops

- Identify different Flip-Flop (ICs) by the number printed on them.
- Construct and test four bit latch using 7475. Construct and test R-S flip-flop using IC7400 with clock and without clock pulse. Verify the truth tables of Flip-Flop ICs (RS, D, T, JK, MSJK) by connecting switches and LEDs.

21. Electronic circuit simulator

- Prepare simple digital and electronic circuits using the software. Simulate and test the prepared digital and analog circuits. Convert the prepared circuit into a layout diagram.
- Prepare simple, power electronic and domestic electronic circuit using simulation software.

22. Counter & shift Registers

- Construct and test a four-bit asynchronous binary counter using 7493,7493 as a modulus-12 counter, four-bit Synchronous binary counter using 74163. Construct and test synchronous Decade counter.
- Construct and test an up/down synchronous decade counter using 74190 and monitor the output on LEDs.
- Identify and test common anode and common cathode seven segment LED display using multi meter.
- Display the two digit count value on seven segment display using decoder/driver ICs.
- Construct a shift register using RS/D/JK flip flop and verify the result.
- Construct and test four bit SIPO register, four bit PIPO register, bidirectional shift registers.

23. Op – Amp & Timer 555 Applications

- Use analog IC tester to test the various analog ICs.
- Construct and test various Op-Amp Circuits Inverting, Non-inverting and Summing Amplifiers.
- Construct and test Differentiator and Integrator, zero crossing detector and Instrumentation amplifier. Construct and test a Binary weighted and R-2R Ladder type Digital-toAnalog Converters
- Construct and test Astable timer circuit using IC 555, mono stable timer circuit using IC 555, VCO (V to F Converter) using IC 555, 555 timers as pulse width modulator.

24. Digital Storage Oscilloscope

- Identify the different front panel control of a DSO. Measure the Amplitude, Frequency and time period of typical electronic signals using DSO. Take a print of a signal from DSO by connecting it to a printer and tally with applied signal. Construct and test function generator-using IC 8038.

25. Basic SMD (2, 3, 4 terminal components)

- Identification of 2, 3, 4 terminal SMD components. De-solder the SMD components from the given PCB.
- Solder the SMD components in the same PCB. Check for cold continuity of PCB.
- Identification of loose /dry solder, broken tracks on printed wired assemblies.

26. SMD Soldering and De-soldering

- Identify various connections and setup required for SMD Soldering station. Identify crimping tools for various IC packages. Make the necessary settings on SMD soldering station to de-solder various ICs of different packages (at least four) by choosing proper crimping tools. Make the necessary settings on SMD soldering station to solder various ICs of different packages (at least four) by choosing proper crimping tools.
- Make the necessary setting rework of defective surface mount component used soldering / de-soldering method.

27. PCB Rework

- Checked and Repair Printed Circuit Boards single, Double layer, and important tests for PCBs.
- Inspect soldered joints, detect the defects and test the PCB for rework.
- Remove the conformal coatings by different methods. Perform replacement of coating, baking and preheating.
- Repair solder mask and damage pad.

28. Protection devices

- Identify different types of fuses along with fuse holders, overload (no volt coil), current adjust (Biometric strips to set the current). Test the given MCBs. Connect an ELCB and test the leakage of an electrical motor control circuit.

29. Electrical control circuits

- Measure the coil winding resistance of the given motor. Prepare the setup of DOL starter and Control an induction motor. Construct a direction control circuit to change direction of an induction motor. Connect an overload relay and test for its proper functioning.

30. Electronic Cables & Connectors

- Identify various types of cables viz. RF coaxial feeder, screened cable, ribbon cable, RCA connector cable, digital optical audio, video cable, RJ45, RJ11, Ethernet cable, fibre optic cable splicing, fibre optic cable mechanical splices, insulation, gauge, current capacity, flexibility etc. used in various electronics products, different input output sockets. Identify suitable connectors, solder/crimp /terminate & test the cable sets. Check the continuity as per the marking on the connector for preparing the cable set. Identify and select various connectors and cables inside the CPU cabinet of PC. Identify the suitable connector and cable to connect a computer with a network switch and prepare a cross over cable to connect two network computers.

31. Communication electronics

- Modulate and Demodulate various signals using AM and FM on the trainer kit and observe waveforms
- Construct and test IC based AM Receiver and FM transmitter
- Construct and test IC based Construct and test IC based AM transmitter and test the transmitter power. Calculate the modulation index. Dismantle the given FM receiver set and identify different stages (AM section, audio amplifier section etc.)
- Modulate two signals using AM kit draw the way from and calculate percent (%) of modulation. Modulate and Demodulate a signal using PAM, PPM, PWM Techniques

32. Microcontroller (8051)

- Identify various ICs & their functions on the given Microcontroller Kit.
- Identify the address range of RAM & ROM. Measure the crystal frequency, connect it to the controller.
- Identify the port pins of the controller & configure the ports for Input & Output operation.
- Use 8051 microcontroller, connect 8 LED to the port, blink the LED with a switch.
- Perform the initialization, load & turn on a LED with delay using Timer. Perform the use of a Timer as an Event counter to count external events. Demonstrate entering of simple programs, execute & monitor the results.
- Perform with 8051 microcontroller assembling language program, check the reading of an input port and sending the received bytes to the output port of the microcontroller, used switches and LCD for the input and output.

33. Sensors, Transducers and Applications

- Identify sensors used in process industries such as RTDs, Temperature ICs, Thermocouples, proximity switches (inductive, capacitive and photo electric), load cells, strain gauge. LVDT PT 100 (platinum resistance sensor), water level sensor, thermostat float switch, float valve by their appearance.
- Measure temperature of a lit fire using a Thermocouple and record the readings referring to data chart.
- Measure temperature of a lit fire using RTD and record the readings referring to data chart. Measure the DC voltage of a LVDT.
- Detect different objectives using capacitive, inductive and photoelectric proximity sensors

34. Analog IC Applications

- Make Applications using ICs 741, 723, 555, 7106,7107 such as Laptop protector, Mobile cell phone charger, Battery monitor, Metal detector, Mains detector, Lead acid battery charger, Smoke detector, Solar charger, Emergency light, Water level controller, Door watcher.

35. Digital IC Applications

- Make Applications using various digital ICs (digital display, event counter, stepper motor driver etc) such as Duty cycle selector, Frequency Multiplier, Digital Mains Resumption Alarm,Digital Lucky Random number generator, Dancing LEDs, Count down timer, Clap switch, Stepper motor control, Digital clock, event counter, remote jammer.

36. Fiber optic communication

- Identify the resources and their need on the given fiber optic trainer kit. Make optical fiber setup to transmit and receive analog and digital data. Set up the OFC trainer kit to study AM, FM, PWM modulation and demodulation. Perform FM/ PWM/ PPM modulation and demodulation using OFC trainer kit using audio signal and voice link.

37. Digital panel Meter

- Identify LED Display module and its decoder/driver ICs. Display a word on a two line LED. Measure/current flowing through a resistor and display it on LED Module and LED module (DPM).
- Identify LCD Display module and its decoder/driver ICs. Measure/current flowing through a resistor and display it.

38. SMPS and Inverter

- Identify the components/devices and draw their corresponding symbols. Dismantle the given stabilizer and find major sections/ ICs components. List the defect and symptom in the faulty SMPS. Measure / Monitor major test points of computer SMPS.
- Troubleshoot the fault in the given SMPS unit. Rectify the defect and verify the output with load. Record your procedure followed for trouble shooting the defects. Install and test the SMPS in PC and an inverter.
- Troubleshoot the fault in the given inverter unit. Rectify the defects and verify the output with load.
- Construct and test IC Based DC-DC converter for different voltages. Construct and test a switching step down regulator using LM2576 and MC 34063

39. UPS

- Connect battery stack to the UPS. Identify front panel control & indicators of UPS. Connect Battery & load to UPS & test on battery mode. Open top cover of a UPS; identify its isolator transformers, the UPS transformer and various circuit boards in UPS.
- Identify the various test point and verify the voltages. Identify various circuit boards in UPS and monitor voltages at various test points. Perform load test to measure backup time. Perform all above experiment for three phase UPS.

40. Solar Power (Renewable Energy System)

- Install a solar panel to a roof. Wire a solar controller to a battery storage station.
- Install solar power 500 panel to directly 12 V DC appliances. Connect storage batteries to a power inverter
- Connect and test solar panel to the Inverter and run the load. Install a solar power to charge a rechargeable 12 V DC battery and find out the charging time. Install a Solar Inverter.

41. Cell phones

- Dismantle, identify the parts and assemble different types of smart phones. Dismantle the cell phone/smart phone remove the key pad and clean it, test for the continuity of the matrix/tracks. Interface the cell phone/smart phone to the PC and transfer the data card. Flash the various brands of cell phone/smart phone. Format the cell phone/smart phone for virus. Unlock the handsets through codes and software
- Perform the interfacing of cell phone/smart phone to the PC and dismantle the cell phone and identify the power section and test its healthiness
- Find out the fault of basic cell phone system. Rectify the fault in ringer section and check the performance
- Replace various faulty parts like mic, speaker, data/ charging/ audio jack etc.

42. LED Lights

- Dismantle the LED light, identify the connections of LEDs stacks, protection circuits, regulator
- Identify the rectifier, controller part of LED lights. Make series string connection of six LED's and connect four Series strings in parallel. Connect to such parallel sets in Series to create a matrix of LED's. Apply suitable voltage and check Voltage across series strings.

43. LCD and LED TV

- Identify and operate different Controls on LCD, LED TV Identify components and different sectors of LCD and LED TV.
- Dismantle; Identify the parts of the remote control
- Dismantle the given LCD/LED TV to find faults with input stages through connectors.
- Detect the defect in a LED/LCD TV receiver given to you. Rectify the fault.
- Troubleshoot the faults in the given LED/LCD TV receiver. Locate and rectify the faults.
- Test LED/LCD TV after troubleshooting the defects
- Identify various connectors and connect the cable operators external decoder (set top box) to the TV.

TRADE: ELECTRONICS MECHANIC
SYLLABUS FOR COMPETITIVE WRITTEN EXAMINATION

1. Importance of safety and precautions to be taken in the industry. Introduction to PPEs and First Aid. Response to emergencies e.g. power failure, fire, and system failure. Occupational Safety & Health: Health, Safety and Environment guidelines, legislations & regulations as applicable.

2. Identification, specifications, uses and maintenance of commonly used hand tools. State the correct shape of files for filing different profiles. Riveting of tags and lugs, cutting and bending of sheet metals, chassis and cabinets.

3. Basic terms such as electric charges, Potential difference, Voltage, Current, Resistance. Basics of AC & DC. Various terms such as +ve cycle, -ve cycle, Frequency, Time period, RMS, Peak, Instantaneous value. Single phase and Three phase supply. Terms like Line and Phase voltage/ currents. Insulators, conductors and semiconductor properties. Different type of electrical cables and their Specifications. Types of wires & cables, standard wire gauge (SWG). Classification of cables according to gauge (core size), number of conductors, material, insulation strength, flexibility etc.

4. Single range meters- Introduction to electrical and electronic measuring instruments. Basic principle and parts of simple meters. Specifications, symbols used in dial and their meaning.

5. Cells & Batteries - Construction, types of primary and secondary cells. Materials used, Specification of cells and batteries. Charging process, efficiency, life of cell/battery. Selection of cells / Batteries etc. Use of Hydrometer. Types of electrolytes used in cells and batteries. Series/ parallel connection of batteries and purpose of such connections.

6. Introduction to electrical measuring instruments. Importance and classification of meters. Forces necessary to work a meter. MC and MI meters. Range extension, need of calibration. Characteristics of meters and errors in meters. Multi meter, use of meters in different circuits. Care and maintenance of meters. Use of CRO, Function generator, LCR meter.

7. Different types of soldering guns, related to Temperature and wattages, types of tips. Solder materials and their grading. Use of flux and other materials. Selection of soldering gun for specific requirement. Soldering and De-soldering stations and their specifications. Different switches, their specification and usage.

8. Ohm's law and Kirchhoff's Law. Resistors; types of resistors, their construction & specific use, color-coding, power rating. Equivalent Resistance of series parallel circuits. Distribution of V & I in series parallel circuits.

9. Principles of induction, inductive reactance. Types of inductors, construction, specifications, applications and energy storage concept. Self and Mutual induction. Behaviour of inductor at low and high frequencies. Series and parallel combination, Q factor. Capacitance and Capacitive Reactance, Impedance. Types of capacitors, construction, specifications and applications. Dielectric constant. Significance of Series parallel connection of capacitors. Capacitor behaviour with AC and DC.

10. Concept of Time constant of a RC circuit. Concept of Resonance and its application in RC, RL & RLC series and parallel circuit. Properties of magnets and their materials, preparation of artificial magnets, significance of electromagnetism, types of cores. Relays, types, construction and specifications etc. Semiconductor materials, components, number coding for different electronic components such as Diodes and Zeners etc. PN Junction, Forward and Reverse biasing of diodes. Interpretation of diode specifications. Forward current and Reverse voltage. Packing styles of diodes. Different diodes, Rectifier configurations, their efficiencies, Filter components and their role in reducing ripple. Working principles of Zener diode, varactor diode, their specifications and applications. Working principle of a Transformer, construction, Specifications and types of cores used. Step-up, Step down and isolation transformers with applications. Losses in Transformers. Phase angle, phase relations, active and reactive power, power factor and its importance.

11. 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. 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. Introduction to power point Basics of preparing slides, different design aspects of slides, animation with slides etc. Concept of Internet, Browsers, Websites, search engines, email, chatting and messenger service. Downloading the Data and program files etc. Computer Networking: - Network features - Network Medias Network topologies, protocols- TCP/IP, UDP, FTP, models and types. Specification and standards, types of cables, UTP, STP, Coaxial cables. Network components like hub, Ethernet switch, router, NIC Cards, connectors, media and firewall. Difference between PC & Server.

12. Regulated Power supply using 78XX series, 79XX series. Op-amp regulator, 723 regulators, (Transistorized & IC based). Voltage regulation, error correction and amplification etc. Construction, working of a PNP and NPN Transistors, purpose of E, B & C Terminals. Significance of α, β and relationship of a Transistor. Need for Biasing of Transistor. VBE, VCB, VCE, IC, IB, Junction Temperature, junction capacitance, frequency of operation. Transistor applications as switch and amplifier. Transistor input and output characteristics. Transistor power ratings & packaging styles and use of different heat sinks. Different types of biasing, various configurations of transistor (C-B, C-E & CC), their characteristics and applications. Transistor biasing circuits and stabilization Techniques. Classification of amplifiers according to frequency, mode of operation and methods of coupling. Voltage amplifiers - voltage gain, loading effect. Single stage CE amplifier and CC amplifier. Emitter follower circuit and its advantages. RC coupled amplifier, distinguish between voltage and power amplifier, Push pull amplifier and class C tuned amplifier. Alpha, beta, voltage gain, Concept of dB dBm. Feedback and its types. Introduction to positive feedback and requisites of an oscillator. Study of Colpitts, Hartley, Crystal and RC oscillators. Types of multi vibrators and study of circuit diagrams.

13. Diode shunt clipper circuits, Clamping / limiting circuits and Zener diode as peak clipper, uses their applications. Construction of FET & JFET, difference with BJT. Purpose of Gate, Drain and source terminals and voltage /current relations between them and Impedances between various terminals. Heat Sink- Uses & purpose.

   Suitability of FET amplifiers in measuring device applications. Working of different power electronic components such as SCR, TRIAC, DIAC and UJT. MOSFET, Power MOSFET and IGBT, their types, characteristics, switching speed, power ratings and protection. Differentiate FET with MOSFET. Differentiate Transistor with IGBT.

14. Working and application of LED, IR LEDs, Photo diode, photo transistor, their characteristics and applications. Optical sensor, opto-couplers, circuits with opto isolators. Characteristics of LASER diodes.

15. Introduction to Digital Electronics. Difference between analog and digital signals. Logic families and their comparison, logic levels of TTL and CMOS. Number systems (Decimal, binary, octal, Hexadecimal). BCD code, ASCII code and code conversions. Various Logic Gates and their truth tables. Combinational logic circuits such as Half Adder, Full adder, Parallel Binary adders, 2- bit and four bit full adders. Magnitude comparators. Half adder, full adder ICs and their applications for implementing arithmetic operations. Concept of encoder and decoder. Basic Binary Decoder and four bit binary decoders. Need for multiplexing of data. 1:4-line Multiplexer / Demultiplexer.

16. Introduction to Flip-Flop. S-R Latch, Gated S-R Latch, DLatch. Flip-Flop: Basic RS Flip Flop, edge triggered D Flip Flop, JK Flip Flop, T Flip Flop. Master-Slave flip flops and Timing diagrams. Basic flip flop applications like data storage, data transfer and frequency division. Study the library components available in the circuit simulation software. Various resources of the software.

17. Basics of Counters, types, two bit and three bit Asynchronous binary counters and decade counters with the timing diagrams. 3-bit Synchronous counters and synchronous decade counters. Types of seven segment display. BCD display and BCD to decimal decoder. BCD to 7 segment display circuits. Basics of Register, types and application of Registers.

18. Block diagram and Working of Op-Amp, importance, Ideal characteristics, advantages and applications. Schematic diagram of 741, symbol. Non-inverting voltage amplifier, inverting voltage amplifier, summing amplifier, Comparator, zero cross detector, differentiator, integrator and instrumentation amplifier, other popular Op-Amps. Block diagram of 555, functional description. w.r.t. different configurations of 555 such as monostable, astable and VCO operations for various application.

19. Advantages and features of DSO. Block diagram of Digital storage oscilloscope(DSO)/ CRO and applications. Applications of digital CRO. Block diagram of function generator. Differentiate a CRO with DSO.

20. Introduction to SMD technology Identification of 2, 3, 4 terminal SMD components. Advantages of SMD components over conventional lead components. Soldering of SM assemblies - Reflow soldering. Tips for selection of hardware, Inspection of SM. Introduction to Surface Mount Technology (SMT). Advantages, Surface Mount components and packages. Introduction to solder paste (flux). Soldering of SM assemblies, reflow soldering. Tips for selection of hardware, Inspection of SM. Identification of Programmable Gate array (PGA) packages. Specification of various tracks, calculation of track width for different current ratings. Cold/ Continuity check of PCBs. Identification of lose / dry solders, broken tracks on printed wiring assemblies. Introduction to Pick Place Machine, Reflow Oven, Preparing stencil, & stencil printer. Introduction to Static charges, prevention, handling of static sensitive devices, various standards for ESD. Introduction to non-soldering interconnections. Construction of Printed Circuit Boards (single, Double, multilayer), Important tests for PCBs.

21. Introduction to rework and repair concepts. Repair of damaged track. Repair of damaged pad and plated through hole. Repair of solder mask. Necessity of fuse, fuse ratings, types of fuses, fuse bases. Single/ three phase MCBs, single phase ELCBs. Types of contactors, relays and working voltages. Contact currents, protection to contactors and high current applications.

22. Fundamentals of single phase Induction motors, synchronous speed, slip, rotor frequency. Torque-speed characteristics, Starters used for Induction motors.

23. Cable signal diagram conventions Classification of electronic cables as per the application w.r.t. insulation, gauge, current capacity, flexibility etc. Different types of connector & their terminations to the cables. Male / Female type DB connectors. Ethernet 10 Base cross over cables and pin out assignments, UTP and STP, SCTP, TPC, coaxial, types of fibre optical Cables and Cable trays. Different types of connectors Servo 0.1" connectors, FTP, RCA, BNC, HDMI Audio/video connectors like XLR, RCA (phono), 6.3 mm PHONO, 3.5 / 2.5 mm PHONO, BANTAM, SPEAKON, DIN, mini DIN, RF connectors, USB, Fire wire, SATA Connectors, VGA, DVI connectors, MIDI and RJ45, RJ11 etc.

24. Radio Wave Propagation – principle, fading. Need for Modulation, types of modulation and demodulation. Fundamentals of Antenna, various para- meters, types of Antennas & application. Introduction to AM, FM & PM, SSB-SC & DSB-SC. Block diagram of AM and FM transmitter. FM Generation & Detection. Digital modulation and demodulation techniques, sampling, quantization & encoding. Concept of multiplexing and de multiplexing of AM/ FM/ PAM/ PPM /PWM signals. A simple block diagram approach to be adopted for explaining the above mod/demod techniques.

25. Introduction Microprocessor & 8051Microcontroller, architecture, pin details & the bus system. Function of different ICs used in the Micro- Controller Kit. Differentiate microcontroller with microprocessor. Interfacing of memory to the microcontroller. Internal hardware resources of microcontroller. I/O port pin configuration. Different variants of 8051 & their resources. Register banks & their functioning. SFRs & their configuration for different applications. Comparative study of 8051 with 8052. Introduction to PIC Architecture.

26. Basics of passive and active transducers. Role, selection and characteristics. Sensor voltage and current formats. Thermistors/ Thermocouples - Basic principle, salient features, operating range, composition, advantages and disadvantages. Strain gauges/ Load cell – principle, gauge factor, types of strain gauges. Inductive/ capacitive transducers - Principle of operation, advantages and disadvantages. Principle of operation of LVDT, advantages and disadvantages. Proximity sensors – applications, working principles of eddy current, capacitive and inductive proximity sensors. Discussion on the identified projects with respect to data of the concerned ICs. Components used in the project. Discussion on the identified projects with respect to data of the concerned ICs. Components used in the project. Introduction to optical fiber, optical connection and various types optical amplifier, its advantages, properties of optic fiber, testing, losses, types of fiber optic cables and specifications. Encoding of light. Fiber optic joints, splicing, testing and the related equipment/ measuring tools. Precautions and safety aspects while handling optical cables.

27. Different types of seven segment displays, decoders and driver ICs. Concept of multiplexing and its advantages. Block diagrams of 7106 and 7107 and their configuration for different measurements. Use of DPM with seven segment display. Principles of working of LCD. Different sizes of LCDs. Decoder/ driver ICs used with LCDs and their pin diagrams. Use of DPM with LCD to display different voltage & current signals.

28. Concept and block diagram of manual, automatic and servo voltage stabilizer, o/p voltage adjustment. Voltage cut-off systems, relays used in stabilizer. Block Diagram of different types of Switch mode power supplies and their working principles. Various types of chopper circuits. Inverter; principle of operation, block diagram, power rating, change over period. Installation of inverters, protection circuits used in inverters. Battery level, overload, over charging etc. Various faults and its rectification in inverter. Block diagram of DC-DC converters and their working principals. Concept of Uninterrupted power supply. Difference between Inverters and UPS. Basic block diagram of UPS & operating principle. Types of UPS: Off line UPS, On line UPS, Line interactive UPS & their comparison UPS specifications. Load power factor & types of indications & protections UPS circuit description and working - controlling circuits, Micro controller circuits, power circuits, charging circuits, alarm circuits, Indicator circuits. Installation of single phase & three phase UPS.

29. Need for renewable energy sources, Solar energy as a renewable resource. Materials used for solar cells. Principles of conversion of solar light into electricity. Basics of photovoltaic's cell. Module, panel and Arrays. Factors that influence the output of a PV module. SPV systems and the key benefits. Difference between SPV and conventional power. Solar charge controller or regulator and its role. Safety precautions while working with solar systems.

30. Introduction to mobile communication. Concept cell site, hand off, frequency reuse, block diagram and working of cell phones, cell phone features. GSM and CDMA technology. Use IEMI number to trace lost/misplaced mobile phone.

31. Types of LED panels used in various lighting applications. Stacking of LEDs. Driving of LED stacks. Difference between a conventional CTV with LCD & LED TVs. Principle of LCD and LED TV and function of its different section. Basic principle and working of 3D TV. IPS panels and their features. Different types of interfaces like HDMI, USB, RGB etc. TV Remote Control –Types, parts and functions, IR Code transmitter and IR Code Receiver. Working principle, operation of remote control. Different adjustments, general faults in Remote Control.

TRADE: MACHINIST
SYLLABUS FOR TRADE TEST

1. List of tools & Machinery used in the trade. Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE). First Aid Method and basic training. Safe disposal of waste materials like cotton waste, metal chips/burrs etc. Hazard identification and avoidance. Identification of safety signs for Danger, Warning, caution & personal safety message. Preventive measures for electrical accidents & steps to be taken in such accidents. Use of fire extinguishers. Precautions to be followed while working in fitting jobs.

2. Safe use of tools and equipment used in the trade. Identification of tools & equipment as per desired specifications for marking, filing & sawing. Visual inspection of raw material for rusting, scaling, corrosion etc.

3. Familiarization of bench vice. Filing- Flat and square (Rough finish). Marking with scriber and steel rule. Filing practice, surface filing, marking of straight and parallel lines with odd leg calipers and steel rule. Marking out lines, gripping suitably in vice jaws, hack sawing to given dimensions. Sawing different types of metals of different sections. Marking practice with dividers, odd leg callipers, scriber and steel rule (circles, arc, parallel lines).

4. Grinding, centre punch, dot punch, chisel and scriber. Marking off straight lines and arcusing scribing block and dividers. Marking, filing, filing square and check using trysquare. Marking according to drawing for locating, position of holes, scribing lines on chalked surfaces with marking tools. Finding centre of round bar with the help of 'V' block and marking block. Prepare mushroom head and round bar and bending metal plate by hammering. Marking using scale, surface gauge and angle plate. Chipping flat surfaces along a marked line. Make a square from a round job by chipping up to 20mm length.

5. Slot, straight and angular chipping. Mark off and drill through holes. Drill and tap on M.S. flat. Cutting external thread on M.S. rod using Die. Punch letter and number (letter punch and number punch). Counter sinking, counter boring and reaming with accuracy +/- 0.04 mm. Drill blind holes with an accuracy 0.04 mm. Form internal threads with taps to standard size (blind holes). Prepare studs and bolt. Make Male & Female 'T' fitting with an accuracy +/- 0.2 mm and 1 degree. Make male female square fit with accuracy +/- 0.1 mm. Make Male & Female Hexagon fitting with accuracy +/- 0.06 mm.

6. Identify & function of different parts of lathe. Practice on operation of lathe (dry/idle run). Setting lathe on different speed and feed. Dismantling, assembling & truing of 3-jaw & 4-jaw chucks. Grinding of R.H. and L.H. tools, V-tool, parting tool, Round nose tool. Checking of angles with angle gauge/ bevel protractor. Grinding of "V" tools for threading of Metric 60- degree threads. Perform facing operation to correct length. Centre drilling and drilling operation to required size. Perform parallel turning and step turning operation. Perform drilling, boring and undercut operation, parting, grooving, chamfering practice.

7. Measurement with steel rule and outside calliper with an accuracy of ± 0.5 mm. Perform different Knurling operation in lathe with accuracy of ± 0.5 mm. Perform Drilling & boring of blind hole with an accuracy of ± 0.3 mm. Make taper turning by form tool with an accuracy of 1 degree. Make taper turning by compound slide swiveling with an accuracy of ± 30 minute. Make taper by off-setting tailstock with an accuracy of ± 30 minute. Checking taper by Vernier Bevel Protractor and sine bar & slip gauge. Cutting V thread (external) in a lathe and check with Screw Pitch Gauge. Cutting V thread (internal) in a lathe and check with Screw Pith Gauge. Fitting of male & female threaded components.

8. Identification of slotting machine parts & its construction, use of rotary table. Practice on slotting key ways on pulley with accuracy +/- 0.04 mm. Slotting a double ended spanner with accuracy +/- 0.1 mm. Cutting sprocket teeth on slotting machine with accuracy +/- 0.04 mm. Cutting internal spline on slotting machine with accuracy +/- 0.04 mm.

9. Identification of milling machine. Demonstrate working principle of Milling Machine. Set vice & job on the table of Milling Machine. Set arbor on the spindle of milling machine. Set the cutter on arbour. Safety points to be observed while working on a milling machine. Demonstrate Up Milling and Down Milling Process. Sequence of milling six faces of a solid block. Check the accuracy with the help of try-square and Vernier height gauge. Perform Step milling using side and face cutter checking with depth micrometer. Perform slot milling using side and face cutter. Make "V" Block using Horizontal Milling Machine with accuracy +/-0.02 mm Make concave surfaces with an accuracy +/-0.02 mm. Make convex surfaces with an accuracy +/-0.02 mm. Straddle milling operation with an accuracy +/-0.02 mm. Gang milling operation with an accuracy +/-0.02 mm. Make Dovetail fitting (male & female) on Milling Machine with an accuracy +/-0.02 mm. Make T-Slot fitting (male & female) on Milling Machine with an accuracy +/-0.02 mm.

10. Demonstrate indexing head. Set and align indexing head with reference to job on milling machine. Make square job by direct/ simple indexing method with an accuracy +/-0.02 mm. Make hexagonal job by simple indexing method with an accuracy +/-0.02 mm.

11. Checking of alignment of lathe centres and their adjustments. Turning practice-between centres on mandrel (gear blank) with an accuracy +/-30 minute. Taper turning by swivelling the cross slide. Make square thread (external) on a lathe with an accuracy +/- 0.02 mm. Make square thread (internal) on a lathe with an accuracy +/- 0.02 mm.

Check with thread gauge – grinding of tool & setting in correct position. Fitting of male & Female Square threaded components. Make multi-start V thread on lathe with Screw Pitch gauge. Perform eccentric turning with an accuracy +/- 0.02mm.

12. Identification of different types of grinding machine. Wheel balancing & truing. Dressing of grinding wheel. Grinding of block (six sides) by surface grinding machine with an accuracy of +/- 0.01 mm. Grinding of step block by surface grinding machine with an accuracy of +/- 0.01 mm. Grinding of slot block by surface grinding machine with an accuracy of +/- 0.01 mm. Set and perform angular grinding using universal vice/ sign vice to standard angle. Make slide fit with an accuracy ± 0.01mm (male female). Perform form grinding. Make dovetail fitting with an accuracy ± 0.01mm (male & female)

13. Cylindrical grinding: External parallel cylindrical grinding (Both holding in chuck/ collet and in between centers. Plunge grinding. Perform straight bore grinding, step bore grinding, Internal taper bore grinding. Make male female fitting with an accuracy of +/- 0.01 mm. External step cylindrical grinding with an accuracy of +/- 0.01 mm. External taper Cylindrical grinding with an accuracy of +/- 0.01 mm. Demonstrate and practice of grinding of different single point tools and grinding of slab milling cutter.

14. Re-sharpening side and face milling cutter. Demonstrate and practice of grinding of end mill cutter. Re-sharpening of shell end mill cutter. Practice of facing on milling Machine. Drill on P.C.D on milling Machine with accuracy+/- 0.02 mm.

15. Perform Tapping and Reaming operation using milling Machine with an accuracy +/- 0.02 mm. Perform spot facing operation using milling machine with accuracy +/-0.02 mm. Make slot on face of the job using milling Machine with an accuracy +/-0.02 mm. Make Internal Grooving using milling Machine with an accuracy 0.02 mm. Make Straight Teeth Rack using Milling Machine with an accuracy 0.05 mm. Make Helical Teeth Rack using Milling Machine with an accuracy 0.05 mm one straight rack.

16. Measurement of teeth by Vernier Gear Tooth Caliper. Make spur gear using Simple indexing with an accuracy 0.05 mm. Make spur gear using differential indexing with an accuracy 0.05 mm. Perform Boring operation on Vertical Milling Machine with an accuracy 0.05 mm. Make helical gear on milling machine with an accuracy 0.05 mm. Make straight flute milling on Milling Machine with an accuracy 0.05 mm. Make helical flute on Milling Machine with an accuracy 0.02 mm.

17. Measure Current, Voltage and Resistance using Simple Ohm`s Law Circuit and Familiarizing Multi-meter. Soldering Techniques. Step up and step-down transformers. Working with Solenoids and Relays. Working of Motor & Generators. Behaviour of Proximity Sensors and ultrasonic sensors. Logical Operation of Sensors. Limit & Level Control using Sensors. Interfacing of Sensors with Electrical Actuators.

18. Know rules of personal and CNC machine safety, safe handling of tools, safety switches and material handling equipment using CNC didactic/ simulation software and equipment. Identify CNC lathe machine elements and their functions, on the machine. Understand the working of parts of CNC lathe, explained using CNC didactic/ simulation software. Identify machine over travel limits and emergency stop, on the machine. Decide tool path for turning, facing, grooving, threading, drilling. Identification of safety switches and interlocking of DIH modes. Identify common tool holder and insert shapes by ISO nomenclature.

19. Select cutting tool and insert for each operation. Fix inserts and tools in tool holders. Decide cutting tool material for various applications. Select cutting parameters from tool manufacturer's catalogue.

20. CNC programs for simple tool motions and parts using linear and circular interpolation, check on program verification/ simulation software. CNC part programs using canned cycles for stock removal, grooving, threading operations, with drilling and finish turning. Use TNRC commands for finish turning. Check simulation on program verification/ simulation software. Avoiding collisions caused by program errors. Knowing causes and effects of collisions due to program errors, by making deliberate program errors and simulation on program verification/ simulation software.

21. Conduct a preliminary check of the readiness of the CNC lathe - cleanliness of machine, functioning of lubrication, coolant level, correct working of sub- systems, on the machine. Starting the machine, do homing on CNC simulator. Entering the CNC program in EDIT mode for an exercise on Simple turning & Facing (step turning) without using canned cycles, on CNC simulator. Mounting jaws to suit the part holding area on CNC machine. Mounting tools on the turret according to part and process requirement, on CNC simulator &on CNC machine. Perform Work and tool setting: Job zero/work coordinate system and tool setup and live tool setup.

22. Determining work and tool offsets using JOG, MDI, MPG modes, on CNC simulator. Entering the tool offsets, tool nose radii and orientation for TNRC in offsets page, on CNC simulator. Program checking in dry run, single block modes, on CNC simulator & CNC machine. Absolute and incremental programming assignments and simulation. Checking finish size by over sizing through tool offsets, on CNC simulator. Prepare part program and cut the part in auto mode in CNC machine for the exercise on Simple turning & Facing (step turning)

23. Recovering from axes over travel, on CNC simulator. Part program writing, setup, checking and Automatic Mode Execution for exercise on Turning with Radius/ chamfer with TNRC on CNC machine. Part program writing, setup,

checking and Automatic Mode Execution for exercise on Turning with TNRC, grooving and threading, on CNC simulator & on CNC machine. Checking finish size by over sizing through tool offsets, on the machine.

24. Machining parts on CNC lathe with combination step, taper, radius turning, grooving &threading, with external and internal operations, first and second operation, on the machine. Machining long part on CNC lathe held in chuck and tailstock (between centers). Starting from interruption due to power shutdown, tool breakage.

25. Changing wear offsets to take into account tool wear. Part program preparation, Simulation & Automatic Mode Execution of CNC Machine for the exercise on Blue print programming contours with TNRC.

26. Carryout Drilling/Boring cycles in CNC Turning. (First 60% of the practice is on CNC machine simulator, followed by 40% on machine.). Know rules of personal and CNC machine safety, safe handling of tools and material handling equipment. Using CNC didactic/ simulation software and equipment.

27. Identify CNC vertical machining center machine elements and their functions, on the machine. Understand working of parts of CNC VMC, explained using CNC didactic/ simulation software. Identify machine over travel limits and emergency stop, on the machine. Decide tool path for Face milling, Side milling, Pocket milling, Drilling, Counter sinking, tapping, Reaming, Rough boring, Finish boring, Spot facing. Identify common tools, tool holders and inserts. Select cutting tool, insert and holder for each operation. Fix inserts and tools in tool holders. Decide cutting tool material for various applications. Select cutting parameters from tool manufacturer's catalog. CNC programs for simple parts using linear and circular interpolation, absolute and incremental modes, check on program verification software.

28. Write CNC part programs for parts with face milling, pocket milling with subprograms. Check on program verification software. Write CNC part programs for pocket milling, drilling with canned cycle, countersinking with canned cycle, tapping with canned cycle. Check on program verification software. Avoiding collisions caused by program errors. Knowing causes and effects of collisions due to program errors, by making deliberate program errors and simulation on program verification software.

29. Conduct a preliminary check of the readiness of the CNC VMC - cleanliness of machine, functioning of lubrication, coolant level, correct working of sub- systems. On the machine. Starting the machine, do homing on CNC simulator. Entering the CNC program in EDIT mode for an exercise on face milling and drilling without using canned cycles, on CNC simulator. Mounting tools on the ATC according to part and process requirement, on CNC simulator & CNC machine.

30. Determining work and tool offsets using JOG, MDI, MPG modes, on CNC simulator& CNC machine. Tool change in CNC milling and JOG, MDI, MPG mode operation. Entering the work offset, tool length offsets, tool radii and, on CNC simulator. Program checking in dry run, single block modes, on CNC simulator. Checking finish size by over or under sizing through tool offsets, on CNC simulator.

31. Prepare part programme, enter, edit and simulate. Carryout tool path simulation. Recovering from axes over travel, on virtual machine simulator. Part program writing, setup, checking and Automatic Mode Execution for exercise on side milling with CRC, on CNC simulator & CNC machine. Part program writing, setup, checking and Automatic Mode Execution for exercise on face milling, drilling, countersinking, tapping using canned cycle, on CNC simulator & CNC machine Automatic mode execution of CNC Machine Exercises with Block Search and restart. Mounting clamps, locators, supports, truing part and fixture. Machining parts on CNC VMC with combination face milling, side milling with CRC, drilling, countersinking, tapping. Use canned cycles and subprograms wherever possible.

32. Machining of part with closely controlled slot dimension using CRC. Machining of part with pockets. End milling with polar co-ordinates. Part programs & Simulation Automatic Mode Execution of CNC Machine for the exercise on End milling with polar co-ordinates and practical on Simple drilling - G 81.

33. Determining and entering wear offsets. Restarting machine from power shutdown or sudden stoppage. Program transfer to machine through electronic media – USB and flash drive Merging the work zero with program zero point, geometry and wear offset correction. Practical on Chamfer and counter-sink drilling. Carryout Deep hole drilling G 83. Perform Threading and tapping G 84. Carryout Boring cycles G 85 - G 89.

34. Preparations of part programs for thread cutting/thread milling for CNC machining centres. Drilling milling patterns, Thread milling etc. Circular and rectangular pockets machining. Calculation of machine hour rates for typical CNC lathe and VMC. Estimation of cycle time for parts with face milling, side milling, drilling, tapping operations.

35. Prepare different types of documentation as per industrial need by different methods of recording information. Perform Periodic Lubrication system on Machines, perform simple repair work and Perform the routine maintenance with check list.

36. Inspection of Machine tools such as alignment, leveling etc. Accuracy testing of machine tools such as geometrical parameters. Cutting teeth on helical slab/ cylindrical cutter and end mill cutter with an accuracy of +/- 0.05 mm. Cutting bevel gears on a milling machine with an accuracy of +/-0.05 mm. Cutting a plate cam with angular setting in milling machine with an accuracy of +/-0.05 mm. Cutting worm wheel on a milling machine with an accuracy of +/- 0.05 mm. Cutting worm thread on a milling machine with an accuracy of +/- 0.05 mm.

TRADE: MACHINIST
SYLLABUS FOR COMPETITIVE WRITTEN EXAMINATION

1. Importance of safety and general precautions observed in the industry/shop floor. 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.

2. Basic understanding on Hot work, confined space work and material handling equipment. Linear measurements - its units, steel rule dividers, callipers – types and uses, Punch – types and uses. Uses of different types of hammers. Description, use and care of marking off table. Bench vice construction, types, uses, care & maintenance, vice clamps, hacksaw frames and blades, specification, description, types and their uses, method of using hacksaws. Files - elements, types, specification and their uses. Methods of filing. Care and maintenance of files. Measuring standards (English, Metric Units).

3. Pedestal grinding machine: Use, care and safety aspect. Marking off and layout tools, scribing block, care & maintenance. Try square, ordinary depth gauge, Care & main- tenance of cold chisels- materials, types, cutting angles. Combination set - its components, uses and cares. Marking media, Prussian blue, red lead, 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.

4. Drill, Tap, Die - types & application. Determination of tap drill size. Basic terminology related to screw thread. Reamer - material, types (Hand and machine reamer), parts and their uses, determining hole size for reaming, Reaming procedure. Vernier height gauge: construction, graduations, vernier setting & reading. Care and maintenance of Vernier height Gauge. 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.

5. Interchangeability: Necessity in Engg., field, Limit- Definition, types, terminology of limits and fits-basic size, actual size, deviation, high and low limit, zero-line, tolerance zone, allowances. Different standard systems of fits and limits. (British standard system & BIS system). Vernier caliper - its parts, principle, reading, uses & care. Outside micrometer - its parts, principle, reading, uses, Reading of Vernier Micrometre), care & maintenance. Dial test indicator-its parts, types, construction and uses.

6. Getting to know the lathe with its main components, lever positions and various lubrication points as well. Definition of machine & machine tool and its classification. History and gradual development of lathe. Introduction to lathe- its types. Centre lathe construction, detail function of parts, specification. Safety points to be observed while working on a lathe.

7. Lathe cutting tool - different types, material, shapes and different angles (clearance, rake etc.) and their effects, specification of lathe tools, grinding process of tools. Types of chips, chip breaker. Tool life, factors affecting tool life. Driving mechanism, speed and feed mechanism of Lathe. Concept of Orthogonal and Oblique Cutting. Chucks & different types of job holding devices on lathe and advantages of each type. Mounting and dismounting of chucks. Vernier Bevel Protractor – parts, reading and uses. Lathe operations - facing, turning, parting-off, grooving, chamfering, boring etc.

8. Knurling - types, grade & its necessity. Taper – different methods of expressing tapers, different standard tapers. Method of taper turning, important dimensions of taper. Taper turning by swiveling compound slide, its calculation. Calculations of taper turning by off-setting tail stock. Sine Bar – description & uses. Slip gauge –description and uses. Different thread forms, their related dimensions and calculations of screw cutting in a lathe (Metric thread on English lathe and English thread on Metric lathe). Measurement of threads by three wire methods. Use of Screw Pitch Gauge.

9. Slotter – Classification, principle, construction, Safety precaution. Introduction and their indexing process on a Slotter by its Rotary table graduations. Driving mechanisms, quick return motion and speed ratio. Safety points to be observed while working on a Slotter. Job holding devices - vice, clamps, V-block, parallel block etc. Slotting tools - types, tool angles. Use of tool with holder for internal operations. Precautions to be observed during slotting internal operations. Use of circular marks on the table for slotting curves. Chain, Sprocket and their applications. Spline – types and uses. Coolant & lubricant – Introduction, types, properties, application & applying methods.

10. Milling Machine: Introduction, types, parts, construction and specification. Driving and feed mechanism of Milling Machine. Different types of milling cutters & their use. Cutter nomenclature. Different milling operations - plain,

face, angular, form, slot, gang and straddle milling etc. Up and down milling. Different types of milling attachments and their uses.

11. Jigs and Fixtures – Introduction, principle, types, use, advantages & disadvantages. Properties of metals general idea of physical, mechanical properties of metals, colour, weight, hardness toughness, malleability, ductility their effect on machinability. Heat Treatment – Introduction, necessity, types, Purposes, different methods of Heat Treatment. Heat Treatment of Plain Carbon Steel.

12. Indexing - introduction & types. Indexing head - types &constructional details, function of indexing plates and the sector arms. Calculation for various types of indexing. Turning of taper by taper turning attachment - advantages and dis-advantages, taper calculations. Mandrel, Lathe centres, Lathe dog, catch plate/ Driving plate, Face plate, Rests, their types & uses. Terms relating screw thread major/ minor diameter, pitch and lead of the screw, depth of thread. Simple gear train and compound gear train change gears for fractional pitches. Square thread and its form and calculation of depth, core dia, pitch dia. Difference between single and multi-start threads- their uses, merits and demerits.

13. Grinding – Introduction, grinding wheel abrasive, types, bond, grade, grid, structure, standard marking system of grinding wheel, selection of the grinding wheel. Dressing, types of dresser. Glazing and Loading of wheels – its causes and remedies. Roughness values and their symbols. Explain the importance and necessity of quality. Surface Grinder – Types, Parts, construction, use, methods of surface grinding, specification & safety. Cylindrical grinder: Introduction, parts, construction, types, specification, safety, different methods of cylindrical grinding. Cutting speed, feed, depth of cut, machining time calculation. Wet grinding and dry grinding, various types of grinding wheels and their application, grinding defects and remedies. Tool & cutter grinder -Introduction, parts, construction, use and specification, different types of tool rest & their application. Various methods of cutter grinding. Various cutter grinding attachments and their uses.

14. Geometrical tolerances - definition, symbol and their application. Depth Micrometer – Parts, reading, uses and safety. Different types of micrometers and their uses. Inside Micrometer – its parts, reading and uses. Bore Dial Gauge – its parts, reading (both in Metric and English system) and uses. Telescopic gauge. Gauges – different types and their uses, difference between Gauges and Measuring Instruments. Gear - introduction, use and type. Elements of a spur gear. Gear tooth of each forms types, merits and demerits of each. Rack – types, uses and calculations. Selection of gear cutter type and form & various methods of checking gear and its parts. Vernier gear tooth caliper - its construction and application in checking gear tooth. Spur gear calculations, curves and their uses. Use of radius gauges and template.

15. Vertical Milling Machine - its parts. Method of boring in Vertical milling. Difference between Horizontal and Vertical Milling Machine. Helix and Spiral introduction, types and elements. Difference between helix & spiral. Difference between R.H. and L.H. helix. Helical gear- elements, application. Calculations for cutting helical gear. Reamer – types, elements and uses. Calculations for cutting Reamer. Twist drill - nomenclature, cutter selection. Calculations for cutting twist drill.

16. Study of basic Electricals - Voltage – Current etc. Working Of Solenoids, Inductors, Motors, Generator Based On Electromagnetic Induction Principle Switches, Fuse and Circuit Breakers. Introduction To Sensors & Fundamental Of Sensor Proximity Sensors Classification and Operation- Proximity Sensor & Types Of Proximity Sensor And Their Working. Industrial Application Sensors For Distance And Displacement -LVDT-Linear Potentiometer- Ultrasonic And Optical Sensors-Industrial Application.

17. Personal safety, safe material handling, and safe machine operation on CNC turning centers. CNC technology basics, Comparison between CNC and conventional lathes. Concepts of positioning accuracy, repeatability. CNC lathe machine elements and their functions. bed, chuck, tailstock, turret, ball screws, guide ways, LM guides, coolant system, hydraulic system, chip conveyor, steady rest, console, spindle motor and drive, axes motors, tail stock, encoders, control switches. Feedback, CNC interpolation, open and close loop control systems.

18. Machining operations and the tool paths in them – stock removal in turning and facing, grooving, face grooving, threading, drilling. Concept of Co-ordinate geometry, concept of machine coordinate axis, axes convention on CNC lathes, work zero, machine zero. Converting part diameters and lengths into coordinate system points. Absolute and incremental programming. Programming – sequence, formats, different codes and words. ISO G codes and M codes for CNC turning. Describe CNC interpolation, open and close loop control systems. Co-ordinate systems and Points. Program execution in different modes like MDI, single block and auto. Canned cycles for stock. removal

(turning/facing), grooving, threading, for external and internal operations. Tool nose radius compensation (TNRC) and why it is necessary. Find the geometry page in CNC machine.

19. Cutting tool materials, application of various materials. Cutting tool geometry for internal and external turning, grooving, threading, face grooving, drilling. Insert holding methods for each. Insert cutting edge geometry. ISO nomenclature for turning tool holders, boring tool holders, Indexable inserts. Cutting parameters- cutting speed, feed rate, depth of cut, constant surface speed, limiting spindle speed. Tool wear, tool life, relative effect of each cutting parameter on tool life. Selection of cutting parameters from a tool manufacturer's catalogue for various operations.

20. Writing part programs as per drawing & checking using CNC program verification/ simulation software. Process planning, work holding, tool and cutting parameters selection according to the part geometry and dimensions. Collisions due to program errors, effects of collisions. Costs associated with collisions – tool breakage, machine damage, injuries. Program execution in different modes like MDI, single block and auto. Process planning & sequencing, tool layout& selection and cutting parameters selection. Work and tool offsets. Inputs value to the offset/ geometry page into machine. Turning in multiple setups, hard and soft jaws, soft jaw boring, use of tailstock and steady rest. Length to diameter (L/D) ratio and deciding work holding based on it.

21. Machine operation modes – Jog, MDI, MPG, Edit, Memory. Entering and editing programs on machine console, entering offsets data in offsets page. Use of Emergency stop, Reset, Feed rate override, spindle speed override, edits lock on/off buttons and keys. First part checking: Program checking in single block and dry run modes – necessity and method. Tool offsets adjustment on first part for close tolerance dimensions, by over sizing (for outside dimensions) or under sizing (for inside dimensions) the dimension to prevent part rejection.

22. Wear offset setting – necessity, relationship with tool wear, entering in offsets page. Process and tool selection related to grooving, drilling, boring and threading. Axes over travel, recovering from over travel. Collisions due to improper machine setup and operation – causes and effects. Recovering from collisions. Find out alarm codes and meaning of those codes. Safety aspects related to CNC VMC.CNC technology basics, Comparison between CNC VMC and conventional milling machines.

23. Concepts of positioning accuracy, repeatability. CNC VMC machine elements and their functions. bed, chuck, Auto tool changer (ATC), ball screws, guide ways, LM guides, coolant system, hydraulic system, chip conveyor, rotary table, pallet changer, console, spindle motor and drive, axes motors, encoders, control switches. Feedback, CNC interpolation, open and close loop control systems. Machining operations and the tool paths in them

24. Face milling, Side milling, Pocket milling, Drilling, Countersinking, Rigid tapping, floating tapping Reaming, Rough boring, Finish boring, Spot facing. Concept of Co-ordinate geometry & polar coordinate points, concept of machine axis, axes convention on CNC lathes, work zero, machine zero. Converting part dimensions into coordinate system points.

25. Absolute and incremental programming. Programming - sequence, formats, different codes and words. ISO G and M codes for CNC milling. Canned cycles for drilling, peck drilling, reaming, tapping, finish boring. Subprograms. Cutter radius compensation (CRC)and why it is necessary. Cutting tool materials, application of various materials. Cutting tool geometry for face mill, end mill, drill, countersink, tap, finish bore, reamer. Insert holding methods face mill, insert type end mill and insert type drill. Insert cutting edge geometry.

26. Cutting parameters- cutting speed, feed rate, depth of cut. Tool wear, tool life, relative effect of each cutting parameter on tool life. Selection of cutting parameters from a tool manufacturer's catalog for various operations. Writing part programs as per drawing & check using CNC program verification software. Process planning, work holding, tool and cutting parameters selection according to the part geometry and dimensions.Collisions due to program errors, effects of collisions. Costs associated with collisions - tool breakage, machine damage, injuries.

27. Program execution in different modes like manual, single block and auto. Process planning & sequencing, tool layout & selection and cutting parameters selection. Work offset, tool length offset, tool radius offset. Work holding with temporary holding and fixtures. Truing of part and fixture. Machine operation modes - Jog, MDI, MPG, Edit, Memory. Entering and editing programs on machine console, entering offsets data in offsets page.

28. Use of Emergency stop, Reset, Feed rate override, spindle speed override, edit lock on/off buttons and keys. First part checking: Program checking in single block and dry run modes -necessity and method. Tool offsets adjustment on first part for close tolerance dimensions, by oversizing (for outside dimensions) or under sizing (for inside dimensions) the dimension to prevent part rejection.

29. Axes over travel, recovering from over travel. Collisions due to improper machine setup and operation - causes and effects. Recovering from collisions. State the importance of Helical inter-polar and thread milling, advantage and limitation in CNC machine. Tool wear and necessity for wear offsets change, entering wear offsets in offsets page.

30. Effects of sudden machine stoppage due to power shutdown or use of emergency stop. Restarting machine from sudden stoppage. Means of program transfer through electronic media. Productivity concepts, cycle time, machine down time, causes of down time - breaks, machine breakdown, inspection, part loading and unloading, chip cleaning. Effect of down time on profitability, reducing down time. Machine hour rate, components of machine hour rate - principal repayment, interest, overheads (power, tooling, space, salaries, indirect expenses).

31. Calculation of machining cost, cost of down time. Machine productivity concepts – cycle time, down time, cycle time estimation. Costing - machine hour rate, machining cost, tool cost, cost of down time.

32. Importance of Technical English terms used in industry. Technical forms, process sheet, activity log, job card, in industry-standard formats. Lubricating system-types and importance.

33. Maintenance: Definition, types and its necessity. System of symbol and colour coding. Possible causes for failure and remedies. Calculations for cutting helical slab/ cylindrical cutter. Calculations for cutting End Mill cutter.

34. Bevel gear-elements, types, application, calculation for cutting bevel gear. Cam-types, elements & application, Plate cam manufacturing & calculations. Drum cam- its calculation, advantages, types of follower & its purposes. Worm wheel-application, elements & calculation, Worm & calculation. Types of Keys and their uses. Variation - types and causes. Testing of Gear and error.

35. Engineering Drawing: Introduction to Engineering Drawing and Drawing Instruments – Conventions, Sizes and layout of drawing sheets, Title Block, its position and content, Drawing Instrument, Lines- Types and applications in drawing Free hand drawing of: Geometrical figures and blocks with dimension. Machinist. Transferring measurement from the given object to the free hand sketches. Free hand drawing offhand tools and measuring tools. Drawing of Geometrical figures: Angle, Triangle, Circle, Rectangle, square, Parallelogram. Lettering & Numbering- Single Stroke.

36. Dimensioning: Types of arrow head, Leader line with text, Position of dimensioning (Unidirectional, Aligned). Symbolic representation: Different symbol used in the related trades. Concept and reading of Drawing in: Concept of axes plane and quadrant. Concept of Orthographic and ISO metric projections. Method of first angle and third angle projections (definition and difference).

37. Reading of drawing of nuts, bolt, screw thread, different types of locking devices e.g., Double nut, Castle nut, Pin, etc. Reading of foundation drawing. Reading of Rivets and rivetted joints, welded joints, welded joints. Reading of drawing of pipe and pipe joints. Reading of Job Drawing, Sectional View & Assembly view.

38. Mass, Weight, Volume and Density: Mass, volume, density, weight and specific gravity Related problems for mass, volume, density, weight and specific gravity, Speed and Velocity, Work, Power and Energy Work, power, energy, HP, IHP, BHP and efficiency. Heat & Temperature and Pressure: Concept of heat and temperature, effects of heat, difference between heat and temperature, boiling point & melting point of different metals and non-metals. Concept of pressure - Units of pressure, atmospheric pressure, absolute pressure, gauge pressure and gauges used for measuring pressure.

39. Basic Electricity: Introduction and uses of electricity, electric current AC, DC their comparison, voltage, resistance and their units Levers and Simple machines: Simple machines - Effort and load, mechanical advantage, velocity ratio, efficiency of machine, relationship between efficiency, velocity ratio and mechanical advantage.

40. Friction - Advantages and disadvantages, Laws of friction, co-efficient of friction, angle of friction, simple problems related to friction, Friction – Lubrication Friction - Co- efficient of friction, application and effects of friction in workshop practice. Centre of Gravity: Centre of gravity - Centre of gravity and its practical application Area of cut out regular surfaces and area of irregular surfaces. Area of cut out regular surfaces - circle, segment and sector of circle Related problems of area of cut out regular surfaces - circle, segment and sector of circle. Area of irregular surfaces and application.

41. Elasticity - Elastic, plastic materials, stress, strain and their units and young's modulus. Ultimate stress and working stress. Heat Treatment: Heat treatment and advantages, Different heat treatment process – Hardening, tempering, annealing, normalizing and case hardening. Heat Treatment: Heat treatment and advantages. Heat treatment - Different heat treatment process – Hardening, tempering, annealing, normalising and case hardening.

42. Estimation and Costing: Estimation and costing - Simple estimation of the requirement of material etc., as applicable to the trade Estimation and costing - Problems on estimation and costing

TRADE: FITTER
SYLLABUS FOR TRADE TEST

1. List of tools & Machinery used in the trade. Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE). First Aid Method and basic training. Safe disposal of waste materials like cotton waste, metal chips/burrs etc. Hazard identification and avoidance. Safety signs for Danger, Warning, caution & personal safety message. Preventive measures for electrical accidents & steps to be taken in such accidents. Use of Fire extinguishers. Practice and understand precautions to be followed while working in fitting jobs. Safe use of tools and equipment's used in the trade.

2. Identification of tools &equipment as per desired specifications for marking & sawing. Selection of material as per application. Visual inspection of raw material for rusting, scaling, corrosion etc. Marking out lines, gripping suitably in vice jaws, hacksawing to given dimensions. Sawing different types of metals of different sections. Filing Channel, Parallel. Filing- Flat and square (Rough finish), Filing practice, surface filing, marking of straight and parallel lines with odd leg calipers and steel rule. Marking practice with dividers, odd leg calipers and steel rule (circles, ARCs, parallel lines). Marking off straight lines and ARCs using scribing block and dividers. Chipping flat surfaces along a marked line, Marking, filing, filing square and check using tri square.

3. Marking according to simple blueprints for locating, position of holes, scribing lines on chalked surfaces with marking tools. Finding centre of round bar with the help of 'V' block and marking block. Joining straight line to an ARC. Chipping, Chamfering, Chip slots & oils grooves (Straight). Filing flat, square, and parallel to an accuracy of 0.5mm. Chip curve along a line-mark out, keyways at various angles & cut keyways. Sharpening of Chisel. File thin metal to an accuracy of 0.5 mm. Saw along a straight line, curved line, on different sections of metal. Straight saw on thick section, M.S. angle and pipes. File steps and finish with smooth file to accuracy of $\pm$ 0.25 mm. File and saw on M.S. Square and pipe. File radius along a marked line (Convex & concave) & match. Chip sheet metal (shearing). Chip step and file. Mark off and drill through holes. Drill and tap on M.S. flat.

4. Punch letter and number (letter punch and number punch). Practice use of different punches. Marking of straight lines, circles, profiles and various geometrical shapes and cutting the sheets with snips. Marking out of simple development. Marking out for flaps for soldering and sweating. Make various joints: wiring, hemming, soldering and brazing, form locked, grooved and knocked up single hem straight and curved edges form double hemming.

5. Punch holes-using hollow and solid punches. Do lap and butt joints. Bend sheet metal into various curvature form, wired edges- straight and curves. Fold sheet metal at angle using stakes. Make simple Square container with wired edge and fix handle. Make square tray with square soldered corner.

6. Practice in soft soldering and silver soldering. Make riveted lap and butt joint. Make funnel as per development and solder joints. Drill for riveting. Riveting with as many types of rivet as available, use of counter sunk head rivets.

7. Welding - Striking and maintaining ARC, laying Straight-line bead. Making square, butt joint and 'T' fillet joint-gas and ARC. Do setting up of flames, fusion runs with and without filler rod, and gas. Make butt weld and corner, fillet in ARC welding. Gas cutting of MS plates.

8. Mark off and drill through holes. Drill on M.S. flat. File radius and profile to suit gauge. Sharpening of Drills. Practice use of angular measuring instrument. Counter sink, counter bore and ream split fit (three-piece fitting). Drill through hole and blind holes. Form internal threads with taps to standard size (through holes and blind holes).

9. Prepare studs and bolt. Form external threads with dies to standard size. Prepare nuts and match with bolts. File and make Step fit, angular fit, angle, surfaces (Bevel gauge accuracy 1 degree). Make simple open and sliding fits. Enlarge hole and increase internal dia.

10. File cylindrical surfaces. Make open fitting of curved profiles. Correction of drill location by binding previously drilled hole. Make inside square fit. Make sliding 'T' fit. File fit- combined, open angular and sliding sides. File internal angles 30minutes accuracy open, angular fit. Make sliding fit with angles other than 90º

11. Scrap on flat surfaces, curved surfaces and parallel surfaces and test. Make & assemble, sliding flats, plain surfaces. Check for blue math of bearing surfacesboth flat and curved surfaces by wit worth method. File and fit combined radius and angular surface (accuracy $\pm$ 0.5 mm), angular and radius fit. Locate accurate holes & make accurate hole for stud fit.

12. Fasten mechanical components / subassemblies together using screws, bolts and collars using hand tools. Make sliding fits assembly with parallel and angular mating surface. (± 0.04 mm). Lathe operations, True job on four jaw chuck using knife tool. Face both the ends for holding between centers. Using roughing tool parallel turn ± 0.1 mm. Measure the diameter using outside caliper and steel rule.

13. Holding job in three jaw chuck. Perform the facing, plain turn, step turn, parting, deburr, chamfer-corner, round the ends, and use form tools. Shoulder turn: square, filleted, beveled undercut shoulder, turning-filleted under cut, square beveled. Sharpening of -Single Point Tools. Cut grooves- square, round, 'V' groove. Make a mandrel-turn diameter to sizes. Knurl the job. Bore holes –spot face, pilot drill, enlarge hole using boring tools. Make a bush step borecut recess, turn hole diameter to sizes. Turn taper (internal and external). Turn taper pins. Turn standard tapers to suit with gauge.

14. Practice threading using taps, dies on lathe by hand. Make external 'V' thread. Prepare a nut and match with the bolt. Simple repair work: Simple assembly of machine parts from blueprints. Rectify possible assembly faults during assembly. Perform the routine maintenance with check list. Monitor machine as per routine checklist. Read pressure gauge, temperature gauge, oil level. Set pressure in pneumatic system. Assemble simple fitting using dowel pins and tap screw assembly using torque wrench. Make 'H' fitting. Power tools: Practice operation of power tool for fastening.

15. Tightening of bolt/ screw with specified torque. Selection of right tool as for Tightening or loosening of screw/bolt as per accessibility. Assembly sliding for using keys, dowel pin and screw, ± 0.02 mm accuracy on plain surface and testing of sliding fitting job. File & fit angular mating surface within an accuracy of ± 0.02 mm & 10 minutes angular fitting. Drill through and blind holes at an angle using swivel table of drilling machine.

16. Precision drilling, reaming and tapping and Test Job. Make Dovetailed fitting and radius fitting. File and fit, combined fit with straight, angular surface with ± 0.02 mm accuracy and check adherence to specification and quality standards using equipment like Verniercalipers, micrometres etc. Drilling and reaming, small dia. holes to accuracy & correct location for fitting. Perform drilling using 'V' block and a clamp. Make male and female fitting parts, drill and ream holes not less than 12.7 mm. Make Sliding Diamond fitting. Lap flat surfaces using lapping plate.

17. Prepare Stepped keyed fitting and test job. Lapping holes and cylindrical surfaces. Dovetail and Dowel pin assembly. Scrape cylindrical bore. Scrapping cylindrical bore and to make a fit. Scrapping cylindrical taper bore and check taper angle with sine bar. Make a cotter jib assembly. Hand reams and fit taper pin. Drilling and reaming holes in correct location, fitting dowel pins, stud, and bolts. Making a snap gauge for checking a dia. of 10 ± 0.02 mm. Scrape external angular mating surface and check angle with sine bar. Scrape on internal surface and check

18. Practice in dovetail fitting assembly and dowel pins and cap screws assembly. Preparation of gap gauges, perform lapping of gauges (hand lapping only), Preparation of drill gauges. File and fit straight and angular surfaces internally.

19. Identify different ferrous metals by spark test. Flaring of pipes and pipe joints. Cutting & Threading of pipe length. Fitting of pipes as per sketch observing conditions used for pipe work. Bending of pipes- cold and hot.

20. Dismantling & assembling – globe valves, sluice valves, stop cocks, seat valves and non-return valve. Fit & assemble pipes, valves and test for leakage & functionality of valves. Visual inspection for visual defects e.g. dents, surface finish. Measuring, checking and recording in control chart. Make a simple drilling jig. Use simple jigs and fixtures for drilling. Marking out for angular outlines, filing and fitting the inserts into gaps.

21. Exercises on finished material such as aluminium/ brass/ copper / stainless steel, marking out, cutting to size, drilling, tapping etc. without damage to surface of finished articles.Making an adjustable spanner: - Marking out as per Blueprint, drilling, cutting, straight and curve filing, threading, cutting slot and cutting internal threads with taps.

22. Dismantling and mounting of pulleys. Making & replacing damaged keys. Dismounting, repairing damaged gears and mounting and check for workability. Repair & replacement of belts and check for workability. Making of template/gauge to check involute profile. Repair of broken gear tooth by stud and repair broker gear teeth by dovetail. Make hexagonal slide fitting.

23. Prepare different types of documentation as per industrial need by different methods of recording information. Marking out on the round sections for geometrical shaped fittings such as spline with 3 or 4 teeth. Finishing and fitting to size, checking up the faces for universality. Identify pneumatic components – Compressor, pressure gauge, Filter-Regulator- Lubricator (FRL) unit, and Different types of valves and actuators. Dismantle, replace, and assemble FRL unit. Demonstrate knowledge of safety procedures in pneumatic systems and personal Protective Equipment (PPE).

24. Identify the parts of a pneumatic cylinder. Dismantle and assemble a pneumatic cylinder. Construct a circuit for the direction & speed control of a small-bore single-acting (s/a) pneumatic cylinder. Construct a control circuit for the control of a d/a pneumatic cylinder with momentary input signals.

25. Construct a circuit for the direct & indirect control of a d/a pneumatic cylinder with a single & double solenoid valve. Dismantling & assembling of solenoid valves.

26. Demonstrate knowledge of safety procedures in hydraulic systems. Identify hydraulic components – Pumps, Reservoir, Fluids, Pressure relief valve (PRV), Filters, different types of valves, actuators, and hoses. Inspect fluid levels, service reservoirs, clean/replace filters. Inspect hose for twist, kinks, and minimum bend radius, Inspect hose/tube fittings . Identify internal parts of hydraulic cylinders, pumps/ motors

27. Construct a circuit for the control of a s/a hydraulic cylinder using a 3/2-way valve (Weight loaded d/a cylinder may be used as a s/a cylinder), 4/2- & 4/3- way valves. Maintenance, troubleshooting, and safety aspects of pneumatic and hydraulic systems. Dismantle, overhauling & assemble cross- slide & hand-slide of lathe carriage

28. Simple repair of machinery: - Making of packing gaskets. Check washers, gasket, clutch, keys, jibs, cotter, Circlip, etc. and replace/repair if needed. Use hollow punches, extractor, drifts, various types of hammers and spanners, etc. for repair work. Dismantling, assembling of different types of bearing and check for functionality.

29. Perform routine check of machine and do replenish as per requirement. Inspection of Machine tools such as alignment, levelling. Accuracy testing of Machine tools such as geometrical parameters. Practicing, making various knots, correct loading of slings, correct and safe removal of parts. Erect simple machines.

TRADE: FITTER
SYLLABUS FOR COMPETITIVE WRITTEN EXAMINATION

1. Importance of safety and general precautions observed in the in the industry/floor. 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. Introduction to 5S concept & its application. Occupational Safety & Health: Health, Safety and Environment guidelines, legislations &regulations as applicable.

2. Basic understanding on Hot work, confined space work and material handling equipment. Linear measurements- its units, dividers, calipers, hermaphrodite, centre punch, dot punch, prick punch their description and uses of different types of hammers. Description, use and care of 'V' Blocks, marking off table. Measuring standards (English, Metric Units), angular measurements.

3. Bench vice construction, types, uses, care & maintenance, vice clamps, hacksaw frames and blades, specification, description, types and their uses, method of using hacksaws. Files- specifications, description, materials, grades, cuts, file elements, uses. Types of files, care and maintenance of files. ensuring standards (English, Metric Units), angular measurements. Marking off and layout tools, dividers, scribing block, - description, classification, material, care & maintenance. Try square, ordinary depth gauge, protractor & de- scription, uses and cares. Uses, care & maintenance of cold chisels- materials, types, cutting angles. Marking media, marking blue, Prussian blue, red lead, chalk and their special application, description. Use, care and maintenance of scribing block.

4. Surface plate and auxiliary marking equipment, 'V' block, angle plates, parallel block, description, types, uses, accuracy, care and maintenance. Physical properties of engineering metal: colour, weight, structure, and conductivity, magnetic, fusibility, specific gravity. Mechanical properties: ductility, malleability hardness, brittleness, toughness, tenacity, and elasticity.

5. Power Saw, band saw, Circular saw machines used for metal cutting. Micrometer- outside and inside – principle, constructional features, parts graduation, reading, use and care. Micrometer depth gauge, parts, graduation, reading, use and care. Digital micrometer. Vernier calipers, principle, construction, graduations, reading, use and care. Vernier bevel protractor, construction, graduations, reading, use and care, dial Vernier Caliper, Digital Vernier caliper. Vernier height gauge: material construction, parts, graduations (English & Metric) uses, care and maintenance. Drilling processes: common type (bench type, pillar type, radial type), gang and multiple drilling machine. Determination of tap drill size.

6. Safety precautions to be observed in a sheet metal workshop, sheet and sizes, Commercial sizes and various types of metal sheets, coated sheets and their uses as per BIS specifications. Shearing machine- description, parts and uses. Marking and measuring tools, wing compass, tin man's square tools, snips, types and uses. Tin man's hammers and mallets type-sheet metal tools, types, specifications, uses. Trammel- description, parts, uses. Hand grooves- specifications and uses. Sheet and wire gauge.

7. Stakes-bench types, parts, their uses. Various types of metal joints, their selection and application, tolerance for various joints, their selection & application. Wired edges. Solder and soldering: Introduction-types of solder and flux.

8. Composition of various types of solders and their heating media of soldering iron. Method of soldering, selection and application- joints. Hard solder- Introduction, types and method of brazing. Various rivets shape and form of heads, importance of correct head size. Rivets-Tin man's rivets types, sizes, and selection for various works. Riveting tools, dolly snaps description and uses. Method of riveting, The spacing of rivets. Flash riveting, use of correct tools, compare hot and cold riveting.

9. Safety-importance of safety and general precautions observed in a welding shop. Precautions in electric and gas welding. Introduction to safety equipment and their uses. Machines and accessories, welding transformer, welding generators. Welding hand tools: Hammers, welding description, types and uses, description, principle, method of operating, carbon dioxide welding. H.P. welding equipment: description, principle, method of operating. L.P. welding equipment: description, principle, method of operating. Types of Joints - Butt and fillet as per BIS SP: 46- 1988 specifications.

10. Gases and gas cylinder description, kinds, main difference and uses. Setting up parameters for ARC welding machines - selection of Welding electrodes. Care to be taken in keeping electrode. Oxygen acetylene cutting-machine description, parts, uses, method of handling, cutting torch description, parts, function and uses.

11. Drill- material, types, (Taper shank, straight shank) parts and sizes. Drill angle-cutting angle for different materials, cutting speed feed. R.P.M. for different materials. Drill holding devices- material, construction and their uses.

12. Counter sink, counter bore and spot facing-tools and nomenclature. Reamer - material, types (Hand and machine reamer), kinds, parts and their uses, determining hole size (or reaming), Reaming procedure. Screw threads: terminology, parts, types and their uses. Screw pitch gauge: material parts and uses. (B.S.P.) and metric /BIS (coarse and fine) material, parts (shank body, flute cutting edge).

13. Tap wrench: material, parts, types (solid &adjustable types) and their uses removal of broken tap, studs (tap stud extractor). Dies: British standard, metric and BIS standard, material, parts, types, Method of using dies. Die stock: material, parts and uses. Drill troubles: causes and remedy. Equality of lips, correct clearance, dead centre, length of lips. Drill kinds: Fraction, metric, letters and numbers, grinding of drill.

14. Grinding wheel: Abrasive, grade structures, bond, specification, use, mounting and dressing. Selection of grinding wheels. Bench grinder parts and use. Radius/fillet gauge, feeler gauge, hole gauge, and their uses, care and maintenance. Interchange ability: Necessity in Engg, field defini-tion, BIS. Definition, types of limit, terminology of limits and fits - basic size, actual size, deviation, high and low limit, zero line, tolerance zone Different standard systems of fits and limits. British standard system, BIS system.

15. Method of expressing tolerance as per BIS Fits: Definition, types, description of each with sketch. Vernier height gauge: material construction, parts, graduations (English & Metric) uses, care and maintenance. Pig Iron: types of pig Iron, properties and uses. Cast Iron: types, properties and uses Wrought iron:- properties and uses. Steel: plain carbon steels, types, properties and uses. Non-ferrous metals (copper, aluminium, tin, lead, zinc) properties and uses.

16. Simple scraper- flat, half round, triangular and hook scraper and their uses. Blue matching of scraped surfaces (flat and curved bearing surfaces). Testing scraped surfaces: ordinary surfaces without a master plate. Vernier micrometer, material, parts, graduation, use, care and maintenance. Calibration of measuring instruments. Introduction to mechanical fasteners and its uses. Screw thread micrometer: Construction, graduation and use. Dial test indicator, construction, parts, material, graduation, Method of use, care and maintenance. Digital dial indicator. Comparators-measurement of quality in the cylinder bores.

17. Safely precautions to be observed while working on a lathe, Lathe specifications, and constructional features. Lathe main parts descriptionsbed, head stock, carriage, tail stock, feeding and thread cutting mechanisms. Holding of job between centres, works with catch plate, dog, simple description of a facing and roughing tool and their applications.

18. Lathe cutting tools Nomenclature of single point & multipoint cutting tools, Tool selection based on different requirements and necessity of correct grinding, solid and tipped, throw away type tools, cutting speed and feed and comparison for H.S.S., carbide tools. Use of coolants and lubricants.

19. Chucks and chucking the independent four-jaw chuck. Reversible features of jaws, the back plate, Method of clearing the thread of the chuck mounting and dismounting, chucks, chucking true, face plate, drilling - method of holding drills in the tail stock, Boring tools and enlargement of holes. General turning operations parallel or straight, turning. Stepped turning, grooving, and shape of tools for the above operations. Appropriate method of holding the tool on tool post or tool rest, Knurling: - tools description, grade, uses, speed and feed, coolant for knurling, speed, feed calculation. Taper – definition, use and method of expressing tapers. Standard tapers-taper, calculations Morse taper.

20. Square, worm, buttress, acme (nonstandard-screw threads), Principle of cutting screw thread in centre lathe – principle of chasing the screw thread – use of centre gauge, setting tool for cutting internal and external threads, use of screw pitch gauge for checking the screw thread.

21. Maintenance -Total productive maintenance - Autonomous maintenance -Routine maintenance. -Maintenance schedule -Retrieval of data from machine manuals Preventive maintenance objective and function of Preventive maintenance, section inspection. Visual and detailed, lubrication survey, system of symbol and colour coding. Revision, simple estimation of materials, use of handbooks and reference table. Possible causes for assembly failures and remedies. Installation, maintenance and overhaul of machinery and engineering equipment.

22. Assembling techniques such as aligning, bending, fixing, mechanical jointing, threaded jointing, sealing, and torqueing. Dowel pins: material, construction, types, accuracy and uses. Screws: material, designation, specifications, Property classes (e.g. 9.8 on screw head), Tools for tightening/ loosening of screw or bolts, Torque wrench, screw joint calculation uses. Power tools: its constructional features, uses & maintenance.

23. Locking device: Nuts- types (lock nut castle nut, slotted nuts, swam nut, grooved nut) Description and use. Various types of keys, allowable clearances & tapers, types, uses of key pullers. Special files: types (pillar, Dread naught, Barrow, warding) description & their uses. Templates and gauges Introduction, necessity, types.

24. Limit gauge: Ring gauge, snap gauge, plug gauge, description and uses. Description and uses of gauge- types (feeler, screw, pitch, radius, wire gauge). Slip gauge: Necessity of using, classification & accuracy, set of blocks (English and Metric). Details of slip gauge. Metric sets 46: 103: 112. Wringing and building up of slip gauge and care and maintenance. Application of slip gauges for measuring, Sine Bar- Principle, application & specification. Procedure to check adherence to specification and quality standards.

25. Lapping: Application of lapping, material for lapping tools, lapping abrasives, charging of lapping tool. Surface finish importance, equipment for testing- terms relation to surface finish. Equipment for tasting surfaces quality – dimensional tolerances of surface finish. Honing: Application of honing, material for honing, tools shapes, grades, honing abrasives. Frosting- its aim and the methods of performance. Metallurgical and metal working processes such as Heat treatment, various heat treatment methods - normalizing, annealing, hardening and tempering, purpose of each method, tempering colour chart. Annealing and normalizing, Case hardening and carburising and its methods, process of carburising (solid, liquid and gas). Tapers on keys and cotters permissible by various standards

26. The various coatings used to protect metals, protection coat by heat and electrical deposit treatments. Treatments to provide a pleasing finish such as chromium silver plating, nickel plating and galvanizing. Gauges and types of gauge commonly used in gauging finished product-Method of Selective assembly 'Go' system of gauges, hole plug basis of standardization. Bearing-Introduction, classification (Journal andThrust), Description of each, ball bearing: Single row, double row, description of each, and advantages of double row.

27. Roller and needle bearings: Types of roller bearing. Description & use of each. Method of fitting ball and roller bearings. Bearing metals – types, composition and uses. Synthetic materials for bearing: The plastic laminate materials, their properties and uses in bearings such as phenolic, Teflon polyamide (nylon). The importance of keeping the work free from rust and corrosion.

28. Pipes and pipe fitting commonly used pipes. Pipe schedule and standard sizes. Pipe bending methods. Use of bending fixture, pipe threads- Std. Pipe threads Die and Tap, pipe vices. Use of tools such as pipe cutters, pipe wrenches, pipe dies, and tap, pipe bending machine etc. Standard pipe fitting Methods of fitting or replacing the above fitting, repairs and erection on rainwater drainage pipes and household taps and pipe work. Inspection & Quality control -Basic SPC -Visual Inspection. Drilling jig-constructional features, types and uses. Fixtures-Constructional features, types and uses.

29. Aluminum and its alloys. Uses, advantages and disadvantages, weight and strength as compared with steel. Non-ferrous metals such as brass, phosphor bronze, gunmetal, copper, aluminum etc. Their composition and purposes, where and why used, advantages for specific purposes, surface wearing properties of bronze and brass. Power transmission elements. The object of belts, their sizes and specifications, materials of which the belts are made, selection of the type of belts with the consideration of weather, load and tension methods of joining leather belts. Vee belts and their advantages and disadvantages, use of commercial belts, dressing and resin creep and slipping, calculation.

30. Power transmissions-coupling types-flange coupling,-Hooks coupling universal coupling and their different uses. Pulleys-types-solid, split and 'V' belt pulleys, standard calculation for determining size crowning of faces-loose and fast pulleys-jockey pulley. Types of drives-open and cross belt drives. The geometrical explanation of the belt drivers at an angle. Power transmission –by gears, most common form spur gear, set names of some essential parts of the set-The pitch circles, Diametral pitch, velocity ratio of a gear set. Helical gear, herring bone gears, bevel gearing, spiral bevel gearing, hypoid gearing, pinion and rack, worm gearing, velocity ratio of worm gearing.

31. Repair of gear teeth by building up and dovetail method. Method or fixing geared wheels for various purpose drives. General cause of the wear and tear of the toothed wheels and their remedies, method of fitting spiral gears, helical gears, bevel gears, worm and worm wheels in relation to required drive. Care and maintenance of gears.

32. Fluid power, Pneumatics, Hydraulics, and their comparison, Overview of a pneumatic system, Boyle's law. Overview of an industrial hydraulic system, Applications, Pascal's Law. Compressed air generation and conditioning, Air compressors, Pressure regulation, Dryers, Air receiver, Conductors and fittings, FRL unit, Applications of pneumatics, Hazards & safety precautions in pneumatic systems. Pneumatic actuators:- Types, Basic operation, Force, Stroke length, Single-acting and double acting cylinder. Pneumatic valves:- Classification, Symbols of pneumatic components, 3/2- way valves (NO & NC types) (manually-actuated & pneumatically actuated) & 5/2-way valves, Check valves, Flow control valves, One-way flow control valve Pneumatic valves: Rollervalve, Shuttle valve, Two pressure valve Electro-pneumatics: Introduction, 3/2-way single solenoid valve, 5/2-way single solenoid valve, 5/2-way double solenoid valve, Control components - Pushbuttons (NO & NC type) and Electromagnetic relay unit, Logic controls.

33. Symbols of hydraulic components, Hydraulic oils – function, properties, and types, Contamination in oils and its control. Hydraulic Filters – types, constructional features, and their typical installation locations, cavitation, Hazards & safety precautions in hydraulic systems. Hydraulic reservoir & accessories, Pumps, Classification – Gear/vane/piston types, Pressure relief valves – Direct acting and pilot-operated types. Pipes, tubing, Hoses and fittings – Constructional details, Minimum bend radius, routing tips for hoses. Hydraulic cylinders –Types - Hydraulic motors – Types. Hydraulic valves: Classification, Directional Control valves – 2/2- and 3/2-way valves.

34. Hydraulic valves: 4/2- and 4/3-way valves, Centre positions of 4/3-way valves. Hydraulic valves: Check valves and Pilot-operated check valves, Load holding function. Flow control valves: Types, Speed control methods – meter-in and meter-out malfunctions due to contamination, leakage, friction, improper mountings, cavitation, and proper sampling of hydraulic oils.

35. Importance of Technical English terms used in industry-Technical forms, process charts, activity logs, in required formats of industry, estimation, cycle time, productivity reports, job cards. Method of lubrication-gravity feed, force (pressure) feed, splash lubrication. Cutting lubricants and coolants: Soluble off soaps, sudsparaffin, soda water, common lubricating oils and their commercial names, selection of lubricants. Clutch: Type, positive clutch (straight tooth type, angular tooth type). Washers-Types and calculation of washer sizes. The making of joints and fitting packing. Chains, wire ropes and clutches for power transmission. Their types and brief description.

36. Lubrication and lubricants purpose of using different types, description and uses of each type. Method of lubrication. A good lubricant, viscosity of the lubricant, Main property of lubricant. How a film of oil is formed in journal Bearings. Foundation bolt: types (Lewis cotter bolt) description of each erection tools, pulley block, crowbar, spirit level, Plumb bob, wire rope, manila rope, wooden block. The use of lifting appliances, extractor presses and their use. Practical method of obtaining mechanical advantage. The slings and handling of heavy machinery, special precautions in the removal and replacement of heavy parts.

37. Engineering Drawing: Introduction to Engineering Drawing and Drawing Instruments –Conventions: Sizes and layout of drawing sheets, Title Block, its position and content, Drawing Instrument. Lines- Types and applications in drawing Free hand drawing of Geometrical figures and blocks with dimension, Transferring measurement from the given object to the free hand sketches. Free hand drawing of hand tools and measuring tools. Drawing of Geometrical figures: Angle, Triangle, Circle, Rectangle, Square, Parallelogram .Lettering & Numbering – Single Stroke. Dimensioning, Types of arrowhead, Leader line with text, Position of dimensioning (Unidirectional, Aligned). Symbolic representation – Different symbols used in the related trades. Concept and reading of Drawing in Concept of axes plane and quadrant, Concept of Orthographic and Isometric projections. Method of first angle and third angle projections (definition and difference).

38. Reading of Job drawing of related trades. Reading of drawing of nuts, bolt, screw thread, different types of locking devices e.g., Double nut, Castle nut, Pin, etc. Reading of foundation drawing. Reading of Rivets and riveted joints, welded joints. Reading of drawing of pipes and pipe joints. Reading of Job Drawing, Sectional View & Assembly view.

39. Mass, Weight, Volume and Density: Mass, volume, density, weight and specific gravity. Related problems for mass, volume, density, weight and specific gravity, Speed and Velocity, Work, Power and Energy: Work, power, energy, HP, IHP, BHP and efficiency,

40. Heat & Temperature and Pressure: Concept of heat and temperature, effects of heat, difference between heat and temperature, boiling point & melting point of different metals and non- metals. Concept of pressure - Units of pressure, atmospheric pressure, absolute pressure, gauge pressure and gauges used for measuring pressure. Basic Electricity: Introduction and uses of electricity, molecule, atom, how electricity is produced, electric current AC,DC their comparison, voltage, resistance and their units. Levers and Simple machines: Simple machines - Effort and load, mechanical advantage, velocity ratio, efficiency of machine, relationship between efficiency, velocity ratio and mechanical advantage.

41. Friction: Advantages and disadvantages, Laws of friction, co- efficient of friction, angle of friction, simple problems related to friction. Friction – Lubrication. Friction - Co- efficient of friction, application and effects of friction in workshop practice. Centre of gravity: Centre of gravity and its practical application Area of cut out regular surfaces and area of irregular surfaces. Area of cut out regular surfaces - circle, segment and sector of circle. Related problems of area of cut out regular surfaces - circle, segment and sector of circle. Area of irregular surfaces and application related to shop problems. Elasticity: Elastic, plastic materials, stress, strain and their units and young's modulus, Elasticity - Ultimate stress and working stress. Heat Treatment: Heat treatment and advantages, Heat treatment - Different heat treatment process – Hardening, tempering, annealing, normalizing and case hardening.

42. Estimation and Costing: Estimation and costing - Simple estimation of the requirement of material etc., as applicable to the trade. Estimation and costing - Problems on estimation and costing.

TRADE: INSTRUMENT MECHANIC
SYLLABUS FOR TRADE TEST

1. List of tools & Machinery used in the trade. Personal Protective Equipment (PPE). First Aid Method and basic training. Safe disposal of waste materials like cotton waste, metal chips/burrs etc. Hazard identification and avoidance. Safety signs for Danger, Warning, caution & personal safety message. Preventive measures for electrical accidents & steps to be taken in such accidents. Use of Fire extinguishers.

2. Practice and understand precautions to be followed while working in fitting jobs. Safe use of tools and equipments used in the trade. Demonstration and uses of hand tools- screwdrivers, pliers, spanners, tweezers, tester, wire stripper, electrician knife, steel rule, scriber, punches, hammer. Identification of tools & equipments as per desired specifications for marking & sawing. . Visual inspection of raw material for rusting, scaling, corrosion etc.

3. Filing- flat & square (Rough finish). Filing practice, surface filing, side and checking 900 by try square. Marking out lines, filling and saving use of vice to given dimensions. Filing- Flat, square and Parallel to an accuracy of 0.5mm. Use and care non precision instruments such as different types of callipers, gauges, and making tools.

4. Practice of marking and measurement with combination set. File radios along a marked line (convex and concave) and match. Check the internal and external radius of curved surface by radius gauge. Identify and use of various types of Fasteners & Fastening devices. Measurement of Length, Height & Diameter by Vernier callipers and Micrometers. Determine positional errors of surfaces and measurements of deformation using dial test indicator.

5. Carry out maintenances, servicing and calibration Precision Measuring Instruments. Familiar with drilling machine operation, care and use. Select drill bits, reamers and tapes. Drill through holes and blind holes. Form internal thread with taps to standard size (Through holes & blind holes). Form external thread with dies to standard size. Flaring of tube and tube joints. Cutting and threading of tube length.

6. Fitting of tube and per sketch observing conditions used for tube work. Bending of tube cold and hot. Fit and assemble tubes, PI arc and ferrule fittings. Test leakage and functionality of PI arc and ferrule. Identify the Phase, Neutral and Earth on power socket, use a tester to monitor AC power. Construct a test lamp and use it to check mains healthiness. Measure the voltage between phase and ground and rectify earthing. Identify and test different AC mains cables. Prepare terminations, skin the electrical wires /cables using wire stripper and cutter. Measure the gauge of the wire using SWG and outside micrometre. find current carrying capacity of wires. Measure AC and DC voltages using multi meter.

7. Use the multi meter to measure the various functions (AC V, DC V, DC I, AC I, R). Identify the different types of meter for measuring AC & DC parameters. Identify the different types of passive electronic components. Measure the resistor value by colour code and verify the same by measuring with multi-meter. Identify resistors by their appearance and check physical defects. Soldering on IC bases and PCBs. De-soldering using pump and wick. Join the broken PCB track and test.

8. Measurement of parameters in combinational electrical circuit by applying Ohm's Law for different resistor values and voltage sources. Measurement of current and voltage in electrical circuits to verify Kirchhoff's Law. Verify laws of series and parallel circuits with voltage source in different combinations. Measure the resistance, Voltage, Current through series and parallel connected networks using multi meter. Identify the primary and secondary cells.

9. Measure and test the voltages of the given cells/battery using analog/digital multi-meter. Charging and discharging the battery and Maintain the secondary battery. & Use a hydro meter to measure the specific gravity of the secondary battery. Dismantle and identify the different parts of a relay. Connect a timer relay in a circuit and test for its working. Connect a contactor in a circuit and test for its working. Construct and test series and parallel resonance circuit.

10. Identify and use SPST, SPDT, DPST, DPDT, tumbler, push button, toggle, piano switches used in electronic industries. Make a panel board using different types of switches for a given application. Wind a solenoid and determine the magnetic effect of electric current. Identify various conduits and different electrical accessories. Cutting, threading of different sizes & laying Installations.

11. Draw layouts and practice in PVC Casing-capping, Conduit wiring with minimum to a greater number of points of minimum 15 mtrs. length. Wire up PVC conduit wiring to control one lamp from two different places. Draw layouts and practice Wiring for instrument panel. Identify the different types of inductors. Measure the inductor value by written/colour code and verify the same by measuring with LCR meter. Identify inductor by their appearance and check physical defects. Measure quality factor of inductors in series and parallel circuits with voltage source in different combination.

12. Identify the different types of capacitor and check by multi-meter whether open or short. Identify capacitor by their appearance and check physical defects. Measure charge, energy store tof capacitor in series and parallel circuits with voltage source in different combination. Construct and test RC time constant circuit. Identify the different capacitors and measure capacitance of various capacitors using LCR meter. Measure capacitive and inductive reactance with increase/decrease the input frequency of the circuit. 83. Measure current & voltage and determine the characteristics of RL, RC and RLC in AC series circuits.

13. Measure the resonance frequency in AC series circuit and determine its effect on the circuit. Measure current & voltage and determine the characteristics of RL, RC and RLC in AC parallel circuits. Measure the resonance frequency in AC parallel circuit and determine its effects on the circuit. Measure Current, voltage, power, energy and power factor in three phase circuits.

14. Identify parts and terminals of different types of single-phase AC motors. Install, connect and determine performance of single-phase AC motors. Start, run and reverse the direction of rotation of single-phase AC motors. Practice on speed control of single-phase AC motors. Identify parts and terminals of different types of single-phase DC motors. Install, connect and determine performance of single-phase DC motors. Start, run and reverse the direction of rotation of single-phase DC motors.

15. Install an alternator, identify parts and terminals of alternator. Connect, start and run an alternator and build up the voltage. Perform speed control of DC motors - field and armature control method. Connect, start and run three phase induction motors by using DOL, star-delta and auto-transformer starters. Identify parts and terminals of different type of stepper motors. Verify terminals, identify components and calculate transformation ratio of single-phase transformers.

16. Identify the primary and secondary transformer windings, test the polarity and Measure the primary and secondary voltage of different transformers. Perform OC and SC test to determine and efficiency of single phase transformer. Determine voltage regulation of single-phase transformer at different loads and power factors. Verify and measure voltage regulation of auto transformer at different loads. Perform series and parallel operation of two single phase transformers.

17. Identify the terminals and measure voltage & current of PT and CT transformer. Familiar with absolute and different types of secondary instruments. Identify the instrument specification and internal construction. Overhaul, check, fault find, repair, test of voltmeter and ammeter.

18. Identify different types of torques. Install, wire up and test the spring control and gravity control operation. Familiar with damping and identify various functional element like- air friction damping, fluid friction damping and eddy current damping. Study the construction circuit operation and adjustment for correct functioning of zero errors on voltmeter and ammeter. Identify different parts, its function and operation of PMMC instruments.

19. Find the minimum and maximum measurable range of the meter. Check the accuracy, sensitivity and maximum power capability of ammeter & voltmeter. Test the shunt and series resistance of various range of ammeter. . Practice multipliers for different range extension of voltmeter and ammeter. Determine errors in meter movement and find the resistance.

20. Identify the different types of Ohm meter. Test and calibrate of various type of Ohm meter. Prepare pipe earthing and measure earth resistance by earth tester/ megger. Prepare plate earthing and measure earth resistance by earth tester/ megger. Test earth leakage by ELCB and relay.

21. Identify different parts, its function and operation of Dynamometer type instrument and MI. Overhaul, check and fault find of Dynamometer type instrument. Test and calibrate Dynamometer type instrument. Measure the power using wattmeter. Test and calibrate wattmeter. Familiar with the construction of energy meter and ampere hour meter. Overhaul, check and fault find of ampere hour meter. Test and calibrate ampere hour meter.

22. Measure power in single and three phase circuit using voltmeter &ammeter. Overhaul and maintenance of KWH meter and energy meter. Test and calibrate KWH meter and energy meter. Measure power factor in three phase circuit by using power factor meter and verify the same with voltmeter, ammeter and wattmeter readings.

23. Use voltage tester to Test electrical power in circuit, to test for proper grounding, to determine whether adequate voltage is present in a wire. Test continuity of wires, circuit and switches using continuity tester. Used rotation tester to: - determine 3 phase indication; Indication of phase rotation and Indication of motor rotation direction of running motor.

24. Determines the phase sequence of the three-phase supply system using Phase sequence indicator. Identify different parts of frequency meter and Measure the frequency of a periodic electrical signal. Identify different parts of frequency meter AND Measure the frequency of a periodic electrical signal. Identify different parts /section; check its function and operation of phase sequence meter and synchronoscope. To use Synchroscope for synchronizing the electrical machines.

25. Identify different types of diodes, diode modules and their specifications. Test the power diode, Zener diode, tunnel diode, photo diode using multi meter and determine forward to reverse resistance ratio. Determine V-I characteristics of semiconductor diode. Measure the voltage and current through a diode in a circuit and verify its forward characteristic. Measure the voltage and current through a Zener diode in a circuit and verify its forward and reverse characteristic. Identify and check different type of transistors their package and specification.

26. Construct and test fixed-bias, emitter-bias and voltage divider-bias transistor amplifier. Construct and Test a common emitter amplifier with and without bypass capacitors. Construct and Test common base amplifier. Construct a single stage amplifier and measure current gain, voltage gain & power gain.

27. Identify different power electronic components, their specification and terminals. Construct and test a FET Amplifier. Identify various Power MOSFET by its number and test by using multimeter. Identify different heat sinks used with power MOSFET test circuit with a small load. Identify different types of transformers and test.Identify the primary and secondary transformer windings and test the polarity. Construct and test a half wave, full wave and Bridge rectifier circuit.

28. Construct and test different filter circuit used in rectifier and measure output voltage with load. Measure ripple voltage, ripple frequency and ripple factor of rectifiers for different load and filter capacitors. Construct and test voltage doubler and Tripler. Construct and test Zener based voltage regulator circuit. Construct and test Zener based shunt regulator. Construct and test Zener and transistor-based series regulator. Construct and test a +12V fixed voltage regulator. Construct and test a fixed +15ve and –15ve voltage regulator using ICs. Construct and test a 1.2V – 30V variable output regulated power supply using IC LM317T and its characteristics.

29. List the defect and symptom in the faulty SMPS. Measure / Monitor major test points of computer SMPS. Troubleshoot the fault in the given SMPS unit. Rectify the defect and verify the output with load. Record your procedure followed for trouble shooting the defects. Identify front panel control & indicators of UPS. Open top cover of a UPS; identify its isolator transformers, the UPS transformer and various circuit boards in UP. Perform load test to measure backup time. Install and test an inverter. Troubleshoot the fault in the given inverter unit. Rectify the defects and verify the output with load.

30. Construct and test thyristor-based devices and check SCR, DIAC, TRIAC and other discrete components. Measure and plot input and output characteristics of a CE amplifier. Check for cold continuity of PCB. Solder the SMD components from the given PCB. De-solder the SMD components in the same PCB. Identify loose /dry solder, broken tracks on printed wired assemblies. Repair solder mask and damage pad. Construct and test a CE amplifier and measure the AC & DC load line.

31. Oscillators: Demonstrate Colpitts oscillator, Hartley oscillator circuits and compare the output frequency of the oscillator by CRO. Construct and test a RC phase shift oscillator circuits. Construct and test a crystal-controlled oscillator circuit.Construct and test a clapp oscillator circuits. Construct and test different type of ICs based Oscillator circuit. Use analog IC tester to test the various analog ICs. Construct and test various Op-Amp circuits Inverting, Non- inverting and Summing Amplifiers.

32. Construct and test Differentiator and Integrator circuits. . Construct and test a voltage to current and current to voltage converter circuit using Op-amp. Construct and test Instrumentation amplifier. Identify the pin configuration and check the output voltage of the pins. Construct and test Astable timer circuit using IC 555. Construct and test mono stable timer circuit using IC 555. Construct and test VCO (V to F Converter) using IC 555. Construct and test 555 timers as pulse width modulator. Construct and test automatic delay on circuit using 555 IC and other discrete components.

33. Identify different Logic Gates (AND, OR, NAND, NOR, EX-OR, EX-NOR, NOT ICs) by the number printed on them. Verify the truth tables of all Logic Gate ICs by connecting switches and LEDs. Construct and verify the truth table of all the gates using NAND and NOR gates. Use digital IC tester to test the various digital ICs (TTL and CMOS). Construct and verify the truth table of all the gates using DTL circuit. Construct Half Adder circuit using ICs and verify the truth table.

34. Construct Full adder with two Half adder circuit using ICs and verify the truth table. Construct Half subtractor and full subtractor circuit using ICs and verify the truth table. Construct the adder cum subtractor circuit and verify the result. Identify different Flip-Flop (ICs) by the number printed on them. Construct and test R-S flip-flop using IC7400 with clock and without clock pulse. Verify the truth tables of JK Flip-Flop using ICs by connecting switches and LEDs.

35. Construct and test 7493 as a modulus-12 counter. Construct and test a four-bit Synchronous binary counter using 74163. Construct and test synchronous Decade counter. Construct and test an up/down synchronous decade counter using 74190 and monitor the output on LEDs. Construct and test a multiplexer and de-multiplexer circuit using ICs. Identify and test common anode and common cathode seven segment LED display using multi meter.

36. Construct and test octal to binary encoder & decoder circuit using IC 74148 and IC 74132. Construct and test decimal to BCD encoder using IC 74147 and seven segment LED display. Construct and test seven segment LED display decoder with IC 7447.Measure current flowing through a resistor and display it on LED Module.Identify different parts, its function and operation of LCD, CRT, Electro-luminescent displays, electro-phoretic image display, liquid vapour display and dot metrix display.

37. Identify different parts, its function, operation &specification of D/A and A/D circuits. Construct and test Digital to Analog (D/A) Binary Weighted resistor converter by using op-amps. Construct and test Digital to Analog (D/A) converter using R-2R ladder network circuit. Construct and test Digital Ramp Analog to Digital Converter (ADC) circuit. Perform the interfacing of IEEE 488.2 standard with a single controller can control up to 15 different instrument connected star topology.

38. Identify different pins, signal and source of RS232. Perform the interfacing of RS232 to the PC. Convert RS-485 signals to RS-232 signals using RS-485 to RS- 232 converter. Identify different parts, its function and operation of frequency meter, phase measuring meter, time measuring instrument and digital capacitance meter. Identify LED Display module and its decoder/driver ICs. Display a word on a two-line LED. Measure/current flowing through a sensor and display it on a LED module (DPM). Measuring instruments in single and three phase circuits e.g. Phase sequence meter and Frequency meter etc.

39. Identify the different capacitors and measure capacitance of various capacitors using digital capacitance meter. Time measuring instrument to measure the time in different electrical control circuit. Identify the different front panel control of a CRO. Measure the Amplitude, Frequency and time period of typical electronic signals using CRO. Take a print of a signal from DSO by connecting it to a printer and tally with applied signal. Identify different types of CRO probes used to measure the signals.

40. Identify PC components and devices, windows interface and navigating windows. Customize the desktop settings and manage user accounts. View system properties and control panel details. Install necessary application software for windows i.e. office package and media player. Familiar with Multi Media System consisting of CD ROMS, DVD ROMS, Sound Cards. Burn data, video and audio files on CD/DVD using application software. Identify different parts, its function and operation of CPU. Familiar with different CPU operations.

41. Identify various computer peripherals and connect it to the system. Dismantle and assemble the desktop computer system. Replace RAM and ROM from CPU. Install driver for printer and print document using different commands. Identify different parts, its function and operation of modem. Install a modem to the computer to send and receive data over a telephone line or a cable or satellite connection. Construct and test DAC and ADC using computer network circuit.

42. Identify various ICs & their functions on the given Microprocessor Kit. Identify the address range of RAM & ROM. Measure the crystal frequency, connect it to the processor. Identify the port pins of the processor & configure the ports for Input & Output operation. Use 8085 microprocessor, connect 8 LED to the port, blink the LED with a switch. Familiar with instruction set of 8085 microprocessor Data transfer group, Arithmetic group and Logic group. Perform addition and subtraction of two 8-bit numbers using 8085 microprocessors.

43. Demonstrate entering of simple programs, execute &monitor the results. Write a programme in assemble language load accumulator with 8-bit data and transfer the data accumulator to B register. Write a programme in a assemble language data to load two 8-bit data into two memory location add them result be store in another memory location.Identify different parts, pins diagram, function and operation of 8255.Identification of various instruments by their specifications.

44. Finding the range, span and accuracy of instrument (example- ammeter, voltmeter etc.).Identifying the measuring units of instrument and Calculating resolution, multiplication factor of meter (multi-range meter or analog multi-meter). Test the voltmeter/ammeter using std. voltage/ current source for total range. Check the dead zone, repeatability, reproducibility, drift, Dead band, backlash, hysteresis.Check the speed of response and lag of measuring instruments. Identify the strain gauge type, cantilever or load cell specification. Check the strain gauge using ohm meter / multimeter. Measure the load using strain gauge instrument. [using half (two), quarter(one), full (four) strain gauges on bridge]. Determine the sensitivity, liner range of strain gauge measurement. Make null balance and gain adjustment. Calibrate strain gauge instrument by adjusting zero and span.

45. Identifying the various parts of LVDT. Study the specification of LVDT like range, exiting frequency, voltage, sensitivity etc.Identifying the coils in LVDT. Verifying the connection of secondary coils. Testing the LVDT coils using multimeter. Verify the LVDT characteristics by changing the displacement. Determine the liner range and sensitivity, resolution of LVDT. Measure the phase difference of LVDT secondary coils on CRO. Calibrate the LVDT by adjusting zero and span.

46. Identify Construction &Operation of instruments used for Displacement, Acceleration, and Thickness. Test and calibrate displacement meter, accelerometer and thickness instruments. Identify different parts, its function &Operation of vibrometers and accelerometer and Study of Construction.

47. Measure the vibration of motor/ machine. Servicing and maintenance vibrometers & accelerometer. Identify different parts, its function &Operation of mechanical tachometer and Study Construction. Measure the speed of motor. Identify different parts, its function &Operation of eddy current, type AC and DC tachometer. Servicing and maintenance of mechanical and electrical tachometer.

48. Identify different parts/section, its function &Operation and use Stroboscope and find motion of object. Familiar with different unit of pressure and conversion. Study the specifications, construction and identifying various parts of android barometer. Measure the atmospheric pressure using barometer. Check the changes in barometer by applying the air using suction and blow pumps (simple pumps). Identify the various types of manometers. Identify specification and construction of each manometer and find their range, scale type, resolution, type of liquid using, tube material, isolation valve types, fitting types and sizes, zero adjustment and spirit bubbler etc.

49. Measure the differential pressure, gauge pressure and vacuum pressure using U tube manometer.Measure gauge and vacuum pressure using well type and inclined manometer. Dismantle and assemble the manometer. Cleaning the glass tube, aligning the gravity balances etc. Calibrate the manometer using standard gauge.

50. Identify the various types of pressure gauges – gauge pressure, vacuum pressure, absolute, compound etc. Identify the basic specifications of gauge like range, resolution, size of dial, type of sensor (symbol), sealed type, liquid filled or dry, number scales, connection type, threading size and type- (male, female NPT/SAE), body material, mounting type (back or bottom) etc. Dismantle and assemble the pressure gauge (bourdon tube, diaphragm type), Identify the various parts like sensing element, link, liver, pinion gear, hair spring, pointer size shape material, sensor material etc.

51. Measurement of gauge pressure and vacuum pressure using bourdon tube / diaphragm gauge. Measurement of differential pressure using diaphragm/ capsule gauge. Identify specifications of pressure switch – range, differential pressure span, contact types, contacts current rating, number of contacts etc. Dismantle and assemble the pressure switch – identify the various parts- sensing elements, control spring, pressure and differential pressure adjustment screws, shaft arrangement pivoting, contacts relay operation and change of contacts. Type of material using for various parts etc. Connect and operate the pressure switch with load at various pressure and differential pressure settings. Make adjust the errors screws. Identify the basic specifications of pressure indictor/ transmitter (electronic) like range, resolution, size of display, type of sensor (symbol), sealed type, number scales, connection type, tap threading size and type- (male, female NPT/SAE), body material, mounting type (back or bottom) etc.

52. Test and operating the pressure transmitter with supply, milli ammeter, pressure source (pneumatic/hydraulic). Finding the resolution, accuracy etc. Familiar with pressure calibrator controls and settings. 328. Calibrating the pressure gauge using standard meter/ pressure calibrator. Measuring gauge, vacuum and differential pressure using DP transmitter. Calibrating the DP transmitter using standard meter / pressure calibrator.

53. Study the specification, construction and identification of various parts in Mcleod Gauge. Measuring low pressure/ vacuum using McLeod gauge. Study construction, Operation and use of thermal conductivity gauges& measure the vacuum. Study construction, & Operation of pirani gauges, & measure the vacuum. Study   specifications, construction, Operation of Standard Calibrator/Dead weight Tester.

54. Test & calibrate of Pressure gauges, indicators, transmitters with Dead Weight Tester. Test & calibrate of Pressure gauges, indicators, transmitters with comparator Tester. Familiar with pressure Installation components, impulse line, safety guideline and accessories. Installation of pressure gauge in pipeline with safety valve and pig tail /siphon etc. measuring pressure in flow line. Installation and testing of pressure switch and pressure relief valve with compressor. Installation and testing of pressure switch with solenoid and alarm in process line. Fault finding in pressure gauge. Simple fault finding in pressure transmitter. Fault finding in pressure process line.

55. Familiar with flow units on instruments and converting in various forms. Familiar with specifications of flow meter. Measurement of pressure in flow line with different flow rates. Measurement of flow rate using fixed volume tank. Operating fluid pump and observing the pressure at input and output. verifying flow variation by adjusting bypass line. Study the construction of venturi tube. Measuring inlet outlet thought, tap sizes. Identifying material end connection types etc. Identifying various types of orifices. Identifying various parts. Identifying the flow nozzle and identifying various parts. Identifying the pitot tube and its parts.

56. Measurement of DP of venturi and orifice using manometer. Measurement of DP using DP gauge. Adjusting the valves of manifold and observing the changes in DP gauge. Calibrating the pneumatic DP transmitter for flow rate measurement. Calibration electronic DP transmitter for flow rate. Verifying the square root relation and linear relation of DP. Installing a head type flow meter with venturi or orifice, manifold and DP, milli ammeter or indicator, supply. Measuring flow rate in line. Calibrating head type flow meter with standard volumetric tank.

57. Dismantling, checking, overhauling and calibration of D.P. cell/ transmitter. (Pneumatic & electronic). Identify and carry out preventive maintenance. Study of construction of weirs, notches and flumes their shape and connections and use. Study of construction and identifying various parts of rotameter. Dismantling, checking overhauling and calibration of Rota meters. Identify and carry out preventive maintenance of Rota meters. Install and testing of Rota meters in flow line. Vertical alignment. Measurement of flow rate and calibrating rotameter.

58. Identification of various types of quantitative flow meter. Read the specification of various types of positive displacement meters. Dismantle, identify different parts, its function, AND operation of various types of positive displacement meters. Study the dial of flow meters and calculating flow indicated on display.

59. Installation, testing and calibrating quantitative flow meter. Dismantle and assemble quantitative flow meters like Oscillating piston type, Rotating vane meter, Lobed impeller andoval flow meter. Identify and carry out preventive maintenance of positive displacement flow meters.

60. Study the specifications, construction and identify the various parts of turbine, Vortex, Mass, Ultrasonic flow meter. Installation, testing and calibration of turbine, Vortex, Mass, Ultrasonic flow meter flow meter. Measuring semi solid liquid flow rate using flow meter. Calibrating and adjustment of flow meter for solid flow.

61. Identify and carry out maintenance& preventive maintenance of solid flow measuring system. Service and calibrate solid flow meter. Familiar with open and closed process vessel for liquid and solid measuring system. Measurement of liquid level using stick gauge and converting liquid level into volume and mass (using specific gravity).

62. Study the construction and operation of various types of sight glasses. Installation, testing and calibration of liquid level indicator. Cleaning the glass tube and operating the isolation valves, calibrating zero adjustments. Identify different parts, its function, and operation of various types of floats and displacers liquid level indicators.

63. Calibrating and Measuring the liquid level using float type, displacer type level systems. Identify test and use different types of level switches for liquid vessel. Identify and carry out maintenance& preventive maintenance of displacers liquid level indicators and switches. Measuring the liquid level of open and close tank using pressure / DP gauge. Converting liquid height into pressure using liquid density. Calibrating DP transmitter for liquid level measurement. Adjusting square root to linear scale display. Installation, testing measurement of liquid level using air purge level measurement. Service and calibrate different types level indicators and transmitters.

64. Identify and carry out maintenance& preventive maintenance of above level indicators and transmitters. Construct and operate conductivity probe Level indicator. Construction and operation of capacitance probes indicating transmitters and sonic level detector. Install and test capacitance probes indicating transmitters and sonic level detector. Service and calibrate capacitance probes indicating transmitters and sonic level detector.

65. Identify and carry out maintenance& preventive maintenance of above level indicators and transmitters. Study the construction, operation and use of load cell technique to determine solid level in vessel. Study the construction, operation and use of different types of solid level switches. Study the construction, and operation of capacitance probes transmitters, microwave level detector / gauges.

66. Install and test various types of solid level indicating transmitters and sonic level detector. Service and calibrate various types of solid level indicating transmitters and sonic level detector. Identify and carry out maintenance & Preventive maintenance of above level indicators and transmitters. Identifying temperature scales on instruments and their ranges Familiar with different unit of temperature and conversion into other.

67. Identify different types of heating sources and their controls and study the safety futures. Study the construction, operation and use of temperature- controlled oil bath/furnace for low and high temperature. Identify different types of thermometers and measure the temperature &Check the accuracy. Dismantling identify different parts, its function, adjustment, assemble and operation of Bimetallic and fluid filled (liquid, gas and vapour) system thermometers & thermo switches.

68. Install and test various types of thermometers and switches. Service and calibrate various types of thermometers and switches. Identify and carry out maintenance& preventive maintenance of thermometers and switches. Identify and check different types of RTD's, and Thermistors for temperature measurement. Verify the characteristics of different types of RTD's, and Thermistors. Study circuit operation of signal conditioner for RTD's, and Thermistors. Install and test various types of two and three wire RTD transmitters. Service and calibrate various types of RTD transmitters using temperature calibrator or resistors. Identify and carry out maintenance& preventive maintenance of various types of RTD transmitters.

69. Identify and check different types of Thermo-couples, Ex-tension wires and protecting wells.Verify the characteristics of different types of Thermocouples. Study circuit operation of signal conditioner for Thermocouples based indicator and transmitters. Install and test various types of Thermocouples based indicator and transmitters. Service and calibrate various types of Thermocouples based indicator and transmitters using temperature calibrator or milli volt source.

70. Identify and carry out maintenance& preventive maintenance. Construct and Operate Optical and Radiation pyrometer. Measure high temperature using Optical and Radiation pyrometer. Identify and carry out maintenance& preventive maintenance for Optical and Radiation pyrometer. Identify and check different types of humidity sensors. Measure the relative humidity using humidity sensors. Identify specifications, controls and construction of thermal imager. Measure the various points like motor, drilling point, hill person temperature etc. using thermal image.

71. Identify different types of recorders and their connections and controls. Practice recording of variable signal. Study the construction, operation and use of circular chart recorder for temperature or pressure or mV or mA. Study the construction, operation and use strip chart recorder- pneumatic and electronic recorders. Calibrating electronic recorder and pneumatic recorder. Overhaul, check, fault find, repair, test of pneumatic, electronic recorders. (single point &multipoint).

72. Study of paperless LCD/LED recorder. Identify and carry out maintenance& preventive maintenance. Identify different final control elements in process control loop. Identifying valve regulator, dismantlingand checking various parts. Study the specifications and construction of valve actuator. Installation and testing valve actuator (pneumatic) with control valve.

73. Calibrating valve positioner with control valve. Study the construction and specifications current to pressure converter. Calibrating current to pressure converter. Calibrating voltage to current converter.

74. Study the specifications and constructions of electro pneumatic positioner. Installation and testing electro pneumatic positioner with control valve. Calibrating electro pneumatic positioners with control valve. Dismantle, fault finding, repair, clean, reassemble and test of actuators and positioners. Identifying various pneumatic Piping tubing and fitting. Identifying various types of valves. Examine the specifications, construction and various parts of globe, ball, butterfly rotary, split body valves. Identify the cut sections of various types of control valves and identify internal parts and its function.

75. Record specification of linear, equal, percentage quick opening control valves. Record the characteristic of control valves. Remove and install control valves with service line. Dismantling, reconditioning, checking, replacing parts and resetting of control valves. Carry out maintenance of control valves.

76. Identifying the proximity switch and study the specifications, constructions, No. of contacts etc. Installation and testing micro and limit switches with the load. Verifying its function. Installation and testing capacitance or inductive proxy with the load (buzzer/ indicator etc). testing its function. Installation and testing, adjusting the range of IR or ultrasonic proxy with load. Installation of proxy with relay and operating high current load (like motor or AC lamp etc.).

77. Identify cut sections of various types of control valves. Identify Feed water control system. Identify final control elements in system and manually control feed water rate at desire value. Operate of, sequential. Control and block valves. Operate of electromechanical and solid-state relay. Service & test and use electromechanical and solid-state relay. Design and test sequential. Logic operation using relay.

78. Identify turbine control system operation. Familiar with process control system and identify various functional elements. Study construction & operation of thermostatic pressure and humidity switches. Service and maintenance above switches. Install, wire up and test the control operation. Study construction & operation of ON-OFF Electronic and pneumatic Controllers. Service and maintenance of ON-OFF Electronic and pneumatic Controllers.

79. Install, wire up, test and monitor the performance of control operation using ON-OFF Electronic and pneumatic Controllers. Practical on PID controller trainer on various process parameters. Study construction & operation of PID Electronic / DIGITAL Controllers. Service and maintenance of PID Electronic/DIGITAL Controllers. Install, wire up, Configure, test the control operation using PID Electronic / DIGITAL Controllers. Verify the steady state and transient responses of PID Electronic / DIGITAL Controllers in P, PI, PD, PID.

80. Study construction & operation of PID pneumatic Controllers. Service and maintenance of PID pneumatic Controllers. . Install, connect pneumatic signal, align and test the control operation using PID pneumatic Controllers. Verify the steady state and transient responses of PID pneumatic Controllers in P, PI, PD, PID.

81. Familiar with feed forward and feedback process control system check loop and identify various functional elements. Perform the control operation in manual and automatic mode. Familiar with Cascade and ratio process control system. Check loop and identify various functional elements. Perform the control operation in manual and automatic mode. Set "optimum setting for unit process in PID Controller (Electronic and pneumatic).

82. Identify each module in a rack and mount in the specified slot. Wire and connect the digital I/OS field devices to the I/O Module of PLC. Install PLC Programming software and establish communication with PC and PLC. Hardware configuration and Prepare the input and output addresses for each slot. Prepare and download ladder programs for various switching Gates.

83. Write and execute program logic control operation. Develop programs using arithmetic, / data copy operation and execute. Write and execute program on sequence control using timers and counters. Develop programs using shift bit operation. Interface analog I/p module of plc with sensor. Interface analog o/p module of plc with actuator, relay. Prepare programs based on on-delay and off-delay timers making on and off of a single LED taking one input and one output.

84. Two LEDs on and off using pushbutton as an input. first LED on for 3 sec and off for 2 sec, and second Led on for 2 sec and off for 3 sec for continuous cycle till stop is pressed. Sequencer task using three LEDs as output and two input pushbuttons one as input (NO) for start and other for stop (NO). Configuring the project using analog input and output instructions and implement a on off closed loop control for the given process.

85. Development of ladder logic for various tasks related to timers and counter based industrial applications. Development of the ladder logic for the running a traffic control with the different display indication. Familiar with facilities, function, operation and use HART communicators. Study the DD files and uploading DD files. Installing & Operating HART transmitters/devices (I/O). Creating tag, measuring the parameter, configuring the parameter values in Hart transmitter using communicator. Measure various trends.

86. Identify the cables and network components. Study various network lines. Preparation network cables and connectors. Testing network cables. Preparation of network cables - serial (RS232/485 standards or equivalent) and Ethernet. Connect network connectivity hardware and check for its functioning. Dismantle and assemble the desktop computer system. Study the operation of Pulse Code Modulation and Demodulation. Connect any one data output of the decade counter to the Data Inputs of the FSK Modulator and measure output waveform.

87. Identify and adjust the frequency of the sampling pulse generator and level of modulating signal to obtain the PWM waveform on CRO. Familiar with different faculties and function of DCS system. Identify the different modules of DCS and different process instruments in process plant. Wire and connect the I/O Module of DCS to field signals. Install DCS Programming software and establish communication with PC and DCS. Set the communication between DCS and SCADA System.

88. Concept of Tag/Points Generation. Attaching points to the display Element. Practice HMI, operator panel and touch panel operation and related software. Set up and configure HMI with PLC. Animate objects on a HMI screen to monitor motor status. Use security features to do tag logging and command execution.

89. Familiarization of - Hydraulics trainer and safety measure to handle hydraulic system. Practice symbolic representation of Hydraulic components. Familiar with hydraulic hoses and fitting. Feature and function of hydraulic pump, hydraulic accumulator and hydraulic power system.

90. Identification Hydraulic components and check its function. Service and test different types of valves. Design hydraulic circuit for double acting cylinder actuation. Calculation relating to cylinder motion.

91. Design hydraulic circuit using Pilot operated check valve, Pressure reducing Valve, Pressure relief & Pressure regulating valve, Pressure sequencing circuit and Pressure compensated flow control. Study construction operation and use of air compressor. Identify different devices in air Distribution system and study construction.

92. Operation and use of air filters, regulators and lubricator. Use of Pneumatic Piping, tubing and fitting. (Metallic and non-metallic.). Draw Symbolic representation of different Pneumatic components, various supply elements such as Compressors, pressure regulating valve, service unit etc. Set up a system to provide Pneumatic (air) supply of 20 psi output from the available compressor. Build a pneumatic circuit of a single acting cylinder being controlled by 3 way 2 position directional control valves. Build a pneumatic circuit of a double acting cylinder being controlled by 5 way 2 position directional control valves. Build a pneumatic AND, OR circuit by 3 way 2 position directional control valves to operate double acting cylinder. Build a pneumatic circuit of a pilot controlled double acting cylinder of being controlled by 3 way 2 position directional control valves and 5 way 2 positions valve. Build a pneumatic circuit to test logical latch circuit by 5 way 2 position, 3 way 2 valve direction control valves. Build a pneumatic circuit to control oscillation of piston by pilot operated 5 way 2 position, 3 way 2 direction control valves.

93. Cutting the metallic tube as per dimensions using tube cutter. Bending the tube in to 900and 450 using pipe bending tools. Installation of simple piping diagram. Study the circuit operation of pH meter conductivity meter and dissolved oxygen Meter. Wire up pH meter electrode to pH meter. Calibrate pH meter using buffer solution. Determination of pH (by pH meter). Wire up conductivity meter to electrode and find the electrolytic conductivity of solution. Service and maintenance of conductivity meter & Dissolved oxygen meter.

TRADE: INSTRUMENT MECHANIC
SYLLABUS FOR COMPETITIVE WRITTEN EXAMINATION

1. Elementary First Aid. Safety and hazards. Sign boards and types. Hazardous and nonhazardous. Environmental pollution related to the trade caused, consequences, mitigation and control. Basic hand tools, types, classification use & metal cutting fundamentals. Filing- Flat, square and Parallel to an accuracy of 0.5mm. Measurement & measuring instruments, marking tools, Fasteners & Fastening devices. Precision Measuring Instruments, gauge blocks, sine bar, dial indicators, vernier calipers, micrometers, bevel protractor, thickness gauges. Element & types of screw threads used in instruments, Calculation of drill size for tapping.

2. Types of tubes used for instrumentation. Tube cutter, flaring tools, swedging tools, equipment's & fixture required for pipe bending, straightening, thread cutting, method of installation. Electrical components conductor, semiconductor & insulators. Standard wire gauge (SWG). Introduction of electricity- static electricity. Current, voltage, P.D, E.M.F, resistance. Electrical circuit - D.C & A.C circuit differences. Importance of grounding. Electrical components conductor, semiconductor & insulators. Standard wire gauge (SWG).

3. Introduction of electricity- static electricity. Current, voltage, P.D, E.M.F, resistance. Elec- trical circuit - D.C & A.C circuit differences. Importance of grounding. Switches and types. Magnet and magnetism, magnetic properties. Magnetic campus and its uses. Explanation of Electro-magnetism, Advantages, disadvantages application-types E.M. relays.Types- uses of Solenoids. Circuit breakers and their working.

4. Principles of alternating current, AC & DC electricity, types of wave forms, time period and frequency, peak to peak values, RMS values, Average values. Inductor and Inductance, types of inductors, Factors affecting the value of inductance, selfinductance (L), Mutual inductance (M), Inductors in series and parallel, Q factor of the coil. Capacitance, types of capacitor, unit of capacit- ance, factors affecting the value of capacitors, charge, energy stored in capacitors. Capacitors in series and parallel. Capacitors in DC circuit, RC time constant. A.C.-impedance, Inductive reactance, capacitive reactance. AC current through - R, L, C circuits. Resonance in RLC circuit. Importance - of series and parallel resonance, properties. Impedance, Admittance, Q- factor. Introduction of AC and DC generators working principles, construction. Operation, field magnets, armature windings, commutator and brushes, EMF equation.

5. Faraday's Law, Lenz's Law, Fleming's left Hand and right-hand rules. DC motors working principles, construction, operation, types. Different speed controlling techniques of DC motors. AC motors, induction motors, three phase motors, stepper motors. Transformer, types, transformation ratio. Open circuit test and short circuit test, regulation Auto transformer. Current measurement. Instrument transformer. Potential transformer and current transformer. Basics of electrical measuring instruments. Types - absolute and secondary instruments. Types of secondary instruments, Essential of electrical measuring instruments deflecting torque, controlling torque, damping torque etc. Types of controlling torques-spring control, gravity control.

6. Types of damping - air friction damping, fluid friction damping, eddy current damping. DC instruments - 'D1 Arsonval meter, PMMC meter- working principle, method of working, moving coil operation. Construction-damping, magnetic shielding, bearings. Terminology -parallax error, (FSD) full scale deflection reading, measurement value, meter sensitivity, accuracy. Meter resistance, maximum power, capability etc. Ideal and practical characteristics of ammeter, voltmeter. Meter range extension- Converting galvanometer into ammeter, voltmeter. Range extension of voltmeter, ammeter. Shunt resistance and series resistance value calculation. Meter resistance, meter FSD identification techniques.

7. Ohm meters- measuring electrical resistance. Basic construction of Ohm meter, working method of ohmmeter. Types of Ohm meter - series and shunt type of ohm meters. Megger/insulation tester, earthtester - construction working advantages and disadvantages of various types of ohm meter. AC instruments-Types of AC measuring instruments - MI, electro dynamometer type, Working principle, construction, advantages and disadvantages of MI instruments and electro dynamometer instruments. Various applications.Electro dynamometer applications - as volt- meter, ammeter, power measuring instrument, energy measuring instrument, power factor meter etc. AC voltage and current measurement using PMMC meter (rectifier type).

8. Induction type meters-working principle construction and operation of induction type instruments. Construction and Applications - single phase and three phase energy meter, watt meter. Walt hour meter, Ampere Hour meter, power factor meter etc. Special instruments: voltage tester, continuity tester, rotation test, phase sequence indicator, synchronizing, the synchroscope, _ frequency meter. Thermocouple type ammeters. Semiconductor, Covalent bond, Doping,Intrinsic and extrinsic semiconductor. PN junction diode, Forward and Reverse characteristics. Specification of diodes (data sheets). Applications of diode. Special semiconductor diode-Zener diode, tunnel diode, Photo diode.

9. Transistors - Defining transistors, NPN& PNP transistor, Symbol, operation, Biasing of Transistor & mode of Application. Transistor CB, CC, CE Amplification, current gain, voltage gain, and power gain. Introduction to FET, MOSFET. Rectifiers: half wave rectifier, full wave (bridge & center tapped) rectifier. Voltage multipliers. Filters: Introduction, purpose and use of ripple filter. Types of filters. Capacitance filter, inductance filters, RC filters, LC filters, voltage dividers and bypass filters.

10. Voltage regulators. Introduction & purpose Zener regulators, shunt regulators, series regulators, IC regulators, variable regulators. Power Supply units-Introduction, purpose & use. UPS and SMPS, inverters and converters and their applications. Thyristor devices: basic description and applications of SCR, TRIAC, DIAC. General characteristics of an amplifier, Concept of amplification. Types of Amplifiers. Effect of temperature. DC load line and AC load line.PCB basic construction, applications. Lay outing circuit on PCB.

11. Oscillator's oscillations -oscillation frequency, basic working principle and working of Talk circuit, Crystal controlled oscillators, Phase shift oscillators, RC phase shift oscillators, Colpitt, Clapp, Hartley, and IC oscillators. Operational Amplifier -Differential amplifier, ideal opamp. Op-amp with feedback, advantages of feedback. Inverting and Non inverting and inverting amplifier, Opamp as summer, differential amplifier. V to I converter and I to V converter, Instrumentation amplifier Basics of op- amp applications - integrator, differentiator, Introduction of timers (555) and its applications. Number systems: binary, octal, decimal and hexadecimal number system. Conversion of number systems. Boolean algebra, binary ad- dition, subtraction, multiplication and division. 1's and 2's compliment, BCD code, ASCII code, gray code.

12. Logic Circuits. Basic gates-AND, OR and NOT gates. De-Morgan \s Theorem. Universal gates - NAND and NOR gates.Special gates - Ex-OR, Ex -NOR gates and Buffer and its applications. Basic digital ICs, function, digital application, logic symbols. Adders - Half adder, full adder Subtractor - Half subtractor, full subtractor. Flip flops - RS flip flop, clocked RS flip flop, JK flip flop, Basics of Counters and registers. Multiplexer and de-multiplexer. Encoder and decoder. BCD display, BCD to decimal decoder. BCD to 7 segment display circuits. Digital meters: displays: LED, 7 segment display, LCD, CRT, electro- luminescent displays, electro-phoretic image display, liquid vapor display, dot matrix display.

13. A/D and D/A converters - Introduction, weig hted register D / A converter, binary(R-2R) ladder D / A converter, specification for D / A converter, Ramp or counter type A/D converter, GPIB (general purpose interface bus) IEEE - 488, RS 232. Digital meters: frequency meter, phase meas- uring meter, and time measuring instruments. Digital capacitance meter.

14. CRO: introduction and applications of CRO, functional block diagram of CRO, CRT power supply. Various types of probes. Applications of various types of CROs like dual beam CRO, Dual trace CRO, storage oscilloscope. Introduction to Computer, Block diagram of PC, software familiarization of Multimedia System consisting of CD ROMS, DVD ROMS, Sound Cards. Computer Hardware, Computer systems, computer hardware, CPU, CPU operations, ROMs and RAMs, I/P and O/P and peripheral equipments, terminals, printers, MODEMS, Data interface, ADC and DAC. Introduction to microprocessor microcomputers, Memories Intel 8085. Architecture Instruction set of 8085, Microprocessor. Data transfer group, Arithmetic group, Logic group, Basic Programming of 8085 such as adding, subtraction of two 8-bit numbers, etc. Block diagram and pin' diagram 8255 and its operation. Microprocessor applications. Scope and necessity of instrumentation.

15. Fundamentals of measurement systems- functional block diagram of measurement system. Calibration and calibration standards– basic standards, secondary standards, working standards. Fundamental units - The metric system, Base& supplementary units, Derived Units, Multiplying factors and standards of length, mass, time & frequency. Temperature & electrical units. Instrument characteristics Static characteristics– accuracy, precision, sensitivity, resolution dead zone, repeatability, reproducibility, drift, Dead band, backlash, hysteresis. Dynamic characteristics– speed response, fidelity, lag. Error, deviation, true value, data. Types of errors- systematic, random& illegitimate error. Certainty/uncertainty, validity Of result. Measuring system Response. Introduction, amplitude responses, Phase response, Delay, rise time & slew rate. Damping & its importance. Statistical analysis – arithmetic mean, deviation from the mean average deviation, standard deviation. Stress & Strain Measurement.

16. Introduction to Strain gauges, types of strain gauges and differences. Applications of strain gauges, load cells. LVDT, RVDT, advantages and limitations. Measurement of motion, velocity /vibrometers and acceleration. Difference between tachometer and speedometers. Types of Tachometers-Eddy current type, AC and DC tachometer. Stroboscope and its applications. seismic instrument. Principle of Pressure in Liquids & Gases. Properties of matter Principles of liquid pressure, units of pressure Liquids pressure and volume, density and specific gravity. Factors affecting liquid pressure. Pressure relation with volume, temperature and flow. Units of pressure and unit conversions.

17. Types of pressure: absolute, gauge, atmospheric and vacuum pressures and their relationships. Barometers, manometers types and applications. Types of pressure sensing elements-bourdon tube, diaphragms, capsules, and bellows. Each one types, shapes, material used for various applications, ranges advantages and limitations. Pressure switches types and applications. Electrical pressure transducers. Method of conversion, primary and secondary pressure transducers. Potential metric pr. Transducers, Capacitive pr. transducers, reluctance-servo pressure transducers, strain gauge pressure transducers, piezo electric pressure transducer. Differentials pressure transducers.

18. Low Pressure Measurement. Vacuum, gauges, thermal conductivity gauges, pirani gauges, thermocouple gauges, slack diaphragm. Ionization gauge, McLeod gauge, capacitance manometers. Method of pressure instrument calibration. Dead weight tester and comparators/manifolds. Pressure Instrument Installation and Servicing. Elements of pressure transmitters, Installation components, pressure taps, Isolation valve, instrument piping, connections and fittings blow down valve, instrument valve, pulsation damper, diaphragm seal, pressure transmitter. Installation, procedure, locating and mounting, piping, electrical wiring placing into service, guidelines for periodic maintenance, troubles shooting and repair, instrument shop safety.

19. Properties of Fluid Flow. Basic properties of fluids, fluids in motion, getting fluids to flow, units of flow rate and quantity flow, factors affecting flow rate, Reynolds number, relation between flow rate and pressure, area, quantity.Types of flow meters –head type, variable area type, quantitative flow meters. Mass flow meters. Head type of flow meters: working principle, types venturi tube, orifice plates and its shapes. Pitot tube, flow nozzles, constructions, tapings, advantages, limitations, applications, materials used for various flows. Types of secondary devices used to measure for flow rates. Open channel flow meters - principle of open channel flow, weirs, notches and flumes. Various shapes and their applications, maintenance, Variable area type flow meter- Rota meter, constructions, working principle, applications.

20. Various shapes of float, type of materials used for body and float. Factors affecting rotameter performance, measuring gas and liquid flow. Positive Displacement. Meters. Advantages and disadvantages of positive displacement meters, piston meter, oscillating piston meter, rotating vane meter, notating disk meter, lobed impeller and oval flow meter, calibrating positive displacement meters. Target flow meters, turbine flow meter, magnetic flow meters, vertex flow meter. Construction, working principle, advantages and disadvantage, applications. Carioles mass flow meter, thermal flow meters and summary basics of ultrasonic flow meters.

21. The Doppler hit method. The beam deflection method, frequency difference method. Metering the flow of solid particles. Measuring volumetric and mass flow rate of solids, volumetric solids flow meter, mass flow meter for solids, belt type solid meters belt type solid meters belt speed sensing and signal processing, slurries, constant weight feeders. Principles of level measurement. Types of level measurements-solid and liquid, volume and mass, mechanical and electrical type.

22. Surface sensing gauges, storage tank gauges, sight glasses, magnetic gauges, buoyancy, displacement gauges. Factors need to consider for open and closed channel level measurements level switches, mercury level switches in high pressure tank, level detectors, magnetic reed switches. Pressure head instruments. Hydrostatic pressure, specific gravity, pressurized fluids, pressure head instrumentation, air bellows, U- tube manometers, air purge systems, liquid purge systems, force balance diaphragm system. Electrical method conductivity and capacitance method for. measuring the liquid level, capacitance probes, zero and span adjustments, sonic level detectors, point level detection. Solid level measurement Using weight to determine level, sonic solid level measurement with microwaves, using capacitance probes to measure solid level, diaphragm switches, nuclear gauges, microwave solid level detectors.

23. Temperature measurement. Temperature, heat, specific heat, changing physical state Fahrenheit and Celsius temperature scales Rankin and Kelvin scales, calibration of temperature scales primary and secondary standards. Industrial application of temperature measuring instruments with compensating link & precautions to be taken. Bimetallic and fluid filled temperature instruments. Bimetallic thermometers, liquid- in-glass thermometers, filled system thermometers, thermometer bulbs, capillary & bourdon tube, temperature transmitters for filled system, advantages & disadvantages of filled systems.

24. Electrical temperature instrument. Resistance thermometer, how it works, RTD bridge circuits, lead wire error, RTD elements. Protecting wells for RTD, advantages and disadvantages of RTDs, thermistors, thermocouples, Ex-tension wires, compensating for changes in reference junction temperature, construction of thermocouple junction, types of thermocouple, advantages and disadvantages of thermocouples.

25. Pyrometry. Molecular activity and electromagnetic radiation, defining pyrometry, effects of emittance, effects of temperature, wavelength and radiated energy, pyrometers and wavelengths, using of optical and radiation pyrometer, Measurement of humidity. Thermal imagers. Recorders. Introduction to recorders, Construction, working principle, various parts installation and use of pneumatic and electronic recorders. Strip-chart, circular chart.

26. Final control elements in process loops. Final control elements, actuators, load set Point compensation, feedback loops, control variables, effects of disturbances on performance, parts of final control sub- system, control signal, electric control signals, fluidic control signals, Pneumatic and Hydraulic Actuators.Pneumatic principles, effects of changing pressure, pressure /volume/ temperature relationship, effects of changing temp. Pneumatic actuators, diaphragm actuator, spring and spring less actuators, direct and reverse acting actuator, piston actuator, positioner, Electrical actuators and their advantages.

27. Control valves -Control valves functions and components, types' of control valves, based on valve flow characteristics liner, equal percentage, quick opening valves, globe valves, cage valves, butterfly valves, ball valves, sliding gate valves, diaphragm valves, split body valves, capacitive, inductive type valve, proximity switch, IR switch, micro switch, limit switch, other control valves, control valve mechanical considerations, selecting control valves, valve positioner. Control elements applications. Feed water control system works, sequential. valve control, control and block valves, applying relays in final control elements, relay logic in operation, automatic valve control, controllers and activators, turbine control System, throttle and governor valves and activators.

28. Introduction of internal parts of different types of control valves. Introduction to controllers. Basic block diagram of control systems. Advantages Process variable and set point, analog controllers, digital controllers, control angles and limits, control loop measuring Pv, amplifying signals final control elements, current proportioning. Hunting & its effect on the product.

29. Types of controller and their operation. Types of controller, range limit of controllers. ON/OFF controllers, direct and reverse acting controllers' proportional controllers, automatic/manual split control, pneumatic control. Adaptive, limiting and batch control, ratio control system, feed forward, feedback control systems and cascade control system.Comparison between pneumatic and electronic control systems. Basic knowledge on communication protocol.

30. Controller models and tuning. Controller tuning, setting, controller modes, proportional mode, off-set, integral mode, reset mode, derivative mode(rate), single, mode controller, two mode controller, three mode controllers, tuning the control loop, step- change- response method.Introduction to programmable controllers. History of programmable controllers, general characteristics of programmable controllers, some limitation of PLCs, method of developing PLC programming Input/output devices. Definition of input /output devices, I/O interface, input modules, output modules, input devices encoders, output devices, the opto isolators, safety.

31. Processing and programming functions. The processor unit, the memory, memory organization, ladder diagrams, data logger, most used programming symbols, start, stop, station example, other programming symbol timers and counters, data manipulation instructions, alternate PLC symbols. Digital control systems: need of smart devices, HART transmitters futures, advantages, applications. Working method of HART devices, HART protocol. HART communicators and PC based HART device configuration. Steps in calibration of HART devices. Communication.

32. Networking: types of networks used in digital instrument systems. LAN, WAN, Ethernet. Point to point and multi networking. Ring, delta, star connections. Redundant Net. TCP/IP addresses and descriptions. Types of Cable categories (CAT), and their descriptions. Various types of Cable connectors. Advantages and disadvantages of co-axial cable and fiber optic cables. Various tools used in networking- wire cutter, crimp tool, memory blade holder, memory blade cartridge, cable strip tool with blade cassettes.

33. Terminators and extra connectors, taps, calibration tool etc. fundamentals: modulation and demodulation, signal to noise ratio, digital communication basics-PWM, PCM, FSK. Fundamentals of SCADA and DCS. History of DCS development. Basic architecture, description advantages and disadvantages, applications. Terminology- RTU (remote transmitting unit, central monitoring station, types of communications, field instruments and types.

34. Field bus: futures, advantages, architecture, basic block diagram, working. Work station, Human Machine Interface (HMI). Controller (with basic types), filed bus interfacing modules, gateway, network manager, I/O modules, field bus devices (I/0), remote transmission panel (RTP), Ethernet.

35. Electronic device description language (EDDL) and device description (DD). Field bus power supply and its function. Introduction of digital and multi drop communication protocol Vendors. Futures- library, call up, various visualized futures, Reports (alarms, events), history, trading etc. Basic Hydraulics: Principles of Hydraulics. Fluid power and hydraulics, force, weight and mass, pressure, work, power, energy, incompressibility and non-diffusion, hydrostatic pressure, Pascal's law, transmission of fluid power, fluid flow in pipes, Bernoulli's principle, the effect of heat on liquids.

36. A typical hydraulic power system. Hydraulic Fluids. Functions of Hydraulic fluids, physical properties, viscosity, viscosity index, viscosity and pressure, power point, fluid selection, component protections, chemical properties, system contamination, water, dissolve air, foaming, corrosion and rusting, types of hydraulic fluids.

37. Directional control valves. Directional control valve classification, review of two way valves, 'globe, gauge, plug, needle, ball, automatic two way valves, check valves, pilot operated check valves, spool valves, three ways pool valves, controlling hydraulic motors, NO and NC valves, holding valves, four and five way valves, rotary spool valves, schematic symbols, flow ratings, accessories. Pneumatic principles, mass, pressure, work and energy, compressibility, law of pneumatics, transmission of pneumatic fluid power, pneumatic leverage, air properties, airflow in pipelines, viscosity of air pressure, Bernoulli's law, components of pneumatic power system.

38. Primary air treatment. Air treatment, preliminary filtering, relative. Humidity, effects of moisture, water removal, dew point, moisture separators, oil scrubbers, air dryers, (deliquescent and absorption type) air receivers. Secondary air treatment. Methods of treatment, contaminate separation, contaminate filtration and filter classification and rating, types of media surface filters, depth filters, absorption filters, Lubricating the air.

39. Piping houses and fittings. Requirement of piping, airflow, piping dimensions and safety factors, piping connections, compressed air piping applications, metallic tubing, tubing bending and tube fitting, tube installation, nonmetallic tube houses, hose fittings and coupling, hose installation. Analytical instruments. Exposure to basic analytical instruments. Types of electrodes used for PH measurements. Relation of PH and mV. PH indicator and controllers. Conductivity meters. Dissolved oxygen meter.

TRADE: WELDER
SYLLABUS FOR TRADE TEST

1. Demonstration of Machinery used in the trade. Identification to safety equipment and their use etc. Hack sawing, filing square to dimensions. Marking out on MS plate and punching. Setting of oxy-acetylene welding equipment, Lighting and setting of flame. Perform fusion run without filler rod on MS sheet 2mm thick in flat position. Setting up of Arc welding machine & accessories and striking an arc. Deposit straight line bead on MS plate in flat position. Depositing bead with filler rod on M.S. sheet 2 mm thick in flat position. Edge joint on MS sheet 2 mm thick in flat position without filler rod. Straight line beads on M.S. plate 10 mm thick in flat position. Weaved bead on M. S plate 10mm thick in flat position. Setting up of oxy-acetylene and make straight cuts (freehand).

2. Perform marking and straight line cutting of MS plate 10 mm thick by gas. Accuracy within ±2mm. Beveling of MS plates 10 mm thick, cutting regular geometrical shapes and irregular shapes, cutting chamfers by gas cutting. Circular gas cutting on MS plate 10 mm thick by profile cutting machine. Marking and perform radial cuts, cutting out holes using oxy-acetylene gas cutting.

3. Identify cutting defects viz., distortion, grooved, fluted or ragged cuts; poor draglines; rounded edges; tightly adhering slag. Square butt joint on M.S. sheet 2 mm thick in flat Position. (1G). Fillet "T" joint on M.S. Plate 10 mm thick in flat position. (1F). Open corner joint on MS sheet 2 mm thick in flat Position (1F).

4. Fillet lap joint on M.S. plate 10 mm thick in flat position. (1F). Fillet "T" joint on MS sheet 2 mm thick in flat position. (1F). Open Corner joint on MS plate 10 mm thick in flat position. (1F) Fillet Lap joint on MS sheet 2 mm thick in flat position. (1F). Single "V" Butt joint on MS plate 12 mm thick in flat position (1G). Testing of weld joints by visual inspection. Inspection of welds by using weld gauges.

5. Square Butt joint on M.S. sheet. 2 mm thick in Horizontal position. (2G). Straight line beads and multi-layer practice on M.S. Plate 10 mm thick in Horizontal position. Fillet "T" joint on M.S. plate 10 mm thick in Horizontal position. (2F). Fillet Lap joint on M.S. sheet 2 mm thick in horizontal position (2F). Fillet Lap joint on M.S. plate 10 mm thick in horizontal position (2F). Fusion run with filler rod in vertical position on 2mm thick M.S sheet.

6. Square Butt joint on M.S. sheet. 2 mm thick in vertical position (3G). Single Vee Butt joint on M.S. plate 12 mm thick in horizontal position (2G). Weaved bead on M.S Plate 10mm in vertical position. Fillet "T" joint on M.S sheet 2 mm thick in vertical position. (3F). Fillet "T" joint on M.S. plate 10 mm thick in vertical position. (3F). Structural pipe welding butt joint on MS pipe Ø 50 and 3mm WT in 1G position. Fillet Lap joint on M.S. Plate 10 mm in vertical position. (3G).

7. Open Corner joint on MS plate 10 mm thick in vertical position. (2F). Pipe welding - Elbow joint on MS pipe Ø 50 and 3mm WT. (1G). Pipe welding "T" joint on MS pipe Ø 50 and 3mm WT. (1G). Single "V" Butt joint on MS plate12 mm thick in vertical position (3G). Pipe welding 45 ° angle joint on MS pipe Ø 50 and 3mm WT. (1G). Straight line beads on M.S. plate 10mm thick in overhead position. Pipe Flange joint on M.S plate with MS pipe Ø 50 mm X 3mm WT (1F). Fillet "T" joint on M.S. plate 10 mm thick in overhead position. (4F).

8. Pipe welding butt joint on MS pipe Ø 50 and 5 mm WT. in 1G position. Fillet Lap joint on M.S. plate 10 mm thick in overhead position. (4G). Single "V" Butt joint on MS plate 10mm thick in overhead position(4G). Pipe butt joint on M. S. pipe Ø 50mm WT 6mm (1G Rolled). Square Butt joint on S.S. sheet. 2 mm thick in flat position. (1G). Square Butt joint on S.S. Sheet 2 mm thick in flat position. (1G). Square Butt joint on Brass sheet 2 mm thick in flat position. (1G). Square Butt & Lap joint on M.S. sheet 2 mm thick by brazing in flat position. Single "V" butt joint C.I. plate 6mm thick in flat position. (1G). Arc gouging on MS plate 10 mm thick. Square Butt joint on Aluminium sheet. 3 mm thick in flat position. Bronze welding of cast iron (Single "V" butt joint) 6mm thick plate (1G).

9. Welding methods of cast iron –Dye penetrant test, Magnetic particle test, Nick- break test, Free bend test, Fillet fracture test, Introduction to safety equipment and their use etc. Setting up of GMAW welding machine & accessories and striking an arc. Depositing straight line beads on M.S Plate. Fillet weld – "T" joint on M.S plate 10mm thick in flat position by Dip transfer. (1F), Lap joint on M.S. sheet 3mm thick in flat position by Dip transfer. (1F), "T" joint on M.S. sheet 3mm thick in flat position by Dip transfer. (1F), corner joint on M.S. sheet 3mm thick in flat position by Dip transfer. (1F), Butt weld – Square butt joint on M.S sheet 3mm thick in flat position (1G), Single "V" butt joint on M.S plate 10 mm thick by Dip transfer in flat position. (1G), Fillet weld – "T" joint on M.S plate 10mm thick in Horizontal position by Dip transfer. (2F).

10. Fillet weld – corner joint on M.S plate 10mm thick in Horizontal position by Dip transfer. (2F), "T" joint on M.S. sheet 3mm thick in Horizontal position by Dip transfer. (2F), corner joint on M.S. sheet 3mm thick in Horizontal position by Dip transfer. (2F), "T" joint on M.S plate 10mm thick in vertical position by Dip transfer. (3F), Corner joint on M.S plate 10mm thick in vertical position by dip transfer. (3F), Lap joint on M.S. sheet 3mm thick in vertical position by Dip transfer. (3F), corner joint on M.S. sheet 3mm thick in vertical position by Dip transfer. (3F), Lap and "T" joint on M.S sheet 3mm thick in overhead position by Dip transfer. (4F).

11. Tee Joints on MS Pipe Ø 60 mm OD x 3 mm WT 1G position – Arc constant (Rolling), Depositing bead on S.S sheet in flat position. Butt joint on Stainless steel 2 mm thick sheet in flat position by Dip transfer, Depositing bead on Aluminium sheet 2 mm thick in flat position. Square butt joint on Aluminium sheet 1.6mm thick in flat position.

12. Fillet weld – "T" joint on Aluminium sheet 1.6 mm thick in flat position. (1F), Fillet weld – Outside corner joint on Aluminium sheet 2 mm thick in flat position. (1F), Butt weld - Square butt joint on Stainless steel sheet, 1.6 mm thick in flat position with purging gas (1G), Fillet weld – "T" joint on Stainless steel sheet 1.6 mm thick in flat position. (1F), Pipe butt joint on Aluminium pipe Ø 50 mm x 3 mm WT in Flat position. (1G). "T" Joints on MS Pipe Ø 50 mm OD x 3 mm WT, position – Flat (1F).

13. Straight cutting on ferrous and non-ferrous. Lap joint on Stainless steel sheet by Resistance Spot welding. MS sheets joining by Resistance Spot welding. Square butt joint on Copper sheet 2mm thick in flat position. (1G). "T" joint on Copper to MS sheet 2mm thick in flat position by Brazing (1F). Silver brazing on S.S Sheet with copper sheet "T" joint.

14. Silver brazing on copper tube to tube. Repair welding of broken C.I. machine parts by oxy- acetylene welding with C.I and bronze filler rod. Repair welding of broken C.I machine parts by C.I. electrode. Repair plastic broken parts or pipes by plastic welding machine. Make a plastic tank with plastic sheet of PVC. Dimensions 150*100*100. Hard surfacing practice on M.S round rod Ø 25 mm by using Hard facing electrode in flat position.

TRADE: WELDER
SYLLABUS FOR COMPETITIVE WRITTEN EXAMINATION

1. Elementary First Aid. Importance of Welding in Industry. Safety precautions in Shielded Metal Arc Welding, and Oxy – Acetylene Welding and Cutting. Introduction and definition of welding. Arc and Gas Welding Equipment, tools and accessories. Various Welding Processes and its applications. Arc and Gas Welding terms and definitions.

2. Different process of metal joining methods: Bolting, riveting, soldering, brazing, seaming etc. Types of welding joints and its applications. Edge preparation and fit up for different thickness. Surface Cleaning. Basic electricity applicable to arc welding and related electrical terms &definitions. Heat and temperature and its terms related to welding. Principle of arc welding. And characteristics of arc.

3. Common gases used for welding & cutting, flame temperatures and uses. Chemistry of oxy-acetylene flame. Types of oxy-acetylene flames and uses. Oxy-Acetylene Cutting Equipment principle, parameters and application.

4. Arc welding power sources: Transformer, Motor Generator set, Rectifier and Inverter type welding machines and its care & maintenance. Advantages and disadvantages of A.C. and D.C. welding machines. Welding positions as per EN &ASME: flat, horizontal, vertical and overhead position. Weld slope and rotation. Welding symbols as per BIS & AWS. Arc length – types – effects of arc length.

5. Polarity: Types and applications. Weld quality inspection, common welding mistakes and appearance of good and defective welds Weld gauges & its uses. Calcium carbide properties and uses. Acetylene gas properties   and generating methods. Acetylene gas Purifier, Hydraulic back pressure valve and Flash back arrestor. Oxygen gas and its properties. Production of oxygen by Air liquefaction. Charging process of oxygen and acetylene gases. Oxygen and Dissolved Acetylene gas cylinders and Color coding for different gas cylinders.

6. Gas regulators, types and uses. Oxy acetylene gas welding Systems (Low pressure and High pressure). Difference between gas welding blow pipe (LP &HP) and gas cutting blow pipe Gas welding techniques. Rightward   and Leftward techniques. Arc blow – causes and methods of controlling. Distortion in arc & gas welding and methods employed to minimize distortion. Arc Welding defects, causes and Remedies. Specification of pipes, various types of pipe joints, pipe welding all positions, and procedure. Difference between pipe welding and plate welding. Pipe development for Elbow joint, "T" joint, Y joint and branch joint. Manifold system.

7. Gas welding filler rods, specifications and sizes. Gas welding fluxes – types and functions. Gas Brazing & Soldering: principles, types fluxes & uses. Gas welding defects, causes and remedies- Electrode: types, functions of flux, coating factor, sizes of electrode Coding of electrode as per BIS, AWS. Effects of moisture pick up. Storage and baking of electrodes. Special purpose electrodes and their applications.

8. Weld ability of metals, importance of pre heating, post heating and maintenance of inter pass temperature. Classification of steel. Welding of low, medium and high carbon steel and alloy steels. Effects of alloying elements on steel. Stainless steel types- weld decay and weld ability. Brass – types – properties and welding methods. Copper – types – properties and welding methods. Aluminium and its alloys, properties and weld ability, Welding methods

   Arc cutting & gouging. Cast iron and its properties types. Welding methods of cast iron.

9. Types of Inspection methods. Classification of destructive and NDT methods. Welding economics and Cost estimation. Safety precautions in Gas Metal Arc Welding and Gas Tungsten Arc welding. Introduction to GMAW - equipment– accessories. Various other   names   of   the   process.   (MIG/MAG/CO2   welding.). Advantages of GMAW welding over SMAW, limitations and applications. Process variables of GMAW.

10. Modes of metal transfer – dip or short circuiting transfer, spray transfer (free flight transfer) and globular transfer (intermittent transfer) and Pulsed metal transfer.

11. Wire feed system – types – care and maintenance. Welding wires used in GMAW, standard diameter and codification as per AWS. Types of shielding gases and gas mixtures used in GMAW and its applications. Flux cored arc welding – description, advantage, welding wires, coding as per AWS. Edge preparation of various thicknesses of metals for GMAW.GMAW defects, causes and remedies

12. Heat input and techniques of controlling heat input during welding. Heat distribution and effect of faster cooling. Pre heating & Post Weld Heat Treatment. Use of temperature indicating crayons. Submerged arc welding process – principles, equipment, advantages and limitations. Electro slag and Electro gas welding processes–principles, equipment, advantages and limitations.

13. Thermit welding process types, principles, equip- ment, Thermit mixture types and applications. Use of backing strips and backing bars. GTAW process - brief description. Difference between AC and DC welding, equipment, polarities and applications. Various other names of the process (TIG, Argon arc). Power sources for GTAW - AC &DC. Tungsten electrodes – types & uses, sizes and preparation. GTAW Torches- types, parts and their functions GTAW filler rods and selection criteria. Edge preparation and fit up GTAW parameters for welding of different thickness of metals. Pulsed TIG welding - brief description, pulse parameters slope up and slope down.

14. Argon / Helium gas properties – uses.GTAW Defects, causes and remedy. Friction weldingprocess   equipment and application. Laser beam welding (LBW)and Electron beam welding(EBW). Plasma Arc Welding (PAW) and cutting (PAC) process – equipment and principles of operation. Types of   Plasma arc,   advantages   and applications.

15. Resistance welding process – types, principles, power sources and welding parameters. Applications and limitations. Metalizing – types of metalizing principles, equipment, advantages and applications. Manual Oxy – acetylene powder coating process principles of operation and applications. Welding codes and standards. Reading of assembly drawing. Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR). Hard facing/ surfacing necessity, surface preparation, various hard facing alloys and advantages of hard facing. Plastic welding machine with hot air gun and plastic material: Polypropylene (PP) Polyethylene (PE) Polyvinylchloride (PVC)

16. Introduction to Engineering Drawing and Drawing Instruments; Conventions Sizes and layout of drawing sheets Title Block, its position and content Drawing Instrument - Free hand drawing of; Geometrical figures and blocks with dimension Transferring measurement from the given object to the free hand sketches. Free hand drawing of hand tools and measuring tools. - Lines Types and applications in drawing - Drawing of Geometrical figures; Angle, Triangle, Circle, Rectangle, Square, Parallelogram. Lettering & Numbering – Single Stroke, double stroke, inclined - Reading of dimension and Dimensioning Practice. - Reading of fabrication drawing, sectional view of different types of welding Joints. Sectional view of different pipe joints - Symbolic representation different symbols used in the related trades Reading of Job Drawing of related trades.

TRADE: ELECTRICIAN
SYLLABUS FOR TRADE TEST

1. Identify safety symbols and hazards. Preventive measures for electrical accidents and practice steps to be taken in such accidents. Practice safe methods of fire fighting in case of electrical fire. Use of fire extinguishers. Practice elementary first aid. Rescue a person and practice artificial respiration.

2. Disposal procedure of waste materials. Use of personal protective equipment. Practice on cleanliness and procedure to maintain it. Identify trade tools and machineries. Practice safe methods of lifting and handling of tools & equipment. Select proper tools for operation and precautions in operation. Care & maintenance of trade tools. Operations of allied trade tools. Workshop practice on filing and hacksawing.

3. Prepare hand coil winding assembly. Practice on preparing T-joint, straight joint and dovetail joint on wooden blocks.

4. Sawing, planning, drilling and assembling for making a wooden switchboard. Practice in marking and cutting of straight and curved pieces in metal sheets, making holes, securing by screw and riveting. Workshop practice on drilling, chipping, internal and external threading of different sizes. Practice of making square holes in crank handle. Prepare an open box from metal sheet. Prepare terminations of cable ends.

5. Skinning, twisting and crimping. Identify various types of cables and measure conductor size using SWG and micrometer. Make simple twist, married, Tee and western union joints. Make Britannia straight, Britannia Tee and rat-tail joints. Practice in Soldering of joints / lugs. Identify various parts, skinning and dressing of underground cable.

6. Make straight joint of different types of underground cable. Test insulation resistance of underground cable using megger. Test underground cables for faults and remove the fault.

7. Measurement of parameters in combinational electrical circuit by applying Ohm's Law for different resistor values and voltage sources and analyze by drawing graphs. Measure current and voltage in electrical circuits to verify Kirchhoff's Law. Verify laws of series and parallel circuits with voltage source in different combinations.

8. Measure voltage and current against individual resistance in electrical circuit. Measure current and voltage and analyze the effects of shorts and opens in series circuit. Measure current and voltage and analyze the effects of shorts and opens in parallel circuit. Measure resistance using voltage drop method. Measure resistance using Wheatstone bridge.

9. Determine the thermal effect of electric current. Determine the change in resistance due to temperature. Verify the characteristics of series parallel combination of resistors. Determine the poles and plot the field of a magnet bar. Wind a solenoid and determine the magnetic effect of electric current. Measure induced EMF due to change in magnetic field.

10. Determine direction of induced EMF and current. Generation of mutually induced EMF. Measure the resistance, impedance and determine inductance of choke coils in different combinations. Identify various types of capacitors, charging / discharging and testing. Group the given capacitors to get the required capacity and voltage rating.

11. Measure current, voltage and PF and determine the characteristics of RL, RC and RLC in AC series circuits. Measure the resonance frequency in AC series circuit and determine its effect on the circuit. Measure current, voltage and PF and determine the characteristics of RL, RC and RLC in AC parallel circuits. Measure the resonance frequency in AC parallel circuit and determine its effects on the circuit. Measure power, energy for lagging and leading power factors in single-phase circuits and compare characteristic graphically. Measure Current, voltage, power, energy and power factor in three-phase circuits. Improvement of PF by use of capacitor in three-phase circuit. Ascertain use of neutral by identifying wires of a 3- phase 4-wire system and find the phase sequence using phase sequence meter.

12. Determine effect of broken neutral wire in three phase four wire system. Determine the relationship between Line and Phase values for star and delta connections. Measure the Power of three phase circuit for balanced and unbalanced loads. Measure current and voltage of two phases in case of one phase is short-circuited in three phase four wire system and compare with healthy system.

13. Use of various types of cells. Practice on grouping of cells for specified voltage and current under different conditions and care. Prepare battery charging and details of charging circuit. On routine, care/ maintenance and testing of batteries. Determine the number of solar cells in series / parallel for given power requirement.

14. Identify various conduits and different electrical accessories. Cutting, threading of different sizes & laying Installations. Prepare test boards / extension boards and mount accessories like lamp holders, various switches, sockets, fuses, relays, MCB, ELCB, MCCB etc. Draw layouts and practice in PVC Casing-capping, Conduit wiring with minimum to more number of points of minimum 15 mtr length.

15. Wire up PVC conduit wiring to control one lamp from two different places. Wire up PVC conduit wiring to control one lamp from three different places. up PVC conduit wiring and practice control of sockets and lamps in different combinations using switching concepts. Wire up the consumers' main board with ICDP switch and distribution fuse box.

16. Prepare and mount the energy meter board. Estimate the cost/bill of material for wiring of hostel/ residential building and workshop. Wiring of hostel and residential building as per IE rules. Wiring of institute and workshop as per IE rules. Testing / fault detection of domestic and industrial wiring installation and repair.Prepare pipe earthing and measure earth resistance by earth tester / megger. Prepare plate earthing and measure earth resistance by earth tester / megger. Test earth leakage by ELCB and relay.

17. Install light fitting with reflectors for direct and indirect lighting. Group different wattage of lamps in series for specified voltage. Installation of various lamps e.g. fluorescent tube, HP mercury vapour, LP mercury vapour, HP sodium vapour, LP sodium vapour, metal halide etc.

18. Prepare decorative lamp circuit using drum switches. Prepare decorative lamp circuit to produce rotating light effect/running light effect. Install light fitting for show case lighting. Various analog and digital measuring Instruments. On measuring instruments in single and three phase circuits e.g. multi-meter, Wattmeter, Energy meter, Phase sequence meter and Frequency meter etc.

19. Measure power in three phase circuit using two wattmeter methods. Measure power factor in three-phase circuit by using power factor meter and verify the same with voltmeter, ammeter and wattmeter readings. Measure electrical parameters using tong tester in three phase circuits. Range extension and calibration of various measuring instruments.

20. Determine errors in resistance measurement by voltage drop method. Test single-phase energy meter for its errors. Dismantle and assemble electrical parts of various electrical appliances e.g. cooking range, geyser, washing machine and pump set.

21. Service and repair of bell/ buzzer. Service and repair of electric iron, electric kettle, cooking range and geyser. Service and repair of induction heater and oven. Service and repair of mixer and grinder. Service and repair of washing machine.

22. Verify terminals, identify components and calculate transformation ratio of single-phase transformers. Perform OC and SC test to determine and efficiency of single-phase transformer. Determine voltage regulation of single-phase transformer at different loads and power factors. Perform series and parallel operation of two single-phase transformers. Verify the terminals and accessories of three phase transformer HT and LT side.

23. Perform 3 phase operation-delta-delta, delta-star, star-star & star-delta by use of three single-phase transformers. Perform testing of transformer oil. Practice on winding of small transformer. Practice of general maintenance of transformer. Identify terminals, parts and connections of different types of DC machines.

24. Measure field and armature resistance of DC machines. Determine build up voltage of DC shunt generator with varying field excitation and performance analysis on load. Test for continuity and insulation resistance of DC machine. Start, run and reverse direction of rotation of DC series, shunt and compound motors.

25. Perform no load, load test, and determine characteristics of series and shunt generators. Perform no load, load test, and determine characteristics of compound generators (cumulative and differential) .Dismantling and assembling in DC shunt motor. Dismantling and assembling in DC compound generator. Conduct performance analysis of DC series, shunt and compound motors. Dismantle and identify parts of three point and four- point DC motor starters. Assemble, Service and repair three point and four- point DC motor starters.

26. Maintenance of carbon brushes, brush holders, Commutator and slip rings. Perform speed control of DC motors - field and armature control method. Carry out overhauling of DC machines. Perform DC machine winding by developing connection diagram, test on growler and assemble. Identify parts and terminals of three phase AC motors. Make an internal connection of automatic star-delta starter with three contactors.

27. Connect, start and run three phase induction motors by using DOL, star-delta and autotransformer starters. Connect, start, run and reverse direction of rotation of slip-ring motor through rotor resistance starter and determine performance characteristic. Determine the efficiency of squirrel cage induction motor by brake test. Determine the efficiency of three-phase squirrel cage induction motor by no load test and blocked rotor test.

28. Measure slip and power factor to draw speed-torque (slip/torque) characteristics. Test for continuity and insulation resistance of three phase induction motor. Perform speed control of three phase induction motors by various methods like rheostatic control, autotransformer etc. Perform winding of three phase AC motor by developing connection diagram, test and assemble. Maintain, service and troubleshoot the AC motor starter.

29. Identify parts and terminals of different types of single-phase AC motors. Install, connect and determine performance of single- phase AC motors. Start, run and reverse the direction of rotation of single-phase AC motors. Practice on speed control of single phase AC motors. Compare starting and running winding currents of a capacitor run motor at various loads and measure the speed. Carry out maintenance, service and repair of single- phase AC motors. Single/double layer and concentric winding for AC motors, testing and assembling. Connect, start, run and reverse the direction of rotation of universal motor. Carry out maintenance and servicing of universal motor.

30. Install an alternator, identify parts and terminals of alternator.Test for continuity and insulation resistance of alternator. Connect, start and run an alternator and build up the voltage. Determine the load performance and voltage regulation of three phase alternator. Parallel operation and synchronization of three phase alternators.

31. Install a synchronous motor, identify its parts and terminals. Connect, start and plot V – curves for synchronous motor under different excitation and load conditions. Identify parts and terminals of MG set. Start and load MG set with 3 phase induction motor coupled to DC shunt generator. Determine the value of resistance by colour code and identify types.

32. Test active and passive electronic components and its applications. Determine V-I characteristics of semiconductor diode. Construct half wave, full wave and bridge rectifiers using semiconductor diode. Check transistors for their functioning by identifying its type and terminals. Bias the transistor and determine its characteristics. Use transistor as an electronic switch and series voltage regulator. Operate and set the required frequency using function generator.

33. Make a printed circuit board for power supply. Construct simple circuits containing UJT for triggering and FET as an amplifier. Troubleshoot defects in simple power supplies. Construct power control circuit by SCR, Diac, Triac and IGBT. Construct variable DC stabilized power supply using IC. Various logics by use of logic gates and circuits.

34. Generate and demonstrate wave shapes for voltage and current of rectifier, single stage amplifier and oscillator using CRO. Design layout of control cabinet, assemble control elements and wiring accessories for: Local and remote control of induction motor. Forward and reverse operation of induction motor. Automatic star-delta starter with change of direction of rotation. Sequential control of three motors.

35. Carry out wiring of control cabinet as per wiring diagram, bunching of XLPE cables, channeling, tying and checking etc. Mount various control elements e.g. circuit breakers, relays, contactors and timers etc.

36. Identify and install required measuring instruments and sensors in control panel. Test the control panel for its performance. Perform speed control of DC motor using thyristors / DC drive. Perform speed control and reversing the direction of rotation of AC motors by using thyristors / AC drive. Construct and test a universal motor speed controller using SCR.

37. Assemble circuits of voltage stabilizer and UPS. Prepare an emergency light. Assemble circuits of battery charger and inverter. Test, analyze defects and repair voltage stabilizer, emergency light and UPS. Maintain service and troubleshoot battery charger and inverter. Install an Inverter with battery and connect it in domestic wiring for operation.

38. Draw layout of thermal and hydel power plant and identify function of different layout elements. Visit to transmission / distribution substation. Draw actual circuit diagram of substation visited and indicate various components.

39. Prepare layout plan, identify different elements of solar, and wind power system. Assemble and connect solar panel for illumination. Practice installation of insulators used in HT/LT line for a given voltage range. Draw single line diagram of transmission and distribution system. Measure current carrying capacity of conductor for given power supply. Fasten jumper in pin, shackle and suspension type insulators. Erect an overhead service line pole for single-phase 230V distribution system in open space. Laying of domestic service line.

40. Install bus bar and bus coupler on LT line. Identify various parts of relay and ascertain the operation. Setting of pick up current and time setting multiplier for relay operation.

41. Identify the parts of circuit breaker, check its operation. Test tripping characteristic of circuit breaker for over current and short circuit current. Practice on repair and maintenance of circuit breaker.

TRADE: ELECTRICIAN
SYLLABUS FOR COMPETITIVE WRITTEN EXAMINATION

1. Safety rules and safety signs. Types and working of fire extinguishers. First aid safety practice. Hazard identification and prevention. Personal safety and factory safety. Response to emergencies e.g. power failure, system failure and fire etc. Concept of Standards and advantages of BIS/ISI.

2. Trade tools specifications. Introduction to National Electrical Code- 2011. Allied trades: Introduction to fitting tools, safety precautions. Description of files, hammers, chisels hacksaw frames, blades, their specification and grades. Marking tools description and use. Types of drills, description & drilling machines. Various wooden joints. Marking tools; calipers Dividers, Surface plates, Angle plates, Scribers, punches, surface gauges Types, Uses, Care and maintenance. Sheet metal tools: Description of marking & cutting tools. Types of rivets and riveted joints. Use of thread gauge.

3. Description of carpenter's tools Care and maintenance of tools. Fundamentals of electricity, definitions, units & effects of electric current. Conductors and insulators. Conducting materials and their comparison. Joints in electrical conductors. Techniques of soldering. Types of solders and flux.

4. Underground cables: Description, types, various joints and testing procedure. Cable insulation & voltage grades. Precautions in using various types of cables. Ohm's Law; Simple electrical circuits and problems. Kirchhoff's Laws and applications. Series and parallel circuits. Open and short circuits in series and parallel networks. Laws of Resistance and various types of resistors.

5. Wheatstone bridge; principle and its applications. Effect of variation of temperature on resistance. Different methods of measuring the values of resistance. Series and parallel combinations of resistors. Magnetic terms, magnetic materials and properties of magnet. Principles and laws of electro-magnetism. Self and mutually induced EMFs.

6. Electrostatics: Capacitor - Different types, functions grouping and uses. Inductive and capacitive reactance, their effect on AC circuit and related vector concepts. Comparison and Advantages of DC and AC systems. Related terms frequency, Instantaneous value, R.M.S. value Average value, Peak factor, form factor, power factor and Impedance etc. Sine wave, phase and phase difference. Active and Reactive power. Single Phase and three-phase system. Problems on A.C. circuits. Advantages of AC poly-phase system.

7. Concept of three-phase Star and Delta connection. Line and phase voltage, current and power in a 3 phase circuits with balanced and unbalanced load. Phase sequence meter. Chemical effect of electric current and Laws of electrolysis. Explanation of Anodes and cathodes. Types of cells, advantages / disadvantages and their applications. Lead acid cell; Principle of operation and components. Types of battery charging, Safety precautions, test equipment and maintenance.

8. Basic principles of Electroplating and cathodic protection. Grouping of cells for specified voltage and current. Principle and operation of solar cell. I.E. rules on electrical wiring. Types of domestic and industrial wirings. Study of wiring accessories e.g. switches, fuses, relays, MCB, ELCB, MCCB etc. Grading of cables and current ratings. Principle of laying out of domestic wiring. Voltage drop concept. PVC conduit and Casing-capping wiring system.

9. Different types of wiring - Power, control, Communication and entertainment wiring.

10. Wiring circuits planning, permissible load in sub-circuit and main circuit. Estimation of load, cable size, bill of material and cost. Inspection and testing of wiring installations. Special wiring circuit e.g. godown, tunnel and workshop etc.

11. Importance of Earthing. Plate earthing and pipe earthing methods and IEE regulations. Earth resistance and earth leakage circuit breaker. Laws of Illuminations. Types of illumination system. Illumination factors, intensity of light. Type of lamps, advantages/ disadvantages and their applications.

12. Calculations of lumens and efficiency. Classification of electrical instruments and essential forces required in indicating instruments. PMMC and Moving iron instruments. Measurement of various electrical parameters using different analog and digital instruments. Measurement of energy in three-phase circuit. Errors and corrections in measurement. Loading effect of voltmeter and voltage drop effect of ammeter in circuits. Extension of range and calibration of measuring instruments.

13. Working principles and circuits of common domestic equipment and appliances. Concept of Neutral and Earth. Working principle, construction and classification of transformer. Single phase and three phase transformers. Turn ratio and EMF equation. Series and parallel operation of transformer. Voltage Regulation and efficiency. Auto Transformer and instrument transformers (CT & PT). Method of connecting three single-phase transformers for three-phase operation. Types of Cooling, protective devices, bushings and termination etc. Testing of transformer oil. Materials used for winding and winding wires in small transformer.

14. General concept of rotating electrical machines. Principle of DC generator. Use of Armature, Field Coil, Polarity, Yoke, Cooling Fan, Commutator, slip ring and Brushes, Laminated core etc. E.M.F. equation. Separately excited and self-excited generators. Series, shunt and compound generators. Armature reaction, Commutation, inter poles and connection of inter poles. Parallel Operation of DC Generators. Load characteristics of DC generators. Application, losses & efficiency of DC Generators. Routine & maintenance. Principle and types of DC motor.

15. Relation between applied voltage back e.m.f., armature voltage drop, speed and flux of DC motor. DC motor Starters, relation between torque, flux and armature current. Changing the direction of rotation. Characteristics, Losses & Efficiency of DC motors. Routine and maintenance. Methods of speed control of DC motors. Lap and wave winding and related terms. Working principle of three phase induction motor.

16. Squirrel Cage Induction motor, Slip-ring induction motor; construction, characteristics, Slip and Torque. Different types of starters for three phase induction motors, its necessity, basic contactor circuit, parts and their functions. Single phasing prevention. No load test and blocked rotor test of induction motor. Losses & efficiency. Various methods of speed control. Braking system of motor. Maintenance and repair.

17. Concentric/ distributed, single/ double layer winding and related terms. Working principle, different method of starting and running of various single phase AC motors. Domestic and industrial applications of different single phase AC motors. Characteristics, losses and efficiency. Concentric/ distributed, single/ double layer winding and related terms. Troubleshooting of single phase AC induction motors and universal motor.

18. Principle of alternator, e.m.f. equation, relation between poles, speed and frequency. Types and construction. Efficiency, char- acteristics, regulation, phase sequence and parallel operation. Effect of changing the field excitation and power factor correction. Working principle of synchronous motor. Effect of change of excitation and load.

19. V and anti V curve. Power factor improvement. Rotary Converter, MG Set description and Maintenance. Resistors – colour code, types and characteristics. Active and passive components. Atomic structure and semiconductor theory. P-N junction, classification, specifications, biasing and characteristics of diodes.

20. Rectifier circuit - half wave, full wave, bridge rectifiers and filters. Principle of operation, types, characteristics and various configuration of transistor. Application of transistor as a switch, voltage regulator and amplifier. Basic concept of power electronics devices. IC voltage regulators Digital Electronics - Binary numbers, logic gates and combinational circuits. Working principle and uses of oscilloscope. Construction and working of SCR, DIAC, TRIAC and IGBT.

21. Principle, types and applications of various multi-vibrators. Study and understand Layout drawing of control cabinet, power and control circuits. Various control elements: Isolators, pushbuttons, switches, indicators, MCB, fuses, relays, timers and limit switches etc. Wiring accessories: Race ways/ cable channel, DIN rail, terminal connectors, thimbles, lugs, ferrules, cable binding strap, buttons, cable ties, sleeves, gromats and clips etc. Testing of various control elements and circuits.

22. Working, parameters and applications of AC/ DC drive. Speed control of 3 phase induction motor by using VVVF/AC Drive. Basic concept, block diagram and working of voltage stabilizer, battery charger, emergency light, inverter and UPS. Preventive and breakdown maintenance.

23. Conventional and non-conventional sources of energy and their comparison. Power generation by thermal and hydel power plants. Various ways of electrical power generation by non-conventional methods. Power generation by solar and wind energy. Principle and operation of solar panel. Transmission and distribution networks. Line insulators, overhead poles and method of joining aluminum conductors.

24. Safety precautions and IE rules pertaining to domestic service connections. Various substations. Various terms like – maximum demand, average demand, load factor, diversity factor, plant utility factor etc. Types of relays and its operation. Types of circuit breakers, their applications and functioning. Production of arc and quenching.

TRADE: REFRIGERATION AND AIR-CONDITIONING MECHANIC
SYLLABUS FOR TRADE TEST

1. **Safety Precautions:** Identify workshop & machineries. Demonstrate Safety precautions and First aid. Demonstrate fire-fighting. Demonstrate working at height using PPE's and identify the hazards and take personal safety precautions.

2. **Hand tools and their uses:** Identify general tools, instruments & equipment. Care and maintenance of tool, instruments and equipment and check using precision measuring instruments Viz. Vernier caliper, Micrometer, etc.

3. **Filing:** Perform flat filing, marking, punching and hack sawing to make a job as per drawing. Perform flat filing, marking, punching, hack sawing, drilling, tapping, reaming, dieing to make a job as per drawing

4. **Cutting:** Perform Sheet Cutting by straight snip as per drawing. Perform Sheet Cutting by bent snip as per drawing. Bend, fold and join metal sheets in different process. Join sheet metal by using rivet set and snap. Solder sheets of metal. Prepare a box or funnel with sheet metal as per drawing.

5. **Electrical and Electronics:** Identify, use and maintain electrical tools. Prepare simple twist joints of wires. Prepare married joints of wires. Measure current, voltage, resistance, power, frequency, energy using analog and digital meter through a single phase circuit. Test insulation and earth resistance using Megger. Star & Delta connection on a three-phase motor and show line voltage, line current, phase voltage and phase current. Three phase power & power factor measurement. Identify electronic components, tools & instrument. Colour coding of resistors. Verify Ohm's Law. Use voltmeter, ammeter and multi-meter. Practice soldering & de-soldering. Identify transistors, resistors, capacitors, diodes, S.C.R., U.J.T., amplifier and I.C. Construct and test full wave rectifier using diodes. Construct and test a bridge rectifier. Construct and test series voltage regulator circuit. Construct and test power supply using fixed voltage regulator ICS. Identify and test SCR. Construct and test an electronic timer using UJT & SCR. Apply OP-AMP, photo transistor and test performance.

6. **Welding:** Identify gas welding equipment & accessories. Demonstrate safety precaution in handling of Oxyacetylene cylinders, regulators etc. Setting up of AIR-LPG, O2- LPG and O2-C2H2 using can type portable flame set. Oxy-acetylene gas welding, brazing and cutting on thin sheet metal. Demonstrate Care & Safety of welding tools and equipment. Back fire arrester. Set Oxy-acetylene plant, use two stage regulator, adjustment of flame, gas pressure – O2 and DA. Perform brazing between Cu to Cu and Cu to MS, Cu to aluminium pipes. Join metal plates by using gas welding (lap joint, butt joint, etc.)

7. **Basic Refrigeration:** Identify & use of general hand tools, instruments & equipment used in refrigeration work. Identify & use of special tools, instruments & equipment used in refrigeration work. Identify various refrigeration equipment and components of vapour compression system like compressor, condenser, expansion device and evaporator. Identify and Check vapour absorption refrigeration cycle (VARC). Unroll, cut and bend soft copper tubes. Swage and make a brazed joint on copper tubing. Make flare joints and test them with flare fittings. Pinch off copper tubing. Use lock ring tool and various fittings of lock ring for servicing of appliances. Brazing of Cu to Cu, Cu to steel, Cu to brass using AIR LPG suitable in RAC machine. Brazing of Cu to Cu, Cu to steel, Cu to brass using Oxy LPG. Brazing of Cu to Cu, Cu to steel, Cu to brass using Oxy Acetylene. Identify electrical and mechanical components of refrigerator. Check and replace electrical components of refrigerators. Leak test, evacuation, gas charging in refrigerators. Wiring circuit of refrigerator. Installation of refrigerator. Identify electrical components of direct cool refrigerator. Identify mechanical components of direct cool refrigerator. Installation of refrigerator. Checking door alignment, adjustment of door switch operation & replacing of gaskets. Tracing the mechanical components of refrigerator. Check, Find Fault and test the electrical and other system components of refrigerator. Testing of compressor. Identification of motor terminals. Start of compressor with and without relay. Test performance of direct start refrigerator. Cleaning and flushing of evaporator and condenser with dry nitrogen. Replacement of capillary tube and drier. Installation of gauge manifold in the system. Leak testing, evacuation and gas charging in refrigerator. Check electrical wiring of refrigerator

8. **Refrigerator (Frost Free):** Check electrical wiring of refrigerator. Tracing electrical circuit of Frost-Free refrigerator. Checking, fault finding and testing of electrical accessories like thermostat, timer, defrost heaters, bimetal, air louvers etc. and other system components. Checking air distribution system. Servicing of refrigerator. Testing the performance of refrigerator. Identify three and four doors no frost refrigerator. Stripping of components. Tracing electric circuit. Testing components. Leak testing, evacuation, gas charging.

9. **Compressor:** Acquainting with hermetic compressor of Refrigerator or window type AC. Cut the compressor and dismantle. Identify different compressor and Service it. Lap necessary parts and cut the gasket. Assemble the compressor with the new gasket. Dismantle rotary / wobble plate/ swash plate/scroll compressor. Identify different parts of dismantled compressor. Rectify defects and repair accordingly. Identify terminal sequence of hermetic compressor motor by using digital multi-meter and start by DOL starter and measure starting current and running current by using ammeter and AVO meter. Familiarization with commercial type reciprocating compressor and centrifugal compressor. Dismantling and checking of compressor & accessories. Checking and servicing of capacity

control of compressor. Measure power consumption of compressor with respect to the evaporator/condenser temperature variation. Check belt tension and replace. Check and test lubricating system. Servicing of filter and oil pump. Checking and servicing of capacity control of compressor. Measure power consumption of compressor with respect to the evaporator/condenser temperature variation. Checking and servicing of main end and rear end bearing and shaft seal assembly. Cutting gasket. Fitting and testing. Assemble compressor and Test overall efficiency. Servicing of water-cooled condenser and receiver. Testing its performance by inlet and outlet pressure and temperature. Necessary repairing for tube leakage. De-scaling by diluted HCl to increase efficiency. Pump down the gas for necessary servicing and repairing.

10. **Motor:** Identification of terminal sequence of CSIR motor by using digital multi-meter and start by DOL starter and measure starting current and running current by using Ammeter and AVO meter. Direct start using ammeter and voltmeter. Start CSR motor through DOL starter and measure starting current and running current and changing of DOR. Start shaded pole motor through DOL starter and changing of DOR, dismantle motor identify parts and assemble. Select a hermetic compressor of any kind. Start the compressor motor by RSIR, CSIR, PSC & CSR method by using different type relay, capacitors, OLP's, etc. Check and Test different type relay, Capacitors, OLP's, find out fault, rectify and install. Identify the terminals of a Squirrel cage induction motor. Start the motor through DOL starter and measure starting current, running current and show changing of DOR. Start the motor through Star Delta or Auto transformer starter and measure starting current, running current and show changing of DOR. Familiarize with Slip-ring induction motor and identify its terminals. Start the Slip-ring induction motor through Rotor resistance starter and measure starting current, running current and show changing of DOR. Rectify fault through insulation test, continuity test, open circuit test and short circuit test. Explain control circuit of variable speed air conditioners (Inverter ACs). Identify components of control system of Inverter ACs including printed circuit board (PCB) NTC, PTC e.g. Power PCB, Filter PCB, Heat sink reactor. Wiring of the control system.

11. **Condenser:** Familiarise with different types of condensers used in refrigerators, Bottle coolers, visible coolers, deep freezers, Window and Split AC. Clean, flush, service and leak test different type of air cooled condensers, micro channel condensers. Remove dust from fins in air cooled condenser, micro channel condensers. Identify with different types of water-cooled condensers like Shell and Tube type, Tube within tube type, shell, coil & evaporative type, etc. Identify different items necessary for de-scaling like diluted HCl, Pump & motor, hose, etc. Dilute acid and water according to amount of scaling and perform de-scaling. Fit the pump motor with condenser and start. Take safety measure on concentration of acid which may damage tube.

12. **Drier:** Identify drier and capillary tube used in different cooling machines. Replace drier and capillary tube at the time of gas charging according to manufacturer's direction. Install different diameter capillary tube used in different type of cooling machines.

13. **Expansion Valves:** Install with different types of expansion valves used in small cooling machines and central plant like Automatic expansion valve, Thermostatic expansion valve, hand expansion valve, and electronic expansion valves, etc. Test and adjust the expansion valves fitted with machines. Familiarize with thermostatic and Electronic expansion valve. Installation and testing of thermostatic and Electronic expansion valve. Connect external and internal equalizer. Show superheat adjustment positioning of the sensing bulb. Identify automatic expansion valve. Fitting and checking its efficiency. Install and fitting of high side and low side float valves. Checking its efficiency.

14. **Evaporator:** Identify and service different types of evaporators like plate and tube type, Fin and tube type, etc. fitted in refrigerators, Bottle coolers, water cooler, Window and split AC. Perform leak test, flush to remove oil by dry nitrogen. Demonstrate different type of defrosting in different machines. Identify extended surface forced air-cooled evaporators. Service air cooled evaporator by blower.

15. **Refrigerant:** Identify and explain different colour code of different type refrigerant cylinder like HCFCs (HCFC-22, HCFC-123). HFCs (HFC-134a, HFC-32, R-410A, R-407C and R-404A) and low-Global Warming Potential (GWP) refrigerants like ammonia, R-290, HFC-32, blends of HFCs (R-410A, R-404A, R-407C etc.) and hydro fluoroolefins (HFOs: HFO-1234yf, HFO-1234ze, HFO-1233zd, HFO-1336mz), blends of HFCs and HFOs. Identify unknown refrigerant by its idle pressure using head pressure gauge. Recover refrigerant from a faulty machine. Transfer / Recycle refrigerant from one cylinder to another using ice. Measure pressure-temperature of refrigerants including HCFC-22, ammonia, R-290, HFC-32, HFC-134a, R-404A, R-407C and R-410A, HFOs. Identify flammability and toxicity of A3 and A2L of refrigerants. Demonstrate safe handling of refrigeration cylinders. Demonstrate handling of cylinder valves. Good servicing practices onTest leak, evacuation and charge refrigerant in refrigerator by weight in capillary system. Recover CFC by recovery pump and cylinder on CFC filled domestic refrigerator. Flush the system with dry nitrogen. Evacuate and charge hydrocarbons.

16. **Thermal Insulation and Testing:** Test and Use sealed component (Electrical) like thermostat, relay, overload protector etc. Identify insulating foam (polyurethane rigid foam and polystyrene). Fill with insulation material like PUF and glass wool. Pack insulation inside door panel and adjust gasket to prevent air leak. Acquainting with electrical and mechanical components used in window air-conditioner. Acquainting with electrical components like selector switch, thermostat switch, relay, starting capacitor, running capacitor, overload protector, remote and PCB control, etc. Demonstrate working of mechanical components like compressor condenser, expansion valve (capillary) and evaporator. Trouble shooting, installation, tracing wiring circuit. Leak testing, evacuation and gas charging.

17. **Installation of Window AC:** Hands on practice on installation of window AC following step by step procedure. Install gauge manifold in the system. Show discharge pressure and sanction pressure during running time. Check performance of different parameters i.e. pressure, temperature, pull down time, air flow and current drawn.

18. **Split AC:** Identify various components of split AC like mounted, floor and ceiling mounted, duct able and multi split AC. Identify electrical circuits. Test different components and fault finding. Leak testing of the system, evacuation and gas charging. Hands on practice on Installation and trouble shooting. Same as Split AC in the case of wall mounted split AC. Same as Split AC in the case of floor, Ceiling /Cassette mounted Split AC. Same as Split AC in the case of Ductable split AC. Same as Split AC in the case of Multi Split AC. Same as Split ACin the case of Inverter Split AC. Identify various mechanical components used in car AC. Identify various electrical components used in electrical circuits in car AC. Testing of system components & fault finding Install gauge manifold to check suction and discharge pressure in charging time and running time. Leak testing using dry nitrogen, evacuation and gas charging (HFC-134a, HFO-1234yf and blends of HFCs and HFOs). Installation and troubleshooting Testing magnetic clutch, compressor overhauling, condenser cleaning and add refrigerant. Regular maintenance.

19. **Cooling tower:** Servicing of natural draft, forced draft and induced draft cooling tower. Clean its nozzles, louvers, sumps, strainers etc. thoroughly. Remove algae and fungi from different parts. Assemble and test performance. Dismantle water circulating pumps. Identify different parts of pump, service the impeller of different types. Change or repair defective parts. Assemble and test performance

20. **Water cooler and Condenser:** Service water cooled or brine cooled chiller. Check de-frosting system and anti-freeze thermostat. Oil removing from coil. Servicing of liquid - suction heat exchanger used in central plant. Service suction liquid heat exchanged used in small machines. Service accumulator and check its functionality. Service oil separator and check its functionality. Identify parts, control, electric circuit, accessories of storage type water cooler and Bubble type water dispenser. Solder copper tube on stainless steel. Trouble shoot of commonly faced problems like condenser fan motor failure, corrosion etc. Install gauge manifold, Leak test and refrigerant charging after evacuation. Installation, servicing and maintenance of water cooler and dispensers. Checking and servicing of visible cooler and bottle cooler and its parts. Preventive maintenance and troubleshooting Evacuation, flushing with dry nitrogen, Retrofit the machine with HFC 134a, R-600a, R-290. Check wiring circuit, test components & replace. Install and Test performance of the machine.

21. **Deep Freezer:** Checking and servicing of horizontal and vertical deep freezer / display cabinet and their different parts. Preventive maintenance and trouble shooting. Check wiring circuit, test and replace defective components. Install gauge manifold, evacuate and gas charge. Install and test performance.

22. **Ice cube Machine:** Checking and servicing of ice cube machine and its different components. Check and service flow system of gases and preventive maintenance and trouble shooting. Check Electric circuit and four-way solenoid valve. Test leakage, evacuation and charge gas. Check defrosting system and overall performance.

23. **Ice candy plant:** Identify different parts, controls and accessories used in ice-candy plant. Prepare brine solution, function of agitator and temperature maintained in brine. Check wiring circuit, service, test, trouble shoot, and replace defective components. Retrofit R22 with R134a. Install gauge manifold, leak test, evacuate and gas change. Install and Test performance.

24. **Ice Plant:** Identify parts, accessories and controls of ice plant. Maintain temperature in brine and check function of agitator. Check motor and wiring circuit, service and trouble shoot, Test component and replace defective parts. Evacuate and charge gas. Install and test performance.

25. **Walk in cooler and Reach in Cabinet:** Identify parts, accessories, controls and operation of walk in cooler and reach in cabinet. Preventive maintenance, trouble shooting and servicing of components. Service and trouble shoot, check wiring circuit, Test component and replace defective parts. Install gauge manifold, leak test, evacuate and gas charge.

26. **Cold Storage:** Identify parts, controls and accessories of Cold storage plant. Service and operation of cold storage plant. Test electrical controls and cooling system. Charge refrigerant and oil. Test leak, evacuation and gas charging. Periodic maintenance. Install ammonia compressor. Check Electrical wiring of the compressor and plant Check the refrigeration system of the plant. Perform cold storage servicing. Measure pressure and temperature. Evacuation by two stage rotary vacuum pumps. Gas charging and performance testing. Operate and maintain cold storage plant. Find out DBT, WBT, RH & other properties by using psychrometric chart Use psychrometer. Use Anemometers for measuring air flow. Use pitot tube for air flow measurement. Service of fans and blowers used in air-conditioning system. Service of motors used in air-conditioning system

27. **Ducts:** Install Ducts. Construct Ducts as per duct layout drawing. Insulate Ducts. Longitudinal and transverse joints.

28. **Filters:** Service and maintain different filters. Placing of filters

29. **Package AC:** Identify various components of Package AC (with Air Cooled Condenser). Identify Electrical circuit of Package AC (with Air Cooled Condensers). Leak testing, evacuation, gas charging. Commissioning and trouble shooting. Identify various components of package AC, Water cooled condenser. Electrical circuit of package AC. Descale the Water cooled condenser. Leak testing, evacuation, gas charging. Trouble shooting. Identify various components of split package AC. Electrical circuit of split package AC. Testing components. Leak testing, evacuation, gas charging. Installation and trouble shooting.

30. **Central AC:** Identify various components of central AC plant. Electrical circuit of central AC plant. Testing components, gas charging. Servicing AHU including fire dampers. Checking airflow, damper, temperature and pressure. De-scaling condenser and cooling tower. Pump down gas from central AC plant. Add oil to compressor. Top up gas to the central AC system. Check temperature and pressure control. Identify various components of direct

expansion type central AC plants. Electrical circuit of direct expansion type central AC plants. Testing components. Leak testing, evacuation, gas charging. Trouble shooting. Operation & Maintenance of central AC plants. Insulate chilled water piping's. Servicing of FCU and water control valves. Mixing dampers. Bypass dampers checking. Servicing and troubleshooting of direct expansion AC plants. Servicing and troubleshooting of indirect expansion AC plants. Erection of commercial type condensing unit. Vibrating eliminator, water proofing insulation. Check different controls used in central AC system. Trouble shooting of central AC. Estimate the capacity of AHU, CFM of air and Find the tonnage of cooling & heating load effect in a duct-based AC.

31. **Direct Expansion System:** Identify VRF / VRV system. Check and service VRF / VRV system. Connect master unit and IDU. Identify the location of ODU. Identify the size of piping's and laying work. Check control system. Identify error code. Identify various components of indirect expansion type central AC plants. Electrical circuit of indirect expansion type central AC plants. Testing components. Leak testing, evacuation, gas charging / top up gas. Trouble shooting.

32. **Mobile AC:** Repair and maintenance of bus AC system. Servicing and testing magnetic clutch operation. Compressor overhauling. Leak testing, evacuation, gas charging, oil charging. Testing wiring system. Repair and maintenance of train AC system. Leak testing, evacuation, gas charging. Checking air flow. Measure temperature and pressure. Check solenoid valve.

TRADE: REFRIGERATION AND AIR-CONDITIONING MECHANIC

SYLLABUS FOR COMPETITIVE WRITTEN EXAMINATION

1. **Introduction to trade and related industries:** General safety precautions and first aids, firefighting equipment and electrical safety. History of Refrigeration and Air conditioning. Function, use and specifications of refrigeration tools, instruments and equipment. Grooming of technicians

2. **Fitting:** Different types of Fitting hand tools, power tools, - their use. Function, construction, Specification & their application. Machineries and equipment used in fittings like drilling machines, grinding machines – types, specifications and care and maintenance. Precision measuring instruments – Function, construction, Specification & their application.

3. **Sheet Metal:** Function, construction, working, use, and application, specification of Sheet metal tools, instruments and equipment. Care and maintenance of tools. Types of sheet metal joints (cold and hot) and their use. Rivet & riveting-their types and use. Solder and its composition.

4. **Electrical:** Electrical terms such as AC and DC supply, Voltage, Current, Resistance, Power, Energy, Frequency etc. Safety precautions to be observed while working on electricity. Conductors and Insulators, Materials used as conductors. Series and parallel circuit, open circuit, short circuit, etc. Measuring Instruments such as voltmeter, ammeter, ohm meter, watt meter, energy meter and frequency meter. Earthing and its importance. Earth resistance.

5. **Basic Refrigeration:** Basic principle of refrigeration, working, use, specifications of refrigeration tools, instruments and equipment. Fundamentals of Refrigeration, units and measurements, Pressure & its Measurements. Thermodynamics laws. Science related to refrigeration, work, power, energy, force, Heat and Temperature, Different temperature scales, Thermometers, Units of heat, sensible heat, latent heat, super heating and sub-cooling, saturation temperature, pressure, types, units. Types of Refrigeration systems, including Vapour absorption refrigeration cycle (VARC), water –combination. Study the construction and working of vapor compression cycle, low side & high side of vapour compression system. Applications of vapour compression cycle. Coefficient of Performance (COP), Ton of Refrigeration. Construction and working of V.C Cycle, fundamental operations, sub cooling and super heating. Study of PH, TS, PV diagram.

6. **Refrigerator (Direct cool):** Function, construction, working of single door direct cool refrigerator, specifications, trouble shooting, care and maintenance. Requirement of Vacuum and level of vacuum. Study the construction &working of direct cool Refrigerator. Study the electrical components of refrigerator. Study the mechanical components of refrigerator and their types. Study the heat exchanger, door gaskets, Heat Insulation Materials Care and maintenance of refrigerator. Importance of flushing in evaporator and condenser, use of dry nitrogen for flushing, necessity of replacing capillary and drier. Evacuation, leak testing, gas charging method in refrigerator. Refrigerants used in Refrigerators and its properties. Desiccant drying agent

7. **Frost Free Refrigerator:** Study the construction and working of Frost Free (2 or 3 door) Refrigerator parts particularly, the forced draft cooling, Air Duct circuit, temperature control in Freezer & cabinet of Refrigerator, air flapper / louver used in refrigerator section, automatic defrost system. Study of Electrical accessories & their functions (Timer, Heater, Bimetal, Relay, OLP, T/S etc.) Refrigerator cabinet volume calculation.

8. **Refrigerator (Inverter Technology):** Study the construction and its working of two and three door frost free refrigerator Care and maintenance, installation method

9. **Compressor**: Function, construction, working, application of compressor, (Fixed speed and variable speed compressor) like Reciprocating, rotary, scroll and inverter type. Study the construction & working of reciprocating, rotary, scroll, screw and centrifugal compressor, wobble & swash plate compressor. Compressor efficiency factors wet compression, oil, properties, lubrication methods AC motors and their types. Advantages of AC motor over DC motor. Revolving field theory & Phase splitting theory. Capacitor method and inductor method used to split the single phase. Torque – starting torque and running torque. Split phase induction motors, working principle and construction. Starting winding and running winding. Starting current and running current. Method of changing the direction of rotation (DOR). Capacitor starts induction run motor, working principle and construction. Centrifugal switch and its function. Starter and its necessity. DOL starter and the safety devices incorporated in it. Description of hermetic compressor motor. Capacitor starts capacitor run motor, working principle and construction. Starting capacitor and running capacitor Shaded pole motors, working principle and construction. Torque comparison among various single phase AC motors. Common faults, causes and remedies in motors

10. **Motors:** Motors used in refrigeration and Air conditioning system, types, construction, working & their starting methods. Function of Starting relay, Capacitors, OLP's. Production of rotating magnetic field by three phase AC supply. Working principle of three phase induction motor. Terms such as torque, slip, rotor frequency and their relation. Construction of squirrel cage induction motor. Importance of phase sequence. Construction of slip ring induction motor. Comparison between SCIM and SRIM. Three phase motor starters such as DOL starter, Star – Delta starter, Auto transformer starter and Rotor resistance starter. Common faults, causes and remedies in three phase AC motors. Working principle of inverter technology, advantages of variable speed technology over fixed speed.

Working principle of control system for inverter Air Conditioners (ACs). Printed circuit board (PCB), including power PCB, filter PCB, heat sink and reactor. Wiring diagram.

11. **Condenser:** Function of condenser, types, Construction of air-cooled condenser. Effect of chocked condenser. Advantages, de scaling of air-cooled condenser. Effects of air fouling and bypass air in condenser. Types of water-cooled condenser, application, and advantages. Liquid receiver, pump down, application, types, function and working. Description of water-cooled condenser

12. **Drier:** Function of drier, types, application and its advantage. Description of desiccants.

13. **Expansion Valve:** Expansion valve used in domestic refrigeration and air conditioning systems. Capillaries, Automatic and Thermostatic Ex. Valves, and electronic expansion valves.

14. **Evaporator:** Working principle, Function, types of evaporators used in refrigerator, water coolers, bottle coolers, window and split A.C. Super heating in evaporator. Function of accumulator and types. Methods of defrosting.

15. **Refrigerant:** Classification of refrigerants, nomenclature of refrigerants including chemical name and formulas HydroChloroFluoroCarbons (HCFCs), HydroFluorocarbons (HFCs) and Hydrofluoroolefins (HFOs), blends of HFCs and blends of HFCs/HFOs. Climatic impact of refrigerants: Stratospheric ozone depletion, global warming, mechanism of ozone depletion; the Montreal Protocol phase-out schedule of ozone depleting refrigerants (HCFCs) and high global warming refrigerants (HFCs). Brief introduction of Ozone Depleting Substances (Regulation and Control) Rules, 2000 and its amendments. Introduction of properties of refrigerants; environment related properties: Ozone Depleting Potential (ODP), GWP; ODP and GWP of various refrigerants, thermos-chemical properties: flammability and toxicity of refrigerants, lower flammability limit (LFL) and upper flammability limit of A3 and A2L refrigerants. Thermo-physical properties: pressure temperature of different refrigerants. Safe handling of flammable refrigerants. Refrigerant leak detection methods, evacuation and charging of refrigerant, temperature glides of refrigerant blends, procedure of charging of refrigerant blends especially the zeotropic blends, hydrocarbon blends, HFC blends (R- 404A, R-407C, R-410A) and blends of HFC/HFO.

16. **Retrofitting:** Changes of components & practices while retrofitting CFC appliances with HC Refrigerants. Properties of HCs

17. **Thermal Insulation:** Function, types, thermodynamic properties of heat insulation materials used in refrigeration and Air Conditioning systems. Introduction of polyols and foam blowing agents (HCFC-141b, cyclopentane, water, C02, methyl formate, HFO-1233zd (E), HFO-1336mzz (Z)).

18. **Window Air Conditioner:** Study of construction and working principle of window AC and its components; electrical controls and wiring. Installation, troubleshooting and servicing. Energy Efficiency Ratio (EER) – Energy efficiency labeling on ACs

19. **Installation of Window AC:** Advantages of proper installation of window AC with emphasis on proper functioning and avoidance of leakage of refrigerant. Selection of installation location considering safety, exclusive availability of power point and obstruction-free air flow from condenser. Step by step procedure for proper installation, and proper inclination of AC cabinet backward/ outward for drainage of condensate.

20. **Split AC:** Construction and working principle, types, troubleshooting & care and maintenance. Energy Efficiency Ratio (EER) - Energy- efficiency labeling on ACs. Advantages of proper installation with emphasis on proper functioning and avoidance of leakage of refrigerant. Selection of location of indoor and outdoor units ensuring minimum distance between the units, away from flammable materials, if any, good air flow within the cooling space as well as over the condenser. Locate power supply point considering safety and exclusiveness. Step by step procedure for installation both for indoor and outdoor unit. Ensure convenient access for drainage of condensate from the cooling coil

21. **Split AC (Wall Mounted):** Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit

22. **Split A.C (floor, Ceiling /Cassette mounted Split A.C):** Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit

23. **Split A.C (Ducted):** Study of the Duct able split AC, its Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit.

24. **Multi Split A.C:** Study the construction and working, various components, electrical circuits, testing components, fault detection, leak testing, evacuation, gas charging, Installation, trouble shooting.

25. **Inverter Split A.C.:** Study of construction and working principle of inverter AC and its components, electrical circuit and controls, installation, servicing, trouble shooting, fault detection, leak testing and gas charging. Concept of Indian Seasonal Energy Efficiency Ratio ISEER). Energy Efficiency leveling on inverter AC.

26. **Car Air Conditioning:** Study various components, electrical circuits and wiring diagram, testing components, fault detection, leak testing. Study of good service practice, evacuation, gas charging, Installation, trouble shooting, Magnetic clutch operation, free movement of flywheel (nonfunctioning of clutch), care and maintenance.

27. **Commercial Compressor (Fixed & Variable):** Function, types, Construction & working, applications of compressors used in commercial refrigeration. Volumetric efficiency, Capacity control, factor influencing volumetric efficiency. Compressor lubricant oil, types, properties, types of lubrication methods such as splash, forced feed. Study the Construction and working principle of different commercial compressor (Open and Sealed type) (Reciprocating, centrifugal, screw, scroll compressor).

28. **Water Cooled Condenser:** Study the water-cooled Condenser, its type and capacity, construction and working, de scaling, application. Evaporative condenser - Types and their function, construction and application. Liquid receiver, function. Drier, types and application.

29. **Cooling Tower:** Cooling tower, types, Construction, capacity, advantage & disadvantages of different types of cooling tower. Efficiency, approach and Cooling tower range.

30. **Water Treatment:** Necessary, causes of water contamination control of scale deposit, corrosion and algae, Water softening and De-scaling method, pump and fan used. Regenerate and backwash.

31. **Expansion Valve:** Types and function, construction, working principle, & their advantage &disadvantages. Thermostatic Expansion Valves (TXV), Automatic Expansion Valves (AXV), Float valves, fixed and modulating orifice controls & electronic Expansion Valves, LMC (level master control). Selection of Expansion valves and capillaries for various Refrigeration and Air Conditioning applications.

32. **Evaporator:** Function, types, Plate & Tube forced air DX evaporators. Types of Defrost system. Water/ Brine chillers. Types of brine used as secondary refrigerant. Accumulator, its function. Liquid-suction-liquid Heat-exchanger, their function, construction, application & advantages. Study of Accumulator and Oil separator. Accumulator, its function. Liquid-suction-liquid Heat-exchanger, their function, construction, application & advantages. Study of Accumulator and Oil separator.

33. **Water Cooler & Water Dispenser:** Study the refrigeration cycle of water cooler and dispenser, types, construction & working, Capacity & applications. Study the electrical and mechanical components of storage type water cooler and Bubble type water dispenser. Insulation material used in water cooler and dispenser Refrigerant used in the system. UV and RO type water coolers and dispensers.

34. **Visible Cooler and Bottle Cooler:** Visible cooler & bottle coolers. Description, construction & working, with HFC-134a and hydrocarbons, safety especially for flammable refrigerants, maintenance, testing of mechanical and electrical components including sealed electrical components fitted in appliances using flammable refrigerants.

35. **Deep Freezer / Display Cabinet:** Description, Construction, working, specifications, function, care and maintenance, faults and remedies.

36. **Ice Cube Machine:** Description, Construction, working, reverse cycle functioning & Circuit diagram, installation method.

37. **Softy Machine:** Description, Construction and function.

38. **Ice Candy Plant:** Function, construction, working principle, Circuit diagram, capacity& types of compressor used. Brine composition to maintain required temperature. Operation, maintenance, retrofit.

39. **Ice Plant:** Details about components of Ice plant their functioning, working principle, Circuit diagram, capacity & types of compressor used, agitator functioning, temperature maintaining. Properties and handling of ammonia and other flammable low-GWP refrigerants.

40. **Walk in Cooler & Reach in Cabinet:** Details about components, their functioning, working principle, Circuit diagram, capacity & types. Care and maintenance.

41. **Cold Storage:** Study of cold storage plant, parts, Construction, applications, controls & electrical diagram used in cold storage plant. Food preservation spoiling agents - controlling of spoiling agents, preservation by refrigeration system, maintaining temperature in different places. Types of cold storage and its details. Properties of commonly used refrigerants like ammonia and its safe handling. Cold storage- type construction, capacity and specification. Use of vibration eliminator and shock absorber, Study the lay out and electric wiring of the storage plant. Mobile refrigeration in transport vehicles. Method of pressure testing, evacuation & charging to the system and testing efficiency. Cold storage plant operation, its common trouble & remedies. Deep freezing, freezing tunnel, blast freezer its function and working, its application.

42. **HVAC (Plant):** Introduction to HVAC, Fundamentals of Central Air Conditioning / HVAC plant, requirements of comfort A.C Study of psychometric terms, DBT, WBT, RH, enthalpy, dew point, and specific humidity. Types of Central air conditioning (Direct and indirect system) Construction, working, components, faults, care and maintenance. Description of blowers & fans, function and types, static and velocity pressure measurements.

43. **Duct:** Function, types, materials, duct designing, duct insulation, properties of insulating materials 'K' factors, Acoustic insulation, air distribution methods, air flow, AHU, FCU, fan, blower.

44. **Air Filters:** Function of air filters, types, construction, maintenance, effect of chocked Air filter, Hepa filters.

45. Package AC (with Air Cooled Condenser): Study the Package AC (with Air Cooled Condensers), its Construction and working principle, types, trouble shooting.

46. Package A.C with Water Cooled Condenser: Study Package AC, types, construction and working principle, trouble shooting, and various applications. Duct system, AHU Care and maintenance, installation method.

47. Split Package: Construction and working principle, types, Study various electrical and mechanical components, trouble shooting.

48. Centralised/Industrial Air Conditioning: Construction and working principle, types, maintenance of Industrial Air-conditioning plant. Humidification and dehumidification methods. AHU, description of FCU Temperature and pressure controls used in AC plant, its construction, working, safety devices, cooling towers, piping lines.

49. Direct Expansion System: Study Direct expansion system. Operation & Preventive Maintenance Schedule of central AC plant. Maintain log book for daily operation. VRF / VRV system – description and function of different parts. Details of piping have and controls system, Common reason for error code, types of ODU and IDU.

50. Indirect/Chiller System: Study central station AHU and FCU, Air washers used in chilled water system, understanding lay out, modulating valves for temperature control. Expansion valves & other related control – description and function. Study of Humidification & Dehumidification. Humidifiers & Dehumidifier's. Humidity control. Use of hygrometer. Construction and study of commercial. A.C plant, package chillers, screw chillers, reciprocating chillers. Controls used in AC system, Electromechanical, pneumatic and electronic. Detail study of heat load calculation for commercial and industrial buildings.

51. Mobile AC (Bus, train): Study the refrigeration cycle in automobile AC, its Construction, working of bus AC, Magnetic clutch operation, freewheeling (de engaging clutch). Refrigerants used HCFC-22, HFC-134a, HFOs, blends of HFCs and HFOs. Construction & working of train AC and its operation. Trouble shooting in train A.C. Planning for Preventive maintenance and scheduling of maintenance activities in large AC and Refrigeration plant.

ENGINEERING DRAWING:

1. Introduction to Engineering Drawing and Drawing Instruments: Convention. Sizes and layout of drawing sheets. Title Block, its position and content. Drawing Instrument.

2. Lines - Types and applications in drawing. Free hand drawing of Geometrical figures and blocks with dimension Transferring measurement from the given object to the free hand sketches. Free hand drawing of hand tools and measuring tools.

3. Drawing of Geometrical figures: Angle, Triangle, Circle, Rectangle, Square, Parallelogram. Lettering & Numbering – Single Stroke.

4. Dimensioning: Types of arrowhead. Leader line with text. Position of dimensioning (Unidirectional, Aligned) Symbolic representation. Different symbols used in the related trades.

5. Concept and reading of Drawing in. Concept of axes plane and quadrant. Concept of Orthographic and Isometric projections. Method of first angle and third angle projections (definition and difference) Reading of Job drawing related to trades.

6. Reading of Electrical, Electronic & Mechanical Sign and Symbols used in RAC. Sketches of Electrical, Electronic & Mechanical components used in RAC. Reading of Electrical wiring diagram and Layout diagram. Drawing of Electrical circuit diagram used in RAC. Drawing of Block diagram of Instruments & equipment of trades. given object to the free hand sketches. Free hand drawing of hand tools and measuring tools.

WORKSHOP CALCULATION & SCIENCE:

1. Material Science: Types metals, types of ferrous and non-ferrous metals Physical and mechanical properties of metals Introduction of iron and cast iron Difference between iron & steel, alloy steel and carbon steel Properties of insulating materials.

2. Mass, Weight, Volume and Density: Mass, volume, density, weight and specific gravity, numerical related to L, C, O section only Related problems for mass, volume, density, weight and specific gravity. Speed and Velocity, Work, Power and Energy Work, power, energy, HP, IHP, BHP and efficiency

3. Heat & Temperature and Pressure: Concept of heat and temperature, effects of heat, difference between heat and temperature, boiling point & melting point of different metals and non-metals Scales of temperature, Celsius, Fahrenheit, kelvin and conversion between scales of temperature Heat &Temperature - Temperature measuring instruments, types of thermometer, pyrometer and transmission of heat - Conduction, convection and radiation Co-efficient of linear expansion and related problems with assignments Problem of heat loss and heat gain with assignments Thermal conductivity and insulators Concept of pressure - Units of pressure, atmospheric pressure, absolute pressure, gauge pressure and gauges used for measuring pressure.

4. **Basic Electricity:** Introduction and uses of electricity, electric current AC, DC their comparison, voltage, resistance and their units

5. **Mensuration:** Area and perimeter of square, rectangle and parallelogram Area and perimeter of Triangles.

6. **Friction** - Advantages and disadvantages, Laws of friction, co-efficient of friction, angle of friction, simple problems related to friction. Lubrication Friction - Co- efficient of friction, application and effects of friction in workshop practice.

7. **Centre of Gravity:** Centre of gravity - Centre of gravity and its practical application Area of cut out regular surfaces and area of irregular surfaces. Area of cut out regular surfaces - circle, segment and sector of circle Related problems of area of cut out regular surfaces - circle, segment and sector of circle Area of irregular surfaces and application related to shop problems.

8. **Elasticity:** Elasticity - Elastic, plastic materials, stress, strain and their units and young's modulus, Elasticity - Ultimate stress and working stress.

9. **Heat Treatment:** Heat treatment and advantages Heat treatment - Different heat treatment process – Hardening, tempering, annealing, normalising and case hardening.

10. **Estimation and Costing**: Estimation and costing - Simple estimation of the requirement of material etc., as applicable to the trade Estimation and costing - Problems on estimation and costing.

TRADE: COMPUTER OPERATION & PROGRAMMING ASSISTANT

SYLLABUS FOR TRADE TEST

1. **Safe working practices:** Visit COPA Lab. of the institutes and locate the electrical connections with computer system setup. Identifying safety symbols and hazard identification. Practice safe methods of fire fighting in case of electrical fire. Use of fire extinguishers.

2. **Computer components:** Identify computer peripherals and internal components of a disassembled desktop computer. Assemble components of desktop computer.

3. **Using Windows Operating System:** Practice on Windows interface and navigating windows. Practice on managing files and folders using removable drives. Customize the desktop settings and manage user accounts. View system properties and control panel details. Work with keyboard shortcut commands. Print and scan document using different commands.

4. **Computer basics and Software Installation:** View the BIOS settings and their modifications. Install Windows operating system. Format hard disk and create partition. Identify and rectify common hardware and software issues during OS installation. Install necessary application software for Windows i.e. Office Package, PDF Reader, Media Player etc. Configure Bluetooth and Wi – Fi settings. Install Drivers for printer, scanner, webcam and DVD etc. Burn data, video and audio files on CD/DVD using application software.

5. **DOS Command Line Interface & Linux Operating Systems:** Use basic DOS commands for directory listing. Manage files and folders using DOS commands. Install Linux operating system. Install necessary application software for Linux i.e. Office Package, PDF Reader, Media Player etc. Use Basic Linux commands for directory listing, file and folder management, password etc. Use the Linux graphical user interface for file and folder management, exploring the system etc. Customize desktop settings and manage user accounts in Linux. View system properties and manage system setting in Linux.

6. **Using Word Processing Software:** Open MS Word and familiarize with basic word components. Practice creating, saving and renaming of word documents. Edit document using basic formatting tools. Practice Inserting and formatting tables and other objects. Work with Page layout settings and printing documents. Use templates, autocorrect tools, and record and execute a macro. Use Mail merge tool. Use conditional Mail Merge, External Data Source. Practice Letters, Label & Envelop printing using Mail Merge. Use Table of Context, Indexing, Hyperlink, Bookmark, Comment, equation, symbols, citation, cross-reference, footnote, translate, synonyms, thesaurus, spell check &grammar, compare etc. Practice Typing using open source typing tutor. Practice of using shortcut keys and use Open Office as word processor.

7. **Using Spread Sheet Application:** Open MS Excel and familiarize with basic application components. Practice creating, saving and formatting excel spread sheets. Use absolute and relative referencing, linking sheets, conditional formatting etc. Practice Excel functions of all major categories i.e. Financial, Logical, Text, date & time, Lookup, Math, Statistical etc. Use various data types in Excel, sorting, filtering and validating data. Create and format various static and dynamic charts. Practice Importing & exporting excel data. Perform data analysis using "what if" tools and Pivot Table and record and execute a macro. Modify Excel page setup and printing and use open office as Spreadsheet application. Execute simple projects using Excel & Word.

8. **Image editing and creating Presentations:** Use Windows Paint or image editing software like Open Office Draw, GIMP, Irfan View or a similar tool. Perform Image editing using open source applications. Open power point presentation and familiarize with basic application components. Create Slide shows, Insert picture and theme. Add new slide, format text, link with word and excel documents. Practice animating slide transitions and objects. Create slide shows by inserting audio & video and synchronize with presentation. Modify slide page setup and print the slides. Create a simple presentation project using open office.

9. **Database Management with MS Access:** Create database and design a simple table in Access. Practice enforcing integrity constraints and modify properties of tables and fields. Create relationships and join tables. Create and format Forms. Create simple queries with various criteria and calculations. Create Simple update, append, make table, delete and crosstab queries. Modify form design with controls, macros and events. Import and export data to and from Access and create and format various types of reports. Compress and Encrypt databases.

10. **Configuring and using Network:** View Network connections. Connect a computer to a network and share Devices I.e. Printers, files, folders and drives. Work with various Network devices, connectors and cables. Create straight and cross cable and punch a UTP cable in the patch socket and test the connectivity. Practice IP Addressing and Subnet masking for IPV4/ IPV6 and pinging to test networks. Configure Hub and Switch. Set up and configure wired and wireless LAN in a Computer Lab within at least three computers. Use patch panel & I/O Box for wired LAN and installing & configuring Internet connection in a single PC and in a LAN. Set up a proxy server/ DHCP Server with

firewall. Set up video conferencing using open source software. Use various tools (by open source /free) for network troubleshooting, maintenance and security for both Wired and Wireless

11. **Using Internet:** Browse the Internet for information (use at least 3 popular browsers). Create and use e-mail for communication with attachment, priority setting, address book. Communicate with text, video chatting and social networking sites. Use online dictionary, translation software, storage space, share files with e-mail links, download manager, download & upload YouTube files, google map & earth etc. Update windows & other software. Configure Outlook, mail service in mobile phones. Use tools like Skype, Google+ etc. Browser setting for Bookmark, cookies, favorites and pop ups, default website, trusted site, restricted site, content, history and advanced setup.

12. **Designing Static Web Pages:** Practice with basic HTML elements (e.g. head, title, body), tag and attributes. Design simple web page with text, paragraph and line break using HTML tags. Format text, change background color and insert pictures in web page. Design simple web page with tables and lists. Use marquees, hyperlinks and mailto link in designing web pages. Create frames, add style and design layout. Insert text box, check box and combo box in web page. Design web page using password field, submit button, reset button and radio button etc. Design a web page adding flash file, audio and video files. Design web page with forms and form controls using HTML tags. Create web page using Cascading Style Sheet (CSS). Use WYSIWYG (Kompozer) web design tools to design and edit web pages with various styles.

13. **JavaScript & creating Web page:** Practice with basic elements of JavaScript. Embed JavaScript in HTML to display information in web pages, documentation and formatting of HTML source code. Use JavaScript Variables, Data types, Constants and Operators. Use Control statements and Loops in JavaScript. Practice with switch case, loop controls and Errors in JavaScript. Practice with Arrays in JavaScript page. Practice with functions in JavaScript web page. Practice with String, Math and Date functions in JavaScript. Use online tool or open source software to develop and edit web pages containing. Titles, different font sizes and colors, frames, lists, tables, images, image map, controls, CSS, forms, hyperlinks etc., use web template to create a web page of various styles. Develop a simple web project using HTML, JavaScript and host it in IIS and a registered domain.

14. **Programming with VBA:** Practice with basic functions of VBA Editor. Use form controls like buttons, Check boxes, Labels, Combo Box, Group Box, List Box, Option Button, Scroll Bar and Spin button. Modify object properties in VBA program. Write simple programs involving VBA Data types, Variables, Operators and Constants. Create Message boxes and Input boxes in VBA. Work with conditional statements like if, Else-if, and Select. Practice with Loop, Loop Control and Case statements in VBA. Create and Manipulate Arrays in VBA. Practice with string variables in VBA programming. Write programs involving Mathematical, Conversion, Date and String Functions in VBA. Create Functions, Procedures, Passing Parameters and Using Returned Data. Practice with built in functions in VBA programs. Create and edit macros. Write code to work with Excel in VBA forms. Practice with methods and events in VBA Programming. Debug, Step through code, Breakpoints, find and fix errors while debugging. Develop a simple project involving MS excel and VBA.

15. **Using Accounting Software:** Practice Basic accounting with tally interface. Create Company, Account and Voucher entry in Tally. Generate reports for Invoice, Bill, Profit & Loss account etc. Perform Cost Centre & Cost Category management. Create and manage budgeting systems. Create Scenario and Variance Analysis. Use Tally for Costing, Ratio Analysis, Cash flow and Funds flow statements. Analyze and Manage Inventory control. Perform Point of Sales and Taxation (VAT, Excise, Service Tax). Perform System Administration and use other Utilities. Create users, take Backup & Restore of Company. Use Multilingual Functionality in Tally.

16. **E Commerce:** Browse E-commerce websites viz. eBay, Amazon, Flipkart, OLX, Quikr etc. and prepare comparative statement of the main features of these sites. Upload products for selling in E-Commerce Sites and make online purchase from E Commerce sites. Manage security issues in E-Commerce and payment operations.

17. **Cyber Security:** Protect information, computers and networks from viruses, spyware and other malicious code. Provide firewall security for Internet connection and Network System. Protect the computer against various internet threats. Make backup copies of important file, data and information. Secure your Wi-Fi networks using password, WEP, WPA-PSK, WPA2- PSK, SSID, MAC address filtering. Create individual user accounts for each member. Limit member access to data and information, and restrict authority to install unnecessary downloads.

TRADE: COMPUTER OPERATION & PROGRAMMING ASSISTANT
SYLLABUS FOR COMPETITIVE WRITTEN EXAMINATION

1. **Safe working practices:** Scope of the COPA trade. Safety rules and safety signs. Types and working of fire extinguishers.

2. **Introduction to Computer components:** Introduction to computer system. Concepts of Hardware and Software. Function of motherboard components and various processors. Various Input/ Output devices in use and their features.

3. **Introduction Windows Operating System:** Introduction to operating System. Main features of Windows OS. Concept of various shortcut commands.

4. **Computer basics and Software Installation:** Introduction to the booting process. Introduction to various types of memories and their features. Basic Hardware and software issues and their solutions. Usage of Application software and Antivirus.

5. **Introduction to DOS Command Line Interface & Linux Operating Systems:** Introduction to basic DOS Internal and External Commands. Introduction to Open Source Software. Introduction to Linux Operating System features, structure, files and processes. Basic Linux commands.

6. **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.

7. **Spread Sheet Application:** Introduction to Excel features and Data Types. Cell referencing and linking Sheets. Introduction to various functions in all categories of Excel. Concepts of sorting, filtering and validating data. Analyzing data using charts, data tables, pivot tables, goal seek and scenarios.

8. **Image editing, Presentations:** Introduction to Open Office. Introduction to the properties and editing of images. Introduction to different formats of images and their uses. Introduction to Power Point and its advantages. Creating Slide Shows. Fine tuning the presentation and good presentation technique.

9. **Database Management Systems:** Concepts of Data and Databases. Overview of popular databases, RDBMS, OODB and NOSQL. Rules for designing good tables. Integrity rules and constraints in a table. Relationships in tables. Introduction to various types of Queries and their uses. Designing Access Reports and Forms. Introduction to macros, designer objects controls, their properties and behavior.

10. **Networking Concepts:** Introduction to Computer Networks, Necessity and Advantages. Client Server and peer to Peer networking concepts. Concept of Proxy Server and proxy firewall server. Concept of DHCP Server. Network topologies. Introduction to LAN, WAN and MAN. Network components, viz. Modem, Hub, Switch, Router, Bridge, Gateway etc. Network Cables, Wireless networks and Blue Tooth technology. Concept of ISO - OSI 7 Layer Model. Overview of various Network Protocols Viz. TCP/IP, FTP, Telnet etc. Concept of Logical and Physical Addresses, Sub netting and Classes of Networks.

11. **Internet Concepts:** Introduction to www, Concept of Internet, Web Browsers, internet servers and search engines. Concepts of Domain Naming Systems and E mail communication. Introduction to video chatting tools and Social Networking concepts.

12. **Web Design Concepts:** Concepts of Static and Dynamic Web pages. Introduction to HTML and various tags in HTML. Concepts of different controls used in Web Pages. Concepts of CSS and applying CSS to HTML. Introduction to open source CMS viz, Joomla, Word press etc. and Web authoring tools viz. Kompozer, Front Page etc. Concept of good web page designing techniques.

13. **Introduction to JavaScript:** Introduction to Programming and Scripting Languages. Introduction to JavaScript and its application for the web. Introduction to Web Servers and their features. JavaScript Basics – Data types, Variables, Constants and Conversion between data types. Arithmetic, Comparison, Logical Operators in JavaScript. Operator precedence. Program Control Statements and loops in JavaScript. Arrays in JavaScript – concepts, types and usage. The String data type in JavaScript. Introduction to String, Math and Date. Introduction to Functions in JavaScript. Built in JavaScript functions overview. Concepts of Pop Up boxes in JavaScript. Introduction to the Document Object Model. Concepts of using Animation and multimedia files in Java Script.

14. **Introduction to VBA, Features and Applications:** Introduction to VBA features and applications. Properties, events and methods associated with the Button, Check Box, Label, Combo Box, Group Box, Option Button, List Box, Scroll Bar and Spin button controls. VBA Data types, Variables and Constants. Operators in VBA and operator precedence. Mathematical Expressions in VBA. Introduction to Arrays in VBA. Introduction to Strings in VBA. Conditional processing in VBA, using the IF, Else-if, Select Case Statements. Introduction to Loops in VBA. VBA message boxes and input boxes. Introduction to Creating functions and Procedures in VBA. Using the built in functions. Introduction to Object Oriented Programming Concepts. Concepts of Classes, Objects, Properties and Methods. The user forms and control in Excel VBA. Introduction to Debugging Techniques.

15. **Using Accounting Software:** Basics of Accounting, Golden Rules of Accounting, Voucher Entry, Ledger Posting, Final Accounts Preparation. Cash Book. Ratio Analysis, Depreciation, Stock Management. Analysis of VAT, Cash Flow, Fund Flow Accounting. Introduction to Tally, features and Advantages. Implementing accounts in Tally. Double entry system of book keeping. Budgeting Systems, Scenario management and Variance Analysis. Costing Systems, Concepts of Ratios, Analysis of financial statements. Inventory Basics, POS Invoicing, TDS, TCS, FBT, VAT & Service Tax. Tally Interface in Different Languages.

16. **E Commerce Concepts:** Introduction to E-Commerce and advantages. Building business on the net. Payment and Order Processing, Authorization, Chargeback and other payment methods. Security issues and payment gateways.

17. **Cyber Security:** Overview of Information Security, SSL, HTTPS, Security threats, information Security vulnerability and Risk management. Introduction to Directory Services, Access Control, Security, Privacy protection, Audit and Security. Introduction to IT Act and penalties for cybercrimes.

TRADE: DRAUGHTSMAN CIVIL
SYLLABUS FOR TRADE TEST

1. **Drawing:** Draw freehand sketches of hand tools used in civil work following safety precautions. Draw plane figures applying drawing instruments with proper layout and the method of folding drawing sheets. Draw orthographic projections of different object with proper lines, lettering and dimensioning. Draw Isometric/Oblique/Perspective views of different solid/hollow/cut sections with proper lines, lettering and dimensioning. Draw component parts of a single storied residential building with suitable symbols and scales. Draw different types of stone and brick masonry. Draw different types of shallow and deep foundation. Draw different types of shoring, scaffolding, underpinning, framework and timbering. Draw different types of Damp proofing in different position. Draw different types of doors and windows according to manner of construction, Arrangement of component, and working operation. Draw types of ground and upper floors. Draw different types of vertical movement according to shape, location, materials in stair, lift, ramp and escalator. Draw different types of roofs, truss according to shape, construction, purpose and span.

2. **Surveying:** Perform site survey with chain / tape and prepare site plan. Prepare the detailed drawing of electrical wiring system.

3. **CAD:** Create objects on CAD workspace using Toolbars, Commands, Menus, formatting layer and style. Draw a sanction plan of double storied flat roof residential building by using CAD. Create objects on 3D modelling concept in CAD. Prepare a drawing of public building detailing with roof and columns by frame structures using CAD. Prepare detailed drawing of RCC structures using CAD and prepare bar bending schedule. Draw the details of a framed structure and portal frame of a residential building using CAD. Draw the different types of steel section, rivets and bolts using CAD. Draw the details of girders, roof trusses and steel stanchions using CAD

TRADE: DRAUGHTSMAN CIVIL
SYLLABUS FOR COMPETITIVE WRITTEN EXAMINATION

1. **Safety measures:** Importance of safety and general precautions observed in the industry/shop floor. Introduction of first aid. Introduction of PPEs. Response to emergencies e.g: power failure, fire alarm, etc.

2. **Introduction of Code for practice** of Architectural and Building Drawings, Layout of drawing. Lines, Lettering, Dimensioning. Knowledge of different types of scale.

3. **Principle of R.F Materials:** Stones: characteristics, types & uses. Bricks- Manufacturing, characteristics of good bricks, types, uses and hollow bricks, Lime- characteristics, types, manufacturing & its uses. Pozzolanic: characteristics, types & uses. Cement: Manufacturing, characteristics, types, uses and test of good cement.

4. **Different types of projection views:** Orthographic, isometric, Oblique and Perspective.

5. **Building Planning:** Principle of planning, Objectives & importance, Function & responsibility, Orientation, Local building Bye-Laws as per ISI code, lay out plan & key plan, submitted in composition of drawing, Provisions for safety, Requirement of green belt and land. Building Planning: Economy & orientation, Provision for lighting and ventilation, Provision for drainage and sanitation, Types of building, Planning & designing of residential, public and commercial building.

6. **Computer aided drafting:** Operating system, Hardware & software., introduction of CAD, its graphical user interface, method of installation, Basic commands of CAD, Knowledge of Tool icons and set of Toolbars, Knowledge of shortcut key board commands. 3D modeling concept in CAD: 3D coordinate systems to aid in the construction of 3D objects, Knowledge of shortcut keyboard commands.

7. **House drainage of building:** Introduction, Terms used in PHE, Systems of sanitation, System of house drainage, plumbing, sanitary fittings, etc. Types of sewer appurtenance, Systems of plumbing, Manholes & Septic tank, Water treatment plant, Sewerage treatment plant

8. **Prefabricated Structure:** Preparation, Method of construction, assembling, Advantages & disadvantages.

9. **Concepts of design of earthquake resisting buildings**- requirements resistance, safety, flexible building elements, special requirements, base isolation techniques.

10. **Reinforced cement concrete structure:** Introduction to RCC uses, Materials proportions, Form work, Bar bending details as per IS Code, Reinforced brick work. Materials used for RCC: Construction, Selection of materials - coarse aggregate, fine aggregate, cement water and reinforcement., Method of mixing concrete machine mixing and hand mixing, Slump test. Structure columns, beams, slabs one-way slab & two-way slab, Innovative construction, Safety against earthquake, Grade of cement, steel-behavior and test, Bar-bending schedule, Retaining wall, R.C.C. Framed structure.

11. **Steel structures:** - Common forms of steel sections, Structural fasteners, Joints, Tension & compression member, Classification, fabrication, Construction details.

12. **Roads:** History of highway development, General principles of alignment, Classification and construction of different types of roads, Component parts, Road curves, gradient, Curves-types, designation of curves, Setting out simple curve by successive bisection from long chords, simple curve by offsets from long chords, Road drainage system.

13. **Estimating and Costing:** Purpose and common techniques, drawing of construction, Measurement techniques, Estimate- necessity, importance, types – approximate and

detailed estimate-main and sub estimates, revised, supplementary, maintenance /repair estimate-taking off quantities-method, Rate analysis of typical items and their specifications, Labour and materials., Govt. Schedule of rate, estimating of irregular boundaries by trapezoidal and Simpsons formula.

14. **Total Station and GPS:** Components parts, accessories used, characteristics, features, advantages and disadvantages, principle of EMD, Working and need, Setting and measurement, Electronic, display Data reading, Rectangular and polar co-ordinate system, Terminology of open and closed traverse. GPS (Global Positioning System): - Introduction of GPS system, Co-ordinate and time system, Satellite and conversional geodetic system, GPS. Signal, code, and biases, Role of TRANSIT in GPS development, GPS survey methods. Basic geodetic co- ordinate, Ground support equipment, signals, Tracking devises& system, Time measurement and GPS timing.

TRADE: CAD-CAM-OPERATOR-CUM-PROGRAMMER

SYLLABUS FOR TRADE TEST

1. Draw a rectangle, pentagon, hexagon, star using line command with polar coordinate system and relative coordinate system. Draw circles, arc and ellipse by different options. Perform different modifications of the entities created in the previous examples, using modify tool bar.

2. Dimension the drawings created using linear, Aligned, Angular, radius and Diameter dimensioning techniques. Save different styles of Dimensioning for a drawing file. Edit dimension properties. Hatch the closed objects, edit them by changing colors, hatch pattern scale, loading and creating different customized hatch patterns.

3. Create layer for different objects like lines, circles, Dimensions, load line type stored in drawing file, convert a line to different type, assign by layer property for an object & customization of layer. Write text in drawings. Use multiline editors. Use different styles of text.

4. Create & insert a block by drawing a washer or thread of a particular size. Save the block as a universal block. Create & save templates for A4, A3, A0 size papers. Create title blocks for the different sheet sizes. Use Attributes in these templates. Save the templates.

5. Drawing a cube using isometric plane setup. Draw sectional views, Full sections, Half Sections, Assembly sections of different parts like Universal Joint, use viewports for viewing them in different ports. Place these view ports in different layouts for printing.

6. Use UCS command for changing the coordinate system. Draw 3D solid parts as exercise to study the UCS command rotation of X, Y and Z. Use UCS3 point method for creation of new custom made UCS. Mirror the objects in 3D. Rotate the 3D object by an angle.

7. Use of simple solid AutoCAD commands for creating basic primitives like cube, box, cylinder, wedge, cone, sphere. Use FACETRES command for proper shading, view the min different shade mode stand render them, save them as bitmap. Get them as properties, Area, perimeter of a solid. Use LIST command for 2D sketches. Practice on editing Commands Practice on View Commands.

8. Create composite solids using Boolean addition, Subtraction and Intersection by Joining the primitives. Sketch revolved solids like bottle, Cylinder, Pulleys. Create 3D wireframes, 3D surface meshes like box, cone, Dishes, Domes, Pyramids, Spheres, Donuts, and wedges. Use 3D view, V points for different viewing enhancements. Use surf tab. Taper a face, Remove a face.

9. Master cam short cut on desktop, setup master cam for metric system, create tools for different type of marching tools using standard tool catalogues, set up the job for machining in master cam, save the tools, filter tools for specific operation, display settings, coordinate settings. Insert drawings from AutoCAD and other CAD software's like DXF, IGES, Para solids, generate simple tool paths for these inserted drawings, verify the tool paths, back plot, generate post processed program.

10. Machining on created 2 Dcontours like contour, pocket, drilling, island machining, boring, tapping, cutoff, threading and generate toolpaths with study of parameters involved like tool selection, feed rate, spindle speed, jobsetup, plungepoint, feedpoint, zdepthofcut, zig zag pockets, create custom made tool holder, Inserts into Tool Library. Perform the same for surfaces created in the previous examples, Text Embossing and Engraving in the surfaces, use of subprograms for reducing the program length, Custom made drilling cycles, rough and finishes pockets.

11. Transferring Part programs into the CNC machine, editing parameters in CNC machine sample cut of a Teflon job for contour of a drawing created in Master CAM.

TRADE: CAD-CAM-OPERATOR-CUM-PROGRAMMER

SYLLABUS FOR COMPETITIVE WRITTEN EXAMINATION

1. Installation and reinstallation of CAD Software, Install AutoCAD, configure AutoCAD, AutoCAD graphical user interface, point command, zoom command, limits, coordinate systems, Snap and Grids in AutoCAD. Understanding Line command, Circle command, Arc command, Ellipse command, Poly line command, pedit command, OSNAP commands, Explode Pan command. Various types of lines, thickness of lines.

2. Understand Erase by Selection, Erase by Window, Erase by All, MOVE by a Reference, COPY by reference, Copy Multiple, Scale by Reference, Scale by Scale factor, ROTATE by Reference, Rotate by Angle commands. Learn to use different selection tools. Editing commands like Offset, Mirror along an Axis, Mirror along a line, Mirror along an angle, Array rectangular, Array Polar method, Array rotated, Fillet with Trim, Fillet without No trim, Chamfer with Trim, Chamfer without Trim, Extend along a boundary, Trim with delete, and Stretch along a reference, Divide multiple units, Measure along a line.

3. Dimensioning with style creation, Set the Arrow height, length, text height, width, Tolerance, dimension along the dimension line, Dimension extension line, Dimension Extension offset, Dimension Symbols, Modify Dimension, Set Current Dimension and hatching inside an Island, Along a boundary, Hatch Patterns.

4. Study of Creating Layers, Modifying Layers, Freezing Layers, Thawing Layers, Make On and OFF Layers, Create Line types. Modify existing lines to different Line types, Create custom Line types, Import Line types. Text style Creation, Use different fonts, Set different heights, Modify the properties of Texts, save different Text styles by a name, M text within a window, Scaling a multiline, rotating a Multiline with style features. Create Blocks of Standard patterns, Insert Block Patterns, Scale the Blocks, Match the properties of the Blocks, AutoCAD Design center usage, Dragging the design Center Blocks, Attach the Attributes to Blocks, Explode the blocks, Poly lines.

5. Create Layouts, Differentiate Layout with Paper Setup, Multiple Layouts for Multiple Views, Drag the window to a Layout, Drag the Extent to a layout, Create template for Different Paper Sizes, Save the templates, Use Templates for Opening a new Drawing, Use attributes in a Template, Use Text attributes in a template. Use of F5, F6, F7, F8, F9, Functional keys. Fundamentals Of Isometric Drawings, Prospective Drawings, Projectional Drawings, Cut Section drawings, Use of Cut Lines, sectional Lines, hatching along the sectional area.

6. Introduction to UCS, Differentiate WCS and UCS. Create use planes, Rotate UCS along X axis, Y axis, Z axis. Mirror the objects in 3D. Rotate the objects along an angle.

7. Study of Solids primitives like Cube, Wedge, Box, Cylinder, Cone, Sphere, Torii. Use of Facetres for Shade mode of Solids, List out the Mass, Center Of Gravity, Moment Of Inertia, Volume using Mass properties and by LIST command.

8. Create Region. Create Boundary, Differentiate region and Boundary. Use Boolean operation for UNION, SUBTRACTION, INTERSECTION. Use EXTRUDE and REVOLVE for Composite Solids. Introduction to 3D surfaces, 3D surface Primitives, Extruded primitives, Revolved primitive surfaces, Ruled surfaces, Shells.

9. Setup Master CAM, Install and configure Master CAM, Create Tools, Job Setup, TOOL library setup, CONFIGURATION Settings, Review of G and M codes. Exchanging Cad data with master CAM, Numerical control of machine tools, Cam Tool path modeling, and Cam part programming concepts. 3D solid constructions. Use of z planes.

10. Create contours, Set masks for contours, Chain a contour by mask method, use operation manager, Set tools, Change a tool, Pocket menu explanation, Drill menu Explanation, Thread menu explanation, Inserts and Holders menu, Create and Modify Tool Library Surface machining Menu, Tool Paths, Create Text, Embossa Text, Contour the text path as a tool path, and use subprograms for repeated cycles at different heights.

11. Reference Point selection, Job Creation, Back plot, optimizing the machining, Cut and Paste for changing the sequence of Operations using operation manager, Simulation of the tool path. CNC interface with master cam, CNC controls and editing on a machine. High Speed Machining. Cutting speed and feed calculations. Types of Cutting Tools, its' geometry.

TRADE: TURNER

SYLLABUS FOR TRADE TEST AND COMPETITIVE WRITTEN EXAMINATION

1. Measurement, line standard and end standard, steel rule different types, graduation and limitation. Hammer and chiselmaterials, types and uses. Prick punch and scriber.

2. Vice - types and uses, Filesdifferent types of uses, cut, grade, shape, materials etc. Try square- different types, parts, material used etc. Callipers types and uses (firm joint).

3. Vee - block, scribing block, straight edge and its uses. Hacksaw-their types & uses.

4. Center punch- materials, construction & material uses. Drill machine-different parts. Hacksaw blades- sizes, different Parts. Hacksaw blades-sizes, different pitch for different materials. Nomenclature of drill.

5. Surface plate its necessity and use. Tap - different types (Taper 2nd and bottoming) care while tapping. Dies different types and uses. Calculation involved to find Out drill size (Metric and Inch).

6. Getting to know the lathe with its main components, lever positions and various lubrication points as well. Definition of machine & machine tool and its classification. History and gradual development of lathe.

7. Classification of lathe in Function and construction of different parts of Lathe.

8. Types of lathe drivers, merit and demerit. Description in details-head stock- cone pulley type- all geared type construction & function. Tumbler gear set. Reducing speed-necessary & uses. Back Gear Unit-its construction use.

9. Lathe cutting tool-different types, shapes and different angles (clearances and rake), specification of lathe tools. Combination drill- appropriate selection of size from chart of combination drill. Drill, chuck its uses. Lathe accessories, chuck independent, self-centering, collet, magnetic etc., its function, construction and uses.

10. Vernier caliper-its construction, principle graduation and reading, least count etc. Digital vernier caliper. Outside micrometer-different parts, principle, graduation, reading, construction. Digital micrometer. Cutting speed, feed depth of cut, calculation involved-speed feed R.P.M. etc. recommended for different materials.

11. Different types of micrometer, Outside micrometer. Vernier scale graduation and reading. Sources of error with micrometer & how to avoid them. Use of digital measuring instruments. Drills-different parts, types, size etc., different cutting angles, cutting speed for different material. Boring tool. Counter - sinking and Counter boring. Letter and number drill, core drill etc. Reamers- types and uses. Lubricant and coolant-types, necessity, system of distribution, selection of coolant for different material: Handling and care.

12. Knurling meaning, necessity, types, grade, cutting speed for knurling. Lathe mandreldifferent types and their uses. Concept of interchangeability, Limit, Fit and tolerance as per BIS: 919-unilateral and bilateral system of limit, Fits-different types, symbols for holes and shafts. Hole basis & shaft basis etc. Representation of Tolerance in drawing.

13. Driving plate. Face plate & fixed & traveling steadiesconstruction and use. Transfer caliper-its construction and uses. Lathe centers-types and their uses. Lathe carrierfunction types & uses. Mandrel - Different types and its use. Magnetic stand dial indicator, its used and care.

14. Taper - different methods of expressing tapers, different standard tapers. Method of taper turning, important dimensions of taper. Taper turning by swiveling compound slide, its calculation.

15. Bevel protector & Vernier bevel protractor-its function & reading. Method of taper angle measurement. Sine bar-types and use. Slip gauges-types, uses and selection.

16. Method of brazing solder, flux used for tip tools. Basic process of soldering, welding and brazing.

17. Vernier height gauge, function, description & uses, templatesits function and construction. Screw thread-definition, purpose &it's different elements. Driving plate and lathe carrier and their usage. Fundamentals of thread cutting on lathe. Combination set-square head. Center head, protractor head-its function construction and uses.

18. Different types of screw thread- their forms and elements. Application of each type of thread. Drive train. Chain gear formula calculation. Different methods of forming threads. Calculation involved in finding core dia., gear train (simple gearing) calculation. Calculations involving driverdriven, lead screw pitch and thread to be cut.

19. Thread chasing dial function, construction and use. Calculation involving pitch related to ISO profile. Conventional chart for different profiles, metric, B.A., With worth, pipe etc. Calculation involving gear ratios and gearing (Simple & compound gearing). Screw thread micrometer and its use.

20. Calculation involving gear ratios metric threads cutting on inch L/S Lathe and vice-versa.

21. Tool life, negative top rake-its application and performance with respect to positive top rake.

22. Calculation involving tool Thickness, core dia., pitch proportion, depth of cut etc. of sq. thread.

23. Calculation involved - depth, core dia., pitch proportion etc. of Acme thread. Calculation involved depth, core dia., pitch proportion, use of buttress thread.

24. Buttress thread cutting (male & female) & tool grinding.

25. Different lathe accessories, their use and care.

26. Lubricant-function, types, sources of lubricant. Method of lubrication. Dial test indicator use for parallelism and concentricity etc. in respect of lathe work Grinding wheel abrasive, grit, grade, bond etc.

27. Form tools-function-types and uses, Template-purpose & use. Dial test indicator- construction & uses Calculation involving modified rake and clearance angles of lathe tool at above and below the center height. Subsequent effect of tool setting. Jig and fixture-definition, type and use. Chip breaker on tool purpose and type.

28. Cutting tool material-H.C.S., HSS, Tungsten. Carbide, Ceramic etc, Constituents and their percentage. Tool life, quality of a cutting material.

29. Checking of taper with sin bar and roller-calculation involved.

30. Cutting speed, feed, turning time, depth of cut calculation, cutting speed chart (tungsten carbide tool) etc. Basic classification of tungsten carbide tips.

31. Accessories used on face plate -their uses. Angle plate-its construction & use. Balancing its necessity. Surface finish symbols used on working blueprints- I.S. system lapping, honing etc.

32. Preventive maintenance, its necessity, frequency of lubrication. Preventive maintenance schedule., TPM (Total Productive Maintenance), EHS (Environment, health, Safety) Marking table-construction and function. Angle plate construction, eccentricity checking.

33. Roller and revolving steadies, Necessary, construction, uses etc.

34. Different types of attachments used in lathe. Various procedures of thread measurement thread screw pitch gauge. Screw thread micrometer, microscope etc.

35. Tool maker's button and its parts, construction and uses, telescopic gauge its construction and uses.

36. Inside micrometer principle, construction graduation, reading, use etc. (Metric & Inch.)

37. Care for holding split bearing. Fixture and its use in turning.

38. Calculation involving fractional threads. Odd & even threads.

39. Multiple thread function, use, different between pitch & lead, formulate to find out start, pitch, lead. Gear ratio etc.

40. Indexing of start - different methods tool shape for multistart thread. Setting of a lathe calculation for required change wheel.

41. Calculation involving shape of tool, change wheel, core dia etc. Calculation involving shape, size pitch, core dia. Etc.

42. Helix angle, leading angle & following angles. Thread dimensions-tool shape, gear, gear calculation, pitch, depth, lead etc.

43. CNC technology basics: Difference between CNC and conventional lathes. Advantages and disadvantages of CNC machines over conventional machines. Machine model, control system and specification.

44. Axes convention of CNC machine - Machine axes identification for CNC turn centre. Importance of feedback devices for CNC control. Concept of Co-ordinate geometry, concept of machine axis.

45. Programming - sequence, formats, different codes and words. Co-ordinate system points and simulations. Workpiece zero points and ISO/DIN G and M codes for CNC. Different types of programming techniques of CNC machine. Describe the stock removal cycle in CNC turning for OD / ID operation. L/H and R/H tool relation on speed. Describe CNC interpolation, open and close loop control systems. Co-ordinate systems and Points. Program execution in different modes like manual, single block and auto.

46. Absolute and incremental programming. Canned cycles. Cutting parameters- cutting speed, feed rate, depth of cut, constant surface speed, limiting spindle speed, tool wear, tool life, relative effect of each cutting parameter on tool life. Selection of cutting parameters from a tool manufacturer's catalog for various operations. Process planning & sequencing, tool layout & selection and cutting parameters selection.

47. Tool path study of machining operations Prepare various programs as per drawing. Tool Nose Radius Compensation (G41/42) and its importance (TNRC). Cutting tool materials, cutting tool geometry - insert types, holder types, insert cutting edge geometry. Describe Tooling system for turning - Setting work and tool offsets. - Describe the tooling systems for CNC TURNING Centers. Cutting tool materials for CNC Turning and its applications - ISO nomenclature for turning tool holders, boring tool holders, indexable inserts. Tool holders and inserts for radial grooving, face grooving, threading, drilling.

48. Prepare various part programs as per drawing & check using CNC simulator. Processes and Tool selection related to grooving, drilling, boring & threading.

49. Describe Tapping on CNC turning. - Programming for Grooving/Threading on OD/ID in CNC Turning.- Trouble shooting in CNC lathe machine - Identify Factors affecting turned part quality/ productivity. - Parting off operation explanation. - Bar feeding system through bar feeder. - Input and Output of Data. - DNC system. Interlacing with PC. - Use of CAM Programme.

50. Setting of tools for taper threads-calculation of taper setting and thread depth. Heat treatment - meaning & procedure hardening, tempering, carbonizing etc. Different types of metal used in engineering application.

51. Interchangeability meaning, procedure for adoption, quality control procedure for quality production.

52. Terms used in part drawings and interpretation of drawings - tolerances, geometrical symbols - cylindricity, parallelism. Etc.

53. Automatic lathe-its main parts, types diff. Tools used-circular tool etc.

TRADE: MECHANIC (MACHINE MECHANIC, MACHINE TOOLS, MAINTANANCE)

SYLLABUS FOR TRADE TEST AND COMPETITIVE WRITTEN EXAMINATION

1. **Electrical Aspects of refrigeration -**

   Electrical AC and DC supply, Voltage, Current, Resistance, Power, Energy, Frequency etc.. Materials used as conductors and Insulators. Series and parallel circuit, open circuit, short circuit, ete., measuring instruments such as voltmeter, ammeter, ohm meter, watt meter, energy meter and frequency meter, Earthing and its importance, Insulation and continuity test, principle of Diodes. Rectification, Zener diode as voltage regulator, transistors parameters, ICs, Star and Delta connection, Safety precautions and first aids, firefighting equipment and electrical safety.

2. **Welding processes-**

   Welding processes, oxy fuel gas welding/cutting, brazing & soldering, nozzles, base metal and filler metal, Use of flux, difference between soldering and Brazing in terms of temperatures, filler materials, joint strengths and application, Use of Oxy Acetylene, two stage regulators for brazing/soldering, back fire arrester, Solder - its composition and paste.

3. **Basics of refrigeration and Air conditioning -**

   History of Refrigeration and Air conditioning, Basic principle of refrigeration, refrigeration tools. instruments and equipment. Fundamentals Thermodynamics law, Science related to refrigeration, work, power, energy, force, Heat and Temperature, Different temperature scales, Thermometers. Units of heat, super heating and sub-cooling, saturation temperature, pressure, types and units. Types of Refrigeration systems, working of vapor compression cycle, Coefficient of Performance (COP), Ton of Refrigeration, fundamental operations, sub cooling and super heating.

4. **Types of Refrigerators and their working -**

   Working of single door direct cool refrigerator, frost free refrigerator, specifications, trouble shooting, Heat Insulation materials, Care and maintenance of refrigerators, Electrical components of refrigerator, Working of Frost Free (2 or 3 door) Refrigerator, temperature control in Freezer & cabinet, automatic defrost system, Function of Electrical accessories like Timer. Heater, Bimetal, Relay, OLP, T/S etc., Refrigerator cabinet volume calculation. Working of two and three door frost free refrigerator with inverter technology, advantages of variable speed technology over fixed speed, Working principle of control system for inverter Air Conditioners (ACS).

5. **Components of Refrigeration system –**

   Working and application of hermetic compressor, Fixed speed and variable speed compressor like Reciprocating, rotary, scroll, centrifugal Geren, compressor and inverter type. Replications of compressors used in commercial refrigeration, Volumetric efficiency, Compressor abricant oil, types and properties, types of lubrication methods such as splash, forced feed. AC motors and their types. Advantages of AC motor over DC motor. Split phase induction motors, Common faults, causes and remedies in motors, Function of Starting relay, Capacitors, OLP's in motor. Working principle of three phase induction motor, torque, slip, rotor, frequency and their relation, Squirrel cage induction motor, Importance of phase sequence, Slip ring induction motor. Comparison between SCIM and SRIM. Three phase motor starters such as DOL starter, Star-Delta starter. Auto transformer starter and Rotor resistance starter. Common faults, causes and remedies in three phase AC motors.

   Function of condenser, types, effect of chocked condenser, descaling of air-cooled condenser. Function of drier, its types and application. Types of desiccants, Expansion valve used in domestic refrigeration and ACs, Function of accumulator and types, Methods of defrosting, leak testing, gas charging method in refrigerator, Function of Evaporator, types of evaporators. Super heating in evaporators, Plate & Tube forced air DX evaporators. Types of Defrost system, Types of brine used as secondary refrigerant, Water/ Brine chillers Accumulator and its function, Oil separator. Expansion Valve, Types and function, their advantage & disadvantages. Thermostatic Expansion Valves (TXV), Automatic Expansion Valves (AXV). Humidifiers & Dehumidifier's. Humidity control. Use of hygrometer. Water-cooled Condenser, types and capacity, de-scaling. Evaporative condenser and its function. Liquid receiver and its function.

   Function, construction, working and Specification of different types of hand tools used in Refrigeration and Air conditioning work. Machineries and equipment used in fittings like drilling machine and grinding machine.

6. **Types of refrigerants and their properties**

   Classification of refrigerants, nomenclature of refrigerants including chemical name and formulas, hydro-chlorofluorocarbons (HCFCs), hydro fluorocarbons (HFCs) and hydro fluoro olefins (HFOs), blends of HFCs and blends of HFCs/HFOs, Properties of refrigerants, environment related properties. Ozone Depleting Potential (ODP) and Global warming Potential (GWP) of various refrigerants, Thermo-chemical properties flammability and toxicity, lower flammability limit (LFL) and upper flammability limit of refrigerants.

Thermo-physical properties - pressure and temperature of different refrigerants, Handling of flammable refrigerants, Refrigerant leak detection methods, evacuation and charging of refrigerant, procedure of charging of refrigerant blends like zeotropic blends, hydrocarbon blends, HFC blends (R-404A, R-407C, R-410A), Change of components & practices while retrofitting CFC appliances with HC Refrigerants.

7. Types of Air Conditioners and their working -

Window Air Conditioner. Split AC (wall/floor/Cassette), Construction and working principle. types, trouble shooting. Electrical components used in split AC, wiring circuit, testing components, fault detection. Working principle of inverter AC and its components, electrical circuit and controls, installation, servicing, trouble shooting, fault detection, leak testing and gas charging, Concept of Indian Seasonal Energy Efficiency Ratio ISEER), Energy Efficiency labelling on inverter AC, Package AC (with Air Cooled Condenser), Package AC with Water Cooled Condenser, construction and working principle, Duct system, AHU, Care and maintenance

8. Engineering Drawing -

Introduction to Engineering Drawing and Drawing Instruments Conventions, Sizes and layout of drawing sheets. Title Block, Drawing of Geometrical figures: Angle, Triangle, Circle, Rectangle, Square, Parallelogram, Lettering & Numbering. Dimensioning. Types of arrowhead. Leader line with text, Position of dimensioning (Unidirectional, Aligned) Symbolic representation, Concept of axes plane and quadrant, Concept of Orthographic and Isometric projections, Method of first angle and third angle projections, Mensuration Area and perimeter of square, rectangle and parallelogram Area and perimeter of Triangles, Centre of gravity and its practical application, calculating area of cut out regular surfaces and irregular surfaces.

Estimation and Costing. Estimation of the requirement of material etc. Reading of Electrical, Electronic & Mechanical Sign and Symbols used in RAC. Sketches of Electrical, Electronic & Mechanical components used in RAC. Reading of Electrical wiring diagram and Layout diagram Drawing of Electrical circuit diagram used in RAC

9. Insulating materials -

Properties of insulating materials. Scales of temperature, Celsius, Fahrenheit, kelvin and conversion between scales of temperature, Temperature measuring instruments, types of thermometers, pyrometer. Transmission of heat Conduction, convection and radiation. Co-efficient of linear expansion. Thermal conductivity and insulators, Units of pressure. Atmospheric pressure, absolute pressure, gauge pressure and gauges used for measuring pressure. Thermal Insulation Function, types, thermodynamic properties of heat insulation materials used in refrigeration and Air Conditioning systems

10. Water cooler, Deep freezers and Cold storage systems-

Water Cooler, Water Dispenser, refrigeration cycle of storage type water cooler and dispenser Capacity & applications. Electrical and mechanical components of storage type water cooler. Visible Cooler and Bottle Cooler, Deep Freezer/Display Cabinet working, specifications, faults and remedies, Cold Storage plant, Construction, applications, controls & electrical diagram used in cold storage plant.

11. HVAC plant and components -

HVAC (Plant), Fundamentals of Central Air Conditioning/HVAC plant, psychometric terms. DBT, WBT, RH, enthalpy, dew point, and specific humidity. Types of Central air conditioning (Direct and indirect system), Description of blowers & fans, static and velocity pressure measurements. DUCT Function, types, materials, duct designing, duct insulation, properties of insulating material. Air filters and its types, effect of chocked Air filter. Working principle, types and maintenance of Industrial Air-conditioning plant. Humidification and dehumidification methods, Description of AHU and FCU, Temperature and pressure controls used in AC plant. piping lines. Indirect/Chiller System, central station AHU and FCU, specification of Sheet metal tools, instruments and equipment. Rivet & riveting- their types and use, Planning for preventive maintenance and scheduling of maintenance activities in large AC and Refrigeration plant.

Various types of Machine tools and their maintenance.