

**MAHARASHTRA STATE BOARD OF VOCATIONAL EDUCATION EXAMINATION, MUMBAI - 51**

1	Name of Course	Certificate Course in Industrial Automation (303214)																																																													
2	Max. Nos. of Student	25 Students																																																													
3	Duration	1 Year																																																													
4	Type	Full Time																																																													
5	Nos. of Days / Week	6 Days																																																													
6	Nos. of Hours /Days	7 Hrs																																																													
7	Space Required	Theory Class Room – 200 sqft    Practical – 1500 sqft																																																													
8	Entry Qualification	S.S.C.																																																													
9	Objective Of Syllabus/ introduction	1) Awareness of Safety precautions 2) Knowledge of Engineering skill, use of tools in assembly 3) Awareness of Electronics & Computer Skill. 4) Awareness of AC/DC motor Control. 5) Awareness of Process Instrumentation. 6) Awareness of Pneumatics & Hydraulics.																																																													
10	Employment Opportunity	The trainee will either to be able to take up jobs with agencies which maintain and repair Industrial Automation system or with working experience will be in a position to start his own independent Business.																																																													
11	Teacher’s Qualification	Diploma in Electronics or Mechanical or Instrumentation Engg.																																																													
12	Training System	<table><tr><th colspan="7">Training System Per Week</th></tr><tr><td colspan="2">Theory</td><td colspan="2">Practical</td><td colspan="3">Total</td></tr><tr><td colspan="2">18 hrs</td><td colspan="2">24 hrs</td><td colspan="3">42hrs</td></tr></table>						Training System Per Week							Theory		Practical		Total			18 hrs		24 hrs		42hrs																																					
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13	Exam. System	<table><tr><th>Sr. No.</th><th>Paper Code</th><th>Name of Subject</th><th>TH/PR</th><th>Hours</th><th>Max. Marks</th><th>Min. Marks</th></tr><tr><td>1</td><td>30321411</td><td>Basic Workshop Practice &amp; Computer application in Industrial Automation.</td><td>TH</td><td>3 hrs</td><td>100</td><td>35</td></tr><tr><td>2</td><td>30321412</td><td>Electronics &amp; Process Instrumentation in Automation</td><td>TH</td><td>3 hrs</td><td>100</td><td>35</td></tr><tr><td>3</td><td>30321413</td><td>AC/DC Motor Control &amp; Pneumatics &amp; Hydraulics</td><td>TH</td><td>3 hrs</td><td>100</td><td>35</td></tr><tr><td>4</td><td>30321421</td><td>Basic Workshop Practice &amp; Computer application in Industrial Automation.</td><td>PR</td><td>3 hrs</td><td>100</td><td>50</td></tr><tr><td>5</td><td>30321422</td><td>Electronics &amp; Process Instrumentation in Automation</td><td>PR</td><td>3 hrs</td><td>100</td><td>50</td></tr><tr><td>6</td><td>30321423</td><td>AC/DC Motor Control &amp; Pneumatics &amp; Hydraulics</td><td>PR</td><td>3 hrs</td><td>100</td><td>50</td></tr><tr><td></td><td></td><td>TOTAL</td><td></td><td></td><td>600</td><td>255</td></tr></table>						Sr. No.	Paper Code	Name of Subject	TH/PR	Hours	Max. Marks	Min. Marks	1	30321411	Basic Workshop Practice & Computer application in Industrial Automation.	TH	3 hrs	100	35	2	30321412	Electronics & Process Instrumentation in Automation	TH	3 hrs	100	35	3	30321413	AC/DC Motor Control & Pneumatics & Hydraulics	TH	3 hrs	100	35	4	30321421	Basic Workshop Practice & Computer application in Industrial Automation.	PR	3 hrs	100	50	5	30321422	Electronics & Process Instrumentation in Automation	PR	3 hrs	100	50	6	30321423	AC/DC Motor Control & Pneumatics & Hydraulics	PR	3 hrs	100	50			TOTAL			600	255
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# SYLLABUS

## Theory & Practical – I

### Basic Workshop Practice & Computer Application in Industrial Automation

Theory - I	Practical - I
<p>Scope of workshop practice</p> <p>Symbols on sign boards</p> <p>Material handling and storage in the workshop</p> <p>Safety practice - fire extinguisher</p> <p>Health, hygiene and safe working habits</p> <p>Do's and don'ts</p>	<p>WORKSHOP PRACTICES</p> <ul style="list-style-type: none"> <li>• Safety signs</li> <li>• Lifting and shifting of equipments / instruments</li> <li>• Extinguishing of fire</li> <li>• General Workshop safety</li> </ul>
<p>Terms used in measurement</p> <p>Different types of errors</p> <p>Instruments used for linear and angular measurement</p> <p>Care and maintenance of instruments</p> <p>Correct use of micrometers and Vernier Caliper</p>	<p>MEASUREMENT</p> <ul style="list-style-type: none"> <li>• Measure the length, slope, angles, thickness, diameter using appropriate instrument.</li> <li>• Use of micrometers and calipers for precise measurement</li> <li>• Error adjustment in micrometers</li> </ul>
<p>Introduction to fitting trade, familiarize with various hand tools used in fitter trade and their general uses.</p> <p>Methods of measuring , marking and punching</p> <p>Hack saw frames, blades - types and specification.</p>	<p>FITTING</p> <ul style="list-style-type: none"> <li>• Familiarise with the tools</li> <li>• Marking , punching ,hack sawing and chipping</li> </ul>
<p>Types of screws and fasteners used in metal and wood</p> <p>Introduction to TQM.</p> <p>Limit and Fits as per IS 919</p>	<p>FILING</p> <ul style="list-style-type: none"> <li>• Filing practice on flat surfaces</li> <li>• Filing to required shape and sizes.</li> </ul>
<p>Types of drilling machines and their uses - types of drills and</p> <p>Taps and their specifications , – tool holding devices and work holding Devices-</p>	<p>DRILLING</p> <ul style="list-style-type: none"> <li>• Exercises on drilling machine covering various types of Drilling operations (drilling, counter sinking, counter boring Tapping</li> </ul>
<p>Common hand tools used in carpentry workshop, marking, cutting and planing.</p> <p>Types of woods and their uses. Types of joints</p>	<p>WOOD WORK</p> <ul style="list-style-type: none"> <li>• Practice on sawing, planing and making different joints</li> </ul>
<p>Hand tools used in sheet metal workshop</p> <p>Types of joint used in sheet metal</p> <p>Rivet and its types and their uses.</p>	<p>SHEET METAL</p> <p>Practice on shearing and bending</p> <ul style="list-style-type: none"> <li>• Making various joints</li> <li>• Making a rectangular box by riveting and soldering</li> </ul>

<p>Wires and cables; specification , selection and use in electrical Wiring, connectors, lugs, various types of wire joints, crimping, SWG, soldering; precautions to be adopted while solder various composition of solder wires, fluxes and their uses.</p> <p>Characteristics, properties and uses of bakelite, PVC, Porcelain etc</p>	<p><b>WIRING AND SOLDERING</b></p> <ul style="list-style-type: none"> <li>• Selection of wires and cables.</li> <li>• Simple wiring practice.</li> <li>• Exercise on wire joints and crimping.</li> <li>• Practice on Soldering &amp; Desoldering</li> </ul>												
<p>Introduction to Computer</p> <p>Part of computer</p> <p>Booting of computer</p> <p>Using Mouse &amp; Keyboard</p> <p>Storage Devices</p> <p>Floppy Disk, Hard Disk, Flash drive / Pen drive</p> <p>CDROM, DVD ROM</p> <p>Files &amp; Folders</p>	<p>Booting the computer</p> <p>Familiarisation of Desktop, Refreshing</p> <p>Start menu, task bar, Date/time</p> <p>Right click, left click, scrolling of mouse pointer</p> <p>Wing shift, alt, control, number lock</p> <p>Scroll lock, pause Function keys of the keyboard</p> <p>Open file from Hardisk, Floppy disk</p> <p>Create files, folders in it.</p> <p>Delete files, copy files, remove files</p> <p>Save files, create Directories ( folder)</p> <p>Open files from CD. DVD, Copy files from CD to Hard disk</p>												
<p>Using windows XP/2000</p> <p>Use of control panels</p> <p>Add/Remove programs</p> <p>Add Hard ware</p> <p>Regional settings using windows explorer short cuts</p> <p>Applications softwares</p> <p>Using paint, note pad</p>	<p>Using control panel, Identifying system name, changing system ID, Identifying the Hardwares present in the system user accounts, creating passwords,using Hardware wizard or install a new hardware ( like display device) changing the windows. Regional settings like country, currency symbol, date &amp; time patterns.</p> <p>Using windows explorer, opening &amp; closing of application</p> <p>Using note pad to create down</p> <p>Using paint to create sample bitmaps &amp; Jig files</p>												
<p>Familiarisation with parts of computer.</p> <p>Understanding of</p> <table border="0"> <tr> <td>1. AGP slot</td> <td>6. Audio Port</td> </tr> <tr> <td>2. IDE cable</td> <td>7. RAM slot</td> </tr> <tr> <td>3. USB port</td> <td>8. CMOS battery</td> </tr> <tr> <td>4. PS/2 port</td> <td>9. Jumpers</td> </tr> <tr> <td>5. VGA port</td> <td>10. BIOS</td> </tr> <tr> <td>11. Add-on cards</td> <td></td> </tr> </table>	1. AGP slot	6. Audio Port	2. IDE cable	7. RAM slot	3. USB port	8. CMOS battery	4. PS/2 port	9. Jumpers	5. VGA port	10. BIOS	11. Add-on cards		<p>Remove the case of computer</p> <p>Identify III (Theory)</p> <p>By Removing &amp; Replacing cards, fixing the mouse, keyboard to PS/2 port, Connecting display cable to VGA port, Connecting printer to USB port. Connecting Audio jacks to corresponding Audio slots</p> <p>Remove the RA &amp; Replace</p> <p>Remove battery &amp; Replace</p>
1. AGP slot	6. Audio Port												
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## List of Tools & Equipment

Sr. No.	Name Of Tool & Equipment	Quantity
1.	Rule steel 30 cm(metric)	4
2.	Rule steel 60 cm	4
3.	Straight edge 45 cm steel	4
4.	Flat surface 45 x 45 cm	4
5.	Marking table 90 x 90 x90 cm	4
6.	Universal scribing block 22 cm	4
7.	Block V pair 7 cm and 15 cm with clamp	4
8.	Square adjustable blade 15 cm	4
9.	Angle plate 10 x 20 cm	4
10.	Sprit level metal 15 cm	4
11.	Punch letter 3 mm set	4
12.	Punch number 3 mm set	4
13.	Portable hand drill (electric) 0 – 6 mm	4
14.	Drill brace hand 0 – 12mm	4
15.	Drill twist SS 1.5 to 12 mm by 0.4 mm	4
16.	Taps & dies complete set American	4
17.	Taps & dies complete set Metric	4
18.	File warding 15 cm smooth	4
19.	File knife edge 15 cm smooth	4
20.	File cut saw 15 cm smooth	4
21.	File feather edge 15 cm smooth	4
22.	File triangular 15 cm smooth	4
23.	File round 20 cm II cut	4
24.	File square 15 cm II cut	4
25.	File square 25 cm II cut	4
26.	Filler gauge 10 blades	4
27.	File flat 30 cm II cut	4
28.	File flat 30 cm bastard	4

## Theory & Practical – II

### Electronics & Process Instrumentation in Automation

Theory - II	Practical - II
<p>Conductors, Semiconductors &amp; Insulators. Fundamentals of Electricity - Meaning &amp; definition of various terms, units and relationship between voltage, current, power and energy.</p> <p>Common DC sources – Cells &amp; Batteries. Series and parallel connection of DC sources. Electrical supply system – single phase and three phase.</p> <p>Principle of production of AC – single phase and three phase AC alternators.</p> <p>DC generators.</p> <p>Electrical symbols as per BIS standards</p>	<ul style="list-style-type: none"> <li>• Study of Analogue / Digital Multimeter &amp; Oscilloscope operations.</li> <li>• Measurement of voltage, current, power and energy in the given simple circuit.</li> <li>• Identify and measure voltage of dry battery and cells using Multimeter.</li> <li>• Measure DC quantity &amp; sinewave parameters using oscilloscope</li> </ul>
<p>Classification of passive components. Properties and measurement of Resistance, Capacitance &amp; Inductance. Resistance colour coding. Usage of LCR bridge for measurement. Inductors &amp; Transformers – types, principle of operation, specifications &amp; their uses. Ratings, Voltage regulation, efficiency and phase relationship in transformers, Impedance matching using transformers.</p> <p>Capacitors – properties, functioning, colour coding, etc.</p> <p>Types of capacitors &amp; their uses</p>	<ul style="list-style-type: none"> <li>• Identify and read values using colour code wherever applicable, draw symbols and test the various passive components using appropriate meters / instruments.</li> <li>• Identify, draw symbols and test the various passive components using analog and digital multimeters. Verify the condition of the passive components using Component tester of C.R.O</li> </ul>
<p>Solid state devices - Semiconductor diode, construction, characteristics and testing. Diode rectifiers and filters- halfwave, fullwave - centre tap and bridge rectifier, Ripple filters for rectifiers .Clamping and clipping with diodes.</p> <p>Zener diode – construction, working, characteristics and testing, zener diode as a voltage regulator.</p>	<ul style="list-style-type: none"> <li>• Characteristics of PN junction diode</li> <li>• Construction &amp; testing of half wave / full wave rectifiers</li> <li>• Characteristics of zener diode</li> <li>• Zener diode as voltage regulator</li> <li>• Clamping and clipping circuits using diode</li> </ul>
<p>Bipolar junction transistor – classification, construction, working principle, characteristics and testing of transistors. Types of Transistor biasing circuits- CE amplifier, CB amplifier and Emitter follower. Classification of amplifiers. Silicon Controlled Rectifier (SCR), DIAC, TRIAC and UJT – symbol,</p>	<ul style="list-style-type: none"> <li>• Assemble, Test and calculate voltage gain, power gain, input/ output impedance and phase relationship of a common emitter and common base amplifier.</li> <li>• Construct and test a RC coupled amplifier and an emitter follower and verify gain.</li> <li>• Testing &amp; Verification of the Characteristics</li> </ul>

construction, working principle, characteristics and testing procedures	of SCR, DIAC, TRIAC, UJT.
Operational amplifiers – working principle and application circuits - Inverting & Non Inverting Amplifier, Summing amplifier, voltage comparator, voltage limiter, integrator and differentiator., low pass/ band pass filters Oscillators – working principle and applications Oscillator circuits – phase shift oscillator, wein bridge oscillator, colpitts oscillator, Hartley oscillator, crystal oscillator Multivibrator- types ,working principle, circuits and its applications.	<ul style="list-style-type: none"> <li>• Measure offset voltage of OP- AMP 741.</li> <li>• Construct and test the Inverting &amp; Non Inverting Amplifier, Differentiator, Integrator, etc.</li> <li>• Construct and test the voltage comparator using OP-AMP.</li> <li>• Construct and observe &amp; interpret the waveforms on CRO for the phase shift oscillator .</li> <li>• Test the monostable / astable multivibrator circuits of 555 timer IC.</li> </ul>
Regulation of powersupplies. Power supply - Working principle, types and applications of transistor based regulated power supply Voltage regulated IC's - 78XX, 79XX, Op-Amp regulator, 723 regulator	<ul style="list-style-type: none"> <li>• Assemble &amp; test a transistor series and shunt regulator. Assemble and test a + ve / -ve regulator using three pin regulator IC's.</li> <li>• Assemble and test a regulator using op-amp.</li> </ul>
Digital Electronics – Number system & codes, Boolean algebra, Basic gates & Universal gates, flip flops, counters, registers. Working principle of display devices: LED, 7-Segment LED, LCD, TFT, CCD, etc Methods of analog to digital conversion and digital to Analog conversion.	<ul style="list-style-type: none"> <li>• Assemble &amp; Verify the truth table of the basic logic (AND, OR, NOT) circuits using TTL 7400series IC's</li> <li>• Flip flops – RS, D, JK flip flops.</li> <li>• Construct &amp; test up/down counters using flip- flops</li> </ul>
Microprocessor with applications in Process control - Intel 8085 8-bit microprocessor, Architecture, pins / signals details, addressing methods, instructions classifications. Interfacing Logic devices and I/O Interfacing techniques. Introduction to microcontrollers – features, applications in process control industries	<ul style="list-style-type: none"> <li>• Interpreting the microprocessor IC number, package, pin details.</li> <li>• Interpreting the supporting IC's for Microprocessor based system using Trainer kit</li> <li>• Operating procedure and basic commands of 8085 - 8 bit microprocessor trainer kit</li> <li>• Practice on simple Assembly language programming</li> <li>• Demonstration on interfacing of Switches, thermocouple &amp; flow meter, LED's, Relays, Stepper Motor, DC Motor, etc.</li> </ul>
Elements of the measurement system • Metrology – basic concepts • Measurement terminology – measurement, true value, standard, error, accuracy, precision, repeatability, resolution, range, span, offset, calibration	<ul style="list-style-type: none"> <li>• Calculate span, range for various measurement systems in 0% to 100%</li> <li>• Calculate the accuracy and error in percentage &amp; engineering units of various process measuring instruments</li> </ul>

<ul style="list-style-type: none"> <li>☐ Units, Standards &amp; Errors</li> <li>☐ Units of measurement and realization of Mass, Length, Time, Electric Current, Thermodynamic temperature, Amount of substance, luminous intensity.</li> <li>☐ Unit derivations from basic units</li> <li>☐ Introduction standards – History, SI prefixes</li> <li>☐ Errors – study of various classification</li> </ul>	<ul style="list-style-type: none"> <li>• Calculate and list the derived units from fundamental units and its dimension</li> <li>• Calculate conversion of unit from English to SI.</li> <li>• Discuss and List the prefix values and its symbols and equivalent of decimal multiples and submultiples</li> </ul>
<ul style="list-style-type: none"> <li>• Bridge Measurements – Introduction</li> <li>• Wheatstone Bridge / Kelvin Bridge</li> <li>• Guarded Wheatstone Bridge</li> <li>• Wein Bridge</li> </ul>	<ul style="list-style-type: none"> <li>• Construct and testing Wheatstone bridge / Kelvin bridge</li> <li>• Construct &amp; testing of Wein bridge</li> <li>• Calculation of resistance voltage and current using voltage divider and current divider method</li> </ul>
<ul style="list-style-type: none"> <li>☐ Primary sensing elements – filter, rectifier, bellows, bimetallic strip, bourdon tubes (C-type, spiral, twisted, helical), Diaphragms (flat, corrugated, capsule), float, orifice plate, spring, turbine, pitot tube, venturi tube</li> <li>☐ Transducers - Working principle, classifications, applications</li> <li>☐ Passive transducers – Capacitive, Inductive (LVDT), Resistive (Potentiometer, strain gauge- bonded &amp; unbonded strain gauges, RTD, thermistor, Photoconductive cell.</li> <li>☐ Active transducers – tachogenerator, photodiode/photo transistor, piezoelectric, thermocouple</li> </ul>	<ul style="list-style-type: none"> <li>• Identifying the C-type bourdon tube, link, lever, gear and teeth of pressure gauge and its adjustments screws.</li> <li>• Testing LVDT circuit, record the results and draw a graph for linear region.</li> <li>• Measurement and record the output values of RTD &amp; Thermocouple.</li> <li>• Testing of optical detector circuit (photo diode, photo transistor, photo resistor, photovoltaic cell) and record the results.</li> <li>• Measurement of speed using tachogenerator.</li> </ul>
<ul style="list-style-type: none"> <li>• Transducer bridges – bonded strain gauge bridge</li> <li>• Instrumentation amplifier IC's</li> <li>• Signal conditioning circuits using OP07/OP82 IC's</li> </ul>	<ul style="list-style-type: none"> <li>• Testing cantilever type bonded strain gauge, adjusting offset, record readings and results.</li> <li>• Testing Voltage to Current (V to I) and I to V converter circuits using instrumentation amplifier IC's OP07, OP82 and adjust signal ranges with reference to the industrial standard signals.</li> </ul>
<ul style="list-style-type: none"> <li>☐ Digital transducers –direct digital encoding, pulse, time, frequency encoding, analog to digital encoding.</li> <li>☐ Digital encoders-contact, magnetic and optical encodersSelection of a digital transducers</li> </ul>	<ul style="list-style-type: none"> <li>• Testing optical encoder circuit and measurement of pulses through oscilloscope</li> </ul>
<ul style="list-style-type: none"> <li>• Introduction to Controllers</li> <li>• Purpose of controls &amp; its strategies</li> <li>• Block diagram of open loop &amp; closed loop feedback control system</li> <li>• Controller components – sensor, differencing and amplification, actuators and electric system</li> <li>• Electronic controllers – analog controllers</li> <li>• Controller Maintenance</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrate the operation of components requirement for feedback closed loop control and tuning of a feedback control loop.</li> <li>• Draw / practice freehand sketches of process using appropriate control symbols</li> <li>• Configure and calibrate a single loop digital controller</li> <li>• Testing of input signals and power supply terminals of controller</li> </ul>

<ul style="list-style-type: none"> <li>• Instrumentation computer system – block diagram, Analog to digital data acquisition system (DAS).</li> <li>• GPIB IEEE 488 Instrumentation bus standards, RS232, USB port connectors and cables</li> <li>• Operation of Programmable DMM, Function generator.</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstration on PC based measurement using data acquisition hardware module &amp; data acquisition software</li> <li>• Demonstration on interface programmable test &amp; measuring instrument to PC through RS232, USB, or GPIB standard interface and its configuration.</li> <li>• Testing &amp; preparing serial interface cables and D-type connectors of different pin configuration.</li> </ul>
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## List of Tools

Sr. No.	Equipments / Instruments / Trainer Kits, Etc.	Quantity
1.	Combination Pliers 15 Cm Insulated	10
2.	Diagonal Cutter 15 Cm Insulated	10
3.	Digital/ analog hand held multi-meter	10
4.	End Cutting Nipper Insulated 15 Cm.	10
5.	Heat Sink Pliers	10
6.	I.C. Puller	10
7.	Knob Screw Driver Insulated 10 Cm	10
8.	Long Nose Insulated Pliers 15 Cm	10
9.	Neon Lamp Tester	10
10.	Screw Driver set of 6.	10
11.	Soldering Iron (25W)	10
12.	Tweezers 10 Cm Insulated	10
13.	Knife Electrician	10
14.	Allen key sets	10
15.	De soldering pump (hand operated)	10
16.	Digital IC Tester	2Nos.
17.	De-soldering station of latest type with kit for IC extraction	4 Nos.
18.	Different types of resistance, capacitance & coils	Assorted
19.	Diode (different types)	Assorted
20.	Transistor (different types)	Assorted
21.	SCR, Triac, UJT,	Assorted
22.	Common digital (TTL & CMOS) and analog ICs (different types-741, 555, LM311, 78XX, 79XX series, etc.,)	Assorted
23.	General purpose PCBs	Assorted
24.	Multimeter (analog & digital)	02 each
25.	Digital LCR meter	02
26.	Earth tester	02
27.	Dual trace analog type CRO	04

## Theory & Practical - III

### AC/DC Motor Control & Pneumatics & Hydraulics

Theory - III	Practical - III
<p>Safety precautions to be adopted while working with electricity and FIRST AID. I.E.E rules. Classification &amp; types of electrical accessories (PVC &amp; MS conduit), their uses &amp; B.I.S symbols. Types of conductors and cables, internal structure, specifications &amp; their uses. Choice of cables for industrial environment. Cable / conductor joints and their various applications.</p>	<ul style="list-style-type: none"> <li>• Practice on First aid for electrical shock victim.</li> <li>• Identification &amp; fixing practice of wiring accessories such as switches, ceiling rose, ICTP, ICDP, DBs, etc</li> <li>• Identification of multicore cables and conductors.</li> <li>• Termination of cables &amp; conductors for making joints such as straight, brittania, Tee, etc.</li> </ul>
<p>Earthing, types of earthing. Significance, methods and benefits of earthing and ground. System earthing &amp; Equipment earthing. Insulation resistance measurement using Megger. Lightning arrestors – types &amp; its significance. Types of wiring – Domestic &amp; Industrial wiring in PVC &amp; MS conduits.</p>	<ul style="list-style-type: none"> <li>• Measurement of earth resistance using earth resistance tester.</li> <li>• Wiring practice on single lamp control, staircase wiring using both PVC &amp; conduit. Single &amp; 3 phase wiring using MS conduit &amp; testing by megger.</li> </ul>
<p>Faraday's law of electro magnetic induction, Fleming's lefthand rule. Dynamically induced emf – A simple electrical generator. Single phase &amp; 3 phase supply system. AC fundamentals , Advantages of AC Polyphase system. Power factor measurements. Methods of improving P.F.</p>	<ul style="list-style-type: none"> <li>• Identify / test a single phase supply system and Identify and test 3 phase four wire system. Verification of phase sequence by phase sequence meter using low wattage lamps and a capacitor.</li> <li>• Power factor measurement using PF meter.</li> </ul>
<p>DC machines – Classification – Self excited &amp; Separately excited Dc motors, Terms used in DC Motor – Torque, flux, Speed, Back – emf ,armature current, etc. Relation between torque, flux and armature current in DC motor, Torque-Speed characteristics,etc . Construction and Parts of DC machines - series, shunt and compound and their applications. Types of armature winding, armature circuit resistance , commutation &amp; commutator segments, brushes and their functions. Speed control methods of DC motors – Armature voltage control and Field voltage control. Fault finding , Care &amp; maintenance of DC motors.</p>	<p>Identification and testing of motor parts such as field coil(both shunt &amp; series), armature etc.</p> <ul style="list-style-type: none"> <li>• Measurement of DC resistance of shunt &amp; series field and armature.</li> <li>• Study of Characteristics of DC motors with varying load. No load and Full load Vs Speed characteristics.</li> <li>• Study of Armature &amp; Field control using rheostat and test of Direction of Rotation.</li> <li>• Measurement of speed using tachometer.</li> <li>• Testing of insulation resistance using Megger.</li> <li>• Testing of armature using Growler. Checking of carbon brushes for its condition.</li> <li>• Troubleshooting &amp; Maintenance of DC motors.</li> </ul>

<p>Study of Starters to start Electric motors. Reverse &amp; forward control circuits. DOL starters, 3 and 4 point starters, Star-Delta starters-Manual, Semi-Automatic &amp; Fully Automatic starters. Types of timers – electronic, pneumatic &amp; thermal . Working of latching &amp; interlocking circuits. Reading line diagrams. Fault finding methods and maintenance of protective devices.</p>	<ul style="list-style-type: none"> <li>• Measurement of voltage and No-load current, while running the DC motor in forward and reverse direction.</li> <li>• Testing of different types of starters used to start and run AC/DC Motors.</li> <li>• Wiring &amp; testing of Electrical circuits with AC/DC motor using different types of starters.</li> <li>• Verification of proper working by testing at various check points in the circuit.</li> <li>• Fault finding exercises &amp; Maintenance of Starters.</li> </ul>
<p>AC Motors -Construction &amp; Principle of operation . Comparison of AC &amp; DC motors for its Advantages and Disadvantages. 1 phase &amp; 3 phase AC induction motors, types and their characteristics. Starting &amp; Running of AC motors using starters. Reversing of motors. Slip- Torque characteristics. Synchronous Motor and their applications. Low power AC Motors such as shaded pole, Repulsion type, universal Motors etc., Speed control methods of AC Motors – Significance of Variable frequency control. Fault diagnosis procedure &amp; Maintenance of AC Motors.</p>	<ul style="list-style-type: none"> <li>• Identification of AC motors 1-ph &amp; 3ph squirrel cage induction motor &amp; slip ring motors. Starting of Induction motor &amp; reversing.</li> <li>• Dismantling &amp; Assembling of single phase &amp; 3 phase Squirrel cage induction motors.</li> <li>• Testing of various types of Single &amp; 3 phase AC motors.</li> <li>• Measurement of slip &amp; powerfactor at various loads.</li> <li>• Speed control of induction motors.</li> <li>• Fault finding exercises.</li> <li>• Care and maintenance of AC motors.</li> </ul>
<p>Study of various types of Mechanical switches and their applications . Construction, working principle and testing of various Relays such as timing relays, Solid-state relays, Reed relays , Numerical relays etc. Contactors - Types, Construction, working principle &amp; their applications. Circuit breakers – types - MCB, MCCB, ELCB, etc ., working principle &amp; applications</p>	<ul style="list-style-type: none"> <li>• Identify, select, assemble and test a control circuit using safety devices for the given application.</li> <li>• Identify and write the specifications of control circuit devices using datasheets for the given application.</li> <li>• Connect and test the overload relays for various loads.</li> <li>• Fault finding exercises.</li> <li>• Maintenance of Relays, contactors &amp; circuit breakers.</li> </ul>
<p>Thyristors – Types , Methods of Triggering a Thyristor. Thyristor configurations. AC and DC power control circuits using SCR &amp; Triac. Commutation of SCR Solidstate switching circuits using thyristors &amp; MOSFET. Advantage of electronic control of devices using motor control circuits</p>	<p>Identification &amp; testing of different types of Thyristors – SCR, Triac, Diac, UJT, etc. Triggering of thyristors using trainer kits. Assembling &amp; testing of phase control circuits using SCR &amp; Triac. Assembling &amp; testing of Halfwave &amp; Fullwave phase control circuits using SCR. Construction and testing of fan regulator using Triac. Assembling &amp; testing of Universal motor control using SCR.</p>

<p>Introduction to pneumatics- Definition, force, pressure and its units;</p> <p>Physical Fundamentals: - Air composition, definition of atmospheric pressure, absolute pressure, gauge pressure; Safety requirements for pneumatic systems; Air compressors:- Principle operation of reciprocating compressor and applications; Air receiver; Functional description of pressure gauge, FRL (Filter, regulator, lubricator) service unit;</p>	<p>Drawing block diagram of pneumatic system, Layout of pneumatic control lab, Drawing the block diagram of reciprocating piston compressor and its parts, Dismantling and assembly of reciprocating piston compressor</p>
<p>Pneumatic Symbols as per ISO 1219:- compressor, Motor, single acting cylinder, Double acting cylinder, Directional control valves, Non return valves, Pressure control valves, flow control valves, shutoff valve, Energy transmission, Control mechanism- manual, electrical, pressure; designation of connections; Functional description of pneumatic element - single acting cylinder, double acting cylinder, gear motor, 3/2-way valve normally closed, 4/2 way valve with roller lever operation, 4/2-way valve-air applied on both sides, one-way flow control valve.</p>	<p>Drawing practices on pneumatic symbol as per ISO-1219; Identification of pneumatic components – Linear actuators, rotary actuators, Directional control valves, flow control valve, pressure control valve, Non-return valve, logical valve, time delay valve,</p>
<p>Basic circuits :- Brief description of Control of single acting cylinder and Double acting cylinder – with shuttle valve, speed regulation ( flow control valve), Two pressure valve;</p>	<p>Practice on Control of single acting cylinder and Double acting cylinder – with shuttle valve, speed regulation( flow control valve), Two pressure valve;</p>
<p>Basic circuits :- Brief description of Indirect control of a single acting and double acting cylinder; Automatic return of a double acting cylinder using limit switch; Sequential Circuit:- concept of sequential circuit, construction of sequential circuit for A+B+B-A-</p>	<p>Practice on Indirect control of a single acting and double acting cylinder; Automatic return of a double acting cylinder using limit switch; Practice on construction of sequential circuit for A+B+B-A-</p>
<p>Basic Hydraulics: Pascal's law; Application of hydraulics – brief description of stationary and mobile hydraulics; Principle of hydraulic system- hydrostatic , Hydrodynamic , Block diagram of hydraulic circuit-power supply section, power control section, driver section; Differentiate between pneumatic &amp; hydraulic symbols for actuators, Directional control valves, pressure control valves</p>	<p>Drawing block diagram of hydraulic system, identification of hydraulic components. simple calculation using hydrostatic principle;</p>

Hydraulic Pump:- Concept of positive displacement and non-positive displacement pumps; Positive displacement pumps – Functional description of Gear pump, Vane pump, Piston pump, Function of fluid, type of fluid, viscosity, Type of filter- mechanical, absorbent, adsorbent and magnetic filter. Type of seals-definition, function and application of static and dynamic seals; common seal material; Hydraulic reservoir;	Dismantling and assembly of:- gear pump, vane pump, axial piston pump; identification of different type of filters and seals
Hydraulic actuators:- Functional description of hydraulic element:-- single and double acting cylinder, hydraulic gear motor, manually operated 4/2 way valve, 4/3 way valve, pressure relief valve, pressure regulator; spring loaded NRV, one way flow control valve; Hydraulic circuit:- brief description of hydraulic circuit of meter in speed control, meter out speed control and bleed-off speed control circuit;	Practice on construction of hydraulic circuit of meter in speed control, meter out speed control and bleed-off speed control circuit;
Hydraulic circuit:- brief description of hydraulic circuit of regeneration circuit, counter balance circuit, by pass circuit, pressure sequence circuit; General maintenance procedure for hydraulic and pneumatic control system	Practice on construction of hydraulic circuit regeneration circuit, counter balance circuit, by pass circuit, pressure sequence circuit

## List of Tools, Equipments & Machineries

Sr.No.	Description of Items	Quantity
	Trainees Tool Kit comprising of the follg:	10 Nos.
1.	Combination plier 150mm insulated	1
2.	Side cutter insulated 150mm	1
3.	Long nose plier insulated 150mm Flat nose	1
4.	Long nose plier insulated 150mm Round nose plier	1
5.	Electrician Knife (double blade)	1
6.	Screw driver set (set of five bits)	1
7.	Screw driver set 150mm insulated	1
8.	Screw driver set Heavy duty 200mm insulated	1
9.	Neon tester 240V insulated	1
10.	Steel rule 300mm	1
11.	Hammer Cross pane 125gm	1
12.	Tweezer 100mm	1
13.	Soldering Iron 25W/240V	1
14.	Desoldering gun	1
15.	Adjustable spanner 25mm	2 Nos.
16.	Double head spanner set (set of 12)	2 sets
17.	Ring spanner set (set of 12)	2 sets
18.	Allen key set (set of 8)	2 sets
19.	Ball pane hammer 250gms with handle	4 Nos.
20.	Claw hammer 250gms	4 Nos.
21.	Cross cut Flat File Medium 150mm with handle	2 Nos.
22.	Tubular Hacksaw frame adjustable	2 Nos.
23.	Tennon saw 200mm with handle	2 Nos.

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