

Directorate General of Employment & Training
Course Curricula in the Area /Sector of
Broad Based Basic Training course

**Industrial Automation
For Upgradation of**

ITI's into

Centre of Excellence.

Upgradation of ITIs into Centers of Excellence-Broad guidelines for implementation of the scheme for Sector “Industrial Automation”

Upgradation of it is into Centres of Excellence-Broad guidelines for implementation of Broad Based Basic Training in “**Industrial Automation**”.

These centres will be providing multi skill training to meet the skill requirement. The training will be providing multi-skill training to meet the skill requirement of **Industrial Automation** sector of industry with their active involvement in all aspects of training. The training will be provided in three parts as given below:-

Training in Basic skill areas for a period of one year.

Training in Advanced modules for next six months.

The testing certification for the basic skill training during first year and also for advanced training during next six months conducted by NCVT.

Training in specialized modules mainly in industry (The course curriculum, duration etc. will be designed in consultation with the IMC/Local Industry. The trade testing and certification for the component will be done jointly by the State Government & Industry. Said certificate will be recognized by NCVT.

As per the recommendation of EFC, Training in the shop floor should constitute 25 to 40% of the curriculum. The training programme will have multi-exit provisions.

Trainee can opt to go to the Labour Market after completing board based basic training of one year duration as well as after completing one and half year of training.

Trainee can join training after some time for advance/specialized training in another module of same sector.

ITI pass out trainee of the particular trade (s) from the conventional system can seek admission for advanced/specialized trainee in the relevant sector.

As per the approval curricula in the sector of “**Industrial Automation**” uniform rotation of trainees in six modules each of eight weeks durations as mentioned below is envisaged to be taken up. The trades from where existing infrastructure i.e. equipment/instructor etc. could be utilized for the training in sector “**Industrial Automation**” and space requirement of each module is as under:

BASIC	NAME OF THE MODULE	Trade(s) from
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Module		where existing equipment/Instruct or could be utilized
1	2	3
BTIA-I	Workshop Practice	-
BTIA-II	Computer Application in Industrial Automation	COPA & IT&ESM
BTIA-III	Electronics for Automation	Electronic Mechanic /IT&ESM
BTIA-IV	AC/DC motor control	-
BTIA-V	Process Instrumentation	Instrumentation
BTIA-VI	Pneumatics & Hydraulics	-

For each above module, Trade Practical will be 28 hours/week and Trade theory for 4 hours/week. Apart from above, Generic modules as mentioned below will be taught throughout the year.

- G- I WORKSHOP CALCULATION AND SCIENCE - 2 HOURS/WEEK
- G-II ENGINEERING DRAWING - 2 HOURS/WEEK
- G-III ENTREPRENUERSHIP & COMMUNICATON SKILL - 2 HOURS/WEEK

In addition, 4 hours per week have been kept for Library and physical training spoken English Course.

VOCATIONAL INSTRUCTORS

<u>NAME OF THE MODULE</u>	<u>No. of Vocational Instructors(Vis)</u>
BTIA- 1 TO VI -----	Six VI one each for 6 module of relevant trades
G-I & G-II -----	Having Diploma in relevant field.
G- III -----	One contract/part-time/guest faculty for Generic module, ENTREPRE-NUERSHIPAND COMMUNICATION SKILLS.

The eligibility and other criteria will be as follows:-

Eligibility 10th pass under 10 + 2 system

Batch size 96 trainees, 16 in each module (20% supernumeries be allowed to taken care of dropouts as already exist under CTS)

Admission:

For basic training, admission is to be made in August/February each year.

Fee Structure

Fee Structure may be decide by States Govt. in consultation with IMCs. It may be desirable to prescribe a uniform tuition fee for a sector in all Centre of Excellence of a state.

Space :

Since Workshop/theory class rooms are envisaged to be accommodation in the existing building of the ITI, therefore, following norms are prescribed only new infrastructure is to be crated.

- 1) **Workshop space of minimum 100 sqm. for each basic module.**
- 2) **Three Theory classrooms of 30 sqm. each.**

Theory classroom should have latest information including AV aids as per details given below :-

1.	Suitable Chairs/Tables	As required
2.	OHP/Epidiascope	1 No..
3.	Laptop Computer/PC (latest) & LCD Projector	1 No.
4.	Magnetic White board	1 No.
5.	White Board	1 No.
6.	Flip chat	1 No.
7.	Storage Almirah	As required

Optimum utilization/flexibility may be kept in view)

(** Keeping in view the constraints of funds under the scheme, it is proposed to procure Any one set of laptop Computer/PC/LCD projector for CoE. However, States may procure additional Laptop Computer/PC/LCD projector from their fund) While selecting furniture, it should be kept in mind that these are meant for Centres of Excellence. Criteria like maximum flexibility/utilization of space should be kept in view.

Office Equipment:-

For each CoE one Scanner, one photocopy Machine and one PC/printer along with suitable accessories/furniture and internet connection (if not already available in the institute) is proposed to be provided for each Coe, in addition to the equipment prescribed in the syllabus.

Additional/alternation/Construction

For Civil Works, tentative amount of Rs.40.00 lakhs have been proposed per CoE. It is envisaged to have separate blocks/wing for the Centres of Excellence in the ITI campus. In case space is available in the existing building of an ITI for taking up new means as per requirement of the cluster of Industry, the existing space will be renovated as per the need. Alternately, separate block will be build up in the same campus keeping in view the space requirements of the Electrical Sector. While planning for addition/alteration/Construction of Workshop and Class rooms, following may be kept in view:

Concept of a Centre of Excellence

The fact that the requirement of funds for construction/addition/alteration of advanced training will be higher than that of basic training.

Publicity

While publicity & advertisement be given for better response. The role of the local as well as the concerned Industry is very vital for the success of this programme.

State may consider providing additional equipment/other facilities like separate Library/upgradation of existing Library, Conference Hall/Committee Room etc. from their own funds.

**UPGRADATION OF ITI'S INTO CENTERS OF EXCELLANCE (CoE)
SECTOR / AREA: INDUSTRIAL AUTOMATION
BROAD BASED BASIC TRAINING - 1ST YEAR**

MODULE – I: WORKSHOP PRACTICE

COURSE CONTENT: WORK SHOP PRACTICE**DURATION: 8 WEEKS**

WEEK NO	PRACTICAL	THEORY
1	WORKSHOP PRACTICES <ul style="list-style-type: none"> • Safety signs • Lifting and shifting of equipments/instruments • Extinguishing of fire • General Workshop safety 	Scope of workshop practice Symbols on sign boards Material handling and storage in the workshop Safety practice - fire extinguisher Health, hygiene and safe working habits Do's and don'ts.
2	MEASUREMENT <ul style="list-style-type: none"> • Measure the length, slope, angles, thickness, diameter using appropriate instrument. • Use of micrometers and calipers for precise measurement • Error adjustment in micrometers 	Terms used in measurement Different types of errors Instruments used for linear and angular measurement Care and maintenance of instruments Correct use of micrometers and Vernier Caliper
3	FITTING <ul style="list-style-type: none"> • Familiarise with the tools • Marking , punching ,hack sawing and chipping 	Introduction to fitting trade, familiarize with various hand tools used in fitter trade and their general uses. Methods of measuring , marking and punching Hack saw frames, blades - types and specification.
4	FILING <ul style="list-style-type: none"> • Filing practice on flat surfaces • Filing to required shape and sizes. 	Types of screws and fasteners used in metal and wood Introduction to TQM. Limit and Fits as per IS 919
WEEK NO	PRACTICAL	THEORY
5	DRILLING <ul style="list-style-type: none"> • Exercises on drilling machine covering various types of Drilling operations (drilling, counter sinking, counter boring Tapping 	Types of drilling machines and their uses - types of drills and Taps and their specifications , – tool holding devices and work holding Devices-
6	WOOD WORK <ul style="list-style-type: none"> • Practice on sawing, planing and making different joints 	Common hand tools used in carpentry workshop, marking, cutting and planing. Types of woods and their uses. Types of joints.
7	SHEET METAL	Hand tools used in sheet metal workshop

	<ul style="list-style-type: none"> • Practice on shearing and bending • Making various joints • Making a rectangular box by riveting and soldering 	<p>Types of joint used in sheet metal Rivet and its types and their uses.</p>
8	<p>WIRING AND SOLDERING</p> <ul style="list-style-type: none"> • Selection of wires and cables. • Simple wiring practice. • Exercise on wire joints and crimping. • Practice on Soldering & Desoldering. 	<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 soldering various composition of solder wires, fluxes and their uses. Characteristics, properties and uses of bakelite, PVC, Porcelain etc.</p>

SUGGESTED LIST

CATEGORY	SL. NO.	NAME OF TOOL & EQUIPMENT	QUANTITY
Instruments and general shop outfit per unit	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
	29.	File swiss pattern /needle type set of 12	4
	30.	File half round 25 cm II cut	4
	SL. NO.	NAME OF TOOL & EQUIPMENT	QUANTITY

CATEGORY			
	31.	File half round 25 cm bastard	4
	32.	File hand 15 cm	4
	33.	Card file	4
	34.	Spanner double ended 6 – 25 mm set	4
	35.	Spanner adjustable 15 cm	4
	36.	Scraper flat 15 cm	4
	37.	Scraper 3 corner 15 cm	4
	38.	Plier combination 15 cm	4
	39.	Chisel cold & cross cut 9 mm	4
	40.	Chisel cold 19 mm flat	4
	41.	Chisel 9 mm round nose	4
	42.	Clamp C 10 cm	4
	43.	Micrometer 0 – 25 mm outside	4
	44.	Micrometer 25 - -50 mm outside	4
	45.	Micrometer 5 – 50 mm inside	4
	46.	Micrometer 50 – 75 mm outside	4
	47.	Vernier caliper 20 cm	4
	48.	Vernier Height gauge 30 cm	4
	49.	Vernier bevel protractor	4
	50.	Screw pitch gauge	4
	51.	Wire gauge metric standard	4
	52.	Drill chuck 12 mm	4
	53.	Pipe wrench 40 cm	4
	54.	Vice bench jaw type 12 cm	4
	55.	Prick punch	4
	56.	Mallet	4
	57.	Snip straight	4
	58.	Setting hammer with handle	4
	59.	Planishing hammer	4
	60.	Snip bent 25 cm	4

CATEGORY	SL. NO.	NAME OF TOOL & EQUIPMENTS	QUANTITY
	61.	Gauge imperial sheet	4

	62.	Allen key set	4
	63.	Rawl plug tool & bit	4
	64.	Megger 0 – 1000 M ohm & 2.5 to 5 KV	4
	65.	Soldering iron 25W, 35W, 65W, 125W	4
	66.	Desoldering gun	4
	67.	Wire stripper 20 cm	4
	68.	Country drill 18”	4
	69.	Jack plainer 24 “	4
	70.	Carpenter vice 10”	4
	71.	Bench drilling machine 12mm capacity with standard accessories	1
	72.	Bench grinder double end	1
	73.	Hand drill machine ½ HP 2 – 8 mm with power hammer.	2
Lab Furniture	1.	Work bench/table/test bench	as required
	2.	Revolving chair/stool – for participants	16
	3.	Staff table & revolving chair each	1
	4.	Steel racks	as required
	5.	Steel almirah	as required
	6.	Steel lockers for 16 participants	“
	7.	Fire extinguishers	“

MODULE – II: COMPUTER APPLICATION IN INDUSTRIAL AUTOMATION

**COURSE CONTENTS: COMPUTER APPLICATIONS IN INDUSTRIAL AUTOMATION
WEEKS**

DURATION: 8

Week	Theory	Practical												
I	Introduction to Computer Part of computer Booting of computer Using Mouse & Keyboard Storage Devices Floppy Disk, Hard Disk, Flash drive / Pen drive CDROM, DVD ROM Files & Folders	Booting the computer Familiarisation of Desktop, Refreshing Start menu, task bar, Date/time Right click, left click, scrolling of mouse pointer Wing shift, alt, control, number lock Scroll lock, pause Function keys of the keyboard Open file from Hardisk, Floppy disk Create files, folders in it. Delete files, copy files, remove files Save files, create Directories (folder) Open files from CD. DVD, Copy files from CD to Hard disk												
II	Using windows XP/2000 Use of control panels Add/Remove programs Add Hard ware Regional settings using windows explorer short cuts Applications softwares Using paint, note pad	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 & time patterns. Using windows explorer, opening & closing of application Using note pad to create down Using paint to create sample bitmaps & Jig files												
III	Familiarisation with parts of computer. Understanding of <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">1. AGP slot</td> <td style="width: 50%;">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		Remove the case of computer Identify III (Theory) By Removing & 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 Remove the RA & Replace Remove battery & Replace
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														

	Remove jumpers.
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Suggested list of Computer Systems and Peripherals

SL. No.	Items and Computer specifications	Quantity
1.	PC system with latest available Intel / AMD Processor specification / configuration with DVD rewritable, with colour monitor with Ethernet (100/1000) port / NIC	08
2.	Colour Printer (Inkjet / Laser) with 1200 dpi 32MB RAM	1 each
3.	600VA UPS compatible with PC's	8
4.	Modem (Broad band / Dialup) with 5 users internet connection	1
5.	Web camera	2
6.	Vacuum Cleaner	2
7.	Windows xp professional operating system	8
8.	Ethernet cable/Wire stripper, crimping tool	4
9.	Anti Virus for standalone and network (Latest version)	4
10.	PC Diagnostic software (Latest version)	1

MODULE - III : ELECTRONICS FOR AUTOMATION

COURSE CONTENT: ELECTRONICS FOR AUTOMATION

DURATION: 8 WEEKS

WEEK NO.	PRACTICAL	THEORY
1.	<ul style="list-style-type: none">• Study of Analogue / Digital Multimeter & Oscilloscope operations.• Measurement of voltage, current, power and energy in the given simple circuit.• Identify and measure voltage of dry battery and cells using Multimeter.• Measure DC quantity & sinewave parameters using oscilloscope.	<p>Conductors, Semiconductors & Insulators. Fundamentals of Electricity - Meaning & definition of various terms, units and relationship between voltage, current, power and energy. Common DC sources – Cells & Batteries. Series and parallel connection of DC sources. Electrical supply system – single phase and three phase. Principle of production of AC – single phase and three phase AC alternators. DC generators. Electrical symbols as per BIS standards.</p>
2.	<ul style="list-style-type: none">• Identify and read values using colour code wherever applicable, draw symbols and test the various passive components using appropriate meters / instruments.• 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	<p>Classification of passive components. Properties and measurement of Resistance, Capacitance & Inductance. Resistance colour coding. Usage of LCR bridge for measurement. Inductors & Transformers – types, principle of operation, specifications & their uses. Ratings, Voltage regulation, efficiency and phase relationship in transformers, Impedance matching using transformers. Capacitors – properties, functioning, colour coding, etc. Types of capacitors & their uses.</p>
WEEK NO.	PRACTICAL	THEORY

3.	<ul style="list-style-type: none"> • Characteristics of PN junction diode • Construction & testing of half wave / full wave rectifiers • Characteristics of zener diode • Zener diode as voltage regulator • Clamping and clipping circuits using diode 	<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. Zener diode – construction, working, characteristics and testing, zener diode as a voltage regulator.</p>
4.	<ul style="list-style-type: none"> • Assemble, Test and calculate voltage gain, power gain, input/ output impedance and phase relationship of a common emitter and common base amplifier. • Construct and test a RC coupled amplifier and an emitter follower and verify gain. • Testing & Verification of the Characteristics of SCR, DIAC, TRIAC, UJT. 	<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, construction, working principle, characteristics and testing procedures.</p>
5.	<ul style="list-style-type: none"> • Measure offset voltage of OP- AMP 741. • Construct and test the Inverting & Non Inverting Amplifier, Differentiator, Integrator, etc. • Construct and test the voltage comparator using OP- AMP. • Construct and observe & interpret the waveforms on CRO for the phase shift oscillator . • Test the monostable / astable multivibrator circuits of 555 timer IC. 	<p>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.</p>

WEEK NO.	PRACTICAL	THEORY
6.	<ul style="list-style-type: none"> Assemble & test a transistor series and shunt regulator. Assemble and test a + ve / -ve regulator using three pin regulator IC's. Assemble and test a regulator using op-amp. 	<p>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</p>
7.	<ul style="list-style-type: none"> Assemble & Verify the truth table of the basic logic (AND, OR, NOT) circuits using TTL 7400series IC's Flip flops – RS, D, JK flip flops. Construct & test up/down counters using flip- flops. 	<p>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.</p>
8.	<ul style="list-style-type: none"> Interpreting the microprocessor IC number, package, pin details. Interpreting the supporting IC's for Microprocessor based system using Trainer kit Operating procedure and basic commands of 8085 - 8 bit microprocessor trainer kit Practice on simple Assembly language programming Demonstration on interfacing of Switches, thermocouple & flow meter, LED's, Relays, Stepper Motor, DC Motor, etc., 	<p>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.</p>

SUGGESTED LIST

Sl. No.	EQUIPMENTS / INSTRUMENTS / TRAINER KITS, etc.,	Quantity proposed for a batch of 16 tranees
1.	Combination Pliers 15 Cm Insulated	16
2.	Diagonal Cutter 15 Cm Insulated	16
3.	Digital/ analog hand held multi-meter	16
4.	End Cutting Nipper Insulated 15 Cm.	16
5.	Heat Sink Pliers	16

6.	I.C. Puller	16
7.	Knob Screw Driver Insulated 10 Cm	16
8.	Long Nose Insulated Pliers 15 Cm	16
9.	Neon Lamp Tester	16
10.	Screw Driver set of 6.	16
11.	Soldering Iron (25W)	16
12.	Tweezers 10 Cm Insulated	16
13.	Knife Electrician	16
14.	Allen key sets	16
15.	De soldering pump (hand operated)	16
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
Sl. No.	Item/Specification	Quantity proposed
28.	Digital storage oscilloscope	02
29.	Megger analog type	01
30.	Megger digital type	01
31.	Trainer boards- power electronics	04
32.	Trainer boards – digital electronics	04
33.	Trainer boards – Operational amplifiers	04
34.	Microprocessor trainer kit along with interfacing modules such as Digital I/O, ADC/DAC, stepper motor / DC motor modules.	04
35.	Work bench, wires and cables of different size	Assorted
36.	Operating & instructional manuals of equipment	Assorted

<u>MODULE IV : AC / DC MOTOR CONTROL</u>		
DURATION – 8 weeks		
WEEK NO.	PRACTICALS	THEORY
1.	<ul style="list-style-type: none"> Practice on First aid for electrical shock victim. Identification & fixing practice of wiring accessories such as switches, ceiling rose, ICTP, ICDP, DBs, etc Identification of multicore cables and conductors. Termination of cables & conductors for making joints such as straight, brittania, Tee, etc. 	<p>Safety precautions to be adopted while working with electricity and FIRST AID. I.E.E rules. Classification & types of electrical accessories (PVC & MS conduit), their uses & B.I.S symbols. Types of conductors and cables, internal structure, specifications & their uses.</p> <p>Choice of cables for industrial environment.</p> <p>Cable / conductor joints and their various applications.</p>
2.	<ul style="list-style-type: none"> Measurement of earth resistance using earth resistance tester. Wiring practice on single lamp control, staircase wiring using both PVC & conduit. Single & 3 phase wiring using MS conduit & testing by megger. 	<p>Earthing, types of earthing. Significance, methods and benefits of earthing and ground.</p> <p>System earthing & Equipment earthing. Insulation resistance measurement using Megger. Lightning arrestors – types & its significance.</p> <p>Types of wiring – Domestic & Industrial wiring in PVC & MS conduits.</p>
3.	<ul style="list-style-type: none"> 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. Power factor measurement using PF meter. 	<p>Faraday's law of electro magnetic induction, Fleming's lefthand rule.</p> <p>Dynamically induced emf – A simple electrical generator.</p> <p>Single phase & 3 phase supply system.</p> <p>AC fundamentals , Advantages of AC Polyphase system.</p> <p>Power factor measurements. Methods of improving P.F.</p>
4.	<ul style="list-style-type: none"> Identification and testing of motor parts such as field coil (both shunt & series), armature etc. Measurement of DC resistance of shunt & series field and armature. Study of Characteristics of DC motors with varying load. No load and Full load Vs Speed characteristics. Study of Armature & Field control using rheostat and test of Direction of Rotation. Measurement of speed using tachometer. Testing of insulation resistance using Megger. Testing of armature using Growler. Checking of carbon brushes for its condition. Troubleshooting & Maintenance of DC motors. 	<p>DC machines – Classification – Self excited & 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.</p> <p>Types of armature winding, armature circuit resistance , commutation & commutator segments, brushes and their functions.</p> <p>Speed control methods of DC motors – Armature voltage control and Field voltage control.</p> <p>Fault finding , Care & maintenance of DC motors.</p>

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

WEEK NO.	PRACTICAL	THEORY
8	<p>Identification & testing of different types of Thyristors – SCR, Triac, Diac, UJT, etc.</p> <p>Triggering of thyristors using trainer kits.</p> <p>Assembling & testing of phase control circuits using SCR & Triac.</p> <p>Assembling & testing of Halfwave & Fullwave phase control circuits using SCR.</p> <p>Construction and testing of fan regulator using Triac.</p> <p>Assembling & testing of Universal motor control using SCR.</p>	<p>Thyristors – Types , Methods of Triggering a Thyristor.</p> <p>Thyristor configurations.</p> <p>AC and DC power control circuits using SCR & Triac.</p> <p>Commutation of SCR Solidstate switching circuits using thyristors & MOSFET.</p> <p>Advantage of electronic control of devices using motor control circuits.</p>

SUGGESTED LIST OF TOOLS, EQUIPMENTS & MACHINERIES

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

Sl. No	Description of Items	Quantity
25.	Measuring tape 2mtr	4 nos
26.	Needle file set(set of 9)	2 sets
27.	Crimping tool 12mm	2 nos
28.	Drilling machine – light duty 6mm	2 nos
29.	Drilling machine – heavy duty 12 mm	1 no
30.	Box spanner set (set of 4)	1 set
31.	Temperature Controlled Soldering iron station	2 nos
32.	Wall jumper holder with bit, 8mm	2 nos
33.	Twist drill 3mm, 4mm, 6mm, 8mm	4 nos each
34.	SWG	1 no
35.	Bearing puller 25mm	1 no

List of Equipments		
Sl. No	Description of Items	Quantity
1	Portable Digital Multimeter with 4 ½ digit display, to measure current upto 10A or more, provision for testing diode,transistor, capacitor and frequency measurement.	6 nos
2	Analog multimeter	6 nos
3	Earth resistance tester with test bits	1 no
4	Megger (0 to 500V) digital	1 no
5	Tong tester 10A / 100A	1 no
6	AC voltmeter (MI) 0 to 300V	2 nos
7	AC voltmeter (MI) 0 to 500V	2 nos
8	DC voltmeter (MC) 0 to 50V	2 nos
9	DC voltmeter (MC) 0 to 100V	2 nos
10	Ammeter DC (MC) 0 to 500µA	2 nos

<u>Sl.No</u>	Description of Items	Quantity
11	Ammeter DC (MC) 0 to 50 mA	2 nos
12	Ammeter DC (MC) 0 to 100 mA	2 nos
13	Ammeter DC (MC) 0 to 500 mA	2 nos
14	Ammeter DC (MC) 0 to 1A	2 nos
15	Ammeter AC (MI) 0 to 5A	1 no
16	Wattmeter 1ph, 1A, 5A, 10A, 20A	1each
17	Wattmeter 3ph, 5A, 10A, 20A, 50A	1each
18	Power factor meter	1 no
19	Phase sequence meter	1 no
20	Energy meter 1ph, digital	1 no
21	Energy meter 3ph, digital	1 no
22	High rate discharge Tester	1 no

MODULE – V : PROCESS INSTRUMENTATION

COURSE CONTENT: PROCESS INSTRUMENTATION

DURATION: 8 WEEKS

WEEK NO.	PRACTICALS	THEORY
1.	<ul style="list-style-type: none"> • Calculate span, range for various measurement systems in 0% to 100% • Calculate the accuracy and error in percentage & engineering units of various process measuring instruments 	<ul style="list-style-type: none"> • Elements of the measurement system • Metrology – basic concepts • Measurement terminology – measurement, true value, standard, error, accuracy, precision, repeatability, resolution, range, span, offset, calibration.
2.	<ul style="list-style-type: none"> • Calculate and list the derived units from fundamental units and its dimension • Calculate conversion of unit from English to SI. • Discuss and List the prefix values and its symbols and equivalent of decimal multiples and submultiples 	<ul style="list-style-type: none"> ▪ Units, Standards & Errors ▪ Units of measurement and realization of Mass, Length, Time, Electric Current, Thermodynamic temperature, Amount of substance, luminous intensity. ▪ Unit derivations from basic units ▪ Introduction standards – History, SI prefixes ▪ Errors – study of various classification
3.	<ul style="list-style-type: none"> • Construct and testing Wheatstone bridge / Kelvin bridge • Construct & testing of Wein bridge • Calculation of resistance voltage and current using voltage divider and current divider method 	<ul style="list-style-type: none"> • Bridge Measurements – Introduction • Wheatstone Bridge / Kelvin Bridge • Guarded Wheatstone Bridge • Wein Bridge

WEEK NO.	PRACTICALS	THEORY
4.	<ul style="list-style-type: none"> • Identifying the C-type bourdon tube, link, lever, gear and teeth of pressure gauge and its adjustments screws. • Testing LVDT circuit, record the results and draw a graph for linear region. • Measurement and record the output values of RTD & Thermocouple. • Testing of optical detector circuit (photo diode, photo transistor, photo resistor, photovoltaic cell) and record the results. • Measurement of speed using tachogenerator. 	<ul style="list-style-type: none"> ▪ 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 ▪ Transducers - Working principle, classifications, applications ▪ Passive transducers – Capacitive, Inductive (LVDT), Resistive (Potentiometer, strain gauge- bonded & unbonded strain gauges, RTD, thermistor, Photoconductive cell. ▪ Active transducers – tachogenerator, photodiode/photo transistor, piezoelectric, thermocouple
5.	<ul style="list-style-type: none"> • Testing cantilever type bonded strain gauge, adjusting offset, record readings and results. • 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. 	<ul style="list-style-type: none"> • Transducer bridges – bonded strain gauge bridge • Instrumentation amplifier IC's • Signal conditioning circuits using OP07/OP82 IC's
6.	<ul style="list-style-type: none"> • Testing optical encoder circuit and measurement of pulses through oscilloscope. 	<ul style="list-style-type: none"> ▪ Digital transducers –direct digital encoding, pulse, time, frequency encoding, analog to digital encoding. ▪ Digital encoders-contact, magnetic and optical encoders Selection of a digital transducers

WEEK NO.	PRACTICALS	THEORY
7.	<ul style="list-style-type: none"> • Demonstrate the operation of components requirement for feedback closed loop control and tuning of a feedback control loop. • Draw / practice freehand sketches of process using appropriate control symbols • Configure and calibrate a single loop digital controller • Testing of input signals and power supply terminals of controller. 	<ul style="list-style-type: none"> • Introduction to Controllers • Purpose of controls & its strategies • Block diagram of open loop & closed loop feedback control system • Controller components – sensor, differencing and amplification, actuators and electric system • Electronic controllers – analog controllers • Controller Maintenance
8.	<ul style="list-style-type: none"> • Demonstration on PC based measurement using data acquisition hardware module & data acquisition software • Demonstration on interface programmable test & measuring instrument to PC through RS232, USB, or GPIB standard interface and its configuration. • Testing & preparing serial interface cables and D-type connectors of different pin configuration. 	<ul style="list-style-type: none"> • Instrumentation computer system – block diagram, Analog to digital data acquisition system (DAS). • GPIB IEEE 488 Instrumentation bus standards, RS232, USB port connectors and cables • Operation of Programmable DMM, Function generator.

Suggested List of Equipments / Instruments / Machines, etc.,

Sl. No.	Item / Specification	Quantity
1.	Connecting screwdriver 100 mm	16
2.	Neon tester 500 V.	16
3.	Screw driver set (set of 5 bits)	16
4.	Insulated combination pliers 150 mm	16
5.	Long nose pliers 150 mm	16
6.	Soldering iron 25 W. 240 V	16
7.	Electrician knife D.B.	16
8.	Digital multimeter portable	16
9.	Soldering Iron 15 W/25 W/65 W	16
10.	De-soldering pumps	16
11.	Insulated side cutting pliers 150 mm	16
12.	First aid kit	01
13.	Digital Multimeter	08
14.	30-0-30 V, 2 Amps DC regulated power supply	08
15.	0-300 V, 500 mA, DC regulated power supply	02
16.	LCR Bridge (Digital)	01
17.	Signal Generator, 100 KHz	02
18.	Digital storage Oscilloscope, 100 MHz, with probe	02
19.	Megger	01
20.	Digital and Analog IC Tester	02

Sl. No.	Item / Specification	Quantity
21.	Pulse Generator	02
22.	Logic Probes	04
23.	Temp. Controllers	02
24.	Thermocouple (J.K.T.R. S), RTD (Pt-100)	Each 02
25.	Cantilever type Bonded strain gauge	04
26.	Output Power meter	01
27.	Distortion factor, meter Pressure gauges (0-1kg11m2, 0-10kg 11m2)	01
28.	Optical detector trainer kit -	04
29.	Photo Tachometer	02
30.	Rotary encoder	02
31.	Personal computer with latest configuration with printer	04
32.	CRO with GPIB/RS232/USB interface	01
33.	Function generator with GPIB/RS232/USB	01
34.	DMM with GPIB/RS232/USB	01
35.	High voltage testing kit	02
36.	Strain Gauge with signal conditioning unit	02
37.	Load cell with signal conditioning unit	02
38.	L V D T with signal conditioning unit	02
39.	Linear scale	02
40.	Fire extinguisher	02

Sl. No.	Item / specification	Quantity
41.	Soldering Station	01
42.	De soldering Station	01
43.	Hot air soldering station-cum-De-soldering Station for SMD Devices	01
44.	Air Filter pressure Regulator & Test Rig.	02

MODULE - VI : PNEUMATICS AND HYDRAULICS

COURSE CONTENT : PNEUMATICS AND HYDRAULICS

DURATION: 8 WEEKS

WEEK NO.	PRACTICAL	THEORY
1	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.	Introduction to pneumatics- Definition, force, pressure and its units; 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;
2	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,	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.
3	Practice on Control of single acting cylinder and Double acting cylinder – with shuttle valve, speed regulation(flow control valve), Two pressure valve;	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;
4	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-	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-

WEEK NO.	PRACTICAL	THEORY
5	Drawing block diagram of hydraulic system, identification of hydraulic components. simple calculation using hydrostatic principle;	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 & hydraulic symbols for actuators, Directional control valves, pressure control valves.
6	Dismantling and assembly of:- gear pump, vane pump, axial piston pump; identification of different type of filters and seals	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;
7	Practice on construction of hydraulic circuit of meter in speed control, meter out speed control and bleed-off speed control circuit;	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;
8	Practice on construction of hydraulic circuit regeneration circuit, counter balance circuit, by pass circuit, pressure sequence 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.

SUGGESTED LIST OF TOOLS, MACHINERY, EQUIPMENTS ETC.,

SL. No.	Item	Quantity
1.	Air compressor- stationary, compression load 8 bar, suction capacity 200 liters/min, reservoir 200 liters;	1 No
2.	Mobile laboratory work bench for pneumatics	4 Nos
3.	Pneumatic- Trainer kit –consists of cylinders, different types of direction control valves, pressure dependant, time dependant valve, unidirectional and bidirectional flow control valves with accessories for construction and application of different type of pneumatic circuits.	2 Nos
4.	Air motor –gear, vane type	1Nos
5.	Pneumatics cut-away models case	1 sets
6.	Reciprocating air compressor single stage for dismantling and assembling practice– displacement 4 cfm, working pressure 4 bar	2 Nos
7.	Hydraulic trainer kit with power pack – consists of cylinders, different types of directional control valves, pressure control valves and Non-return valve , one-way flow control valve, pilot operated non-return valve with accessories for construction and application of different type of hydraulic circuits	2 Nos
8.	Mobile laboratory work bench for Hydraulics	4 nos
9.	Oil-hydraulic –transparent working model with drive unit kit operating pressure of 10 bar.	1 No
10.	Working model of hydraulic press	1 No
11.	Oil hydraulics pump for dismantling and assembling practice bench -Gear pump, swash plate pump, vane pump	1 No
12.	Pressure sequence valve, counter balancing valve,4/3 way valve with recirculating mid position,	1 No
13.	Hydraulic motor – gear, vane type	1 No
14.	Computer System (Intel/AMD Processor based) with UPS of Latest specification / configuration	2 Nos
15.	Pneumatic., hydraulic, simulation software/videos/textbooks	1 set
16.	Different type of pneumatic/ hydraulic seals and filters	2 sets
17.	Magnetic pneumatic/Hydraulic symbols case	1 set

**UPGRADATION OF ITIs INTO CENTRES OF EXCELLENCE (CoE)
SECTOR/AREA: INDUSTRIAL AUTOMATION MODULE 1ST YEAR**

**MODULE : WORKSHOP CALCULATION & SCIENCE AND DRAWING
(DURATION – 2 HOURS/WEEK – 48 WEEKS)**

1. COURSE CONTENT:

Familiarization with :

1. Basic algebra – algebraic formula – quadratic equations
2. Trigonometry – Trigonometric functions – calculation of area
3. Mensuration – Find the area and volume of different objects conversion of feet, inch mm
4. Find the equivalent resistance on series circuit, parallel circuit
5. Find the equivalent resistance, voltage and current across each component of a series circuit, parallel circuit and series parallel circuit.
6. Solve the series parallel and network circuits using Kirchoffs Law
7. Series and parallel circuits of capacitors/Induction
8. Problems on series as circuits, impedance, power and power factor
9. Series and parallel resonance circuit
10. Find the average ratio, efficiency and losses in transformers
11. Find the average dc, load current and efficiency, ripple factor, in half wave and full wave rectifiers.
12. Find the I_c , I_b , I_e in various types of biasing circuit and transistor configuration circuits.
13. Calculate the voltage gain, current gain and power gain in dB units in single stage emitter following amplifier
14. Problems related to Zener regulator, series regulator and series parallel regulator circuits
15. Find the frequency of oscillation in various oscillator circuits
16. Calculation of range, span, error in percentage.
17. calculation of unit conversion of process variable.
18. Calculation of proportional gain of controller.
19. Problems on conversion of decimal numbers to binary and Hex
20. Addition and subtraction of Binary and Hex numbers
21. Calculations on pulse duration, pulse width, frequency, duty cycle.
22. Conversion and number in bit, byte, kilo byte, mega byte, gega byte etc.
23. Simple calculation of material cost e.g. sheets, wires, battons, papers, cables, etc.

24. Problems on voltage, current & power relationship in single phase & 3 phase systems.
25. Relation between torque, flux and Armature current in DC motor, Torque Vs speed calculations.
26. Armature control and field control problems in DC motors
27. Speed Vs frequency relationship of AC Motors
28. Calculation of losses in Motors
29. Slip and power factor calculations
30. Torque/Speed relationship and load current calculations in AC motor.
31. Percentge error calculation in AC Motors
32. Motor efficiency calculation.

ENGINEERING DRAWING

1. COURE CONTENT

1. Engineers drawing and its importance
2. Types o line and their applications
3. Free hand sketching of tools
4. Lettering practices
5. Dimensioning their methods and specific uses
6. Types of projections
7. Simple orthographic projections in 1st angle method
8. 3rd angle projections of various objects and exercises with dimension
9. Isometric views of objects
10. Sectioning and sectioned views
11. 1st angle and 3rd angle projections of a computer monitor, floppy disk drive and hard disk drive
12. Draw the symbols for various electrical measuring instruments, switches, fuse, protective and controlling devices in electrical circuits
13. Draw the bridge circuits (Wheat stone, wein bridge,2-wire,3-wire,4-wire,RTD configuration)
14. Wiring diagram for process flow of plants and process control loops
15. Draw the symbols of various electronic components and ISA instrument symbols
16. Draw the circuit diagram of various types of rectifiers, amplifiers, oscillators, power supplies, multivibrators
17. Draw the circuits of shift registers, counters, digital clock, multiplexer
18. Details of various TTI and CMOs ICs, RAM, EPROM, A/D Converter,D/A Converter
19. Detailed block diagram of computer
20. Drawing and component layout of motherboard, display card, Ethernet card, etc.
21. Layout of key board
22. Front and Rear view of System Unit of PC, Monitor, FD, HDD, Modem, Printers
23. Pin diagram of various connectors & cables used in personal computer.

