

**Up gradation of ITIs into Centres of Excellence-**  
**Broad guidelines for implementation of Advanced Module of Sector**  
**“Industrial Automation ”.**

These Centres will be providing multiskill training to meet the skill requirement of particular 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 of six months duration after Broad based basic Training(BBBT)
- ◆ Testing & Certification both for the Broad Based Basic Training & Advanced Module Training during subsequent six months will be conducted under the aegis of NCVT .
- ◆ Training in specialized modules mainly by the industry (The course curricula, duration etc will be designed in consultations with the IMC/local industry). The trade testing & certification for specialized module will be done jointly by the State Government & Industry. Said certificate will have recognition from NCVT
- ◆ As per the recommendations of the EFC, Training in the shop floor should constitute atleast 25-40% of the curriculum.

The training programme will have multi-entry and multi-exit provisions as given below:

- trainee can opt to go to the labour market after completing broad based basic training of one year duration or after completing advanced module/s.
- multi-entry and multi-exit provisions would enable a trainee to take admission for advanced/ additional advanced /specialized module as per his/her need .

**Guidelines for Training in Advanced modules**

- A minimum of three modules would be essentially needed , so as to ensure that all the 96 trainees are accommodated in the three modules may be selected in consultation with IMC for which in two shifts .
- If it is felt that available modules for which the course curricula has been developed at National Level are not sufficient to cater to the needs of local industry in a particular state, States are free to select module as per need in consultation with industry . They may develop suitable module(s) accordingly in consultations with the industry clearly indicating tool & equipment list , instructor qualifications , space norms etc. & forward the same to DGE&T for seeking approval of NCVT.
- A trainee at a time can opt only for one Advanced Module .
- Admission Criteria, Space requirement, Qualification of instructor of the various modules of “**Industrial Automation** ” sector are attached herewith.

**Admission to Advanced Module for the graduates of ITI in related trades:**

There is a provision for lateral entry for graduates of ITIs (NTC /NAC passed out from conventional system ) of the related trades subject to availability of seats in Advanced Module. Trades of conventional system mentioned against each advanced module in the enclosed statement, could be offered admission in Advanced Module .

<b>MODULE NO.</b>	<b>NAME OF THE MODULE</b>	<b>Admission criteria</b>	<b>Min Space requirement</b>	<b>Duration In Weeks</b>	<b>Qualification/ Status Of Instructor</b>
IAAM-01	Electrical Maintenance Automation	Completed BBT in Sector Industrial Automation /Electrical OR NTC/NAC in Electrical or any other related trade OR Diploma in Electrical Engineering .	80 sq m	24 weeks	Degree in Industrial Automation /related discipline of module with minimum two years teaching/industrial experience in the relevant field
IAAM-02	Automation &PLC	Completed BBT in Sector Industrial Automation / Electronics OR NTC/NAC in Electronics / IT&ESM or any other related trade OR Diploma in Electronics Engineering .			OR
IAAM-03	Mechanical Maintenance for Automation	Completed BBT in Sector Industrial Automation / Production & Manufacturing OR NTC/NAC in related trade OR Diploma in related Engineering .			Diploma in Industrial Automation or related discipline with min four years teaching/industrial experience in the relevant field  OR  HNTC in Related area with min five years teaching/industrial experience in the relevant field .

**UPGRADATION OF ITI'S INTO CENTRES OF EXCELLENCE (COE)**

**SECTOR/ AREA- INDUSTRIAL AUTOMATION**

**ADVANCED MODULES IN II YEAR**

**(FOR THE FIRST 6 MONTH OF II YEAR)**

MODULE NO.	NAME OF MODULE	DURATION IN WEEK
IAAM-01	Electrical Maintenance Automation	24 weeks
IAAM-02	Automation &PLC	24 weeks
IAAM-03	Mechanical Maintenance for Automation	24 weeks

**ADVANCE MODULE -: ELECTRICAL MAINTENANCE FOR AUTOMATION DURATION: 24 WEEKS**

WEEK NO	PRACTICALS	THEORY
1.	<ul style="list-style-type: none"> <li>• Lab. Exercise on Earthing</li> <li>• Identification of fuses types</li> <li>• Lab demo of elect. tools</li> <li>• Demo on use of PPE</li> <li>• Mock shut down exercises</li> <li>• Identification of caution tag</li> <li>• Demo on positive isolation</li> </ul>	Safety precaution to avoid electric shock shocktreatment,Earthing,ISI rule on earthing,fuses and its type, cheking of electrical tools from safety point of view,Use of PPE from electrical safety point of view,Knowledge of shut- down procedures,positive isolation-fundamentals,use of caution tags.
2.	<ul style="list-style-type: none"> <li>• Demo of different types of magnets&amp;magnetic materials.</li> <li>• Tracing of magnetic lines of force</li> <li>• Demo on Faraday's laws of - Electromagnetic induction</li> </ul>	Magnetism principles,Diamagnetic,paramagnetic,ferromagnetic materials,comparison of electric & magnetic circuits,Faraday's laws of Electromagnetic induction,Fleming's right hand rule,lenz's law, cork screw rule,self & mutual inductance,Eddy currents,inductors
3.	<ul style="list-style-type: none"> <li>• Analysing AC circuits with the help of oscilloscope</li> <li>• Monitoring cycle,amplitude,electrical degrees</li> <li>• Demo on in phase/out of phase lagging /leading current</li> <li>• Inductace/capacitance measurement&amp;impedence calculation.</li> </ul>	AC circuits,definition:- cycle,period,Amplitude,Instantaneous value,Average value,Form factor,Sine - curve,electrical degree, phase-in phase,out of phase,inductance,inductive reactance,capacitive reactance,impedance,lagging & leading of current,power factor-its effect&improvement
4.	<ul style="list-style-type: none"> <li>• Study of SQIM parts</li> <li>• Study of SRIM parts</li> <li>• Study of T-N characteristics</li> <li>• Calculating motor regulation</li> </ul>	AC 3 phase motors,principle of operation,Torque-formulaes,types of induction motor,different parts, comparison between SQIM&SRIM, slip,speed control, Torque/speed characteristics,Motor regulation,DOL starter,
5.	<ul style="list-style-type: none"> <li>• Study of different parts of AC single phase motor</li> <li>• Speed control through electrical&amp; electronic regulator</li> <li>• Simulation of faults &amp; their solution.</li> </ul>	AC single phase motor,principle & working,Why not self starting,ceiling fan working,regulating speed through electrical/electronic regulator ,common problems of single phase motor,Other applications.

WEEK NO	PRACTICALS	THEORY
6.	<ul style="list-style-type: none"> <li>• Lab. Exercise on Synchronous motor parts.</li> <li>• Running synchronous motor &amp; calculating motor speed regulation.</li> <li>• Studying effect of excitation</li> <li>• Lab on electrical connection of</li> </ul>	Synchronous motor-construction,parts,Principle of operation,Motor on load,Motor without load,Effect of excitation on power factor,synchronous motor/induction motor comparison, Synchronous motor speed regulation
7.	<ul style="list-style-type: none"> <li>• Study of alternator parts.</li> <li>• Lab on Parallel operation with Synchroscope &amp; lamp load.</li> <li>• Study of DC generator parts.</li> <li>• Carbon brush changing/adjusting</li> </ul>	Alternators,speed & frequency,Parallel operation,sharing of load,DC generator-main parts,Different types,principle, characteristics curve,Armature reaction,causes of sparking& method of reducing. Interpoles,Troubleshooting.
8.	<ul style="list-style-type: none"> <li>• Lab on different components of DC motor</li> <li>• Lab on speed control of DC motor.</li> <li>• Lab on Commutator/carbon brush checking .</li> <li>• Lab on carbon brush changing .</li> </ul>	DC Motor-Parts,Different types of DC motor,Application,speed control,characteristics curves,Maintenance,Commutator/carbon brush checking,Common problems of DC motor & troubleshooting
9.	<ul style="list-style-type: none"> <li>• Study of Transformer parts</li> <li>• Lab on transformer inspection</li> <li>• Lab on transformer connections.</li> </ul>	Transformer-Types,Construction/parts,Principles,Transformation ratio,Buchhol's relay,efficiency,cooling,Current transformer,potential transformer,Parallel running of 3 phase transformer,Different transformer connections, Transformer inspection,Maintenance,troubleshooting.
10.	<ul style="list-style-type: none"> <li>• Lab on House Wiring</li> <li>• Different types of wiring exercises.</li> <li>• Study of different Automobile electrical circuits learnt during theory session</li> <li>• Troubleshooting</li> </ul>	House wiring-Wiring system,Types of wiring,fuses ISI rules,Megger testing,Automobile electric circuits-Lighting circuits,Battery charging circuits,Ignition system,Starting circuit,

WEEK NO	PRACTICALS	THEORY
11-12	<ul style="list-style-type: none"> <li>• Lab study of different type of circuit-breakers.</li> <li>• Lab demo of different type of relays</li> <li>• Setting of relays(Electromagnetic &amp; Electronic relays)</li> </ul>	Switchgear & protection,Different type of circuit-breakers,Bulk oil circuit breakers,MOCB,VCB,SF6 circuit breakers,ACB, Their parts, specifications, Terminologies,Different types of Electromagnetic, Electronic&microprocessor based relays.
13.	<ul style="list-style-type: none"> <li>• Observation of operation ofgenerating station</li> <li>• Visit &amp; study of power station.</li> <li>• Study of power S/S maintenance practices.</li> </ul>	Generation,Transmission & Distribution of electricity,Type of generating station,Types of Power station, Maintenance of power S/S,O/H line system,Underground cable system,Types of cables.
14.	<ul style="list-style-type: none"> <li>• Lab demo of different types of batteries.</li> <li>• Study of battery-charging practices.</li> <li>• Study of S/S battery maintenance.</li> </ul>	Cells & Batteries,Electrolysis,Faradays laws of electrolysis,Electroplating,PD & EMF difference,Secondary cell& primary cell difference,Battery charging fundamentals,Defects in battery:-Sulphation,Buckling of plates,sedimentation,Power S/S battery maintenance.
15.	<ul style="list-style-type: none"> <li>• Study of Winding technology of different electrical equipments.</li> <li>• Hands on exercises on winding of different 1 phase &amp; 3 phase electrical machines</li> <li>• Practice in soldering</li> </ul>	Winding-Winding terms,Type of Winding,Windng material,Lap winding types,Wave winding types,single phase &3 phase winding. Solders,flux & soldering technique
16.	<ul style="list-style-type: none"> <li>• Use,setting &amp; study of all the Electrical &amp;Electronic meters &amp;instruments</li> </ul>	Electrical instruments-Introduction,Types of deflecting type,recording type instruments,Moving coil & moving iron instrument- Construction,working,properties,Connection of voltmeter,Ammeter,wattmeter,Megger,earth tester,Energymeter,Hotwire instruments,frequencymeter,multimeter(Both analog &digital)

WEEK NO	PRACTICALS	THEORY
17.	<ul style="list-style-type: none"> <li>• Study of Refregerator- -electrical circuits</li> <li>• Study of Airconditioner electrical circuits.</li> <li>• Maintenance practices &amp; troubleshooting.</li> </ul>	Refregeration & Airconditoning- Principles, Vapour compression refrigeration cycle, Electrical circuit of refrigerator, Thermostat & its working, Common faults in refrigerator & remedies. Air conditioning, electrical circuit of Air conditioner.
18.	<ul style="list-style-type: none"> <li>• Connection of motor &amp; electrical control circuit for different system.</li> <li>• Study of lift electrical circuits.</li> <li>• Maintenance &amp; troubleshooting.</li> </ul>	Selection of motors, Advantage of electric drive, Motors used for different types of drives, Electric traction system, Lifts .
19.	<ul style="list-style-type: none"> <li>• Lab demo of PPE &amp; proper tools for Safe &amp; quality welding.</li> <li>• Hands on exercise on welding m/c connection.</li> <li>• Hands on exercise on Electric welding.</li> </ul>	Welding- Electric welding, Arc welding, Welding equipment & Accessories, Application of electric arc welding. welding methodology to avoid welding defects. Checks before welding m/c connection.
20.	<ul style="list-style-type: none"> <li>• Study &amp; handson exercise of connection (All the equipments taught in illumination theory.</li> <li>• Study of parts of All the equipments taught in illumination theory.</li> <li>• Maintenance &amp; troubleshooting of all the above equipments.</li> </ul>	Illumination- Incandescent lamp, filament lamp, Arc lamp, HPMV lamp, sodium vapour lamp, Use of choke, starter, Double tube circuit, Study of electric circuit detail of all the above.
21-24	.Theory & practical Exams.	.

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

Sl. No.	Item / Specification	Quantity
1.	Pliers Insulated 200 mm (Taparia) Heavy duty	16
2.	Screw driver 200 mm (Taparia) Insulated	16
3.	Screw driver 150 mm (Taparia)	16
4.	Screw driver 250 mm (Taparia) Heavy-duty insulated	16
5.	Screw driver 300 mm (Taparia) Heavy duty insulated	16
6.	Screw driver Connector 100 mm	16
7.	Scriber 150 mm. (knurled) center position	16
8.	Steel Rule 12"	16
9.	Pincer 6" 150 mm	16
10.	Center punch 150 mm to 10 mm	16
11.	Knit double bale	16
12.	Hammer Cross pain 150 Gram With Handle	16
13.	Neon Tester 500v Heavy duty	16
14.	Tendons 250 mm.	16
15.	Hammer Ball pain 0.75 kg With Handle	16
16.	Firmer Chisel Wood Handle 12 mm	16
17.	Gimlet 6 mm	16
18.	Bradawl square point 150 mm	16
19.	Pliers side Cutting 150 mm (Taparia)	16
20.	Earth Tester With Accessories	1
21.	Bar Magnet complete set	1 set
22.	Oscilloscope current Volt Digital measurement	1
23.	Power Factor meter Single phase Analog type	1
24.	Power Factor meter Single Phase Digital type	1
25.	Power Factor Three Phase Analog type	1
26.	Power factor Three Phase Digital type	1
27.	Spanner 150 mm Adjustable	2
28.	Chisel Cold Flat 12*200 mm	2
29.	Firmer Chisel 25 mm And 6 mm	4

30.	Hand drill M/C ½"	1
31.	Electric Drill M/C portable 6 mm Capacity (Wolf)	1
32.	Electric Drill M/C 12 mm Capacity	1
33.	Allen Key	1 set
34.	Oil Can 0.12 Liter	2
35.	Grease Gun	1
36.	Digital Multimeter Avo	1
37.	Techometer Digital	1
38.	Digital Clamp meter	1
39.	Analog Multimeter Avo	1
40.	Penal Type MI Volt meter 0-500v	1
41.	Penal Type MI Amp Meter 0-5Amp	1
42.	Penal Type MI Amp Meter 0-15Amp	1
43.	Penal Type MI Meter 0-30Amp	1
44.	Penal Type Digital Voltmeter 0-50Amp	1
45.	Penal Type Digital Amp Meter 0-30Amp	1
46.	Frequency Meter Read Type	1
47.	Frequency Meter Digital Type	1
48.	Penal Type M/C Type Voltmeter 0-500v	1
49.	Penal Type M.C Type Amp Meter 0-15 Amp	1
50.	Penal Type M.C Amp Meter 0-5Amp	1
51.	Penal Type M.C Amp Meter 0-25Amp	1
52.	Penal Type M.C Amp Meter Center 5-0-5Amp	1
53.	Standard Variable Resistance As Used In Laboratories (A) 10 ohm 5.2 Amp (B) 50 ohm 4.1 Amp (C) 190 ohm 3.3 Amp (D) 220 ohm 3.7 Amp (E) 300 ohm 2.8 Amp	1 1 1 1 1
54.	Motor Wound Machine Complete Set	1 set
55.	Hack Saw Frame	8
56.	Pliers Flat Nose 150 mm	6
57.	Pliers Round Nose 150 mm	6

58.	Try Square 200 mm	8
59.	Spanner Set D.E Standard Set of 12	2 set
60.	Ring Spanner Standard Set Of 12	2 set
61.	Drill Machine Bit SS Twist 2 mm To 12 mm	1
62.	File flat 250 mm 2 <sup>nd</sup> Cut	8
63.	File Half Round 250 mm 2 <sup>nd</sup> Cut	4
64.	File Round 250 mm 2 <sup>nd</sup> Cut	4
65.	File Flat Rough 250 mm	4
66.	File Flat Bastard 250 mm	4
67.	Soldering Iron 65 Walt	2
68.	Soldering Iron 125 Walt	2
69.	Bench Vice 4” jaw	2
70.	Pipe Vice 4”	2
71.	Conduit Die Set Complete ½ “ 1” 1 ¼ “	1 set
72.	Hydro Meter	2
73.	Cell Tester	1
74.	Magnet Horse Shoe	4
75.	Battery 12 Volt Car Type	1
76.	Battery 6 Volt Car Type	1
77.	Battery Charger Complete Set 6v 12v.	1
78.	Watt Meter 0-2000watt 230v 50c/s	1
79.	Oven Staving	2
80.	Growlers External and Internal	2 set
81.	Energy meter single phase –0 – 10 amps. 230 V A/C	2
82.	Crimping Lug punching machine (Lug) 15 amp, 30 amp, 100 amp, 200 amp and 250 amps	1 set
83.	Wire stripper 20 cm.	2 Nos.
84.	Electric Hot plate 1500 watt, 230 V with Temperature control	2 Nos.
85.	Electric kettle 1000 watt 230 V	2
86.	Electric Iron 750 watt 230 Volt with temperature control	2
87.	Immersion heater 1000 watt with thermostat switch and temperature control	2

88.	Tapes and die 6 – 12 mm	1 set
89.	Safety belt with tool kits arrangement	05
90.	Rubber hand glove 500 V Heavy duty	2 pair
91.	Out side micrometer 0 – 25 mm	1
92.	Bench grinder motories	1
93.	Rowel plug tools and bit 10 No and 12 No.	2 set each
94.	Pulley puller	1
95.	Bearing puller	1
96.	Leader	2
97.	Blow lamp ½ liter	2
98.	C clamp 200 mm, 150 mm	2
99.	Tape measuring 3 meter	2
100.	Stop watch	1
101.	Scissors bled 150 mm	4
102.	Snip straight 150 mm	2
103.	Snip bend 150 mm	2
104.	Gauge wire imperial	2
105.	Tweezers 150 mm	4
106.	Locker with 18 drawers standard size	2
107.	Bench working 8'× 4'× 2.5'	4
108.	Steel Almirah 6'× 3' × 1.5	4
109.	Table 4'× 2.5×2.5	1
110.	“S” Type Chair	1
111.	Fire Extiguisher	2
112.	Fire bucket	4
113.	Mattel rack 180 ×150 × 45 cm	2
114.	3 point D.C. starter	1
115.	4 point D.C. starter	1
116.	Automatic star delta starter	1
117.	DOL Starter	1
118.	Automatic forwarded and reverse starter	1
119.	Demonstration kit to show the work of motor and generator	1 set

120.	Auto transformer type star delta starter	1
121.	Sheaded pole motor 230 V single phase ¼ Hp 50 C/S 1200 RPM	1
122.	Motor A.C. series type 230 Volt 50 C/S ¼ Hp with starter and switch controlling	1
123.	4 point flasher switches running with eddy current motors	1
124.	Magger (Insulation tester) 0 – 100 m/ohm 1000 Volt	1

### List of General Machinery

125.	Motor generator set consisting of motor induction squirrel cage 7 Hp 400 volt 50 C/S 3 phase with star delta starter and switch directly coupled to D.C. shunt generator 5 kw 440 Volt and switch board mounted with regulator air circuit breaker, ampere meter, Volt meter, knife blade switch with case iron plate fixing bolts foundation bolt and flexible coupling.	1
126.	Motor Generator Set Consisting Of Motor Shunt 5H.P 4 40v With Starting Compensator And Switch Directly Coupled To generator A.C 3.5 K.V.A 400/230v 3 phase 4 Wire 0.8 P.F 50 Cycles With Exiter And Switch Board Mounted With Regulator Circuit Breaker Am Meter, Volt Meter Frequency meter knife Blade Switch And HRC Fuse etc Set Complete With Case Iron Bed Plate Fixing Bolt Foundation Bolt And Flexible Coupling	1 Set
127.	Motor Series D.C 220v. 0.5 To 2 Hp	1 No
128.	Motor Shunt D.C 220 V 0.2 To 3 H.P	1 No
129.	Motor Compound D.C. 220v 3 H.P	1 No
130.	A.C 3 phase Squirrel Case Motor 440 v 50 C/s 2 To 3 H.P	1
131.	Metal Rectifier 10 Amps Silicon Rectifier 10 Amp	1 etch
132.	A.C Motor 3 phase Wound Slip ring Type 5H p 440 V 3 phase 50C/S With Starter And Switch	1
133.	Motor A.C Synchronous Motor Smallest Unit Available With Starter	1
134.	Alternator Suitable For Available Complete Set	1

135.	A.C Single phase Motor 230V 1H P Repulsion Type Complete With Starter With Switch	1
136.	A.C single Phase Motor 230V 50 C/S Capacitor Type With Starter And Switch 1 H P	1
137.	Transformer single phase 3 KVA 230V /115V 50C/S core Type Are Cooled With Taping For Secondary Connection	2
138.	Transformer 5KVA 400 /230V 50C/S Delta Star Shell Type Oil Cooled	1
139.	Current Transformer	1
140.	Potential Transformer	1
141.	Used DC Generator Series Shunt Compound Type For Over Hauling Practice	1 each
142.	D.C Shunt Generator 2.5 KW 230V With Control penal	1
143.	D.C Compound Generator 2.5 KW 250V With Control Penal Including Field Rheostat Voltmeter Amp meter And Circuit Breaker	1
144.	Variable Auto Transformer 0-250 V 5Amp	4
145.	Diesel Generator 5KVA With Change Over Switch current Circuit Breaker Water Cooled With Armature Star Delta Connection	1 set
146.	Oscilloscope	1
147.	Function Generator	1
148.	Oil Testing Kit	1
149.	Flux meter	1
150.	Stepper motor	1
151.	Phase sequence Indicate Motor	1
152.	OCB 5KVA	1
153.	MCB 5 KVA	1
154.	Earth Leakage CKT.Breaker	1
155.	Variable auto transformer 0 – 250 Volt 5 amp	1

**Objective: After successful completion of this programme, students will be able to operate and maintain industrial electronic and process control equipment used in process and engineering industries.**

**MODULE : AUTOMATION & PLC**

**DURATION: 24 WEEKS**

<b>WE EK NO.</b>	<b>PRACTICAL</b>	<b>THEORY</b>
<b>1</b>	<ul style="list-style-type: none"> <li>• Demonstration of care and safe working habits, first aid, treatment of electrical sock</li> <li>• Lab demo of . tools and measuring &amp; test instruments related to the trade</li> </ul>	<p>Safety precaution to be observed in the trade during training hours. Electrical safety. Elementary first aid.</p> <p>Earthing- types and importance. ISI rule on earthing. Fuses and its type. Use of personal protective equipment from electrical safety point of view.</p> <p>Identification, specification, uses and maintenance of hand tools and measuring &amp; test instruments</p> <p>Revision of electrical fundamentals, Ohm's law, semiconductor theory, diode and transistor characteristics</p>
<b>2</b>	<ul style="list-style-type: none"> <li>• Verification of network theorem</li> <li>• Study of RLC circuits</li> <li>• Determination of Q factor of a coil</li> </ul>	<p>Circuit theory: Kirchoff's law, superposition theorem, Thevenin &amp; Norton's theory, Star Delta transformation, maximum power transfer theorem (detailed mathematical treatment not required)</p> <p>Series &amp; parallel AC circuits, AC through R,L,C, RC,RL,RLC network, resonance, Q factor of a coil.</p>
<b>3</b>	<p>Demonstration of conventional methods of DC motor speed control</p>	<p>DC motors- principle, types and characteristics .</p> <p>Speed control methods of DC motors – Armature voltage control and Field voltage control. Motor starter circuits.</p> <p>AC Motors -Principle of operation. of 1 phase &amp; 3 phase AC induction motors, types and their characteristics. Starting &amp; Running of AC motors using starters. Reversing of motors.</p> <p>Synchronous Motors- characteristics and their applications.</p>

		Electrical Braking and its types mechanical brakings, Plugging, Rheostatic braking, Regenerative braking etc
4	Demonstration of conventional methods of AC motor speed control	Synchronous Motor and their applications.  Electrical Braking and its types - Mechanical braking, Plugging, Rheostatic braking, Regenerative braking etc
5	Demonstration of physical systems - mechanical, fluid and thermal.	Introduction to control system, basic concept of control, Open loop and close loop control system with examples, concept of linear and non-linear system.  Definition of a physical system- mechanical , electrical , fluid and thermal system with examples (i.e. dash-pot, electrical motor, tank level and flow control, water heating system etc.)  Elementary idea of transfer function, transfer function of above systems. Block diagram representation of above systems.
6	Demonstration of control system components like servo motors, encoders, tacho-genertaors, stepper motors and synchros, flapper nozzle system	Control system components - Feedback control system and controllers. Principle of working , transfer function and application of following components : D.C. servo motor , A.C. servo motor , D.C. and A.C. Tacho-generators, synchros, stepper motor , rotary encoders, servo mechanism, flapper nozzle system. (Detail mathematical treatment not required.)

7	<p>Use of signal and function generators Observation of output waveform of response of simple electrical system after applying test signals.</p> <p>Study of flapper nozzle system.</p>	<p>Time domain analysis of a system :Standard test signals used , concept of impulse response , response of first and second order system to step input ( steady state and transient response ) , steady state error and error , concepts of stability.</p> <p>Concepts of process characteristics- lag, time delay, dead zone etc.</p>
8	<ul style="list-style-type: none"> <li>• Demonstration of modulations and demodulation on training kits.</li> <li>• Demonstration of pulse modulation</li> </ul>	<p>Introduction to communication system and its importance.</p> <p>Analog communication : fundamentals, modulation and demodulation techniques, basic concepts of AM, FM, and PM and its applications.</p> <p>Electromagnetic waves, frequency ranges, speed of transmission, band-width, antenna.</p> <p>Digital communication : principles of digital communication, different types of pulse modulations : PCM, FSK, PSK, ASK etc, multiplexing.</p> <p>Simple concepts of communication (block diagram only): Telephone (fixed and mobile), radio, microwave and LASER, DA and PA system.</p>
9	<ul style="list-style-type: none"> <li>• Demo of fibre optic system.</li> <li>• Demonstration of serial &amp; parallel communication techniques.</li> </ul>	<p>Fibre optical communication - principles, methods and application.</p> <p>Satellite communication- methods and applications.</p> <p>Data communication: Simplex and duplex modes, serial &amp; parallel communication, modems</p> <p>Serial communication standards : RS-232, RS-422, RS-485 standards.</p> <p>Networking principles and topology, Local area network standards</p>

<p>10</p>	<ul style="list-style-type: none"> <li>• Observation of different types of power electronic components</li> <li>• Thyristor characteristics.</li> <li>• Firing of thyristor : resistance, RC, UJT &amp; logic gates</li> <li>• Commutation of thyristor : natural, line and forced.</li> <li>• Checking of power MOSFET, thyristors, IGBT, GTO, IGCT</li> </ul>	<p><b>Power electronics</b> :Introduction to power electronic devices: Thyristor, its construction, characteristics and family (DIAC, TRIAC, SBS, SUS)</p> <p>Turn “ON” &amp; turn “OFF” behavior of thyristor.</p> <p>Firing &amp; commutation circuits, role of snubber circuit.</p> <p>Rating &amp; protection of thyristor.</p> <p>Power diodes and power BJT, power MOSFET, IGBT, GTO, IGCT and their application</p>
<p>11</p>	<p>Study of converter : half wave, full wave, half wave controlled, Chopper, Inverter.</p>	<p>Thyristor circuits :</p> <ol style="list-style-type: none"> <li>a) Converter</li> <li>b) Regulator (AC)</li> <li>c) Chopper</li> <li>d) Inverter</li> <li>e) IGBT circuit, its use in converter, inverter and UPS</li> </ol>
<p>12</p>	<ul style="list-style-type: none"> <li>• Understanding parameters of DC drives</li> <li>• Checking of firing pulses in a digital drive</li> </ul>	<p>Electric Drive : Classification of load and motor according to their speed/torque characteristics and drive performance characteristics. Behavior of drive system during change of state.</p> <p>Modern drive system : concept of open &amp; closed loop system DC drive : single &amp; four quadrant control.</p>

13	<ul style="list-style-type: none"> <li>• Understanding parameters of AC drives</li> <li>• Checking of firing pulses in a digital drive</li> <li>• Understanding of UPS working</li> </ul>	<p>AC drive : stator V/f, rotor resistance &amp; voltage.</p> <p>Basic concepts of digital drives.</p> <p>Understanding of float charger, off-line UPS and On-line redundant UPS, circuit and maintenance of UPS.</p>
14	<ul style="list-style-type: none"> <li>• Identify simple components such as reservoir, filter pumps, valves, actuators etc.</li> <li>• Operation of proportional and servo valves, functions of control and feedback components</li> </ul>	<p>Fluid power :</p> <p>Basic principles of hydraulic and pneumatics, characteristic of fluid media</p> <p>Operational details of fluid power control element. (Constructional details not required)</p> <p>Energy converter, Fluid conditioner, Control valves</p> <p>Symbols of basic hydraulic and pneumatic components.</p> <p>Basics of proportional and servo valves, its electrical and electronic circuitry, control and feedback systems</p>
15	<ul style="list-style-type: none"> <li>• Simulation of simple hydraulic circuits.</li> <li>• Simulation of simple pneumatic circuits</li> </ul>	<p>Concepts of interfacing of hydraulic &amp; pneumatic components with controllers</p> <p>Hydraulic and pneumatic circuits, reading and interpretation.</p> <p>Specifications of components and safety aspects</p>

WEEK NO.	PRACTICAL	THEORY
16	<p style="text-align: center;"><b><u>Process control</u></b></p> <ul style="list-style-type: none"> <li>• Operation of a controller, setting of its PID values, controller tuning.</li> <li>• Fault finding and trouble shooting exercises on simulators.</li> </ul>	<p style="text-align: center;"><b>Process control automation</b></p> <p>Introduction to process control, process variables, manual &amp; automatic control system close loop &amp; open loop process control systems, process disturbances, process dynamics. P, D &amp; I control modes. Tuning of a controller.</p>
17	<p style="text-align: center;">Overhauling and calibration of control valves, valve positioners and I/P converters.</p>	<p style="text-align: center;">Final control elements: I/P converters: types, working principle, construction, calibration and maintenance. Control valves &amp; actuators : types, working principle, construction, characteristic, calibration and maintenance. Selection and sizing of a control valve. Valve positioner: : types, working principle, construction, calibration and maintenance</p>
18	<ul style="list-style-type: none"> <li>• Familiarization with different I/O modules of PLC.</li> <li>• Development of simple programmes involving bit level instructions, timers and counters, simple</li> <li>• Data manipulation instructions.</li> <li>•</li> </ul>	<p>Introduction to PLC, its hardware details. Function and working of different cards.</p> <p>Program techniques of PLC, inputs, outputs, timer and counter instructions, data manipulation</p> <p>Development of simple programs</p> <p>Documentation, different functional blocks &amp; mathematical</p>

		instructions
19	<ul style="list-style-type: none"> <li>• Feeding and running the programmes in PLC, I/O forcing</li> <li>• Documentation and editing of programmes.</li> <li>• Simple fault finding and trouble shooting</li> </ul>	<p>DCS: basic concepts, advantages. Architecture of typical DCS, function of different nodes and modules, Programming concepts, applications.</p> <p>Industrial weighing system-components and applications. Static and dynamic weighing systems.</p>
20	<ul style="list-style-type: none"> <li>• Demonstration of SCADA system, communication system used in networking of PLC.</li> <li>• Reading &amp; interpretation of P&amp; I diagrams.</li> <li>• Exercise on instrument fault finding and trouble shooting.</li> </ul>	<p>DAS and SCADA, Introduction to MMI packages, applications. Reading and interpretation of PI diagrams, instrument manuals and part list, panel wiring diagram etc.</p> <p>Instrument cabling, relays, terminals, fuse terminals, junction boxes, MCBs, cable gland, pipe and its colour code, air filter regulators.</p> <p>Basic concepts of FIELDBUS, its types and applications area..</p> <p>Earthing and grounding of instruments and its importance.</p>

<b>WEEK NO.</b>	<b>PRACTICAL</b>	<b>THEORY</b>
21	Plant visits	<p>Industrial control application:</p> <p>Cement plant- Process overview, major units, automation strategies, mill automation, kiln automation, dispatch automation, levels of automation, case studies of automation used in major cement plants.</p> <p>Thermal power plants- process overview, major units and process variable, automation strategies, boiler control and automation, turbine control and automation, fuel and its control, levels of automation, case studies.</p>
22	Plant visits	<p>Steel plants- Different zones - iron, steel and mills, process overview of different zones and its control, case studies.</p> <p>Process and automation system used in industries located near the institute may also be covered.</p>
22-24		Project, Revision & Examination

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

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	8
9. Function generator	2
10. Signal generator	2
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. Digital storage Oscilloscope, 100 MHz, with probe	02
18. Analog communication training kits	04
19. Digital communication training kits	04
20. Fibre optics training kits	02

21. Serial communication training kits	04
22. LAN trainers	02
23. Power electronics training kit	08
24. DC Drive with motor and braking arrangement	02
25. AC Drive with motor and braking arrangement	02
26. IGBT trainers	02
27. Proportional Hydraulic trainer	02

28. Servo Hydraulic trainer	02
29. Synchros	02
30. Rotary encoder	02
31. Personal computer with latest configuration with printer	04
32. Pneumatic trainer	02
33. PID controller training kits	01
34. PLC training kits with industrial PLC, programming terminals	02
35. SCADA trainer	02
36. Process control trainer (Feedback make)	02

**ADVANCE MODULE -: MECHANICAL MAINTENANCE FOR AUTOMATION  
DURATION: 24 WEEKS**

<b>WEEK No.</b>	<b>PRACTICAL</b>	<b>THEORY</b>
1	<p>(1) Measuring practice from Outside caliper, inside caliper and steel rule</p> <p>(2) Measuring and checking components with Outside micrometer, inside micrometer, vernier caliper, Depth micrometer, Vernier height gauge, bevel protector, etc.</p> <p>(3) Use of feeler gauge in checking gaps between coupling, bearing and shaft, etc. Use of dial test indicator.</p>	<p>Importance of measuring and checking components precisely,</p> <p>Least count calculation for micrometer, vernier caliper, bevel angle protector, etc. and their specific applications. Effect of zero error and their rectification.</p> <p>Use of feeler gauge, screw gauge, dial test indicator, telescopic gauge, outside caliper, inside caliper, divider, odd leg caliper, etc.</p>
2	<p>(1) Checking of accuracy and trueness of spirit Level.</p> <p>(2) Checking and correcting leveling of machine Beds by using proper shim thickness.</p>	<p>Introduction: Leveling and its importance, Different methods for leveling, Different instruments used for leveling,</p> <p>Construction and working principle of spirit level, Accuracy and trueness checking of spirit level, Different pre-checks and related formula to calculate shim thickness while using spirit level.</p> <p>Method of leveling a machine bed with spirit level, its advantages and limitations.</p> <p>Construction and working principle of water level, method of its calibration and leveling a machine bed using water level, their advantages and limitation.</p> <p>Different safety precautions observed.</p>
3	<p>(3) Checking and correcting leveling of machine Beds by using proper shim thickness.</p> <p>(1) Calibration of water level and using it for Leveling machine bed.</p>	<p>Construction and working principle of water level, method of its calibration and leveling a machine bed using water level, their advantages and limitation.</p> <p>Different safety precautions observed.</p>
4	<p>(1) Identifying different types of misalignment</p>	<p>Introduction: Define coupling alignment, its types, Different sources of misalignment and</p>

	Between two couplings.	their ill effects on machines. Different instruments used for aligning a coupling,
5	(2) Observation of different pre-checks, etc.  (1) Aligning an electric motor with a gearbox or Pump. Calculating shim thickness by actual Observation	Methods of aligning coupling with the help of dial test indicator and feeler gauge/taper gauge method. Different formulae used for calculating shim thickness while alignment. Different pre-checks, advantages and limitations of this method.  Different safety precautions observed.
6	(1) Checking plumbing a vertical pole with plumb Bob method	Introduction: Definition of plumbing, its advantages. Different instruments used for plumbing.  Method of plumbing a vertical pole with plumb bob and spirit level.  Method of plumbing a chimney by Wye level and theologize
7	(1) Balancing an impeller with static balancing Method	Introduction: Define balancing, different sources of unbalancing and its ill effects. Its different types.  Method of balancing, Static balancing and dynamic balancing, Methods of adding and removing material from the rotor.
8	(1) Checking of different holes and shafts and Knowing their allowances and fits	Definition for limit, fit and tolerances, different types of tolerances, allowances, types of fits, their examples, ISO system for fits and tolerances, Hole basis and Shaft Basis, etc.
9	(1) Identification of different types of shafts, Couplings, clutches, keys and cotters, etc.  (2) Mounting and dismounting of coupling on shaft By various methods,	Definition of drives, its types, their specific advantages and limitations.  Different types of shafts, keys, cotters, couplings, clutches, etc. Difference between coupling and clutch, keys and cotter, shaft, axle and spindle.  Mounting of coupling on shaft along with key with proper checking of fit between them. Dismounting of coupling from shaft.
10	(1) Identification of different types of belts and Pulleys.  (2) Calculating of belt length for open and cross Belting,	Definition for belt drive, its different types and specific application,  Different methods of belt jointing, Calculation for belt length for open belt and cross belt,  Identification of vee belt according to its length,

	<p>(3) Verifying Vee belt length and its cross section,</p> <p>(4) Checking belt tension and alignment between Two pulleys,</p>	<p>cross section, matching, etc. Difference between flat belt and Vee belt. Tension checking of belt,</p> <p>Different types of pulleys, etc.</p>
11	<p>(1) Checking of meshing of two spur gears.</p> <p>(2) Checking and correcting alignment of worm Shaft and worm wheel by keeping bearing Clearance correct,</p>	<p>Advantages of gear drives, different types of gears and their specific applications, Gear nomenclature and different related formulae, Condition for meshing of two spur gears, Alignment of worm and worm wheel.</p>
12	<p>(1) Overhauling of a gearbox. Making daily Inspection schedule, etc.</p>	<p>Different types of gear boxes, its applications, its overhauling process, routing maintenance and inspection</p>
13	<p>(1) Physical identification of different types of Sliding contact and rolling contact bearing.</p>	<p>Definition of bearing, Its advantages and types, Selection criteria of bearing. Different bearing materials and their characteristics</p>
14	<p>(1) Mounting of solid bush bearing and split type Bush bearing on shaft and in the housing Measuring and adjusting bearing clearance</p>	<p>Types of Sliding contact bearing, , Mounting of a bush bearing and split bush bearing on the shaft and housing, Process of measuring bearing clearance.</p>
15	<p>(3) Identification of ISO bearing codes for rolling Contact bearing</p> <p>(1) Mounting and dismounting of deep groove ball Bearing on shaft. Measuring clearance of Bearing</p>	<p>Types of rolling contact bearing, its different parts, materials used and its application, ISO nomenclature for bearing identification, Mounting and dismounting of rolling contact bearing, Checking of bearing clearance.</p>
16	<p>(1) Mounting of a taper roller bearing in Face to Face assembly, in back to back assembly, Checking and adjustment of axial play of the Bearing</p>	<p>Importance of mounting taper roller bearing face to face and back to back assembly, Mounting of taper roller bearing on shaft and housing in Face to face assembly and back to back assembly. Checking and adjusting axial play of the bearing.</p>
17	<p>(1) Observation of different</p>	<p>Definition for lubrication, their different</p>

	methods of oil and Grease lubrication system,	advantages, different types of lubricants, Properties of oil, Properties of greases, Methods of checking different properties of oil and grease,  Different methods of oil lubrication, Once through oiling, reservoir method, centralize system, mist lubrication, etc,
18	(2) Overhauling of a gear pump, grease gun, DM Valve, Farval pump, etc.  (3) Identification of different warning and protect Devices, different settings,	Different methods of grease lubrication, by hand, by grease cup and grease gun, centralize system, one line method, two lines methods, multiple lines methods, etc,  Different warning and protective devices used in lubrication system
19	Hands-on practice on different types of hydraulics and pneumatics circuits.	<b>Revision</b> on Hydraulics and pneumatics, principles, different components used in hydraulics and pneumatics, different valves and actuators, circuit design, etc.
20	Hands-on practice on mounting and dismounting of coupling, bearings, etc. from shaft.  Gear meshing, Checking of bearing clearance, etc.	<b>Revision</b> on mechanical drives, shafts, couplings, gear and gearboxes, bearing, their mounting and dismounting, lubrication system, etc.
21-22		Project, Industrial visit
23-24		Revision and Exam

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

Sl. No.	Item / Specification	Quantity
1	Rule steel 30 cm to read metric	4
2	Rule steel 60 cm	4
3	Straight edge 45 cm Steel.	2
4	Flate surface 45 cm × 45 cm.	2
5	Marking table 91×91×122 cm.	1
6	Universal scribing block 22 cm.	2
7	Block-vee pair 7 cm and 15 cm. with clamps.	2
8	Square adjustable 15 cm blade.	2
9	Angle plate 10×20 cm.	2

10	Level spirit 15 cm set.	1
11	Punch Hollow 6 mm to 19 set of 5.	2
12	Punch round 3 mm ×4 mm set of 2.	2
13	Portable hend drill (Electric) 0 to 6 mm.	2
14	Drill brace hand 0 to 12 mm.	2
15	Drill twist S/S 1.5 to 12 mm by 0.4 mm	1 set
16	Drill twist S/S 8mm to 15mm by 1/2 mm.	1 set
17	Brace ratchet with pillar.	1
18	Taps and dies complete set in box B.A.	1
19	Taps and dies complete set in box B.S.F.	1
20	Taps and dies complete set in box Whit –Worth.	1
21	Taps, dies complete set in box American	1
22	Taps and dies complete set in box (Metric)	1
23	File warding 15 cm smooth.	4
24	File knife-edge 15 cm smooth.	4
25	File cut saw 15 cm smooth.	4
26	File featheredge 15 cm smooth.	4
27	File triangular 15 cm smooth.	2
28	File round 20 cm second cut.	8
29	File square 15 cm second cut.	4
30	File square 25 cm second cut.	4
31	Feeler gauge 10 blades.	1 set
32	File triangular 20 cm second cut.	8
33	File flat 30 cm second cut.	8
34	File flat 20 cm bastard.	8
35	File flat 30 cm bastard.	8
36.	File Swiss type needle set of 12.	2 Sets
37.	File half round 25 cm second cut.	8
38.	File half round 25 cm bastard.	4
39.	File round 30 cm bastard.	4
40.	File hand 15 cm second cut.	8
41.	Card file.	8

42.	Stone oil 15 cm × 5 cm × 2.5 cm.	4
43.	Stone carborandum 15 cm × 5 cm × 5 cm × 4 cm.	2
44.	Can oil 0.25 litres.	2
45.	Plier combination 15 cm.	2
46.	Iron soldering 350 gm.	2
47.	Lamp blow 0.55 litres.	2
48.	Spanner whit –worth D.E.6 mm. To 25 mm set of.	8
49.	Spanner adjustable 15 cm.	2
50.	Interchangeable ratchet socket set with a 12 mm driver socket range 4 mm set of 8.	1 set
51.	“Apollo” box spanner set in mm 3×4, 6×7, 9×11, 12×14, 15×19, 22×25, set of 6.	1 set
52.	Glass magnifying 7 cm.	2
53.	Clamp toolmaker 5 cm and 7.5 cm set of 2.	2
54.	Clamp “C” 5 cm.	2
55.	Clamp “C” 10 cm.	2
56.	Reamer adjustable max. 9 mm, 12 mm, 19 mm set of 3.	1 set
57.	Reamer taper 4 mm to 9 mm set of 4.	1
58.	Reamer parallel 16 mm to 12 mm set of 5.	1
59.	Scraper flat 15 cm.	8
60.	Scraper 3 corner 15 cm.	8
61.	Scraper half round 15 cm.	8
61.	Chisel cold 9 mm cross cut 9 mm diamond.	8 Each
62.	Chisel cold 9 mm flat.	8
63.	Chisel cold 9 mm round noze.	8
64.	Extractor stud EZY-out.	2
65.	Set combination 30 cm.	2
66.	Micrometer 0-2.5 cm out side.	3
67.	Micrometer 25-50 mm outside.	3
68.	Micrometer 0-25 mm out side.	4
69.	Micrometer 50-75 mm outside.	2
70.	Micrometer inside 25 mm to 50 mm with extension rods.	1

71.	Vernier caliper 20 cm.	1
72.	Vernier height gauge 30 cm.	1
73.	Vernier bevel protractor.	1
74.	Screw pitch gauge.	1
75.	Wire gauge, metric standard.	
76.	Drill twist T/S 6 mm to 25 mm × 1.5 mm.	1 set
77.	Drill chuck 12 mm.	1
78.	Pipe wrench 40 cm.	1
79.	Pipe wrench 30 cm.	1
80.	Pipe vice No. 4.	2
81.	Adjustable pipe die 0-205 cm cap.	1
82.	Wheel dresser (One for 4 units).	1
83.	Machine vice 10 cm.	1
84.	Machine vice 15 cm.	1
85.	Sleeve drill morse 0-1,1-2,2-3,	1 set
86.	Vice bench 12 cm jaw.	2
87.	Fire extinguisher (for 4 Units).	2
88.	Fire buckets.	2
89.	Machines vice.	2
90.	Wing compass 25.4 cm or 30 cm.	2
91.	Hand hammer 1 kg. With handle.	2
92.	Anvil 50 kg.	1
93.	Anvil Stand.	1
94.	Shovel.	2
95.	Quenching tank.	1
96.	Leather apron.	2
97.	Mallet.	2
98.	Snips straight 25 cm.	2
99.	Drilling machine pillar sensitive 0-20 mm cap with swivel table motorized with chuck & key.	1
100.	Forge portable hand blower 38 cm to 45 cm.	1
101.	Grinding machine (General purpose) D.E. pedestal with 20 cm dia.	1

	Wheels rough and smooth with twist drill grinding attachment.	
102.	Gauge slip as Johnson metric set.	1 set
104.	Gauge snap go and no go 25 to 50 mm by 5 mm.	1 set
105.	Gauge telescopic.	1
106.	Dial test indicator.01 mm on stand.	1
107.	Sine bar 125 mm.	1
108.	Sine bar 250 mm.	1
109.	Lathe tools H.S.S tipped set	2
110.	Lathe tools bit 6 mm × 75 mm.	12
111.	Lathe tools bit 7 mm × 75 mm.	12
112.	Lathe tools bit 9 mm × 85 mm.	12
113.	Arm strong type tool bit holder L.H.	2
114.	Arm strong type tool bit holder straight.	2
115.	Pipe cutter 6 mm to 50 mm wheel type.	1
116.	Pipe face to grip pipe up to 50 mm.	2
117.	Pipe stock and dies complete with stocks, bushing, bushing holders, tap and tap wrenches sizes covered 6mm, 9 mm, 12 mm, 19 mm, 25 mm, 32 mm, 38 mm, 50 mm.	1 set
118.	Pipe bender spool type with stand manually operated.	1
119.	Adjustable spanner 38 cm long.	1
120.	Dial vernier caliper 0-130 mm L.C.O 0.05 mm (Universal Type).	1
121.	Screw thread micrometer with interchangeable 0.4-1.75 mm. Pitch anvils for checking metric threads 60.	1
122.	Depth micrometer 0-100 mm 0.01 mm.	1
123.	Vernier caliper with thumb block 0-130 mm L.C.O.0.2 mm.	1
124.	Comparator stands with dial indicator.	1
125.	Engineer's try square (Knife –wedge).	1
126.	Surface roughness comparison plates "Ruberts".	1 set